Asian Development Bank

RESILIENCE DIVIDENDS OF COMMUNITY-LEVEL INTERVENTIONS: EVIDENCE FROM MYANMAR

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Submitted by Itad in association with GY Associates

Results in development

Acknowledgements

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Executive Summary

Context

There is growing international interest in resilience dividends: the net return for individuals, communities or organisations investing to better respond to climate shocks and stresses. However, there are relatively few examples of community driven development (CDD) – interventions planned with and prioritised by the community - that serve to illustrate these types of resilience dividend. We have found none for Myanmar. This report was undertaken for the Asian Development Bank (ADB) and is the result of cost-benefit analyses conducted in three DFID BRACED programme case study communities.

The three case studies are drawn from the BRACED Myanmar Alliance project, one of the DFID-funded initiatives evaluated by Itad as part of the BRACED programme. Interventions under this project include community planned infrastructure, livelihood capacity building and training for disaster response to strengthen resilience to climate shocks. Although the focus is on building resilience, the aim is to use a *CDD type approach* so that communities select resilience interventions that prioritise vulnerable groups and have wide reaching benefits to communities. All three case study communities have previously experienced annual flooding.

Our approach

For this study, we are concerned with identifying economic returns from reduced losses and with development co-benefits. To do this, we undertake the following three steps:

1. Identifying climate shocks and stresses

We carry out participatory impact assessment of the main climate shocks and the effects experienced by community members. Focus groups are undertaken with affected sections of the community. This evidence is then triangulated with key informant interviews and where possible, baseline survey data is collected as part of the BRACED impact evaluation.

2. Participatory assessment of project interventions, emerging and expected impact

In order to improve confidence in estimates of what has changed, *we compare multiple sources of evidence* and investigate discrepancies, e.g. we ask members of pig breeding groups about changes to livelihoods *and* triangulate responses with other local key informants (e.g. village leaders).

The *process of attributing changes to project interventions is very important*. We aim to identify what would happen in the absence of the project, however, the way of doing this depends on the intervention in question. In order to isolate project-specific effects, we have to compare changes in case study sites **prior** to the project and **after** the intervention with neighbouring control sites over the same period.

Community priorities for infrastructure investments give *their* implicit estimate of the type of risks faced. Hence, two of the case studies are driven by infrastructure interventions to mitigate regular annual flooding whereas only one community is preoccupied by infrastructure to reduce the impact of a catastrophic flooding event.

3. Quantifying economic costs and benefits

Project costs were provided by implementing partners with community contributions valued either at market value or at local wage rates. Where government provided machinery, capital costs and implied usage costs were estimated from the literature. Each case study site was allocated a share of programme management costs.

We identify financial benefits using focus group discussions and key informant interviews and triangulate these with figures from the literature.

All the interventions produce benefits over a number of years. We have evidence on costs and benefits over a year or two at the most, which we need to turn into an estimate over 10 years to generate an estimate of costs and benefits that are due to the project. We use evidence from local implementing partners and the communities themselves to estimate maintenance costs. Benefit and cost streams are discounted back to values at the start of the programme with a conservative discount rate of 12%. We also conducted sensitivity tests at 9% and 6%.

To estimate the benefits and costs for a project providing microfinance and piglets after the project ends, we estimate production models using data from key informants and communities that is checked against international literature.

Some (but not most) project benefits depend on avoiding deaths previously caused by flooding. We estimate the value of a statistical life using published estimates for Thailand and adjust these for GDP differences in line with international evidence.

Key results and conclusions

In all the case studies, estimated economic benefits over a 10-year period (typically based on 12-18 months of post intervention data) are significantly greater than estimated costs over this period. The ratio of discounted benefits to costs varies from 2.4 to 11. Very similar results are obtained with lower discount rates (e.g. 6%).

The highest returns are from relatively small-scale infrastructure investments planned with communities and local government, drawing on BRACED finance with community contributions of labour. Microfinance and pig breeding interventions have generated positive net financial returns for the households involved. This contribution to improved livelihoods has been seen within 12-18 months of the interventions, however, we will only know whether the additional capacity to absorb and adapt to shocks and stresses translates into increases in perceived resilience when the end of programme evaluation is undertaken.

The types of investment prioritised by the case study communities reflect their implicit estimate of the type of risks faced. Hence, two of the three case studies are driven by infrastructure interventions to mitigate regular annual flooding whereas one community is preoccupied by infrastructure to reduce the impact of a catastrophic flooding event. In all cases though, BRACED has supplemented this by work on community capacity building to use early warning information and improve response to disasters. Participation by community members in this type of capacity building is seen as a 'fair exchange' for the CDD infrastructure offered by the programme.

In one case, the value of the community's highest priority intervention (a new, elevated cyclone shelter) depends on avoiding loss of life from a devastating cyclone. Our analysis of a cyclone shelter construction generates an estimated benefit:cost (B:C) ratio of 4.5 (similar to the flood prevention interventions for other case studies). The community ranking of the second most important investment – rain water harvesting – is also the second-best option in economic terms (B:C ratio of 2.9), however, it is more likely to be built as it fits within the project budget.

The high economic returns we find for resilience-building infrastructure proposed by the community indicate that this particular community resilience planning process can effectively articulate the value of avoiding losses relative to costs for this type of infrastructure *without* an explicit cost-benefit analysis. Our findings suggest that this community planning process may have value for broader community development action planning for three reasons:

1. The community planning process was effective in generating costed and prioritised local infrastructure proposals that addressed the most vulnerable groups and produced benefits to the community as a whole;
2. The action plan generated from this process has to be sent to the appropriate authorities to facilitate linkages with existing local development planning; and
3. The resilience planning process in these case studies has combined climate resilience and broader livelihood development interventions. These community resilience planning guidelines will need modification for use in broader community development planning but offer a good way of systematically encouraging mainstreaming of climate resilience into the community development planning process.

It is important to note that the fact that these results were obtained in this context does not mean they will hold in other contexts. Specifically, in this case, the community planning process has been facilitated by experienced international NGOs that have established relationships in their local areas of operation. If there is interest in using this planning process more widely, it will be important to test whether and how the quality of community consultation and planning can be maintained in areas without these established relationships. The quality of project implementation also determines whether similar results could be obtained elsewhere, even in Myanmar.

For example, most infrastructure investments we have considered require community maintenance. The evidence suggests this is occurring because the targeted community sees clear benefits from the intervention *and* the CDD process has involved the relevant local institutions that have a role in organising community labour for maintenance.

Our approach to estimating costs and benefits of CDD type resilience building interventions can be used more widely. We have made considerable efforts to cross-check data generated from participatory discussions both with other local sources and evidence from the international literature. Nonetheless, there are some caveats to bear in mind:

1. One to two years after project investments, most resilience dividends are in terms of avoided losses, with some development co-benefits. We have yet to document changes in economic activity that take advantage of reduced annual flood risks;
2. The project interventions in these case studies have been relatively easy to quantify and have not targeted, for example, eco-system services; and
3. Participatory methods are a good source of evidence for the difference that project interventions have made. Uncertainty over our estimates depends mainly on whether past experience will be a good guide to the future. It is recognised by making conservative assumptions on future costs for maintenance, pig breeding or microfinance returns and repayment.

These case studies indicate that CDD interventions in Myanmar to build resilience involving community-planned and prioritised infrastructure can produce economic benefits that significantly exceed costs. Going forward, government and development partners planning should take this into account.

1. Introduction

There is growing international interest in resilience dividends: the net return for individuals, communities or organisations investing to better respond to climate shocks and stresses. Rodin (2014) illustrates the concept in broad terms with stories from around the world and Tanner et al. (2015) specify three types of dividend from disaster risk management (DRM) investments. However, there are relatively few examples of community driven development (CDD[1]) – interventions planned with and prioritised by the community and which have factored in climate shocks and stresses-related considerations - that serve to illustrate these types of dividend and none for Myanmar.

The UK Department for International Development (DFID) supported BRACED programme[2] is funding grants in 12 countries to build resilience to climate shocks and stresses. In Myanmar, project communities are supported by the BRACED Myanmar Alliance[3] to identify their own disaster risk and climate change adaptation priorities and plan interventions, with some funding from BRACED. Community assessment of climate shocks and stresses followed by action planning is central to identifying and developing BRACED Myanmar programme interventions. The four steps involved in this process are set out in Box 1.

Although the focus is on building resilience, the aim is to use a *CDD approach* so that communities select resilience interventions that prioritise vulnerable groups and have wide reaching benefits to communities. This provides a good potential source of evidence on CDD type of interventions to build resilience to climate shocks and stresses.

As part of the BRACED work, we piloted estimating the costs and benefits of interventions to build climate resilience in one community[4]. Following discussions with the BRACED Myanmar Alliance project team, we were invited by the Asian Development Bank (ADB) to expand this pilot to multiple case study communities and this report presents the results of that exercise.

In Section 2, we briefly set out the theoretical model we use (with further detail provided in Annex 1). In Section 3, we present the findings for each of the three case study sites. We then draw together some conclusions in Section 4.

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[1] Community Driven Development (CDD) is an approach that gives control over planning decisions and investment resources for local development projects to community groups. It targets community-based organizations (CBO) or representative local governments as beneficiary or grantee, allowing them greater roles in planning, design and execution of development projects through supply of inputs, labour, funds or management of contractors or operation and maintenance. A key element of CDD approaches is the provision of resources, usually in block grants, directly to communities to implement development programs or projects. It's defining characteristics are:

- Community control of resources
- Direct flow of fund, usually from the treasure direct to community accounts
- High degree of community facilitation, participation and inclusion
- Community managed (including community provided labour) subproject execution

[2] BRACED is a programme funded by the UK Department for International Development (DFID) helping people become more resilient to climate extremes in South and Southeast Asia and in the African Sahel and its neighbouring countries. To improve the integration of disaster risk reduction and climate adaptation methods into development approaches, BRACED seeks to influence policies and practices at the local, national and international level. For further information, see www.braced.org

[3] Lead consortium members are Action Aid, Plan International and World Vision.

[4] In the Township of Mawlamyne.

Box 1 - Myanmar BRACED Alliance: Community Resilience Assessment and Action Cycle

The approach taken by the program aims to empower communities to take leadership in determining their own disaster risk and climate change adaptation priorities. To support field staff and local government agencies to assess the resilience of a community in order to define specific interventions that will strengthen resilience, the programme developed a handbook (See http://www.braced.org/resources/i/?id=127f0e24-a44a-4468-abca-96db853f6558 for a full copy).

The BRACED Alliance Community Resilience Action cycle sets out four key steps which are listed below along with some associated example questions and consideration (note that full details can be found in the handbook):

Step 1: Preparation, community outreach and rapid assessment

- Are historical hazards and extreme events, and their impacts, documented and discussed with different stakeholders regularly?
- How does the community monitor hazards?
- Are response options identified by using risk maps?

Step 2: Community resilience assessment: preparation, implementation and analysis

- What are the disaster events that have happened or are happening in the community?
- How did they or do they affect the community?
- Who are the most affected?
- Has the impact always been like this?

Step 3: Resilience action planning, prioritization and screening

- Do interventions prioritise the most vulnerable groups and look at activities that have wide reaching benefits to communities?
- The prioritization process involves a transparent set of discussions that are documented to ensure the final selection can be justified and that the resources that are allocated to these actions are appropriate.
- The screening process requires detailed consideration of the potential harm an action may have on the environment, on gender equality or on conflict
- What needs to be done, by whom and when? What are the available resources and what will be the expected results?

Step 4: Resilience action plan implementation and evaluation

- Has any formal approval process at community level been completed?
- Has the action plan been sent to the appropriate authorities to facilitate linkages with the local development planning process, including Community Driven Development?
- Are beneficiary led feedback mechanisms in place?

2. Quantifying resilience benefits

The BRACED Myanmar community resilience planning handbook[5] clusters resilience interventions (generated by the community planning process above) into three broad categories: Disaster mitigation (e.g. Building cyclone shelters); climate change adaptation (e.g. Flood protection and drainage in urban areas); and resilient infrastructure, basic services and assets (e.g. Improved access to assets and financial services). The aim of an

[5] See here for full details: http://www.braced.org/resources/i/?id=127f0e24-a44a-4468-abca-96db853f6558

intervention is to improve the well-being of community members by enabling a more resilient response to climate shocks and stresses. Our focus is to look specifically at the *economic benefits* of these interventions.

Tanner et al. (2015) have already offered an approach to categorising economic benefits from investments in disaster risk management (DRM) and the categories they use are sufficiently wide for the broader resilience-building interventions we consider. Hence, we look for potential economic benefits in terms of three resilience dividends (RD):

1st Dividend of Resilience (RD 1): **Avoided losses** - Avoiding damages and losses from disasters, by, for example:

- Saving lives and reducing number of people affected
- Reducing damage to infrastructure and other physical assets
- Reducing losses to economic flows

2nd Dividend of Resilience (RD 2): **Unlocking Economic Potential** - Stimulating economic activity due to reduced disaster risk, for example by increasing:

- Business and capital investment opportunities
- Household and agricultural productivity
- Increased land value with protective infrastructure

3rd Dividend of Resilience (RD 3): **Generating Development Co-Benefits** - investments can serve multiple uses which can be captured as co-benefits such as:

- Eco-system services
- Reduction in transmittable disease and other health related outcomes
- Transportation uses
- Agricultural productivity gains

These are broad categories and we use them to capture how interventions reduce the impact of climate shocks and stresses. In practice, we only have evidence on changes resulting from project interventions for a maximum of two years and this leads us to focus on avoided losses (RD1) and development co-benefits (RD3). It is possible that some development co-benefits (increased agricultural production, for example) that we attribute to reduced annual flood risk actually reflects changing farmer behaviour (RD2) but this would only be determined in a longer-term research study.

2.1. Summary of CBA steps

In summary, the methods we use to estimate the various benefits in these categories are:

1. Identifying climate shocks and stresses

Participatory impact assessment of the main climate shocks and the effects experienced by community members e.g. flooding leading to increases in dengue. Focus groups are undertaken with affected sections of the community[6]. This evidence is triangulated with key informant interviews and baseline survey data collected as part of the BRACED impact evaluation[7] where possible. Community assessment of shocks and stresses is based on their experience to date and the data analysis and facilitated discussion used in the community resilience planning process at the start of the project. This incorporates an assessment of annual shocks and stresses and trends as well as the risk of catastrophic events.

[6] Groups are formed by the project depending on types of interventions prioritised by the community. Examples include village savings and loans groups, pig breeding. Focus group discussions are held with 8 – 15 members of these groups, with men and women in separate groups where possible.

[7] See here for details of the baseline studies: http://www.itad.com/reports/laying-foundations-measuring-resilience/

2. Participatory assessment of project interventions, emerging and expected impact

In order to improve confidence in estimates of what has changed, *we compare multiple sources of evidence* and investigate discrepancies, e.g. by asking members of pig breeding groups about changes to livelihoods *and* triangulating responses with other local key informants e.g. village leaders. This follows good practice – Richards et al. (2003), Alexander and Bonino (2014).

The *process of attributing changes to project interventions is very important*. We aim to identify what would happen in the absence of the project, however, the way of doing this depends on the intervention in question. Health impacts such as reduction in number of cases of Dengue fever depend on the weather over the past year as well as project-specific reduction in flooding. In order to isolate project-specific effects, we have to compare changes in case study sites **prior** to the project and **after** the intervention with neighbouring control sites over the same period. Where there has been regular annual flooding with consistent losses over many years, it is much easier to attribute changes brought about by project interventions. Likewise, we can use the observed increase in assets that result from microfinance or other livelihood interventions as these activities did not exist pre-project. However, this latter change only captures general development benefits (RD 3 in the preceding section) from asset building interventions as we will have to wait until the end of the project to identify changes in livelihood outcomes from greater resilience relative to the control group[8]. Our participatory assessment is therefore likely to understate benefits from these types of interventions.

As noted above, community priorities for infrastructure investments are based on their implicit estimates of the type of risks faced (emerging from facilitated community resilience planning). This has led to two of the three case studies that we consider being driven by infrastructure interventions to reduce regular annual flooding risk whereas one community has chosen to prioritise infrastructure to reduce the impact of a catastrophic flooding event.

3. Quantifying economic costs and benefits

Project costs were provided by BRACED project implementing partners with community contributions valued either at market value (e.g. cement) or at local wage rates. Where government provided machinery, capital costs and implied usage costs were estimated from the literature. Each project (case study) site was allocated a share of programme management costs[9].

We identify financial benefits using focus group discussions and key informant interviews and triangulate these with figures from the literature.

All the project interventions that we consider produce benefits over a number of years. We have evidence on costs and benefits over a year or two at the most, however, infrastructure investments are long-lasting and the standard practice is to capture costs and benefits over the life of an asset[10]. At the same time, the further we look into the future, there is increasing uncertainty over future project asset use. We consider a payback period of 10 years, which is at the lower end of the range typically reported, but is likely to be appropriate for smaller-scale community infrastructure investments in developing countries[11]. We use evidence from local implementing partners and the communities themselves to estimate maintenance costs. Benefit and cost streams are discounted back to values at the start of the BRACED programme with a discount rate of 12% - as typically used

[8] For the project as a whole (rather than specific communities) using baseline and endline survey data on treatment and control sites.
[9] These were divided equally over all 155 project villages/wards.
[10] The Green Book, Appraisal and Evaluation in Central Government (2011), HM Treasury, UK Government, London (p.19).
[11] See, for example, case studies reported by Buncle et al. (2013)

by ADB - reflecting the fairly high opportunity cost of capital in this context[12]. However, we also present summary results of two sensitivity tests using discount rates of 9% and 6% - with ADB noting that the lowest rate is appropriate for their funding of social sector projects that target poverty reduction or environmental benefits[13].

To estimate the benefits and costs for a project providing microfinance and piglets after the project ends, we estimate production models using data from key informants and communities that is checked against international literature.

Some (but not most) project benefits depend on avoiding deaths previously caused by flooding. We estimate the value of a statistical life using published estimates for Thailand and adjust these for GDP differences in line with international evidence.

Case study sites were selected from a list of BRACED coastal and estuary sites. Field visits were organised by the BRACED Alliance Myanmar team and interviews were undertaken by independent local and international consultants in December 2016. Two to four focus group discussions (FGDs) were held in each site with community members and key informant interviews (KIIs) were undertaken with community representatives, local technical specialists, government officials and project staff.

3. Case study results

3.1. Nyaung Ta Pin

3.1.1 Background

Nyaung Ta Pin is an isolated coastal village of approximately 760 people in the Ayeyarwady delta some 60km south of Labutta township. This village was devastated by cyclone Nargis when more than 70 people (mainly children) died as a result of flooding. Sea water intrusion and land depression eradicated the previous livelihood of betal leaf growing. Today, households primarily rely on crab fishing in the mangroves surrounding the village. The community experiences regular flooding following storm surges in the rainy season and following saline intrusion, it has an on-going problem of accessing drinking water (that is now frequently brought in by boat and sold).

3.1.2 BRACED interventions

The following interventions were undertaken by Action Aid in 2016 following on from the community resilience assessment planning process set out in Box 1:

1. Community resilience planning with representatives focusing on women's empowerment and community planning (RD 1);
2. Child-centred climate resilience group formation with representatives from this village – with the aim of improving household understanding of and response to climate shocks (RD 1);
3. Women's leadership and empowerment training at village level (RD 3);
4. Climate resilient sustainable agriculture (CRSA) support for home gardening (RD 1 and 3); and

[12] The ADB 1997 Guidelines for the Economic Analysis of Projects state that analysts should use the "..opportunity cost of capital (OCC) in the country concerned, though it is difficult to estimate with much precision the opportunity cost of capital or the investment rate of interest for most countries" p21 and that "10%-12%" is used in practice. In a review of international practice for ADB, Juzhong et al. (2007) recognise there is a case for reviewing the established "10%-12%" figure but note that public discount rates in developing countries lie in the (8%-15%) range. Subsequent to our research, the ADB has indicated they will move to using a 9% discount rate.

[13] https://www.adb.org/sites/default/files/institutional-document/32256/economic-analysis-projects.pdf pages 139-140.

5. Formation of self-help groups in March 2016 and provision of 500,000 Khat in loans (RD 1 and 3).

The participatory planning process identified the following as priority infrastructure investments to be implemented in 2017:

6. Cyclone shelter (primarily dividend 1)
7. Rain water storage – primarily for drinking water (dividends 1 and 3)

It is likely that the capital costs of the cyclone shelter are too high to be met by the BRACED project, however, to illustrate likely costs and benefits, we include both cyclone shelter and rain water storage options[14].

3.1.3 Costs and benefits

Considering the interventions above, we have a year of data on the costs and benefits for intervention 4, some 6 months for intervention 5, and estimated costs and benefits for interventions 6 and 7. All costs and benefits are projected forward for ten years as described below using data provided by stakeholders. The net present value (NPV) of costs and benefits are reported in Tables 1 - 3. Full 10-year projection data is available from ADB upon request.

Table 1: Nyaung Ta Pin costs

Costs (monetary values in Myanmar Khat)	Data	NPV
Intervention 4: Home gardening (per garden)		
Bringing soil, preparing garden - adult work days	4	
Opportunity cost of 1 day	5,000	
Total cost/garden - community	20,000	
Number of gardens in Nyuang Ta Pin	54	
Total garden costs - for community as a whole		964,286
Intervention 5: self-help groups		
SHG costs - BRACED provision of capital		446,429
Intervention 7: rain water storage		
Rainwater storage community estimated costs - put to BRACED	5,000,000	4,464,286
Intervention 6: cyclone shelter		
Cyclone shelter community estimated costs - put to BRACED	60,000,000	53,571,429
Programme level costs		
Share of BRACED community level costs (e.g. training)	13,820	11,678
Share of BRACED programme ACU costs	11,928,140	9,549,793
Total costs (including rain water storage & cyclone shelter)		57,237,902

Table 2: Nyaung Ta Pin benefits

Benefits	Data	NPV
Intervention 4: Home gardening		
Saving in food purchase cost/HH (3 rainy months)	6,000	
Number of HH	135	
Proportion taking up home gardening	40%	

[14] The returns to each separately are shown in Table 2.

Benefits	Data	NPV
Saving in food purchase for community		**1,726,353**
Intervention 5: self-help groups		
Profit on rice trading	17%	
Profit on other trading and pig rearing	17%	
Profit on crab net purchase	1101%	
% use for crab fishing	25%	
Average return on self-help group investments	**288%**	**7,673,592**
Intervention 7: rain water storage		
Saving per gallon	60	
Proposed capacity of storage	30,000	
Rain water saving financial value for community	**14,400,000**	**8,941,752**
Intervention 6: cyclone shelter		
Lives lost in Nargis	75	
Risk of catastrophic cyclone event (1/200 year)	0.5%	
Expected loss of life in catastrophic event		
Cyclone shelter value of lives saved based on VSL model	**271,099,333**	**168,340,478**
Total benefits		**186,682,175**

Table 3: Total net benefits for Nyaung Ta Pin (12 % Discount rate)

Summary Data	BC Ratio	NPV
Total net benefits		**129,444,273**
B:C ratio (from NPV)	**3.26**	
B:C for rainwater harvesting (undiscounted & no programme level costs)	2.88	
B:C for cyclone shelter (undiscounted & no programme level costs)	4.52	

Table 4: Sensitivity tests for Nyaung Ta Pin

Discount rate	B:C ratio (from NPV)	NPV total net benefits
12% (base case)	3.26	129,444,273
9%	3.37	146,381,869
6%	3.50	166,904,340

3.1.4 Discussion

With the calculations being dominated by community infrastructure priorities (a cyclone shelter and rainwater harvesting), projected benefits are greater than projected costs for project interventions in this village. The estimated costs and benefits of both of these have been included as they are the top priority resilience strengthening options for infrastructure funding put to BRACED by the community, however, in reality, it will be difficult to secure funding for a new cyclone shelter (the highest priority). Hence, the calculation for Nyuang Ta Pin should be seen as primarily illustrating the returns to alternative options.

The existing government-built shelter in Nyuang Ta Pin is now ineffective. It was constructed at a height of 12ft above sea-level in 2010 and has since fallen to 6ft above sea-level – too low to be effective. The community estimated cost of 60,000,000 Khat (approximately US$45,000) is beyond the budget for BRACED community-infrastructure in one project site. However, the community's prioritisation of a new cyclone shelter reflects their perceived risk of loss of life and the value of preventing this relative to other resilience-building investment priorities (such as drinking water supply). We arrive at the same ranking by estimating the benefits from community shelter construction based on the statistical value of a life we have estimated for Myanmar (scaling down published values for rural Thailand in line with GDP) and a 1/200-year probability of a Nargis-type event – see Annex 1 for further details. This is important because it suggests that the value of statistical life estimated using a relatively simple method for countries without primary data on willingness to pay can give sufficient weight to infrastructure investments such as cyclone or flood defence if qualitative interviews are used to understand the expected loss in the event of catastrophic flooding.

Note also that in practice, an investment in rainwater harvesting – the second priority community investment - is much more likely to be built as it fits within the BRACED budget although it has a predicted benefit:cost ratio of 2.88 relative to 4.52 for the cyclone shelter in the base case.

As expected, lower discount rates lead to higher net present values for the project as most project spending occurs early on while benefits continue to be received up to 10 years into the future. Lower discount rates make the economic argument in favour of the investment even stronger, although there are no practical implications as the differences in results are small.

Findings from this case study suggest that the community planning process outlined in Box 1 may have value for broader community development action planning for the following reasons:

1. The community planning process was effective in generating costed and prioritised local infrastructure proposals that addressed the most vulnerable groups and produced benefits to the community as a whole;
2. The action plan generated from this process has to be sent to the appropriate authorities to facilitate linkages with local development planning – although resource constraints limited the response to "no-objection" in this case; and
3. It was successful in combining climate resilience and broader livelihood development interventions. These community resilience planning guidelines will need modification for use in broader community development planning but offer a good way of systematically encouraging mainstreaming of climate resilience into the community development planning process.

3.2. Dalaban

3.2.1 Background

Dalaban is a village on a river estuary only 16 miles from Yangon but is isolated, has high levels of poverty and is subject to regular annual flooding from sea water surges following storms. It was badly flooded by cyclone Nargis. Under BRACED, community designed infrastructure is focused on preventing damage from regular annual flooding by saline water complemented by community training in disaster risk reduction.

3.2.2 BRACED interventions

The following interventions were undertaken by World Vision approximately 12 months before our interviews following on from the community resilience assessment planning process set out in Box 1:

1. An earthen embankment (dam wall – see the Figure below) approximately 2 meters tall and over 1 km long was built in January 2016 with a water gate to prevent annual flooding from sea water entry. This has reduced losses in a number of areas:
    - Firstly, in terms of rice paddy growing and harvest stored as well as losses of fuelwood and cooking pots and chickens from homes. (RD 1).
    - By reducing the amount of flooding, farm labourers have also lost fewer income days to floods (RD 1 and 3).

- There have also been reduced health costs - primarily from dengue fever (RD 3).

2. Formation of 2 village savings and loans associations and a pig breeding group to strengthen resilience by building financial capital, increasing the ability to cope with shocks and making livelihoods less dependent on activities that are particularly vulnerable to flooding[15] (RD 3 and potentially 2).

3. Members of the community received disaster risk education by trained volunteers and community representatives received disaster risk reduction education (RD 1).

Figure 1: Embankment built following community resilience planning in Dalaban

Source: Gil Yaron 2017

3.2.3 Costs and benefits

We have a year of data on the costs and benefits for the interventions 1 and 2. The benefits of DRR training are likely to be most evident following extreme events, which were fortunately not seen in 2016. Hence, benefits from these activities are not estimated although their costs are included. This will not have a major influence on the results reported below as flood embankment construction and loans for pig breeding account for most of the project spend. All costs and benefits are projected forward for ten years using data provided by stakeholders. The NPV of costs and benefits are reported in table 5 and 6 below. Full 10-year projection data is available from ADB upon request.

[15] FGDs reported that chickens drowned in annual floods whereas pigs moved away and returned as the water fell.

Table 5: Dalaban costs (monetary values in Myanmar Khat)

Dalaban Costs	Cost/calculation	NPV
Intervention 1: Earth flood protection embankment		
BRACED construction cost	20,375,216	
Community contribution - annual maintenance cost (30 days/year x 20 persons falling to 15 days/yr x 20 by 2020)	30	
Daily wage - opportunity cost	4250	
Flood protection embankment - total costs		**29,269,786**
Intervention 2: Pig breeding cost - see Pigs - Dalaban model (annex 1)		
Number of households in pig breeding programme	40	
Total pig breeding cost		**76,487,925**
Intervention 2: VSLA - BRACED cost (over 23 months)	**82,600**	
VSLA - own contribution/borrower (cost) - month	2200	
Number of VSLA borrowers	30	
Borrowing period (months)	3	
VSLA borrower contribution	792,000	
VSLA total cost	**874,600**	**4,548,727**
Share of BRACED community level costs (e.g. training) not otherwise recorded	**1,783,360**	**1,572,506**
Share of BRACED programme ACU costs	**11,928,140**	**9,549,793**
Total costs		**121,428,736**

Table 6: Dalaban benefits

Dalaban Benefits		
Intervention 1: Earth flood protection embankment		**NPV**
Acres of lost paddy due to annual flooding pre-BRACED	100	
Bags of 52lb rice (lost paddy) due to flooding pre-BRACED per acre	50	
Average price of polished rice/bag in community (khat)	12,500	
Gross value of bags of rice saved from flooding	62,500,000	
Rice harvesting costs/acre paddy	35,000	
Cost (labour, transport & processing) of turning paddy harvest into polished rice/acre of paddy	36,000	
Net value of bags of rice saved from flooding		**313,022,356**
Loss of chickens pre-braced		**3,390,134**
Loss of stored fuelwood and cooking pots pre-BRACED		**259,910**
Loss of work days - inability to move around at flood time - pre-BRACED, 6-8 days/month x 4 months x 50 people	1400	
Value of work days lost		**33,618,827**
Avoided fatal snake bites/year (Data from Nepal in Alirol et al 2010 on mortality/100,000)	0.00162	
Avoided fatal snake bites/year (FDGs)	3	
Value of lives saved (based on VSL model) - based on Alirol et al 2010 mortality figures		**790,761,819**
Value of lives saved (based on VSL model) - based on FGD snake bite figures		

Dalaban Benefits		
Intervention 1: Earth flood protection embankment		**NPV**
Dengue incidence hospitalisation pre-BRACED	10	
Dengue incidence hospitalisation with BRACED	0	
Multiplication factor (unreported cases) - not used for KII and FGD data	1	
Lost work day cost for mother (9.1days @ 3500 average)	31,850	
Subsistence and drug costs at hospital (6000/day food, 10,000 x 2 drugs)	74,000	
Transport cost to/from hospital	16,000	
Reduction in dengue hospitalisation case costs - based on KII and FGD data		**6,884,797**
Dengue incidence hospitalisation pre-BRACED 2015	7	
Dengue incidence hospitalisation with BRACED 2016	3	
Multiplication factor (unreported cases)	10	
Lost work day cost for mother (9.1days @ 3500 average)	31,850	
Subsistence and drug costs at hospital (6000/day food, 10,000 x 2 drugs)	74,000	
Transport cost to/from hospital	16,000	
Reduction in dengue hospitalisation case costs - based on public health data		**48,193,577**
Serious diarrhoea incidence hospitalisation pre-BRACED - KII and FGD	10	
Serious diarrhoea incidence hospitalisation with BRACED - KII and FGD	0	
Lost work day cost for mother (7 days @ 3500 average)	24,500	
Subsistence and drug costs at hospital (6000/day food, 10,000 x 2 drugs)	62,000	
Transport cost to/from hospital	16,000	
Reduction in serious diarrhoea hospitalisation case costs - based on KII and FGD data		**5,791,479**
Serious diarrhoea incidence hospitalisation pre-BRACED - lower bound (public health records)	0	
Serious diarrhoea incidence hospitalisation with BRACED - lower bound (public health records)	0	
Lost work day cost for mother (7 days @ 3500 average)	24,500	
Treatment cost at hospital (10,000 x 2)	20,000	
Transport cost to/from hospital	16,000	
Reduction in serious diarrhoea hospitalisation case costs based on public health data (not estimated as no reduction relative to control)		
Total embankment flood protection economic benefits based on KII and FGD data (snake bites from public health)		**1,153,729,321**
Total embankment flood protection economic benefits based on public health data		**1,189,246,623**
Pig breeding - benefits per household - see Dalaban pig model		
Total value of pig breeding		**137,389,274**
VSLA - benefits - see VSLA model		
VSLA loan interest rate per month	3%	
Loan size	30,000	
VSLA borrowing period	3	
Loan repayments - VSLA (per 3-month loan & declining balance)	31,800	
Previous borrowing rate/month	13%	
Pre-BRACED loan repayment period	24	

Dalaban Benefits		
Intervention 1: Earth flood protection embankment		**NPV**
Loan repayments - pre-VSLA, one 30k loan took two years to repay (declining balance)	76,875	
Difference in loan interest = benefit proxy (as loans used for a mix of consumption & business purposes)	46,875	
Value of BRACED VSLA loans based on 4 loans per year	187,500	
Value of BRACED VSLA loans based on 4 loans per year across all borrowers		**31,782,505**
Total benefits (based on KII and FGD data)		**1,322,901,100**
Total benefits (based on public health data)		**1,358,418,402**

Table 7: Total net benefits for Dalaban

	NPV
Total net benefits (based on KII and FGD data)	**1,201,472,363**
Total net benefits (based on public health data)	**1,236,989,665**
B:C ratio (from NPV) - based on KII and FGD data	10.89
B:C ratio (from NPV) - based on public health data	11.19
B:C ratio (from NPV) - flood embankment (KII) - ignores programme level costs	39.42
B:C ratio (from NPV) - pig breeding - ignores programme level costs	1.80

Table 8: Sensitivity tests for Dalaban

Discount rate	B:C ratio (from NPV)	NPV total net benefits
12% (base case)	10.89	1,201,472,363
9%	10.76	1,373,775,778
6%	10.60	1,586,556,074

3.2.4 Discussion

Discounted benefits are significantly higher than discounted costs – with a ratio of approximately 11. That is to say when both costs and benefits are expressed in USD when the programme started, every 1 US$ invested produces US$ 11 of benefits.

As the Figures below show, the earthen flood protection embankment is the critical driver of benefits in Dalaban. This reflects the reduction in snake bites and avoiding 1-2 deaths/year as a result during annual flooding as well as a reducing the loss of rice to floods – that had been a regular event until this infrastructure,

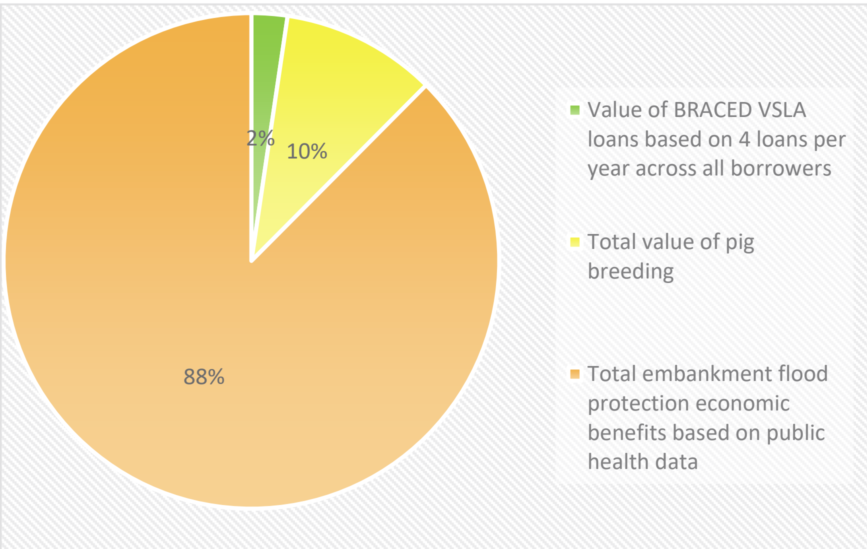

Figure 2: Dalaban - major monetised benefits

prioritised by the community was put in place.

In Dalaban, the value of loans for pig breeding was lower than expected by local project staff due to a mystery illness that led to many pigs dying. Under more normal circumstances, we would expect a higher share of net benefits to accrue to pig breeding but the flood protection embankment would nonetheless be the primary driver of net benefits to the community.

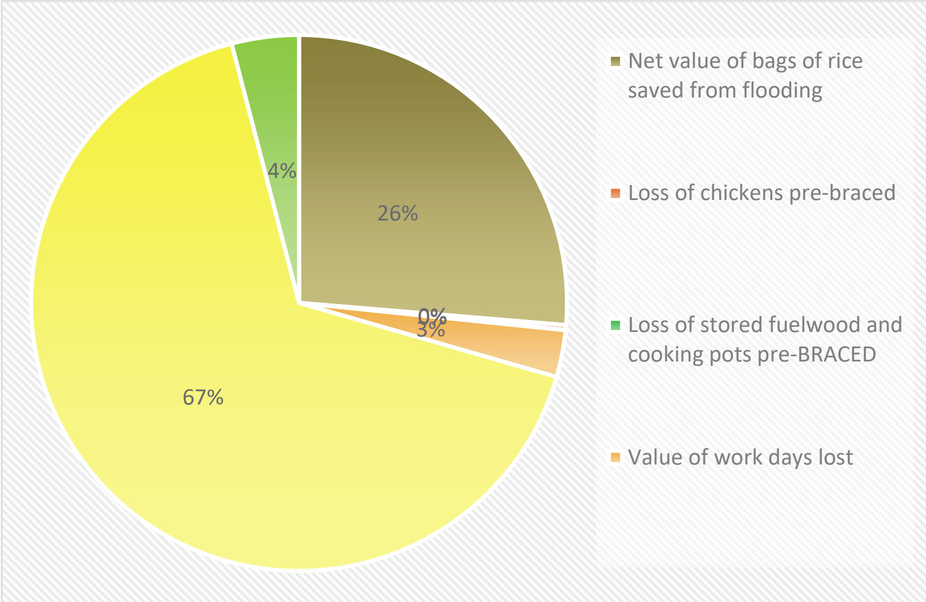

Figure 3: Dalaban embankment flood protection benefits in more detail

The sensitivity tests show that as the discount rate falls, the net present value of the investment rises a little but the ratio of discounted benefits to costs falls very slightly (although remaining at 11 to the nearest whole number). There are no practical implications from this change[16].

In this example, the community resilience planning process seems to be a critical ingredient in generating the infrastructure solution to reduce the incidence of snake bites following annual flooding. An embankment that affects and involves a large section of the community is a public good (rather than something for individuals to purchase directly through the market). It had not been provided by the existing public infrastructure planning process in part due to resource constraints but also due to the difficulty for the community of making an effective case in the face of many competing priorities.

The very high economic return to the earth embankment flood defence suggests that the community resilience planning process (summarised in Box 1) can effectively articulate the value of avoiding losses relative to costs for this type of infrastructure *without* an explicit cost-benefit analysis. The process ensures that the investment fits within the local government development plan and so, if done well, there is scope to use this action planning process more widely. In this case, the community planning process has been facilitated by an experienced international NGO that has an established relationship in this local area. If there is interest in using this planning process more widely, it will be important to test whether and how the quality of community consultation and planning can be maintained in areas without these established relationships.

3.3. Ward 93

3.3.1 Background

Ward 93 is a peri-urban area within Dagon Seikkan Township, located on the river estuary but closer to the sea than Dalaban. It used to be affected by annual floods and tidal surges, but this has been less of a problem since works implemented a few years ago (before the current project) to improve drainage. Nonetheless, regular flooding continued to present problems for the secondary school.

[16] Although we note the unusual (slight) decline in B/C ratio at the same time as an increase in the B-C figure. This reflects the high share of pig breeding in Dalaban total costs and costs increasing with pig breeding over time as this activity expands.

3.3.2 BRACED interventions

The following interventions were undertaken by World Vision approximately 18 months before our data collection, following on from the community resilience assessment planning process set out in Box 1:.

1. Enabling the secondary school to function during the period of annual flooding by providing sand for in-filling a large depression in the compound and constructing a single-track road into and around the compound. School children are now able to use the school throughout the rainy season whereas previously it was typically closed for 10 days/year. This is one of the reasons the number of children enrolled at the school has expanded from 800 – 2000. Benefits from this type of intervention fall into all three resilience dividend categories (although we are only able to quantify avoided losses).
2. Supporting the establishment of three village savings and loan associations (VSLAs) – resilience building and also a development co-benefit (dividend 3). This provides individuals with access to low-cost loans from rotated savings and interest on savings at the end of the year. They also pay into an insurance fund (to repay loans in the event of death or incapacity) which distributes money for community-projects each year if the insurance is not called on. Training is provided to establish VSLAs. There is no specific resilience requirement for VSLA loans, as the logic is that loans help build climate resilience by increasing the capacity of the very poor to respond to climate shocks and stresses. Programme staff also mentioned that community members are more willing to take part in DRR planning if they also benefit from activities where they can see returns in the short term.
3. Establishing a pig-breeding group with loans for 150 borrowers each six months. Although community members see pig-breeding as a development activity, profits have generated household investment to avoid flood losses – new house foundations to raise the height of houses and contributions for maintenance of the community drainage system (dividends 1 and 3). Note that the additional flood protection costs and benefits by some households using profits from pig-breeding are not captured in our analysis, which is likely to understate net benefits.

3.3.3 Costs and benefits

The NPV of costs and benefits are reported in tables 9 – 10 below. Data for each year is given in Annex 1. The lost benefits from closing the school for 10 days per year are difficult to measure and the only data we have obtained is the cost faced in transporting pupils to alternative schools. This was paid by some 20% of parents who could afford this option but is used as a proxy for lost value for all pupils. As we will see, it forms a small component of total project benefits.

VSLA benefits are estimated by modelling loan uptake over 10 years and the difference between local informal and VSLA interest costs.

Evidence on three rounds of pig breeding loans (with new users each round and local figures on pig survival, cost of pig raising, sales and prices) is used to model costs and benefits over a 10-year period.

Table 9: Ward 93 costs

Ward 93 costs (monetary values in Myanmar Khat)	**Data**	**NPV**
Intervention 1: **School flood mitigation** (concrete walkway & filling in ponds with sand) - part of BRACED community level		
School flood mitigation - community contribution, 30 bags cement @ 6000/bag		
School flood mitigation - maintenance @ 10% of capital cost		
School flood mitigation - total cost		246,347
Intervention 3 - Pig breeding (see Pigs Ward 93 model/borrower)		
Number of borrowers	150	

Pig breeding total costs		558,473,415
Intervention 2 - VSLA - BRACED formation cost	261,150	
VSLA - own contribution/borrower (cost) - month	2,100	
Number of VSLA borrowers	54	
Borrowing period (months)	6	
VSLA annual borrower contribution	1,360,800	
VSLA total cost		7,921,993
Share of BRACED community level costs (e.g. training)	13,129,400	11,094,678
Share of BRACED programme ACU costs	11,928,140	9,549,793
Total costs		587,286,226

Table 10: Ward 93 benefits

Intervention 1 - School flood mitigation	Data	NPV
Number of school children absent due to floods each year	200	
Average days of absence	10	
Travel costs to alternative school/child (used by 20% of parents who could afford this option)	72,000	
Actual and implied travel cost saving to alternative school		81,363,212
Intervention 3 - Pig breeding		
Pig breeding - benefits - see Pigs (Ward 93 model/person getting a starter loan)		
Number of loans for pig breeding made/year	150	
Pig breeding - benefits/borrower		
Pig breeding benefits - total (assuming only 150 in group get loans)		1,268,426,491
Intervention 2: VSLA –(see VSLA model)		
VSLA loan interest rate per month	3%	
Loan size	50,000	
VSLA borrowing period (months)	6	
Loan repayments - VSLA (per 6-month loan & declining balance)	55,250	
Previous borrowing rate/month	20%	
Pre-BRACED loan repayment period	24	
Loan repayments - pre-VSLA, one 50k loan took two years to repay (declining balance)	175,000	
Difference in loan interest = benefit proxy (as loans used for a mix of consumption & business purposes)	125,000	
Value of BRACED VSLA loans based on 2 loans per year	250,000	
Value of BRACED VSLA loans based on 2 loans per year across all borrowers		76,278,011
Total benefits		1,426,067,713

Table 11: Total net benefits for Ward 93

Total net benefits		838,781,487
B:C ratio (NPV)		2.43

Table 12: Sensitivity tests for Ward 93

Discount rate	B:C ratio (from NPV)	NPV total net benefits
12% (base case)	2.43	838,781,487
9%	2.44	1,033,151,694
6%	2.46	1,286,353,297

3.3.4 Discussion

Discounted benefits are higher than discounted costs – with a ratio of approximately 2.4. That is to say when both costs and benefits are expressed in prices when the programme started, every 1 US$ invested produces US$ 2.4 of benefits. This is lower than the ratio in the case studies above because there are no direct avoided losses on livelihoods from flood protection interventions (such as embankments) in this case. Sensitivity tests show that reducing the discount rate leads to small increases in estimated net benefits.

In practice, some of the profits from pig-breeding (that accounts for the large majority of costs and benefits in this case study) have been used to build household flood resilience. The net benefits reported do not capture this and hence, the full returns to project interventions are likely to be understated. We hope to document these indirect effects in subsequent work.

4. Conclusions

In all the case studies, estimated economic benefits over a 10-year period (typically based on 12-18 months of post intervention data) are significantly greater than estimated costs over this period. The ratio of discounted benefits to costs varies from 2.4 to 11. Very similar results are obtained with lower discount rates (e.g. 6%).

The highest returns are from relatively small-scale resilience-building infrastructure investments planned with communities and local government, drawing on BRACED finance with community contributions of labour (and government provision of equipment in one instance). For example, earthen flood embankment construction in Dalaban has already reduced the incidence of fatal snake bites and prevented large economic losses that regularly followed annual flooding.

Microfinance and pig breeding interventions have generated positive net financial returns for the households involved. This contribution to improved livelihoods has been seen within 12-18 months of the interventions, however, we will only know whether the additional capacity to absorb and adapt to shocks and stresses translates into increases in perceived resilience when the end of programme evaluation is undertaken.

The types of resilience-building investment prioritised by the case study communities reflect their implicit estimate of the type of risks faced. Hence, two of the three case studies (Dalaban and Ward 93) are driven by infrastructure interventions to mitigate regular annual flooding whereas one community (Nyaung Ta Pin) prioritised investment to reduce the impact of a catastrophic flooding event. In all cases though, the BRACED programme has supplemented this by work on community capacity building to use early warning information and improve response to disasters. Participation by community members in this type of capacity building (with benefits potentially only seen in the longer-term) is seen as a fair exchange for the CDD infrastructure offered by the programme (that is planned and delivered early on).

In the case of Nyaung Ta Pin, the value of the community's highest priority intervention (a new, elevated cyclone shelter) depends on avoiding loss of life from a devastating cyclone. In order to estimate the probability of this occurring we use the lowest probability "catastrophic" event covered by the ASEAN Countries Disaster Risks Assessment (1/200 years). The expected loss of life without a new shelter is perceived by the community to be that which occurred with Nargis and we use the value of a statistical life derived from the published literature.

There are obviously a number of uncertainties in making this projection. However, it generates an estimated B:C ratio of 4.5 (similar to the flood prevention interventions for other case studies). The community ranking of the second most important project investment – rain water harvesting – is also the second-best option in economic terms (with a B:C ratio of 2.9) but is more likely to be built as it fits within the project budget.

The high economic returns we find for resilience-building infrastructure proposed by the community suggests that the community resilience planning process can effectively articulate the value of avoiding losses relative to costs for this type of infrastructure *without* an explicit cost-benefit analysis. Indeed, our findings suggest that this community planning process may have value for broader community development action planning for three reasons:

1. The community planning process was effective in generating costed and prioratised local infrastructure proposals that addressed the most vulnerable groups and produced benefits to the community as a whole;

2. The action plan generated from this process has to be sent to the appropriate authorities to facilitate linkages with local development planning; and

3. The resilience planning process in these case studies has combined climate resilience and broader livelihood development interventions. These community resilience planning guidelines will need modification for use in broader community development planning but offer a good way of systematically encouraging mainstreaming of climate resilience into the community development planning process.

The fact that these results were obtained in this context does not mean they will hold in other contexts. Specifically, in this case, the community planning process has been facilitated by experienced international NGOs that have established relationships in their local areas of operation. If there is interest in using this planning process more widely, it will be important to test whether and how the quality of community consultation and planning can be maintained in areas without these established relationships. The quality of project implementation also determines whether similar results could be obtained elsewhere, even in Myanmar. For example, most infrastructure investments we have considered require community maintenance. The evidence suggests this is occurring because the targeted community sees clear benefits from the intervention *and* the CDD process has involved the relevant local institutions that have a role in organising community labour for maintenance.

The approach we have taken to estimating costs and benefits of CDD resilience building interventions can be used more widely. We have made considerable efforts to cross-check data generated from participatory discussions both with other local sources and evidence from the international literature. Nonetheless, there are some caveats to bear in mind:

1. One to two years after project investments, most resilience dividends are in terms of avoided losses, with some development co-benefits. We have yet to document changes in economic activity that take advantage of reduced annual flood risks;

2. The project interventions in these case studies have been relatively easy to quantify and have not targeted eco-system services; and

3. Participatory methods are a good source of evidence for the difference that project interventions have made in the face of regular annual flooding or to strengthen household livelihoods from activities such as pig breeding. Uncertainty over our estimates depends mainly on whether past experience will be a good guide to the future and a degree of uncertainty is recognised by making conservative assumptions on future costs for maintenance, pig breeding or microfinance returns and repayment. Where the results of project interventions are less clear (due to the type of benefit, mix and scale of beneficiaries or external environment), evidence should be drawn from a comparison of treatment and control groups.

These case studies indicate that CDD interventions in Myanmar to build resilience involving community-planned and prioritised infrastructure can produce economic benefits that significantly exceed costs. Going forward, government and development partners planning should take this into account.

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Annex 1: CBA Methodology Note

1. Estimating the value of a statistical life in rural Myanmar

In three of the case studies in this report, project interventions are believed to have prevented or are intended to prevent loss of life from flooding due to a variety of causes. In the case of Nyaung Ta Pin, the economic viability of the proposed community shelter depends on the value of the expected reduction in mortality following a 1/200 year cyclone. Finally, in Dalaban, the incidence of snake bites following flooding has been reduced and this reduces the risk of fatalities. In each of these cases, estimation of economic benefits from project interventions draws on the estimated value of a statistical life (VSL) as well as a separate analysis of how likely loss of life is to happen.

There has been significant international research on VSL[17] although there are no published results for Myanmar. The 2012 OECD publication - The Value of Statistical Life: A Meta-Analysis by Vincent Biausque – reports two studies for Thailand amongst 37 others. As part of the OECD meta-analysis, each VSL result is standardised by national per capita GDP, providing an indication of outliers. One of the two Thailand results had a VSL/per capital GDP ratio of 2.25 the average while the other had a ratio of 0.96. We have taken the more conservative option – Gibson et al. (2007) - as the basis for estimating a VSL for Myanmar.

Gibson et al. (2007) use the contingent-valuation method to estimate the VSL for a rural population in Northeast Thailand. This produced an estimate of almost US$250,000 in 2001 prices. This is expressed in 2016 prices using the US GDP deflator provided by the World Bank[18].

A VSL estimate for Myanmar is then derived by multiplying the 2016 Thai VSL figure by the ratio of 2015 Myanmar US$ GDP/capita to 2015 Thai US$ GDP/capita using World Bank data[19]. This is expressed in Myanmar Khat as of 31 December 2015[20].

The derivation is shown in the Table below.

Table A1: Estimates of the Myanmar VSL

	VSL Myanmar	VSL Thailand-rural	VSL Thailand-rural
	Khat	Khat	US$
	Projected	Projected	Gibson et al (2007)
2001			248,500
2002			254,163
2003			258,065
2004			263,211
2005			270,448
2006			279,150
2007			287,727
2008			295,384
2009			301,178

[17] See http://www.oecd.org/env/tools-evaluation/valuingmortalityimpacts.htm
[18] http://data.worldbank.org/indicator
[19] As above
[20] https://www.irs.gov/businesses/small-businesses-self-employed/treasury-reporting-rates-of-exchange-as-of-december-31-2015

	VSL Myanmar	VSL Thailand-rural	VSL Thailand-rural
2010			303,466
2011			307,172
2012			313,514
2013			319,289
2014			324,494
2015			329,824
2016	**90,366,444**	436,732,353	333,129

(Source: Authors)

As a sense check, we estimated the VSL for Myanmar using a human capital approach as shown in Table A2 below. This is likely to significantly understate VSL relative to the preferred willingness-to-pay method used in the international studies reviewed by Biausque (2012)[21]. A human capital estimate approximately 2/3 of the willingness-to-pay estimate used in the cost-benefit analysis suggests that the latter is realistic, if somewhat conservative.

Table A2: Human capital estimates of the Myanmar VSL

Life expectancy at birth (rural)	66.8	http://mmsis.gov.mm/statHtml/statHtml.do
Years of working life (60 - 16)	44	
Estimated annual income (USD)	702	http://www.mm.undp.org/content/myanmar/en/home/countryinfo.html
Estimated annual income (Khat)	920,322	
Assumed real income growth rate	2%	
VSL using lost labour value (Khat)	63,964,824	

2. Estimating flood mortality from a catastrophic cyclone

Participatory discussions in Nyuang Ta Pin indicated that the perceived risk of a cyclone Nargis-type event had led the community to prioritise a new, elevated, cyclone shelter as their investment proposal. This reflected the loss of more than 70 lives during Nargis in 2008 when cyclone-induced flooding destroyed the school building. Subsequently, new brick buildings have been constructed, however, due to land depression, no building in the village could provide protection against a storm surge similar in height to that brought about by Nargis. Given the location of the village, near the edge of the Arrawaddy delta, other evacuation options in the face of a Nargis-type event were perceived to be limited.

We interviewed Township Relief and Recovery government staff, but they were unable to provide evidence on risks. Hence, we used the estimated 1/200-year probability (0.5% annual probability) of a catastrophic cyclone for Myanmar – the least likely scenario considered by the ASEAN Disaster Risk Management Initiative (2010) – as the risk for Nyuang Ta Pin. This may over-estimate the risk to the extent that a catastrophic cyclone might affect the country, but not this specific community. However, the location of Nyuang Ta Pin close to the edge of the Irrawaddy delta and the Bay of Bengal makes it a high cyclone risk area. In addition, the incidence of flood

[21] See Landefeld, J. S., & Seskin, E. P. (1982). The economic value of life: linking theory to practice. *American Journal of Public Health*, *72*(6), 555–566.

mortality from more frequent but less damaging cyclonic storms has not been estimated (as we had no data on this) and this omission will tend to understate impacts.

These assumptions are relatively important in determining estimated NPV of project interventions in this case study. The NPV of benefits from the proposed cyclone shelter account for 29% of the total estimated NPV of project benefits in Nyaung Ta Pin.

3. Estimating flood mortality from drowning

Focus group discussions, confirmed by key informant interviews indicated that two children had drowned due to regular annual flooding in project areas of Mawlamyine over the seven years before the project i.e. a 2/7 chance of drowning in each year. Although project interventions have been successful in significantly mitigating flooding in the past two years, we have made a very conservative assumption that this translates into a reduced drowning risk of 1/10, i.e. the life of one child will be saved over a 10-year period.

The case study results are largely insensitive to these assumptions as the estimated NPV of the reduced risk of drowning accounts for approximately 7% of the NPV of all estimated flood reduction benefits in the Mawlamyine base case study.

4. Estimating indirect flood mortality from snake bites

In Dalaban, FGDs and key informant interviews, highlighted the annual benefits of reduced snake bites from project interventions to prevent flooding. Translating this into reduced mortality proved difficult as neither district health records nor key informants could corroborate FGD claims of three deaths per year.

Turning to the international literature, Alirol et al. (2010) undertake an extensive review of published and grey literature of evidence on snake bite incidence and mortality in South Asia. They find very significant under-reporting by district health systems and that “Snake bite incidence and mortality also increase sharply during extreme weather events such as floods” (p.2). They also report evidence showing that “During the 2007 monsoon flood disaster in Bangladesh, snake bite was the second most common cause of death, after drowning” (p.2).

With this in mind, the FGD evidence of three deaths per year looks more plausible. However, in a community of 956 people, three snake bite deaths/year is around twice the highest published rates for South Asia – Sharma et al. (2003). For the base case, we therefore make the conservative assumption that snake bite incidence and mortality in Dalaban without project interventions would have been equal to that reported by Sharma et al. (2003) from a community survey for southeast Nepal in 2002, which revealed the highest published regional annual incidence and mortality rates of 1,162/100,000 and 162/100,000, respectively.

The assumptions around snake bite mortality are important in determining estimated benefits from the project intervention. The NPV of fewer deaths from snake bites accounts for approximately 60% of the total NPV of all estimated benefits from the project intervention.

5. Calculating benefits from reduced incidence of dengue fever and serious diarrhoea

FDGs in Dalaban identified a reduction in dengue fever and serious diarrhoea as benefits of investments to reduce annual flooding. The first methodological challenge in quantifying these benefits was to ascertain whether observed reductions in disease incidence reflected changes in weather or other external factors rather than project interventions.

To do this, we collected data on past and recent incidence of dengue documented by the local public health system for Township wards where the project was operating (treatment group) and neighbouring ones (control group). Project interventions were said to have an effect where there were additional reductions in incidence for project relative to control sites.

FGDs and KIIs reported dengue treatment at hospital or at health clinics if less serious. These discussions were used to identify treatment costs for each option, transport to and from hospital, food costs for carers for the duration of the hospital stay and the time off work for carers valued at average local wage rates. Estimated hospital treatment and indirect costs were US$92/dengue admission and US$28/health clinic case treated. Comparison with the international literature suggests that these are in the right “ball park”, but may be underestimates. Shephard et al. (2013), use empirical data on dengue treatment costs in Cambodia, Malaysia, Singapore and Vietnam together with GDP/capita data to extrapolate for Myanmar (and other Southeast Asian countries). They estimate an average treatment and indirect cost of US$105/dengue case for Myanmar.

Data on incidence of dengue reported by FGDs and documented by the public health system (via the Township Medical Officer) differed significantly. We know from published studies that dengue is significantly under reported in public health systems in Southeast Asia. Clark et al. (2005) report a ratio of 17-60 unreported to reported dengue cases from their review of the literature, but ultimately choose a multiplication factor of 10 for their study of dengue fever incidence in an area of Thailand neighbouring Myanmar. We follow Clark et al. in using this multiplication factor for cases documented by the public health system. However, we also report alternative estimates based on data reported by the FGDs and KIIs.

FGD and KII data also indicate that the incidence of serious diarrhoea also increased during flood and post-flood periods – prior to protection of drinking water sources. The direct and indirect costs of treatment are similar to dengue fever where hospitalisation is required but are usually much lower where cases are treated in health centres. Medical treatment is usually restricted to children. The direct and indirect costs of treatment at a health centre therefore include: ORS medication, transport costs and two days of lost work for a care taker at average local wage rates.

In all cases, we only consider reductions where the public health data shows additional reductions for treatment sites over control sites comparing the pre-project year with years following project implementation. We recognise that this may lead to understatement of project impacts as poorer and more vulnerable sections of the community are a) more likely to be affected by flooding and b) less likely to use hospital or health centre facilities. For this reason, estimated health benefits should be seen as a lower bound.

Estimated project benefits from reduced incidence of dengue fever and serious diarrhoea comprise a small share of total estimated project benefits – 4% in Dalaban.

Agricultural labour and production

FGDs and KIIs identified a number of impacts on agricultural livelihoods as a result of project interventions to reduce annual flooding. Quantities of production regularly lost or lost labouring days in previous years were identified and triangulated. Triangulation across multiple local sources involving both FGDs and KIIs was time consuming but essential. Cost data at local market prices was obtained to value these losses. Agricultural benefits differ by case study, the example in table A3 below illustrates the general principles.

Table A3: Example of estimated agricultural benefits for Dalaban

Earth flood protection embankment - benefits		NPV
Acres of lost paddy due to flooding pre-BRACED	100	
Bags of 52lb rice (lost paddy) due to flooding pre-BRACED per acre	50	
Average price of polished rice/bag in community (khat)	12,500	
Gross value of bags of rice saved from flooding	62,500,000	

Rice harvesting costs/acre paddy	35,000	
Cost (labour, transport & processing) of turning paddy harvest into polished rice/acre of paddy	36,000	
Net value of bags of rice saved from flooding		**313,022,356**
Loss of chickens pre-braced		**3,390,134**
Loss of stored fuelwood and cooking pots pre-BRACED		**259,910**
Loss of work days - inability to move around at flood time - pre-BRACED, 6-8 days/month x 4 months x 50 people	1400	
Value of work days lost		**33,618,827**

At the point of interview, a year or two into the project, local people focussed on avoided income and production losses. These constitute a smaller amount of total estimated benefits than we expected at the outset – approximately 25% of total benefits in Dalaban. It is likely that agricultural practice will change to take advantage of reduced flooding risks but this second type of resilience dividend has not been captured.

Pig breeding

Pig breeding is an income generating and asset building activity implemented by BRACED partners with community members in Dalaban and Ward 93. FGDs with participants and KIIs (with leaders of groups and technical specialists) produced evidence on costs and benefits from one to two years of implementation. The costs and benefits of small-scale pig breeding are highly dependent on local market conditions but it is still worthwhile cross-checking input, sale price and profitability parameters against published data. Psilos (2007), reports cost and performance data for small-scale pig rearing in Cambodia, Vietnam and Thailand. This confirms that the figures reported by our FGD participants are within the ranges reported for other countries in the region. For example, we estimate a profit from piglet raising for slaughter of US$56.5 and data from Psilos (2007), Table 13 suggests a profit of approximately US$60 based on an 80kg pig raised for slaughter, with a feed conversion ratio of 6 and 60kg added using purchased feed after purchase of a piglet.

In developing a pig economics model over time for project participants, the most difficult assumptions were over sale price levels and rates of animal sickness. If the project led to a large increase in supply of pork relative to local demand, future prices would fall. However, this seems unlikely for the two case studies in question as the population in nearby townships is very large compared to local pig production and the project intervention makes only a marginal difference. In terms of animal sickness and survival, the Dalaban group reported a mystery illness that killed all their pigs in year 1 – which is captured in our analysis - but community members that had traditionally raised pigs said this had never been known previously. Local experience in both Dalaban and Ward 93 indicated that we should allow for a 20% mortality rate going forward.

The pig economics model is summarised in the Table A4 – all costs and revenues are in Myanmar Khat.

Table A4: Pig economics for Dalaban and Ward 93

Dalaba - per pig breeding group member										
Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Loan value	80,000		80,000							
Pig purchase	60,000	60,000	60,000	60,000	120,000	180,000	240,000	300,000	360,000	840,000
Fencing	20,000									

Interest charge	10,000		10,000							
Pig food cost	50,000	50,000	50,000	50,000	100,000	150,000	200,000	250,000	300,000	700,000
Pig vet bills	6,000	6,000	6,000	6,000	12,000	18,000	24,000	30,000	36,000	84,000
Pig sale value	275,000	275,000	275,000	275,000	550,000	825,000	1,100,000	1,375,000	1,650,000	3,850,000
Expected pig sale value after allowing for death of 100% in 2016, 20% otherwise	220,000		220,000	220,000	440,000	660,000	880,000	1,100,000	1,320,000	3,080,000
Cash profit	**74,000**	**- 56,000**	**94,000**	**104,000**	**208,000**	**312,000**	**416,000**	**520,000**	**624,000**	**1,456,000**
Cumulative profit (2016 pig purchase cost reimbursed by WV)	74,000	18,000	112,000	216,000	424,000	736,000	1,152,000	1,672,000	2,296,000	3,752,000
N pigs	1	1	1	1	2	3	4	5	6	7
Total cost	146,000	116,000	126,000	116,000	232,000	348,000	464,000	580,000	696,000	1,624,000
Total benefit	220,000	60,000	220,000	220,000	440,000	660,000	880,000	1,100,000	1,320,000	3,080,000
Ward 93										
Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Loan value	81,234									
Pig purchase	60,000	60,000	120,000	180,000	120,000	300,000	360,000	840,000	1,440,000	1,080,000
Fencing	20,000									
Interest charge	10,000									
Pig food cost	50,000	50,000	100,000	150,000	100,000	250,000	300,000	700,000	1,200,000	900,000
Pig vet bills	6,000	6,000	12,000	18,000	24,000	30,000	36,000	84,000	144,000	216,000
Pig sale value	275,000	275,000	550,000	825,000	1,100,000	1,375,000	1,650,000	3,850,000	6,600,000	9,900,000
Expected pig sale value after allowing for death of 20%	220,000	220,000	440,000	660,000	880,000	1,100,000	1,320,000	3,080,000	5,280,000	7,920,000
Cash profit	**74,000**	**104,000**	**208,000**	**312,000**	**636,000**	**520,000**	**624,000**	**1,456,000**	**2,496,000**	**5,724,000**
Cumulative profit	74,000	178,000	386,000	698,000	1,334,000	1,854,000	2,478,000	3,934,000	6,430,000	12,154,000
N pigs (if profit reinvested in pigs)	1	1	2	3	4	5	6	7	8	9
Total cost	146,000	116,000	232,000	348,000	244,000	580,000	696,000	1,624,000	2,784,000	2,196,000
Total benefit	220,000	220,000	440,000	660,000	880,000	1,100,000	1,320,000	3,080,000	5,280,000	7,920,000

Microfinance

In Nyuang Ta Pin, participatory discussion generated evidence on the use of loans – indicating approximately 25% were used for crab fishing with the remainder split between other trading and pig rearing and rice trading. In the time available, the discussion generated information on monthly costs and returns to crab fishing (see below) and the average profitability of the other activities (17%). The average return on loans provided via self-help groups in Nyuang Ta Pin across all these activities was estimated at 288%. However, the benefits from microfinance only constitute around 4% of total estimated benefits of project interventions in this case.

Table A5: Crab net fishing loan use for Nyuang Ta Pin

Month		1	2	3	4	5
Loan borrowed		50,000				
Principal repaid		10,000	10,000	10,000	10,000	10,000
Interest repaid		1,500	1,200	900	600	300
Total repayment	54,500					
Monthly interest (declining balance)		3%				
Effective interest rate		9%				
Loan used for crab net fishing						
Income (15 days @ 8000/day)		120,000	120,000	120,000	120,000	120,000
Total return		1101%				

For Dalaban and Ward 93, the diverse use of savings and loan funds made it difficult to identify representative loan types using FGDs. Nonetheless, all participants highlighted the savings they had made from switching borrowing from informal money lenders. We model monthly payments made with and without the project as shown in ***Table*** below. Given limitations of space, we show pre-project repayments for 6 months but these are actually calculated over 24 months for each 50,000 Khat or 30,000 Khat loan. While the savings from switching from informal to project loans are significant, the number of loans provided by the project are relatively small – even in comparison to capital provided for pig breeding. Consequently, in Dalaban, for example, this project benefit accounts for only 2% of total estimated project benefits.

Table A6: Loan payments pre and with project

Ward 93							
Month		1	2	3	4	5	6
Loan borrowed - BRACED		50,000					
Principal repaid		8,333.33	8,333.33	8,333.33	8,333.33	8,333.33	8,333.33
Principal outstanding - BRACED		50,000	41,667	33,333	25,000	16,667	8,333
Monthly interest (declining balance)	3%	1500	1250	1000	750	500	250
Total repayment	55,250						
Effective interest rate - BRACED		11%					
Loan borrowed - pre-BRACED		50,000					
Principal repaid		2,083.33	2,083.33	2,083.33	2,083.33	2,083.33	2,083.33
Principal outstanding - BRACED		50,000	47,917	45,833	43,750	41,667	39,583
Monthly interest (declining balance)	20%	10,000	9,583	9,167	8,750	8,333	7,917
Total repayment	175,000						
Effective interest rate - pre-BRACED		250%					
Dalaba							

Month		1	2	3	4	5	6
Loan borrowed - BRACED		30,000					
Principal repaid		10,000	10,000	10,000			
Principal outstanding - BRACED		30,000	20,000	10,000			
Monthly interest (declining balance)	3%	900	600	300			
Total repayment	31,800						
Effective interest rate - BRACED		6%					
Loan borrowed - pre-BRACED		30,000					
Principal repaid		1,250	1,250	1,250	1,250	1,250	1,250
Principal outstanding - BRACED		30,000	28,750	27,500	26,250	25,000	23,750
Monthly interest (declining balance)	13%	3,750	3,594	3,438	3,281	3,125	2,969
Total repayment	76,875						
Effective interest rate - pre-BRACED		156%					