

A Strategic Resilience Assessment of the Ayeyarwaddy Delta

Mercy Corps, Welthungerhilfe, and GRET

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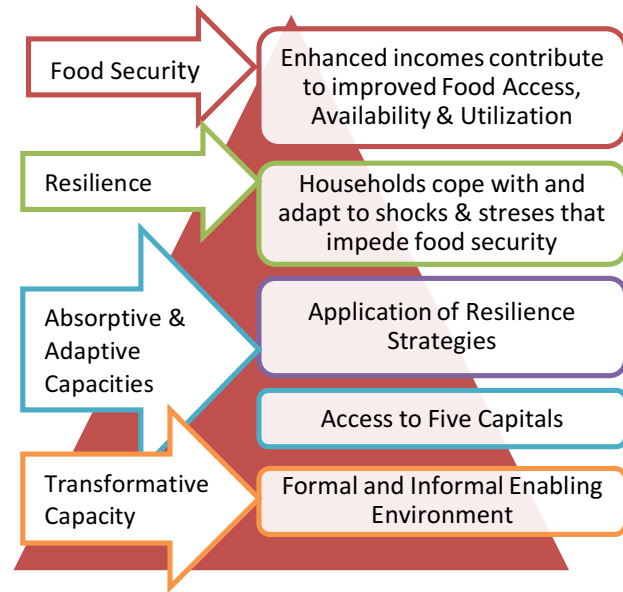
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Executive Summary

The purpose of this assessment was to evaluate the potential for households and communities in Myanmar’s Ayeyarwaddy Delta region to learn, cope, adapt, and transform in the face of shocks and stresses, and therefore ultimately achieve improved well-being outcomes. Mercy Corps’ **Strategic Resilience Assessment (STRESS)** process was employed to analyze the dynamic social, ecological and economic systems within which Delta communities are embedded and how these conditions determine vulnerability to shocks and stresses, and threaten household and community well-being.

The Delta’s overall risk profile is predominantly influenced by climate and topography, but development challenges such as poor agricultural productivity, debt, unsustainable fishing practices, and rapid deforestation, deepen vulnerability, particularly for smallholder farmers and landless households. Hazards and development constraints are mutually reinforcing, and together magnify vulnerability, particularly related to flood risk. Inadequate coverage of flood protection infrastructure exposes many communities to floods and saltwater intrusion that result from extreme weather events, while extreme weather events such as cyclones can cause considerable damage to flood protection infrastructure. Agricultural profitability and ineffective (or short-term) on-farm production practices are linked in a negative feedback cycle, inducing soil and water resource degradation. As the quality of soil and water is diminished, agricultural productivity is further reduced, decreasing productivity, profitability, and ability to invest in effective soil, water, weed, and pest management practices, pushing communities deeper into vulnerability.

In response to this context, two consortia, one led by Mercy Corps and the other by Welthungerhilfe (WHH) and GRET, are implementing three-year food security programs in Laputta, Bogale, and Mawlamyinegyun Townships of the Delta Region. The concurrent LIFT-funded programs collectively known as ‘Delta 3’ aim to improve incomes, resilience, nutrition, and pro-poor policies, amongst smallholder rice producers, landless, and vulnerable households. Results will be supported through two separate tracks. The first is improved performance of smallholder farmers in the rice production value chain. The second is by enhancing non-farm livelihood strategies, particularly for landless and vulnerable households. Via these two pathways, the programs are expected to contribute to both greater resilience and ultimately, improved food security in the Delta.



Shocks such as coastal storms and flooding and stresses such as salinity intrusion and deforestation are undermining development gains in the Delta. To achieve meaningful gains over the long run, poverty reduction efforts must also be tailored to equip stakeholders with the capacity to manage risk by

reducing shock and stress 1| *exposure* – they occur less frequently or with lower severity, thus not as much response is required and 2| *impact* - when hazards occur, people and communities are less affected. Given the scope of the programs and the risk profile of the area, Delta 3 interventions should focus on helping people shift from *reactive* to *proactive* thinking. This means that interventions should focus on *awareness, access, networks, and decision-making*. These elements should be mainstreamed into individual development activities.

- **Awareness** – Project stakeholders are more aware of shocks and stresses, their interactions with one another and development constraints, and their impacts on supporting resources, livelihoods, and wellbeing outcomes. This can be accomplished by enhancing mechanisms that better coordinate the delivery of information for decision-making to beneficiaries.
- **Access** – Improve access of beneficiaries to appropriate and affordable resources, or resilience capacities that can be employed by stakeholders to reduce their exposure to or the impact of shocks and stresses.
- **Networks** – Improve the social capital, or relationships, of stakeholders. Bonding (within communities) and Bridging (across communities) social capital is employed to to diffuse strategies and practices. Bridging social capital (between people and institutions) is employed to improve the inclusive delivery of supporting services and governance.
- **Decision-making** – Interventions are designed to stimulate the use of resources to prevent and respond to shocks and stresses through effective resilience strategies. Stakeholders proactively adopt risk management behavior rather than waiting for support to be provided.

Access to resilience capacities, and their use through improved decision-making is fundamental to reducing vulnerability. The assessment identified specific capacities to help communities in the Delta prepare for, respond to and ultimately mitigate the presence and effects of identified shocks and stresses.

Absorptive Capacity is the ability of people and communities to minimize their sensitivity to shocks and stresses when they occur. In the Delta context, exposure to saltwater and freshwater flooding present the greatest current risk to lives and livelihoods. But low technical capacity in farming, livestock production, and fishing also increases their exposure to pests, disease, and unseasonable rain. In order to effectively mitigate the impacts of these hazards, producers can engage a variety of strategies to **increase the productivity of their soil and water and protect crop and harvest losses when shocks occur.**

Adaptive Capacity is the ability of people and communities to proactively modify conditions and practices in anticipation of or as a reaction to shocks and stresses. In the Delta context, a combination of climate and development trends pose increased risk of exposure to and severity of its risk profile. If farming and fishing are to remain dominant livelihoods, people and communities must maintain critical supporting resources such as soil and water and have the ability to spread their exposure to risk more effectively through diversification. Delta-3 interventions can help people and communities adapt to to the increased risk brought on by climate and development trends by building their capacity to improve long-term **soil productivity and effectively diversify livelihood strategies** including **both agricultural and off-farm.**

Transformative Capacity creates the conditions for systemic change and an enabling environment in which people are willing and able to invest and innovate, while managing risks. Transformative capacity addresses the underlying cultural, institutional and learning dynamics within the system, enabling communities to absorb and adapt over the long-term. Due to the construct of the Delta 3 program, opportunities to enhance transformative capacities are somewhat limited, but could include inclusive

and responsive **governance systems, extension services, and access to appropriate sources of information.**

The Delta STRESS findings indicate that sustained improvements in livelihoods outcomes can only be achieved with a transformation in governance associated with land management and supporting infrastructure. Climate change and escalating pressure on Delta ecosystems will increase the impacts of salinity intrusion and floods. Reducing these risks will require shifts in **governance** associated with **land-use planning** and associated investments in **natural resources management, wastewater management systems, and flood protection infrastructure.** Though such extensive efforts are largely beyond the scope of Delta-3 programming, there is a risk that recurring storms and floods will continue to undermine these development efforts until these systems are in place. The Delta 3 program is currently focused on market interventions and food security. However, the importance of these findings suggest that in order to achieve long-term development gains through resilience to shocks and stresses, a shift in programming approach may be required to include a focus on transformative capacity, for long-term sustainable change.

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I. Introduction

Myanmar's delta region is both a vital center of agricultural production and home to nearly 40% of its total population. Yet, despite decades of investments and policy reforms, poverty rates remain high amongst its predominantly rural (85%) population, largely engaged in agriculturally-based livelihoods. Food insecurity is a persistent challenge with malnutrition rates at 26% and child stunting at 27%¹ despite the fact that between 2009 and 2013 alone, Myanmar received nearly 5.5 billion dollars of official development assistance², much of which has been directed towards the delta region.

The region generally enjoys many geographic advantages for agriculture compared to other areas in Myanmar. It receives significant rainfall, hosts a labyrinth of waterways, features generally fertile and rich soil, level terrain, and a diverse aquatic ecosystem. However, being coastal, it is notably vulnerable to climate risks. The shortcomings of humanitarian and development program effectiveness in delivering enduring benefits is partially explained by the inability of governments and communities to protect themselves from the increased frequency, severity and unpredictability of these risks combined with an associated set development related pressures. According to the Global Resilience Partnership, more than one-third of development spending has been lost to crises in the past 30 years; about \$3.8 trillion worldwide³.

The situation is further complicated by the interconnectedness of shocks and stresses, and the underlying socio-ecological system conditions that stimulate, perpetuate, or exacerbate them. For example, lack of agricultural inputs and weak market access contribute to poor land management resulting in land degradation that further limits agricultural production. These conditions destroy crops, assets and incomes, further encouraging unsustainable agricultural practices, increasing degradation and aggravating hazard risks. Global climate change contributes to sea-level rise, which in turn drives water salinity further inland. The reoccurring nature of shocks means vulnerable families are placed on a downward spiral towards crisis.

Mercy Corps defines **resilience** as the capacity to learn, cope, adapt and transform in the face of shocks and stresses. Capacities can be:

- **Absorptive:** the ability to minimize sensitivity to shocks and stresses;
- **Adaptive:** the ability to proactively modify conditions and practices in anticipation of or as a reaction to shocks and stresses; or
- **Transformative:** Enhance the enabling environment to maximize the use of absorptive and adaptive capacities.

In response to this context, two consortiums, one led by Mercy Corps and the other by Welthungerhilfe (WHH) and GRET, are implementing three-year food security programs in Laputta, Bogale, and Mawlamyinegyun Townships. The concurrent LIFT-funded programs collectively known as '*Delta 3*' aim to improve incomes, resilience, nutrition, and pro-poor policies, amongst smallholder rice producers, landless, and vulnerable households. Results will be supported through two separate tracks. The first is improved performance of smallholder farmers in the rice production value chain. The second is by enhancing non-farm livelihood strategies, particularly for landless and vulnerable households. Via these two pathways, the programs are expected to contribute to both greater resilience and ultimately, improved food security in the Delta.

Mercy Corps defines resilience as the capacity to learn, cope, adapt and transform in the face of shocks and stresses. Resilience capacities include resources – human, natural, social, financial, and physical – or strategies that apply these resources towards resilience. Capacities can be absorptive, to help people, households or systems better prepare for or recover from shocks and stresses; adaptive, mitigating the

¹ LIFT Household Survey 2013

² World Bank Database 2015

³ Global Resilience Partnership (GRP)

very presence, nature, and impacts of shocks and stresses over time; or transformative, fundamentally unlocking the wider system constraints that enable coping and adaptation.

In order to ensure a resilience-building lens is integrated into program strategies, *Delta 3* teams conducted a Strategic Resilience Assessment (STRESS) of target areas. The Delta STRESS was designed to analyze the dynamic social, ecological and economic systems within which beneficiary communities are embedded and how these conditions determine vulnerability to shocks and stresses and program outcomes that contribute to food security. The process was structured around four key resilience questions that defined and focused the exercise (Figure 1).

- *Resilience for whom?* Vulnerability varies across geography and social groups such as gender, race, ethnicity, caste, and age.
- *Resilience of what?* The context and boundaries of the assessment including target the geography, the relevant elements of social, economic and ecological systems within that geography that relate to resilience, and the systemic factors that drive food insecurity and vulnerability.
- *Resilience to what?* The risk profile of the assessment area comprised of shocks and stresses that, collectively, threaten various population groups, at multiple geographic and temporal scales and across social, economic, and ecologic systems.
- *Resilience through what?* Access and use of capacities, including resources and livelihood strategies, that enable individuals, households, communities and systems to absorb and adapt to risks over time. Underpinning these are transformative capacities - the governance processes, formal rules and regulations, and informal norms, attitudes, and perceptions that enable or unlock the full potential of absorptive and adaptive capacities.

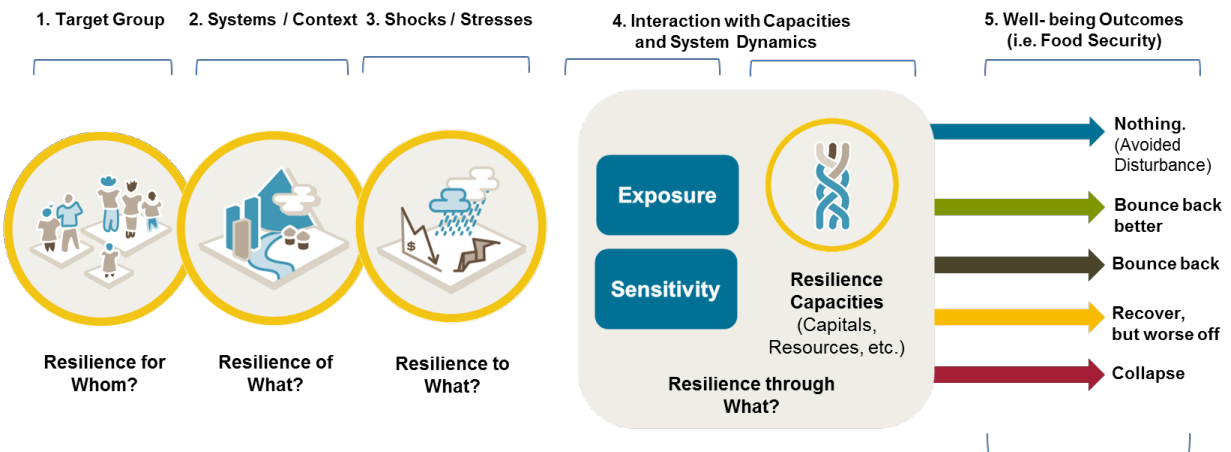


Figure 1, Mercy Corps' Resilience Framework

By mapping socio-ecological systems and the hazard environment, the team began to understand how different populations may be affected, and what capacities they require for their livelihoods activities to bounce back – and ‘bounce back better’ – after a shock. The purpose of this inception-phase activity was to:

1. Characterize the different types of risk that people and communities and their livelihoods activities (including rice market systems) are exposed to;
2. Determine the extent to which the livelihood practices of people and communities reflect proactive risk management behavior?

3. Identify opportunities for tailoring Delta 3 program activities to enhance the agency of people and communities to understand and proactively manage risk?
4. Identify opportunities for tailoring Delta 3 program activities to enhance the support institutions and market actors provide to help smallholder rice producers better evaluate and manage risk?

II. Methodology

The STRESS methodology involves four phases. This includes a scoping phase and preliminary literature review to set the assessment parameters and identify core research questions. The scoping phase is followed by the inform and analyze phases, which include collection and analysis of secondary and field data collection. The fourth “strategize” phase contributes to the opportunities and intervention design.

Phase One: The Scoping Phase began in late October and culminated in a three-day scoping workshop (11-13 November 2015), which brought together senior managers and program staff to establish the key context of the assessment framework through systems analysis, top-level research questions, a sampling strategy, and data collection arrangements.

Phase Two: The Inform Phase was carried out between 16 November and 18 December 2015 and involved tool development, training, pre-testing, and data collection from field work and literature reviews. Sampling criteria at the township scale was set in terms of agro-ecology and socio-economics. Female and male perspectives were captured separately to better understand the differing roles, vulnerabilities and capacities determined by gender:

Agro-Ecological Sampling Criteria

- *Saltwater zone* – Due to coastal proximity, rice can only be grown one time per year
- *Brackish, or Mixed zone* – Further inland, a second rice growing season is possible for some of the land
- *Freshwater zone* – Sufficiently away from the coast for two growing seasons and more consistent access to fresh surface water for irrigation

Socio-Economic Sampling Criteria

- *Smallholder farming households* – These comprise X% of the Delta population. The primary livelihood strategies are rice production combined with small-scale livestock production
- *Landless households* – These comprise X% of the Delta population. The primary livelihood activities include daily unskilled labor (including through migration), fishing, and small-scale livestock production
- *Other Vulnerable Households* – According to the Delta-3 programs, these are disadvantaged, extremely poor households that may be female-headed, include members with disabilities, or with other significant limitations. They comprise X% of the Delta population. The primary livelihood activities are similar to landless households, but with with less success and more constraints.

Training sessions for data collection staff were conducted 23-27 November including pre-tests in Thet Nyant Pan and Ah-lyne Tet Bo villages of Hlegu Township.

<i>Township</i>	<i>Agro-Ecologic Zone</i>	<i>Village</i>	<i>Methods (per village)</i>	
Laputa	Fresh	Yar Thit	<i>KII – Administrators, CBOs, market actors</i>	
		Aung Phone		
	Brackish	Chaung Kyie Kyi		<i>FGD - Smallholder Rice</i>
		Pyoe Kyo Lay		

	Salt	Thy Zon Bo Zon	<i>Producers, landless, vulnerable households, women</i>
Bogale	Fresh	Penne Chaung	
	Brackish	Sin Yoke-	
	Salt	Kyar Hone	
Mawlamyinegyun	Fresh	Bo Tone Kalay	
	Brackish	Ohe Ein Ting	
	Salt	Da Ye Chi	

Table 1, Sampling Plan

In order to gain a deeper understanding of systems dynamics and answer the four core questions around STRESS, the team applied a guided focus group discussion tool and two sets of key informant questionnaires. The focus of the tools and their contribution to overall understanding of resilience in the program is provided below:

Tool	Objectives
<i>Household-level Focus Groups</i>	<ul style="list-style-type: none"> Assess the understanding of the exposure and sensitivity of different types of households and their livelihood strategies to shocks and stresses Understand which strategies different types of households employ to prepare for and respond to shocks and stresses Understanding the types of support different types of households seek to better prepare for and respond to shocks and stresses from institutional and market actors
<i>Community-level Key Informant Interviews</i>	<ul style="list-style-type: none"> Assess the understanding of the exposure and sensitivity of different types of households and their livelihood strategies to shocks and stresses in their community Understand which strategies different types of households employ to prepare for and respond to shocks and stresses in their community Understanding the types of support different types of households seek to better prepare for and respond to shocks and stresses from institutional and market actors in their community
<i>Community and Township-level Market Actor and Institutional Key Informant Interview</i>	<ul style="list-style-type: none"> Assess the understanding of the exposure and sensitivity of different types of households and their livelihood strategies to shocks and stresses Understand the different types of support provided to producer/fishers to better prepare for and respond to shocks and stresses Understand the opportunities to provide better support to producer/fishers to prepare for and respond to shocks and stresses
<i>Literature Review</i>	<ul style="list-style-type: none"> Assess the exposure and sensitivity of different types of households and livelihood strategies to shocks and stresses Understand the key impacts of shocks and stresses on people, communities, market systems, and ecosystems

Table 2, Description of primary data collection tools

Key informant interviews at the village tract and township centers gathered more nuanced understanding of shocks and stresses, and specifically how they impact decisions and actions among households, government institutions and market actors.

Phase Three: The Analyze Phase took place between 21 December 2015 and 15 January 2016. The STRESS team conducted an analysis of field results and literature review in preparation for the analysis workshop, which took place 21-22 January. These sessions were focused on providing nuanced and in-depth answers to the core research questions based on the collected data.

Phase Four: The final Strategize Phase used the STRESS analysis to develop strategies for building risk management into the development support provided both to market actors, government officials, and

program beneficiaries. This work took place in January and February 2016 and culminated in this final report.

III. Vulnerability Analysis

The vulnerability of different social groups living in different areas of the delta results from the interplay between development constraints and hazards. This section is divided into three sections. The first section provides an overview of the key development constraints. The second section provides an overview of the key shocks and stresses. The final section provides an analysis of the resulting impacts of shocks and stresses given the developmental context.

A. Development Context

Low incomes derived from a diverse set of poorly developed livelihoods strategies are the central challenge addressed by *Delta 3* programs. Agricultural and off-farm livelihood options in the Delta are affected by conditions, or performance, of the social, political, economic and ecological systems in which individuals, households and communities are embedded. This section describes and highlights the development constraints that limit the ability of people in the Delta to successfully and reliably generate income.

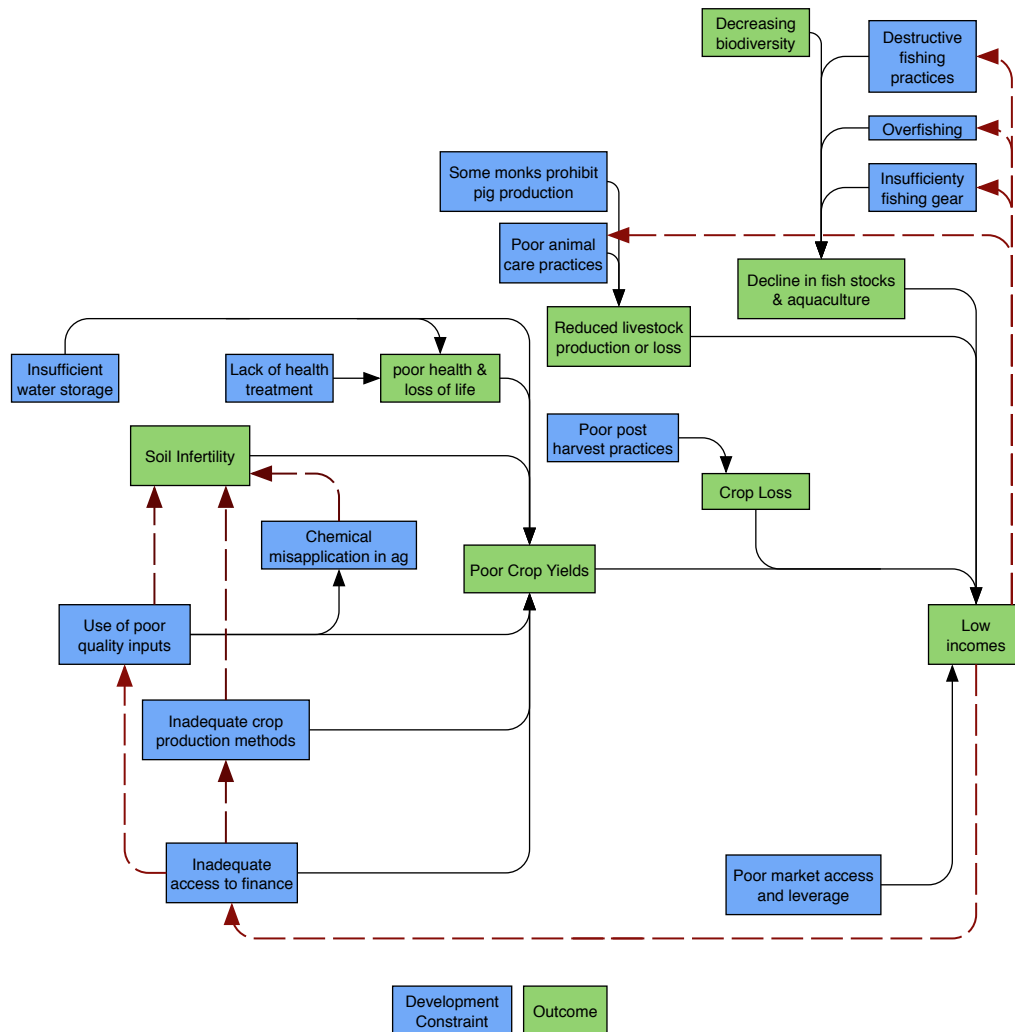


Figure 2, In this systems map of the Delta development context, low incomes derived from rice and horticultural production, livestock, and fishing result from several types of development constraints to be addressed through Delta 3 activities. The impacts on development outcomes are shown in green and the development constraints are shown in blue. Low incomes

resulting from poverty constraints further drive development constraints (shown using dotted red lines). These negatively self-reinforcing pathways are form feedback loops that drive poverty.

Crop Production

Farmers in the *Delta 3* intervention areas employ different farming methods depending on their agro-ecology - fresh, mixed and saltwater systems. All farming systems are sedentary and both intensive and extensive methods are used depending on the financial capacity of the individual farmer. Farms in the intervention area typically range from less than three acres as smallholders to larger landowners, who usually use more than 50 acres. Average farm size is lower in freshwater zones where the value of land is much higher. Farmers in the saltwater zone are limited to rainfed farming methods during the monsoon season. Those in the mixed and freshwater areas are able to grow for a second, summer season *and* are more likely to employ intensive and costly methods using higher inputs, labor, or technologies to achieve high outputs or yields per acre than those who are limited to the monsoon season. Irrigated farming systems are typically found in fresh water zones, particularly to support the summer production season.

The suitability of land in the Delta for crop production varies. As a delta flood-plain region, the land historically has received high amounts of sediment that is rich in nutrients. High rates of deforestation in Delta in recent decades has also contributed to increased sedimentation. In the future, it is predicted that upstream dam development will impede sediment flows into the Delta which could potentially reduce the soil's rate of nutrient replenishment.

Low incomes in the Delta can be largely explained by poor agricultural productivity that together, produce in a negative feedback cycle; combined with poor access to information, farmers are unable to afford to employ adequate agricultural practices, which results in low income and low incomes inhibit effective investments in improved agricultural practices:

Crop yields, though highly variable, remain generally below those of neighboring countries. Lower levels of input use (particularly improved seeds and fertilizer), poor management practices (particularly weed and pest control) and uncertain water control all contribute to dampening paddy yields. As a result, most output gains have come from area expansion rather than increased yields. At an aggregate level, sluggish agricultural productivity growth has resulted in flat per capita farm incomes, while agriculture's share in total GDP has declined from about 57% in the early 2000's to 36% in 2010 as a result of rapid growth in natural gas production and related sectors.⁴

Increasingly, farmers often let portions of their land lie fallow due to resource constraints, such as limited access to sources of new skills and knowledge, market information, quality seeds, tillage services, farm level assets, and financial services. This severely limits productivity, which translates to sub-optimal yields and actual farm profits that are well below their potential. Low output also limits multiplier effects—it reduces demand for labor (and so limits employment opportunities), reduces demand for other services (reducing opportunities for small and medium enterprise development), and reduces opportunities for downstream value addition activities.

Poor access to affordable and appropriate credit limits agricultural investment and income potential. Smallholder farmers typically carry significant debt and largely rely on private credit suppliers to purchase production inputs every season. Loans are often subject to restrictive repayment terms that force farmers to sell their production at when prices are lowest. The debt cycle carries forward as farmers are consistently unable to earn enough profit to finance the next season's inputs. *"Time is quite sensitive for our crop production. But the government loans don't come in time for our seasons so we*

⁴ Strategic Agricultural Sector and Food Security Diagnostic for Myanmar – Michigan State University & MDRI/CESD 2013

have to take loans with much higher interest rates from informal sources. This is also a leading driver for our debt cycle,” focus group discussion with smallholder in Penne Chaung.

Inadequate access to capital and finance remains a major constraint for farmers and landless alike. Many farmers are unable to plant all of their land holdings each season, and the entire value chain is dependent on the ability of farmers to produce. Limited access to finance is also a constraint, for example, for millers, traders, and other market actors along the rice value chain thus further limiting this segment of the market to realize maximum potential. In comparison, landless have even less ability to accessing loans from micro-credit providers because of lack of collateral, and virtually no chance of receiving loans through government schemes offered, for example, by MADB since they are not recognized by government as farmers. The cost of lending to landless in remote areas with less educated populations and little collateral, for example, is generally prohibitive or difficult for formal financial institutions and micro-credit providers alike.

Poor market linkages between farming communities and buyers also constrain agricultural incomes. First, villagers often rely on collectors and traders for pricing information. Farmers have little leverage to set favorable terms of sale and effectively take advantage of market shifts. Second, farmers cannot often afford time to delay sale, partly due to repayment terms as discussed above, but also because they lack access to proper storage facilities. Poor post-harvest practices also result in high yield or quality losses during storage, which increases the longer the time-period is.

The market in Myanmar is still fragmented, inefficient, and risk averse, and ideal market actors and profit incentives are not always available where they can be leveraged to improve efficiencies. There is specific need for linking the private sector to farmers and building the capacity of farmers to benefit within the market, especially as Myanmar’s economy is opening up exponentially. This includes opportunities to access higher value markets such as Yangon. Farmers that sell only in local markets have little incentive to improve the quality of their produce, for example for paddy and, in particular, their post-harvesting techniques as this adds little value if selling in local markets.

Improper access and use of inputs constrain agricultural production. This is partially the result of poverty because fertilizers and pesticides, which are largely imported, are becoming more expensive. Quality control is also poor because there are few effective checks in place to ensure products are as labeled.⁵ Chemical inputs can also be misapplied because farmers lack the knowledge necessary to manage soil and pests effectively. Access to quality seed varieties is also limited. The GoM has placed heavy emphasis on hybrid rice seed varieties with limited success given their “*high cost and low value*”.⁶

Access to and availability of equipment falls far short of existing demand and this is exacerbated by the rising cost of labor. One of the major issues highlighted by farmers in Delta is the lack of access to farming equipment and inputs. Due to the significant reduction in cattle and buffaloes following Cyclone Nargis, farmers realized that they would need alternatives to draft animals to prepare their land. However, the available agricultural equipment in most villages is not sufficient to enable all farmers to prepare their land or thresh their paddy on time. Although some shops in the local towns stock farm equipment, many poor and landless farmers cannot afford to invest in their own equipment due to a lack of savings and/or access to credit. Moreover, many farmers also lack the knowledge and experience to identify the equipment that will best match their needs.

Existing agricultural land policies constrain freedom of crop selection by fixing the type of crop a plot can be used to grow. As a result, farmers are less able to respond to more profitable market opportunities. Accordingly, commercialized horticulture is not officially allowed on paddy designated

⁵ Inputs sellers in both Laputta and Bogale in December 2015

⁶ Strategic Agricultural Sector and Food Security Diagnostic for Myanmar – Michigan State University & MDRI/CESD 2013

plots. However, some leeway is provided if alternate crops are grown aside from the primary (monsoon) growing season or at a small-scale (gardening).

The majority of households in Delta 3 townships do not currently own land. Though the situation has been exacerbated by the lasting impacts of Cyclone Nargis, low agricultural incomes, population growth, agricultural land-use policies, and market constraints are contributing factors. As a result, daily labor is the most prevalent livelihood strategy among rural households. According to the LIFT baseline survey of 2012, within their sample of 800 households in the Ayeyarwaddy Delta/coast region, 72% did not own land while just 4.9% own land greater than 20 acres. Average household income of landless households is about half that of landowning ones.⁷ For example, the average household monthly income in Laputta is approximately \$80/month, but for casual laborers, the average monthly income is only approximately \$44/month.⁸

Employment and wage labor

Although the Delta Region has a large young population and thus a 'demographic dividend', many are at present not fully employed, under-employed or employed in low wage and low- or non-skilled jobs in the informal sectors and productivity is low. The literacy rates, according to 2014 Census data, are fairly high, for both rural and urban areas: 93% and 95% respectively. However, less than 1% of the population over 25 years old has finished high school (grade 11). **Skilled labor opportunities are scarce** both in terms of supply and demand in this Region.

The official unemployment rate for this Region is 3.4%, but a large segment of the working-age population work as seasonal casual laborers for low wages and are under-employed. **Earnings from self-employment are typically low** and daily wages for casual – often seasonal - labor are usually between 2000 to 3000 MMK.

About 87% of the population of the target area of the Project lives in rural areas. If the household does not own land, the main earnings are derived from casual labor in the agriculture and fisheries sectors. A few larger employers provide employment in crab and prawn packaging and cooling factories. In the (small) urban areas, such as Laputta Town, **employment is mainly informal**: in small trade, teashops, micro - family businesses, retail shops and construction.

Fishing⁹

Fishing is the second most important livelihood option in the delta after rice production. This is particularly the case for landless households. Fishing is a marginal source of income for dependent households and a significant portion of the daily catch is directly consumed. **Lack of proper fishing equipment** is reported to be a key constraint. Small-scale aquaculture is largely absent from the delta region. Households report that catch sizes are low and have declined since Nargis, but there are also other key drivers of the decline. One of the key factors is overfishing, which is both a supply and demand problem. Experts and communities also report that fishing is largely carried out using unsustainable harvesting practices.¹⁰ On the supply side, key mangrove forest spawning grounds have been eliminated through deforestation and land development. On the demand side, and increasing landless population has increased the number of households that are dependent on fishing for their livelihood. It has, for example, been expressed that *"free distribution of fishing nets and boats to almost everyone by the humanitarian organizations in the Delta after Nargis has increased the fishermen population in the delta rivers [by] three fold."*

⁷ Driel and Nauta 2013

⁸ Mercy Corps 2011

⁹ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar, Global Water Partnership 2015

¹⁰ Socio- economy Analysis of the Delta Fishery Villages and Small Scale Fishery Livelihood, Ayeyarwaddy Region, MMRD, 2014.

Lack of fishing rights is also a primary constraint. **Licenses are prohibitively expensive** and the system is exposed to corruption. Fisheries governance in the Delta has improved through the formation of different levels of civil society organizations in villages and clusters. These organizations have helped to establish fishing development associations at township and district levels, with the aim of interacting with government stakeholders to ensure that small-scale fisher folk have access to fishing rights. However, challenges remain in advocating for policy changes at the regional government level where current tendering practices for fishing licenses encourage the payment of lump sum fees from successful bidders. Moreover, the requirement that bidders get a recommendation from the tender owner makes it difficult for fishing development associations to get the fish collection license for their centres. Present fishing laws therefore need to be reviewed and a legal framework of fisheries co-management should be established to enable small-scale fisher folk to access their fishing rights.

Livestock Production

Small livestock holdings such as pigs, ducks, and chickens, are an important but limited source of income for rural households. Small-scale livestock production in the delta region is widespread, particularly for home use. However, commercial opportunity and overall profitability remains limited because many villagers employ **poor rearing methods** that include unsanitary living conditions, inadequate shelter, inadequate diets, and ineffective disease control.¹¹ Additionally, in some areas, monks prohibit pig rearing for religious reasons. *“We have to listen to monks because they are quite influential in here. If we don’t, we will become so isolated from other villagers who listen to the monks,” a 42-year-old female in Ohe Ei Ting, Bogale.*

Governance Constraints

Myanmar’s governance limitations manifest in the Delta Region as inadequate budget allocations, poor service delivery, poor coordination between ministries and departments, and few accountability mechanisms. These factors underpin previously identified development constraints to Delta livelihood options.

Delivery of basic services in the Delta region is poor including power, water, and health services This is particularly the case for rural communities, which must travel farther to reach service providers or essential resources such as freshwater. *“Diarrhea is common particularly summer season when clean water access (drinking water) is difficult and at the same time temperature is the highest. We face this trouble every year but no one assisted us,” a 35-year-old female in Bo Zon village, Laputta.*

Access to Extension services are limited. Department officials identified lack of human resources and facilities as key limiting factors, which they related to insufficient budget allocations.¹² As a result, several department officials noted they rely on NGOs to provide technical support to the community. Weaknesses in public extension is a critical factor in the underperformance of farmers in the agriculture sector. Information on good agricultural practices, disease control, and technologies exists in the public extension system, but simply does not reach the farmers. One of the challenges of public extension systems is reaching *“the last mile”* to farmer households, as extension officers are under-resourced and unable to travel to the areas they should be servicing. For example, in the Laputta township Dept. of Agriculture office there are only 16 staff available to service all rice farmers in Laputta who, during monsoon seasons, cultivate a total of 366,496 acres. Transport costs also prohibit the extent to which they reach these farmers resulting in extension service workers generally reaching only to villages near main towns. *“We are ready to come talk about our activities in any villages by invitation of any NGOs or CSOs. We are very happy to educate many villagers as well. But we cannot do ourselves since we don’t have good budget do so,” a government official in Pyapone.*

¹¹ An official at Livestock Department in Laputta, December 2015

¹² Field Trip Notes, in both Laputta and Bogale/Mawlaymyaingyun in mid December 2015.

Poor policies, regulations, and enforcement also constrain Myanmar's agricultural sector. The Farmland Law and the Vacant, Fallow, and Virgin Land Law that leave farmers vulnerable to land grabs by businesses, and the potential distortion of farmer incentives and control over production stemming from the draft Farmer Benefit Act. Though good quality products are available, widespread use of cheap pesticides and fertilizer of unknown and likely poor chemical composition contribute to short- and long-term production deficiencies. Most products are imported from China and quality controls are all but nonexistent.¹³

Gender Constraints

Gender roles constrain the ability of women to realize their profit-earning potential. As a result, for example, female laborers earn 20% less than men on average.¹⁴ This can be explained by **reduced ability to control resources, make informed decisions, and effectively engage in appealing livelihood strategies**. Women typically have less access to social networks and critical systems such as markets, education and training, health and financial services. For example, women-headed HHs have more difficulty accessing loans from MADB, with less control over collateral. In general, women have limited financial decision-making power about household economic activities compared to men. Typically, coping strategies and attempts for women-headed HHs to diversify household income streams are often based on activities/products deemed of lower value such as compost making, trade in firewood and small-livestock rearing resulting in greater challenge compared to men for 'getting ahead.' *"Culturally, women have less power in important decision making. We are used to this," a 37-year-old woman in De Ye Chi, Mawlamyinegyun.*

Women's land rights can be highly insecure. Cultural norms and practices often marginalize women within their marriages and households, and many women lack awareness of their rights as joint owners of family land or as family members with rights of inheritance. Rights held by women-headed households are particularly vulnerable to loss to male family members, local elites and commercial interests.¹⁵

Education can be regarded as economically burdensome and unnecessary for girls destined to become wives and mothers. As a result, school completion rates are much smaller for girls than boys. Lack of basic numeracy and literacy is more likely to be a major constraint to livelihoods. Villages in many of the low lying lands of the Delta must cope with yearly monsoon rains which hampers children's access to schools as the flooding typically requires children to travel by boat in order to reach their classrooms.

Community leadership also remains male dominated in the Delta-3 area. A recent UNDP report, found that only 42 village/ward heads out of more than 16,000 total are female nationally (2013). The identified constraints for women participation in local governance and development issues are limited skills and experience, time constraints, stereotypes and socio-cultural and religious norms (e.g., *Hpone*), and lack of confidence.¹⁶ Gender power relations also affect the realities of women's engagement with social and economic actors and results in fewer opportunities for leadership in community structures and organizations. According to the *2015 Gender Assessment Report* by WHH/Gret, group presidents or managers were nearly all males as were almost all vice-president, except for Small Producer Credit Services (SPCs) which provides credit for vegetables, livestock, and home garden/fruit. In SPCs, females were on average three times more dominant than males in leadership and in being vegetable and livestock master trainers. Since vegetable gardening, fruit growing, and livestock raising are usually part time, small scale, and close to the home, these activities are more attractive for females.

¹³ Myanmar Agriculture in 2011 Old Problems and New Challenges, Harvard 2011.

¹⁴ Qualitative Social and Economic Monitoring, Round 1 Report, World Bank and Myanmar Development Research 2012

¹⁵ Property Rights and Resource Governance, Burma, USAID

¹⁶ UNDP. 2015. Women & Local Leadership: Leadership Journeys of Myanmar's Female Village Tract/Ward

B. The Hazard Analysis

Myanmar's National Adaptation Program of Action identifies the Ayeyarwaddy Delta as the most vulnerable region of Myanmar. Delta communities and their livelihoods strategies are exposed to a wide range of shocks and stresses. As a coastal region, climate is the most significant risk driver such as adverse weather events. The shifting and dynamic tidal cycle, for example, is a major determinant of which areas paddy production is possible. Extreme weather events hit the regions with frequency and intensity. **Coastal storms** occur about every two to three years according to the historic record. Each year, Delta communities are also exposed to **freshwater flooding** originating from upstream.

Climate-related hazards can also stimulate the occurrence of other threats, which means that communities are sometimes forced to deal with multiple types simultaneously. **Pest** and **disease** outbreaks that impact human health, crops, and livestock are often induced or aggravated by unfavorable climate conditions. For example, crop pest outbreaks are most common during extended periods of humid and cloudy weather. Waterborne illness most frequently occurs when water resources availability is most constrained. Outbreaks of malaria are most likely when heavy rains and flooding generate large quantities of standing water for mosquito populations to thrive. Finally, food price fluctuations are influenced by hazards. When production becomes most compromised by natural hazards such as drought, **food prices** are often highest.

Climate change is predicted to drive a broad range of changes to different threats in the Delta.¹⁷ The sea-level is predicted to rise 12 cm in 2020 from the baseline 3 mm rise in 2005.¹⁸ This will increase the area exposed to salinity intrusion, storm surge, and groundwater salinity. Water temperatures in the Bay of Bengal are also expected to increase. As a consequence, coastal storms and extreme weather events are expected to occur with greater frequency and magnitude increasing flood exposure, surface and ground water salinity, and erosion. Increasing erratic weather conditions will increase the occurrence of unseasonable rainfall and extended dry spells. Extreme heat spells are already beginning to occur with greater frequency and intensity, notably during the pre-monsoon months of March, April, and May. These are also expected to increase as a result of steady increases in average temperature.

Primary Shocks and Stresses Overview

Type	Frequency	Magnitude	Trends
<i>Cyclones and Coastal Storms</i>	Tropical cyclones hit Myanmar every three years on average.	Coastal area are most affected but tidal surges can be widespread depending on intensity	Predicted to increase in frequency and intensity
<i>Riverine Floods</i>	The most frequently occurring shock in the Delta. Peak threat level occurs between June and August.	A substantial portion of the Delta 3 area is at moderate and high risk of flooding	Nargis inflicted damage to the existing embankment network (2008) has increased flood risk
<i>Salinity Intrusion</i>	A constant stress depending on location	Coastal communities are most affected, but large tidal surges can salinize water supplies	Climate change is predicted to increase the magnitude of occurrence
<i>Agricultural Pests & Diseases</i>	A high rate of occurrence, particularly of fungal diseases and pests due to the delta climate	Region-wide	Unclear, but climate change could potentially increase exposure
<i>Unseasonable Rain</i>	Every season, especially during harvest and early growth	Region-wide	Climate change is predicted to increase weather variability

¹⁷ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

¹⁸ Myanmar's National Adaptation Programme of Action (NAPA), 2012

<i>Heat Stress</i>	Peak temperatures occur in March and April	Region-wide	Climate change is expected to increase temperatures and the number of days with extreme heat
<i>Mangrove Deforestation</i>	83% of the Delta's mangrove forests have been lost since 1973	Coastal areas most impacted, but region-wide implications on fishing	Unclear
<i>Water Pollution</i>	Data is lacking but increased chemical use in agriculture and quantity of domestic wastewater implies water quality is deteriorating	Depends on the pollutant. Arsenic in groundwater, domestic waste proximal to towns, chemical in agricultural areas	Exposure expected to increase as a result of urbanization and intensified farming practices

Table 3, Overview of the dominant shocks and stresses acting on the Delta Region

Coastal storms are most likely to occur from April to May and October to December.¹⁹ Since 1970, nine cyclonic storms have impacted Myanmar; about one every three years on average. Climate change is expected to increase the number and intensity of coastal storms as a result of increasing water temperatures in the Bay of Bengal.

In May 2008, the category three Cyclone Nargis had devastated impact, killing approximately over 100,000 people and stimulating the worst natural disaster in Myanmar's history. The Cyclone Nargis was characterized by wind speeds of up to 200km/hr accompanied by a 12ft (3.6m) storm surge with lasting impact. A large number of water supplies were contaminated and food stocks damaged or destroyed. The winds tore down trees and power lines, while the accompanying storm surge submerged countless villages. The disaster caused widespread destruction to homes and critical infrastructure, including roads, jetties, water and sanitation systems, fuel supplies and electricity. (Zaw Lwin Tun & Hla Oo Nwe, 2010). *"Due to the Cyclone Nargis, our storage facilities had gone and we are not able to rebuild them yet since we don't have any resources including financial ones," a 40-year-old village administrator in Bo Tone Kalay.* The population of water buffalo, an essential asset for rice production was decimated. A vast and critical network of flood protection structures were badly damaged, leaving much of the most productive part of the country currently vulnerable to catastrophic weather impacts.

Delta communities perceive cyclones and storms to be a serious threat that is beyond their ability to control. They were identified as a frequently occurring shock by the majority of focus groups. *"We don't even want to hear the words, Cyclones or Storms, whatever; we are always not prepared anything yet even for our lives though," a 38-year-old female laborer in Kyar Hone Village, Bogale.*

Riverine floods are the most common type of flood in the Delta given its broad collection of rivers, streams and creeks and its place as the terminus of the Ayeyarwaddy River System. Many of the high flood risk areas of the Delta are located in the Delta-3 region. Riverine floods are most likely to occur in July-August, at the height of the monsoon, but can also occur during the October-November harvest. They occur when intense rains fall over significant upstream areas of the river catchments. Most of the flooding in the delta area originates from the Chindwin River system. When it coincides with upper Ayeyarwaddy floods, severe flooding takes place.

Several notable Delta Region flood events have occurred in recent decades, including 1974, 1991, and 1997. In 1991 for example, the Hteinngu embankment which was constructed in the year 1872 on the Ngawun River, a branch of Ayeyarwaddy River, was breached between mileage 19/6 and 19/7 near Hteinngu village. The impact of the damage was disastrous: 1,146,000 ha of paddy land, 68,000 ha of other crops and 74,740 houses flooded, 74,674 animals drowned and 326,926 people from 269 villages from 8 townships affected.

¹⁹ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

Delta communities are acutely aware of flood risk. *"Floods are less predictable, and can come anytime; unseasonable rain can also happen any time, and any storms can take place any time too. The latter two can be a factor for another flood," a 50-year-old man in Bo Zon, Laputa.* The large majority of focus groups identified flooding as a frequently occurring shock and noted an increase in occurrence since Nargis destroyed much of the flood protection infrastructure.

Salinity intrusion describes the degree to which Delta water resources are saline. The Hydrology Branch of the Irrigation Department places a limit of 1 PPT concentration as the suitable limit for irrigation. Salinity intrusion, therefore, exists in places where the salinity of water resources exceeds that threshold. Tides transport salt-water in and out of an estuary and mix it with fresh river water. The mixing process in an estuary is complex and primary consists of tide-driven and density-driven mixing. River flows drive the density-driven circulation, pushing freshwater towards the coastal outlets. Tidal flows push saltwater inland based on the tides and storm surges. When river flows are lowest and tides or storm surges are highest, salt intrusion travels the greatest distance inland. Maximum intrusion typically occurs in March and minimum intrusion in November coinciding with the start and end of the monsoon rains.

Saltwater intrusion monitoring is limited in the Delta to a few locations and sporadic scheduling. There is no clear evidence suggesting an increase or decrease in the area subject to saltwater intrusion. Strong tidal and storm surges create large-scale intrusion events, salinizing drinking water supplies, inundating fields, rivers and streams with saline water. Sea-level rise coupled with increased upstream water use could increase the geographic extent of saltwater intrusion. Historically, a network of infrastructure has provided a certain level of control. However, as mentioned previously, much of this aging network was badly damaged by Cyclone Nargis.

Farmers are acutely aware of saltwater intrusion. It is one of the most important constraints to rice production, particularly for rainfed system in the saltwater and mixed zones. Farmers must time their production based on when intrusion is lowest. When conditions become unfavorable due to storms or severe tides, farmers must wait for salinity levels to subside. All saltwater and mixed farmer groups identified saltwater intrusion as a major threat. Many respondents noted that soil productivity has declined since Nargis as a result of increased salinity. *"We feel that our soil no longer works. So we've used calcium to make sure soil productivity work again, but we cannot afford that much. We don't have other option to work with either," a 35-year-old male farmer in Ohe Ei Ting, Mawlamyinegyun.*

Unseasonable rain has been identified by respondents as a threat. Typically, monsoon rains begin in late April, peak between June and August, and taper off in October. Farmers who practice rainfed agriculture organize their production schedule around this cycle. However, respondents reported being less able to predict rainfall patterns not than in the past. The township-level Meteorology and Hydrology Departments report that generally, the region is experiencing nowadays *"heavier rain falls, but with decreased number of rain days"*²⁰. The biggest threat occurs during harvesting time when heavy rains can damage the harvest; October-September for monsoon season and December-January for summer season. The planting and initial growing period is another sensitive part of the production cycle where heavy rains can destroy crops and force farmers to replant.

Communities perceive unseasonable rain to be largely beyond their ability to control. The majority of farmer focus groups identified unseasonable rain as a frequently occurring shock and believe their exposure to be increasing. *"Unseasonable rain is just spoiler for all of farmers in here because even after harvesting, we are not safe. The rain can come anytime and can reduce quality (along the price), just prior to our finished product being in storage," a focus group discussion in Chaung Kyie Kyi, Laputa.*

²⁰ Field Trip Notes, in both Laputta and Bogale/Mawlamyaingyun in mid December 2015.

Agricultural Pests & Diseases are prevalent in the Delta intervention area. The most common livestock disease is Hoof and Mouth diseases. Rice sheath blight, bacterial leaf blight (BLB) and sheath rot are the most common diseases for rice. Cutworm and butterflies are common pests for vegetables. The most commonly found rice pests are the stem borer (*Scirpophaga incertulas*), rice gall midge (*Orseolia oryzae*), Jassid (*Nephotettix apicalis*) and rice ear bug (*Leptocorisa* spp.).²¹ Weather conditions influence pest and disease outbreaks. Pests generally favor abnormally heavy rains and diseases, particularly fungal ones, favor cloudy, humid conditions.

Communities perceive plant diseases as out of their understanding—because they are not traditionally familiar with them and are experiencing them to a greater degree than in the past. All focus groups and community meetings mentioned crop and animal diseases as a serious threat currently and potentially growing more serious case especially when they see that weather conditions shift in a way that favors outbreaks. Many respondents also identified mice as a threat to stored production. *“With weather conditions being chaotic, mice along with other animal diseases become widespread in our area. Mice are so many in number that we don’t even know how to control because we don’t have such experience before. We don’t know anything how to control some animal diseases because those are quite new for us, too,”* a focus group discussion with smallholder in Bo Zon, Laputa.

Heat Stress occurs when the combination of temperature and humidity compromise the health of plants and animals. Peak temperatures in lower Myanmar occur during the pre-monsoon months of March and April. The average temperature in Myanmar is increasing at a rate of 0.8 °C per decade and an increasing number of ‘hot’ days (above the historic average).¹⁷ Communities widely perceive heat stress to be an increasingly problematic threat and recognize climate change as its primary driver. Farmers reported rice production losses. Households reported reduced productivity and death of livestock. All households reported reduced human health and productivity. *“Our ducks cannot even produce eggs because of peak temperature; even if they produce so, those eggs are quite smaller and not marketable,”* a 37 male livestock person in Pyoe Kyoe Lay village, Laputa.

Mangrove Deforestation is a significant stress acting on the delta region. The mangrove forests of the Ayeyarwaddy Delta have been seriously degraded over time primarily the result of wood harvesting and conversion to agricultural land-use. The government promotes these activities to ensure self-sufficiency in food production. The mangrove area has decreased from 619,019 acres to 111,318 acres between 1980 and 2013. As a result, a total of 83% of mangrove forest land has been lost.²²

Mangrove forest ecosystems principally provide a wide range of services at the local and national level. Fishermen, farmers, and other rural populations depend on them as a source of wood (e.g. timber, poles, post and fuelwood), and non-wood forest products such as sugar, thatch, and alcohol.²³ The Delta intervention zone has had mangrove area especially in the areas around Bogale and Mawlamyinegyun townships. They are also critical mainstays of biological diversity by providing habitats, spawning grounds for fish, nurseries and nutrients for a number of animals. Assessments of the links between mangrove forests and the fishery sector suggested that for every hectare of forest cleared, nearby coastal fisheries lose some 480 kg of fish per year.²⁴ Importantly, mangrove forests can provide a critical buffer between communities and tidal surges as well as preventing and reducing coastal erosion.

²¹ A Survey of Myanmar Rice Production and Constraints T. A. A. Naing, A. J. Kingsbury, A. Buerkert and M. R. Finckh 2008

²² Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

²³ FAO, 1994. Mangrove forest management guidelines. FAO Forestry Paper 117. Rome.

²⁴ MacKinnon, J. & MacKinnon, K. 1986. Review of the protected areas system of the Indo- Malayan realm. Gland, Switzerland, World Conservation Union (IUCN) (cited in FAO & Wetlands International, 2006).

Some focus group participants noted mangrove deforestation as a stress, mostly related to wood fuel scarcity. Communities generally attributed to deforestation to corruption, *“We call it legal deforestation because this goes through corruption,” a 58-year-old farmer/fisherman in Chaung Kwe Gyi Village in Laputta township.* A few respondents noted that mangrove areas had been good sources of fish but were now limited. No respondents identified the important role mangrove forests play in salinity control and flood protection.

Water Pollution is an increasing threat in the Delta. Due to various policy reforms, chemical fertilizers and pesticides are increasingly being utilized in rice production and utilization rates are highest in the Delta. Urbanization is also increasing the quantity of untreated wastewater flowing into water resources and shallow groundwater. An increase in industrial and mining activities is expected to increase exposure to a range of pollutants in the region. Finally, recent studies have identified arsenic as a naturally occurring pollutant in certain groundwater resources.

In agriculture, many respondents and officials expressed concern that misapplication of chemical pesticides and fertilizers was contributing to increased water (and soil) contamination. However, conditions are largely unclear because there is little data and few monitoring systems in place. *“After the Nargis, our fresh water wells have become salt water wells; our water quality is getting poorer. Our drinking water access is more limited,” a 40-year-old female in Bo Zon Village, Laputa.*

C. Impact Analysis

Individual communities in the Delta deal with specific combinations of shocks and stresses that together, comprise their particular risk profile. Shocks and stresses are rarely experienced individually. Rather, they influence the occurrence and severity of one another. As a result, communities must often manage several simultaneously. The overall Delta risk profile is most influenced by climate and topography because natural hazards dominate the context. However, the overall impacts of a community's risk profile also depends on the development constraints they face, including from the social and governance environment. Development constraints and hazards influence one another. For example, Poor flood protection infrastructure coverage exposes many communities to floods and saltwater intrusion that result from extreme weather events while extreme weather events such as Nargis can cause considerable damage to flood protection infrastructure.

A systems analysis attempts to articulate the different ways in which development constraints and hazards influence one another in order to provide a more complete understanding of the impacts facing people, communities and systems. In Figure X, key productive resources and livelihoods in the Delta are shown to be adversely impacted by layering in the different hazards (*from section 2*) to the development constraints analysis (*from section 1*). In many cases, hazards and development constraints combine to create negative feedback loops. For example, low incomes constrain investments in good quality fertilizers and pesticides. Their use in agriculture can contribute to degradation of soil and water resources, which, over time, reduce agricultural productivity. *“Farm means ‘lei’ in Myanmar language. The term ‘lei’ also means a vicious cycle. Yes, we are in a vicious cycle of debt because farm ‘lei’ makes a big loss due to various shocks and stresses and so forth. The more work we do on the farm, the more we are in trouble,” a 56-year-old female smallholder farmer in Kyar Hone Village in Bogale township.*

Extreme weather events, including coastal storms are chronically responsible for both riverine and saline flooding events in the Delta depending on when and where they occur. There is an important negative feedback relationship between large-scale storm events and flood protection infrastructure. Embankments in the Delta Region, which include drainage facilities, have been historically strengthened to protect large areas from flooding and salt intrusion. Prior to Cyclone Nargis, there were some 318 flood protection works, both government (88%) and private (12%), protecting a total of 1.2 million ha of cultivable land. The network was constructed in several phases, notably 1880, 1920, and strengthened

in 1992. But many of these structures were badly damaged by Nargis leaving the Delta more vulnerable to catastrophic weather impacts than before.

Salinity of soil and water resources is another critical impact driven by a complex set of interactions between development constraints and hazards. Sea-level rise will bring saline water further inland and inundate an increasing area. This is worsened by the inadequate and damaged state of the embankment network. Increased up-river water use, including extensively planned damming projects for domestic and agricultural uses will reduce freshwater flows into the delta, further enabling rising seas to push further inland. Moreover, increased exploitation of groundwater resources and fossil fuels in the region may significantly lower the Delta surface in the short term.²⁵ Combined, this implies there is high likelihood that ground and water salinity will be an increasing issue in the near term.

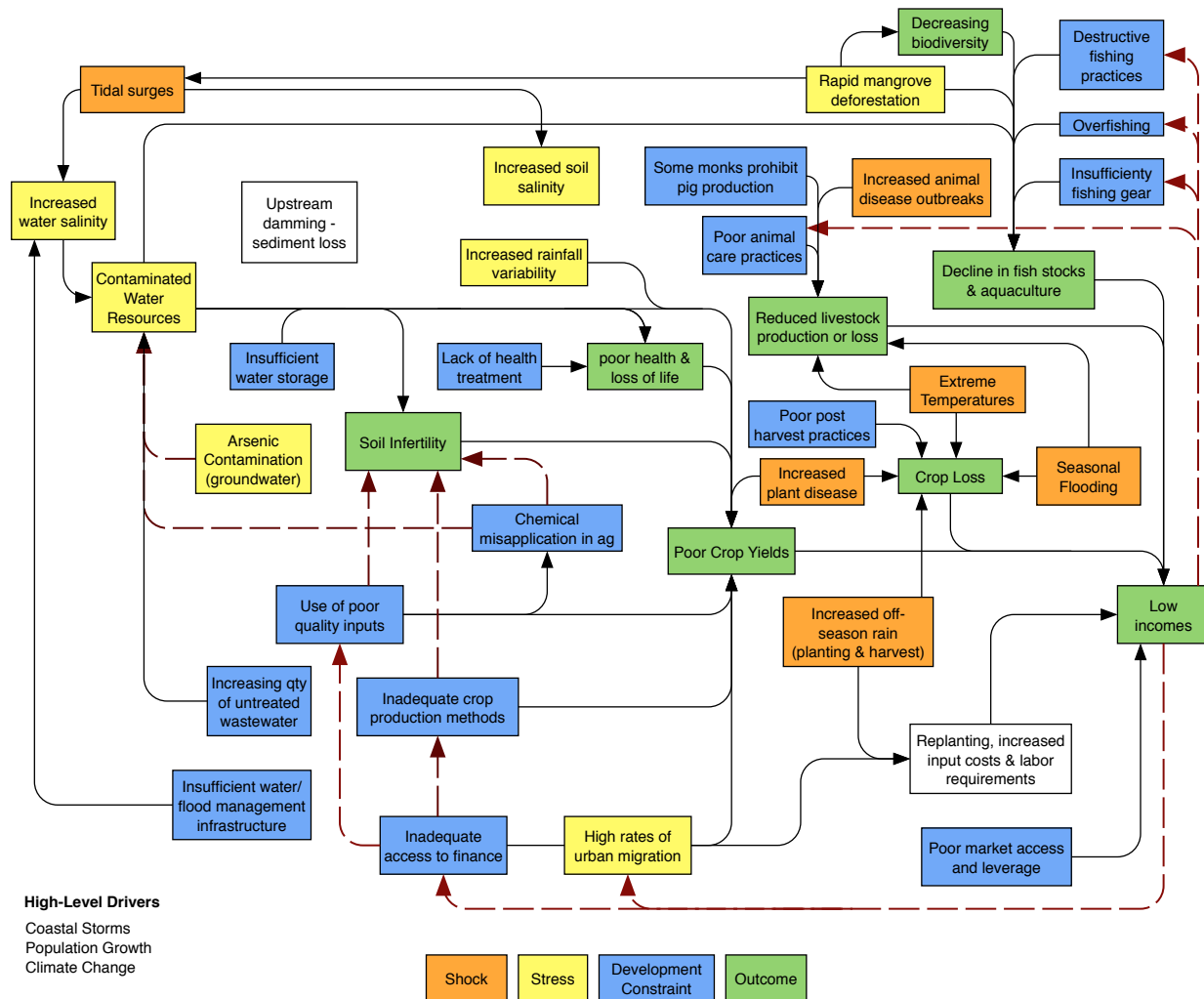


Figure 3, The systems map (figure 2) has been revised by layering in the shocks and stresses (orange and yellow) identified in the previous section. The impacts on well-being and key productive resources are now shown to be the result of the combined effects of hazards and development constraints. For example, soil infertility, not only results from the use of poor quality inputs and practices but also saltwater intrusion, water contamination, and other environmental stresses. Negative feedback loops are shown to expand such that the cycle of poverty is propagated by a combination of occurrence of short term shocks (flooding, disease, unseasonable rain), slow onset changes in resource productivity (soil, water, forests), and development constraints.

²⁵ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

The types of livelihood strategies supported by Delta-3 programming are subject to different shocks and stresses. The ‘risk profiles’ of each one must be evaluated in combination with the development constraints facing a particular stakeholder group in order to develop effective diversification strategies. Coastal storms, floods, and heat stress can be expected to impact all the livelihood strategies because these events have widespread impacts. Water pollution can also be considered a cross-cutting threat, though diversification into off-farm options that don’t have significant water requirements would help a household diversify away from this risk. Pests and disease are more targeted threats to crop and livestock production. Unseasonable rain is a threat to crop production, but may in-fact have benefit for water scarce location. Though mangrove deforestation can be expected to have limited direct impact on most livelihoods options, these should not necessarily be de-prioritized risks. This is because, as the systems analysis shows, these are drivers of several other types of risks, including flood exposure, erosion, and salinity intrusion.

	<i>Development Constraints</i>	<i>Human Health</i>	<i>Crop Production</i>	<i>Fishing</i>	<i>Livestock Production</i>	<i>Off-Farm Options</i>
<i>Coastal Storms</i>	Inadequate flood protection infrastructure and early warning systems	X	X	X	X	X
<i>Riverine Floods</i>	Inadequate flood protection infrastructure and early warning systems	X	X	X	X	X
<i>Heat Stress</i>	Many daily laborers and farmers work outdoors, lack of shelter	X	X	X	X	X
<i>Water Pollution</i>	Chemical misuse, little wastewater treatment	X	X	X	X	
<i>Pests & Disease</i>	Poor sanitation conditions as well as health & agricultural extension services	X	X		X	
<i>Salinity Intrusion</i>	Inadequate flood and irrigation infrastructure	X	X	X		
<i>Mangrove Deforestation</i>	fuelwood demand, poor NRM, demand for land			X		
<i>Unseasonable Rain</i>	Lack of proper storage facilities, poor soil-water management		X			

Figure 4, Overview of which livelihood strategies different shocks and stresses directly impact. In the Delta context, coastal storms, floods, heat stress, and water pollution can be expected to have the broadest reach. Off-farm livelihood options are exposed to the fewest hazards.

Human Health is directly impacted by the majority of hazards. Adverse health impacts can be responsible for productivity losses across the range of Delta livelihood activities. The primary development constraint is limited availability of health services. Health infrastructure is limited, particularly for rural communities. Affordability is another key constraint. Because the majority are in debt, households must secure additional credit in order to pay for health services. This inhibits preventative care, which increases the cost burden of health services further. Storm events and floods are the highest risk shocks with potentially devastating health consequences. The potential for immediate loss of life is high depending on severity. *“Drinking water is very limited so water-related diseases become widespread while health care services are difficult to obtain. We are worried about that condition especially when temperature keeps rising,” a 62-year-old male in Ohe Ei Ting, Mawlamyinegyun.*

Crop Production is directly impacted by the majority of hazards. The impacts floods, storms, pests, diseases, and unseasonable rain induce crop losses during the growing cycle, reduced yields, harvest losses, and reduced quality, depending on the timing. Coastal storms and riverine floods occur with high frequency (every 2-3 years) and the impact of these events on crop production have become more

severe because of the damage to the network of flood protection infrastructure inflicted by Nargis. As a result, the Delta is currently more vulnerable to sudden onset natural hazards than anytime in recent decades. Production in the saltwater and mixed zones are more vulnerable to coastal storms and extreme weather events. Production in the freshwater zones is more vulnerable to riverine floods. Sea-level rise and saltwater intrusion can be expected to decrease viable crop production land, particularly in saltwater and mixed zones. Farmers are reporting that heat stress is also beginning to negatively impact yields, which is projected to worsen with climate change.

In the medium to long-term crop productivity is closely linked to soil quality, which many experts and communities report to be in a general state of decline. Existing crop production methods are reducing the levels of key nutrients in the soil and incorrect chemical fertilizer use is hastening the decline.²⁶ Sediment transfer from upstream provide a vital replenishment of nutrients to Delta systems but will be reduced by planned upstream damming projects over the coming decades. Soil salinity is also worsening across the Delta region, which has been hastened by the damage to flood protection infrastructure. Increased salinity intrusion resulting from climate change will impact more farmland, rendering it less productive.

Medium to long-term crop productivity is also tied to freshwater quality and availability, which experts and communities report to be declining. Water scarcity continues to limit crop productivity in saltwater and mixed farming regions. *“To do farming, we are always waiting for a time when tidal waves get calm while praying,” a 50-year-old male farmer in Bo Khone Village, Laputta township.* Increasing storm surge frequency and intensity can be expected to further limit rainfed production and salinize scarce freshwater resources (including groundwater) in those zones. Increasing pollution of streams, rivers, and irrigation channels is a growing risk to crop production in freshwater zones. *“Previously, we very easily used stream water for our beans. But we can’t use it right away and we have to make sure the water become little fresh because the water is becoming very salty,” a 56-year-old male gardener in De Ya Pyu Village in Bogale township.* Finally, as farmer increase their use of chemicals to combat soil infertility, chemical runoff will lead to increased water pollution.

Fishing is directly impacted by a large number of hazards. Natural hazards such as storms and floods damage fishing equipment such as boats, nets, and other fishing gear. There is also evidence that Nargis depleted riverine fish stocks. Low fish catches are the number one concern of households that depend on it for daily income and they report a decrease in diversity of catches and biomass. Pressures such as overfishing, destructive fishing practices, reduced fish migration routes due to dams, mangrove deforestation, and increasing water pollution are now being exerted on fish stocks and the natural resources that support production in the Delta and there are concerns that current fish production, consumption and export earnings levels may become difficult to maintain²⁷.

Longer-term stresses including water pollution and heat stress also threaten the medium to long-term viability of the Delta fishing industry. *“We often find dead fish in our farm in April because this is the hottest month of a year,” a 34 female farmer in Penne Chaung Village, Bogale.* An increase in sea-level will provide a higher base for storm surges and other extreme climate events. Sea level rise and increased water temperatures are projected to accelerate coastal erosion and cause degradation of the mangroves and more offshore coral reefs, which in turn will negatively influence fisheries productivity.²⁸

Livestock Production in this context is primarily as a supplementary source of income. In this regard, storms and floods are the primary threat. One large-scale exception, however, is that Nargis killed a substantial percentage of water buffalo across the region. This is one of the major contributing factors to the farm labor scarcity that exists today. Heat stress, often combined with water scarcity is a

²⁶ Myanmar Agricultural Sector Review and Strategy, FAO 2005

²⁷ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

²⁸ Myanmar biodiversity conservation investment vision, Wildlife Conservation Society 2013

seasonal threat to livestock. Because livestock are often raised with poor shelter, inadequate feed, and with poor veterinary support, they are more susceptible to shocks and stresses such as heat, water stress, and disease. Respondents generally feel that raising livestock for supplementary income is an increasingly unprofitable strategy. *“There is a famous Myanmar proverb. It says, if you have duck breeding, you can at least breakeven even if you need to feed your duck a lot. That proverb now changes; we adopt a new one because ducks are not productive and foods are difficult to obtain and their eggs are getting much smaller. So ‘when you have duck breeding, you could lose all including your dead duck,’”* a 54-year-old landless man in De Ya Phyu Village, Bogale township.

Off-farm options such as small-businesses avoid the types of hazards that are specific to agriculture or livestock production such as crop or animal disease. They are typically not as directly susceptible to erratic rainfall, but large storms and floods can destroy productive assets, infrastructure, and stocks if severe enough. Human impacts can cut across all livelihood activities thereby affecting off-farm options, including illness, malnutrition, and heat stress. Migration, generally shifts people into a completely different risk portfolio unless the shock is widespread enough to affect both locations.

However, its important to note that any businesses within agricultural or fishing value-chains can be subject to the same set of risks as producers and fishers are. This means that off-farm options are not necessarily diversifying into more risk-averse strategies if they fall within those value-chains including input sales, transportation, value-addition, trading, retail, or other related services.

Impacts on Particular Stakeholder Groups

Smallholder farming households are most likely to be engaged in rice production with secondary engagements in small-scale livestock production and informal small business. Their risk profile is therefore concentrated around that of crop production. As a typically poorer sub-set of rice producers, they are less likely to be able to purchase sufficient inputs or use them effectively. As a results their plots are less productive and they earn less income. Many smallholder farmers are in perpetual debt, in many cases taken loans to pay back other loans. This leaves them less able to manage risk. With less available capital, they are more impacted by shocks and stresses and remain less able to make investments in productivity and their livelihood strategies remain marginal. Delta smallholder farmers are also currently suffering from a labor shortage that is exacerbated by the loss of water buffalo caused by Nargis. As they are less able to afford sufficient labor, they are less able to produce rice than in the past. *“Now is difficult to catch fish. Now is difficult to earn sufficient incomes from farming because of several poor weather conditions. Now is also difficult to earn incomes from other sources in here. So the only option is to migrate, which is good, because we can even earn daily income by working in construction site in Yangon for instance,”* a 45-year-old male labor in Benne Chaung, Bogale.

Landless households are most likely to fish, work as daily labor, small-scale livestock production, engage in informal small-business or migrate. Landless households are 50% poorer on average than landholding households.²⁹ The risk profile of landless households depends on their location and particular selection of livelihood strategies. But generally, they fall into two groups: fishing and daily labor. As the second most popular livelihood option, landless households fish for both for a combination of both basic subsistence and income generation and many suffer from food insecurity. Fishing gear is a major constraint for this group and they are less equipped to recover from shocks such as storms and floods with fewer means to repurchase their lost assets. Farm labor options are unsteady and seasonal. Because the daily labor wages are low, landless households are increasingly looking to others options (such as migration), leading to a reduction in the local labor force. As a result, farmers often have to pay laborers several weeks in advance. *“We understand that farming business in here cannot provide us*

²⁹ Data collection survey on agriculture, Sanju Consultants Inc. (JICA) 2013.

good working days that provide for our family. Our working days get less and less due to the fact that farming sector is deteriorating. Therefore, many family members decided to migrate for obtaining good working days,” a focus group discussion with landless household in Chaung Kyie Kyi, Laputa.

IV. Resilience Capacities

Improved income opportunities within a context of different shocks and stresses require individuals, households and communities to access a set of resources, and apply appropriate strategies that enable them to absorb and adapt to risk. These capacities are contingent on a broader enabling environment of social inclusion, knowledge transfer, and good governance, or transformative capacities for resilience. The STRESS process identified a set of absorptive and adaptive capacities to which communities must have *access* in order to build their resilience in the Delta context, and transformative capacities that enable this access to be achieved permanently at scale. Once established, these capacities directly contribute to improved resilience provided that they are *proactively* employed by stakeholders to manage risk.

Systems thinking provided the means for identifying the set of capacities required to improve the resilience of Delta people and communities. To do so, the systems map (figure 3) was transformed into ‘solution space’ by determining which strategies are needed to either reduce the impact of shocks and stresses or better manage them for different stakeholder groups. The transformative capacities required to inclusively bring these strategies to scale are introduced in the final section. The data collected through KIIs and FGDs were used to determine the status of existing resilience capacity. The high-level outcome in this assessment is increased and more stable incomes in rural Delta communities that contribute to greater food security. The ability of people and communities in the Delta to absorb, adapt, and transform in the face of shocks and stresses is evaluated against this outcome.

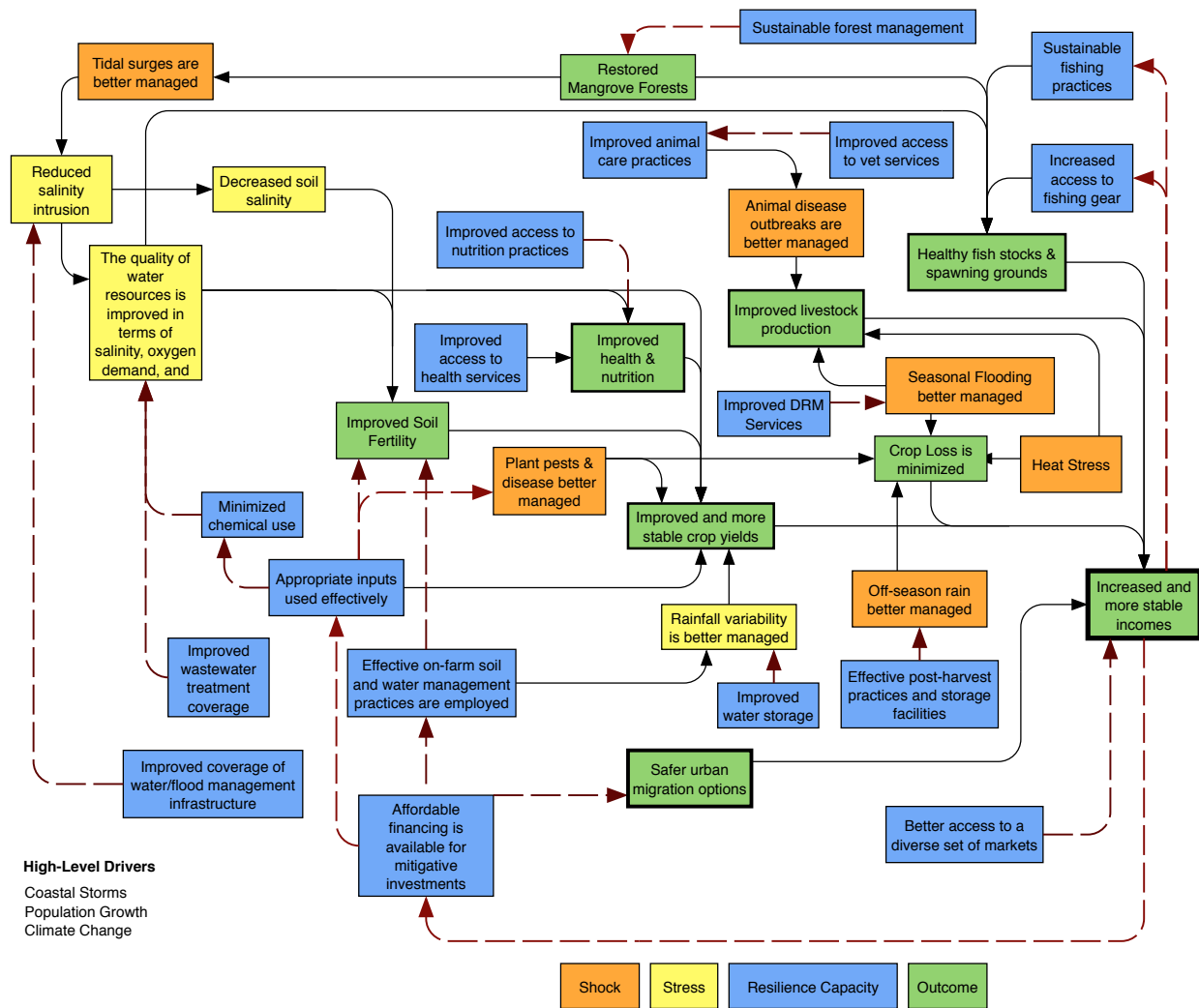


Figure 5, The systems map (figure 2) was transformed into 'solution space' in order to identify what absorptive and adaptive strategies are needed for people and communities to either reduce the impact of shocks and stresses or better manage them. Interventions that enhance resilience capacity become a necessary complement to those that address development constraints. Together, they turn negative feedback loops into positive ones, whereby increased productivity and incomes foster effective investments in livelihoods, health, and education, increasing the productivity of productive resources such as soil, water, and forests, which in turn, provide enhanced services to the public.

Absorptive Capacity is the ability of people and communities to minimize their sensitivity to shocks and stresses when they occur. These can either be preventative strategies or those that help them effectively bounce back when shocks occur. In the Delta context, exposure to saltwater and freshwater flooding present the greatest current risk to lives and livelihoods. But low technical capacity in farming, livestock production, and fishing also increase exposure to pests and diseases.

As discussed in preceding sections, shocks and stresses such as saltwater intrusion and flooding are major contributors to low crop productivity in the Delta. In order to effectively mitigate the impacts of these hazards, producers can engage a variety of strategies to protect the productivity of their soil and water resources and guard against crop and harvest losses when shocks occur.

Strategies that promote improved **soil water retention** are important for managing dry spells, unseasonable rain, and extreme weather events. These strategies enable farmers to extract greater productivity from existing water resources. This is particularly important in saltwater and mixed production zones where most farmers are completely reliant on rain. Respondents did mention the

need for better water retention strategies and indicated that most farmers currently engage in few specific strategies to actively do so.

Effective **pest management** strategies are important for maintaining crop yields when outbreaks occur. *“... pesticide use appears to have grown sharply in Myanmar in recent years, particularly in the years following cyclone Nargis in 2008... Evidence from several countries in Southeast Asia indicates that inappropriate use of pesticide can lead to worsening of pest problems... Our interviews with farmers revealed widespread pesticide use. However, farmers were uniformly unclear about their efficacy and risk. Many noted that instructions on imported pesticides were often printed in Chinese or Thai and so farmers relied heavily on agro-dealers for advice on pesticide use.”*³⁰ Respondents noted that pesticides are becoming more expensive, which has made it more difficult to apply them effectively. This is because farmers either select cheaper (less effective products) or apply them insufficiently. Respondents also noted a significant knowledge gap for how to apply pesticides effectively. *“Most times, when we see pest problems, we go and buy any pesticides that we’ve found at inputs store and use those. Of course we don’t know exactly about those pesticides,”* a 40-year-old male farmer in Chaung Kyo Kyoe, Laputa.

Effective **weed management** strategies are also important for maintaining the quality and quantity of crop production. The literature indicates that farmers face financial and technical constraints to employing these strategies successfully. *“Only 52% of the interviewed respondents practiced any form of weed control, although farmers faced difficulties with weed growth in both the rainy and dry seasons, often exaggerated by poor water management. Hand weeding was the most often employed method of control, as it allows for the selection of weeds useful for animal and human nutrition. Although a variety of herbicides for rice production are available on the Myanmar market, they are little used and were often cited by respondents as being too expensive. Overall, farmers... expressed only very basic knowledge about chemical weed control methods.”*³¹ Many respondents noted that existing labor shortages in farming have further limited the ability of farmers to manage weeds. Migration trends can be expected to continue this constraint, pulling a larger number of daily laborers from rural areas of the Delta. *“We need a lot of labor for weed management season. However, we cannot afford to hire labor much because labor wages are higher than we expected, and daily laborers are always thinking to migrate somewhere where they can get much higher wages,”* a 56-year-old male farmer in De Ye Chi, Mawlamyinegyun.

Harvest protection strategies that prevent harvested crops being destroyed or adversely affected are also vital. In general, a high level of post-harvest loss is reported in the Delta. These can be further exacerbated by unseasonable rain. Some farmers report using plastic or canvas sheets to protect late-stage crops from off-season rain. But employing this strategy at scale is expensive and largely infeasible for most farmers. One key constraint is lack of accessible storage facilities. Another is inadequate drying techniques. The previously mentioned labor scarcity further exacerbates this issue. Farmers are increasingly looking to mechanization to manage risk during this part of the production cycle (i.e. harvesting, threshing, drying, etc.) but access is currently highly constrained and financial limitations also play a key role. *“We would like to request the government to provide soft loans for our mechanization to manage our harvest protection. We don’t have any options excepting making this request. Otherwise, we are always at a loss side,”* a focus group discussion with smallholders in Pyoe Kyo Lay, Laputa.

Animal Care Practices & Veterinary Services are important strategies for effectively managing livestock disease outbreaks. Animals raised in poor sanitary conditions, combined with inadequate nutrition and poor preventative medical care are highly susceptible to disease. Many households, particularly

³⁰ Myanmar Agricultural Sector Diagnostic, Michigan State University 2013

³¹ A Survey of Myanmar Rice Production and Constraints T. A. A. Naing, A. J. Kingsbury, A. Buerkert and M. R. Finckh

smallholder and landless ones often do not provide adequate shelter for their animals. Many report preferring not to purchase food for their animals but rather let them roam. Veterinary services are not easily accessible and relatively expensive. This indicates that many households manage risk by minimizing their investment. However, respondents indicated it is becoming more difficult to successfully raise livestock without making larger investments in food, shelter, and veterinary services.

Cross-cutting

As an absorptive capacity, savings, credit, insurance and remittance access points provide shock-affected households with secure sources of cash for purchasing food, requiring lost productive assets such as fishing gear, and investing in strategies that reduce the impacts of shocks. When shocks occur, **financial services** help keep children in school and preserve productive assets.

Basic access to affordable financial services in the Delta is generally limited. *“Weak rural financial systems, high levels of indebtedness and heavy dependence on informal financing at high interest rates hamper farmer efforts to finance agricultural production and marketing.”*³² Lack of financial services and high levels of debt, therefore, inhibit investments in the shock mitigation strategies introduced above. Secondly, financial services are not necessarily tailored to function well under emergency conditions. Respondents noted that when a household member falls seriously ill requiring medical treatment, the only option is often high-interest loans from private money lenders.

Disaster risk management strategies are fundamental in helping communities absorb – both prepare and cope with storms, floods, and other disasters. This set of capacities includes, functional local committees, early warning systems, risk-mitigating infrastructure, and disaster response mechanisms. By limiting the harm that these disasters cause, they also reduce harmful spin-off shocks and stresses, like food price shocks, migration, and, salinity intrusion.

Despite chronic exposure to these shocks, effective DRM capacity is largely absent from the Delta. Official capacity is low. Village level disaster risk reduction (DRR) committees, a proven model of effective participatory disaster response and planning, remains largely absent. As previously discussed, much of the existing network of embankments and other **tide and water control infrastructure** remains heavily damaged, *“...embankments in the Delta Region, which include drainage facilities, have been strengthened to protect large areas from flooding and salt intrusion. Prior to Cyclone Nargis, there were some 318 flood protection works, both government (88%) and private (12%), protecting a total of 1.2 million ha of cultivable land. Many of these structures were badly damaged during Cyclone Nargis, leaving much of the most productive part of the country vulnerable to catastrophic weather impacts.”*³³

Early warning systems are also underdeveloped. Delta communities depend can receive storm or flood warnings by radio, but the capacity of officials to effectively monitor and assess weather conditions and water resources is limited. *“More accurate and timely information is vital for us but we don’t have any reliable sources yet,” a focus group discussion with smallholders in Da Ye Chi, Mawlamyinegyun.*

Adaptive Capacity enables people and communities to proactively modify conditions and practices in anticipation of or as a reaction to shocks and stresses. In the Delta context, a combination of climate and development trends pose increased risk of exposure to and severity of its risk profile. If farming and fishing are to remain dominant livelihoods, people and communities will require the capacity to manage these trends by maintain critical resources such as soil and water, having more flexibility, and the ability to spread exposure to risk more effectively through diversification. Secondly, people and communities must moderate these trends by reducing the adverse contributions their unsustainable practices have on critical natural resources such as soil and water.

³² Myanmar Agricultural Sector Diagnostic, Michigan State University 2013

³³ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

On-farm strategies that reduce the effects of natural and development related stresses on **soil productivity** are critical to supporting crop production over the long-term. These strategies aim to maintain sufficient key nutrients in the soil that plants require to maximize the yield quantity and quality. The literature reports that the existing ability of farmers, particularly smallholder farmers to do so either through chemical or organic fertilizers is currently low, *“At the current levels... the rice crop is removing far more than is being added through chemical and organic sources. The order of magnitude of the NPK deficit is of concern, and indicates soil nutrient mining with serious implications for long term soil fertility sustainability. Equally of concern is the imbalance in added nutrients, as phosphate and potash use is at such low levels. Such imbalance... [are] likely to cause negative side effects... Farmers are well aware of the need and value of balanced fertilizer application but are unable to access adequate seasonal credit... and lack the confidence to invest in intensification given the history of compulsory procurement and low prices.”* Respondents corroborate feeling unequipped with the technical and financial to effectively maintain soil productivity. Many recognize that existing crop production strategies are degrading soil quality through chemical misuse, monoculture, overproduction, or other factors. *“Climate changes, weather changes, rain pattern changes, heat changes, and everything keeps changing in here, but farming system remains the same.”- Government official, DoA office in Laputta Township.*

If fishing is to remain a viable source of income over the long-term, **sustainable fishing strategies** that promote healthy fish stocks across saltwater, mixed, and freshwater zones are vital. Though the Department of Fisheries is responsible for regulating leased and open inland fisheries, they report that activities are too widespread for them to effectively monitor. There has been a shift in recent years to fishing techniques such as use of chemicals or different kinds of pesticides. For example, fisheries department officials reported that some fishermen drop chemicals in the rivers, and then wait for dead fish being floated within few meters of that poison drop. The department argues, *“we don’t know whether he drops or not until fish floats dead, but how do we monitor it?”*³⁴ Second, electricity shocks are often used in fishing. Some electricity shocks are big and quite commercialized, killing *“not only fish but also fish species.”*³⁵

Poor households often **diversify** into several income generation activities to make ends meet (compared to wealthier households who engage in a smaller selection of strategies more intensively). Smallholder farmer focus groups indicated they divide their efforts across rice production, small-scale livestock production, and, to some extent, small-business. Landless focus groups indicated they tend to divide their efforts across fishing, daily labor, small-scale livestock production, and, to some extent, small-business. However, these activities are often marginally profitable, unstable, and not necessarily exposed to hazards differently. *“We’re already at loss side even before Nargis. After the Nargis, ours is much more exacerbated. Fisheries, farming, and everything. Even for small convenience store cannot make subsistence income because there are a lot of migrants, and less number of customers in villages,” a 50-year-old man in Chaung Kyie Kyi, Laputa.*

Spreading risk exposure across more than one type of livelihood strategies is one way to adapt to the shifting and uncertain impacts of shocks and stresses. Each hazard can occur at different times and in locations with ranging severity. **Income diversification** can be an effective way to manage risk *provided* the different strategies are exposed to risk differently. The exposure of two different types of strategies by a single type of shock (such as riverine floods) may be different. For example, a household’s farmland may be more exposed to flooding than its home because they are located in different places. These factors make effective diversification highly situational. Generally speaking, off-farm strategies are least exposed to risk in the Delta context. If, for example, crop production or fishing is adversely affected by a large flood, off-farm livelihoods are likely to provide income over that period. As with absorptive

³⁴ An official at Fisheries Department in Laputta, December 2015

³⁵ An official at Fisheries Department in Bogale, December 2015

capacity, access to financial services underpins the ability to enhance and diversify livelihood options. For adaptation, financial products must be designed for investments in productive assets and improved inputs. Payment terms must be compatible with practical business plans.

Diversification within agriculture can also be a valuable adaptive capacity. Farmers can be better equipped to manage shifts in water quality, soil conditions, and consumer markets with access to a greater variety of input products including seed varieties, pesticides and fertilizer. At present, seed supplies are limited in both quantity and variety. *“Poor seed and planting material quality is a major... factor limiting growth of almost all crop yields. Seed supply is currently a government-dominated activity that only provides an inadequate seed supply... Registered rice seed produced by the Seeds Division is provided to contract farmers... for multiplication and subsequent farmer-to-farmer distribution. However, there is little attempt to ensure seed quality and no seed certification.”* Farmers can also be better equipped to manage shifts in demand by having access to a great number of markets. At present, farmers report having little choice in buyers and bargaining power which limits their ability to take advantage of emerging market opportunities.

People in the Delta are increasingly diversifying through migration. For example, the Ayeyarwaddy Region is a net exporter of migrants to the formal sector.³⁶ Young men (<25 are the dominant migrant group. Nearly three-quarters of migrants travel without their families. As a result, remittances are a growing source of income for rural Delta households. Migration is an effective diversification option because it is largely removed from the local hazard profile and wage-earning opportunities can be higher than local options. Yangon is the most popular destination, with other Delta locations second. People sometimes migrate on a seasonal basis, coinciding with the primary crop production seasons or on a longer-term basis to more distant locations. Besides Yangon, other common destinations include regional urban centers, plantations in Tanintharyi, and international options such as Thailand and Malaysia as farm or construction labor. Migration does introduce additional risks to households. Migrant workers can easily be exploited by their employers. Households are also at a disadvantage when one or more healthy members are away, which can place additional hardships on families and disrupt local social networks. *“Most migrants go to big cities like Yangon in construction and garment for instance. Of course there are many difficulties to settle down with new jobs, which we don’t know before. Sometimes we should have made more income by asking for better wages but we don’t know how to do it because we are afraid of losing the jobs as well,”* a 40-year-old female in Kyar Hone, Bogale.

At the landscape-scale, climate change adaptation measures will be vital to the long-term prospects of livelihoods and living conditions in the Delta. As described earlier, predicted increases in the frequency and severity of coastal storms, sea-level rise, climate variability, and temperature increases can be expected to amplify the overall risk profile for the Delta. Improved **forest management practices** are a vital adaptive capacity to managing increased saltwater intrusion and storm surges. Mangroves provide several important functions including salt processing, storm-surge buffering, wood fuel, fish spawning grounds, and aquaculture. Mangrove forests are under the jurisdiction of the Department of Fisheries. Secondly, **flood protection infrastructure** provides crucial protection against storm-surges and floods. As previously described, many of these structures are currently non-functional. Putting a functional network of infrastructure in place to protect Delta communities against a greater number of increasingly intense storms and floods will be vital.

Adaptation measures that mitigate development pressures at the landscape scale will also be vital to the long-term prospects of livelihoods and living conditions in the Delta. Improved **water quality management practices** are a vital adaptive capacity with increasing pollution expected from urban population growth, agricultural intensification combined with climate change. This includes the need to establish wastewater treatment facilities to reduce levels of fecal contamination. **Natural resource**

³⁶ Formal Sector Internal Migration in Myanmar, Social Policy and Poverty Research Group 2015

management (NRM) strategies such as spatial planning and land management practices will also be vital to help communities adapt to natural and human development pressures. Mangrove deforestation is the clearest indication of this deficiency. Mangroves have been overexploited for fuelwood, cleared for agricultural land and shrimp farms. Yet, their essential functions have been undervalued and not properly linked to the livelihoods they support. Functional NRM aims to establish land-use strategies that link environmental health to people and livelihoods.

Transformative Capacity - *Creates the conditions for systemic change and a positive environment in which people are willing and able to invest and innovate, while managing risks. Transformative capacity addresses the underlying cultural, institutional and learning dynamics within the system, enabling communities to absorb and adapt over the long-term.*

The STRESS findings highlight the real challenges to participation and their impact on access to resilience capacities. Decisions around local development plans are largely centralized, and developed without sufficient context analysis. Respondents also indicate that corruption is often involved in resource allocations, including land and fishing licensing. As a result, critical public services including those for water, sanitation, health, and extension services suffer. Rural communities, with limited **agency, voice** and **participation** are unable to hold government sufficiently accountable for delivering the services that help individuals cope and adapt to risk. Respondents largely reported feeling powerless to manage the risks they face. *“We don’t even want to hear the words cyclones or storms, whatever. We are always not prepared anything yet even for our lives though,” a 38-year-old female labor in Kyar Hone Village in Bogale.* Given the complexity of interactions between different livelihoods practices, the natural environment, and climate, there are few forums for stakeholders to develop functional solutions. Achieving meaningful progress in establishing access to the absorptive and adaptive capacities discussed above will require meaningful governance reforms that enable formal institutions in the supporting areas of NRM, DRM, and agricultural extension to become more responsive to household and community needs.

Access to information for decision-making remains another critical limitation in the ability of people and communities to employ absorptive and adaptive capacities. There is limited availability of seasonal and short-term weather forecasting, provided by insufficient supporting infrastructure such as radar systems or weather stations. Weather forecasting messaging is also not necessarily formatted for optimal use in agriculture (according to the different stages of the growing cycle). Salinity intrusion measurements are only taken in a few locations a few times per year. Soil and water quality and water levels remains largely unmonitored across the Delta. Mangrove forest stocks are only monitored remotely and infrequently. Given the scarcity of data, it is difficult to envision the possibility of effective management systems being put in place without serious investments in data collection infrastructure and regularized monitoring systems in place. Financial and human resource limitations largely explain these deficiencies but undervaluation of these resources is a key underlying factor. *“You see that our office needs at least 3-4 staff to collect good data and to distribute updated weather information for our areas so that farmers, fishermen and other can mitigate risks advance. But were just 2 staff, without any sufficient facility/resources to do so,” a government staff at Meteorology and Hydrology Department in Pyapone.*

Enforcement of existing rules and regulations also presents a key limitation to absorptive and adaptive capacities. Fishing is one area where policies and regulations exist to some degree but in practice are very poorly enforced. For example, the Department of Fisheries has poor law enforcement capacity to enforce no-catch season orders. Poor regulation of the banking and finance sector is another deficient area, resulting in limited lending, institutional failures and high operating costs.³⁷ Another is imported pesticide and fertilizer quality. Most of these products originate from China where quality control is “all

³⁷ Myanmar Agricultural Sector Review and Diagnostic, FAO 2005

but nonexistent".³⁸ Improved certification systems for inputs including seed, pesticides and fertilizers would improve the ability of farmers to manage production risks. *"Law enforcement is very weak, and you would say, almost non-existence. This is because the government department is underfunded and staffs are not sufficient in number to make sure law enforcement. Many people take advantage of this situation too," a 55-year-old female in Chaung Kyie Kyi, Laputa.*

Insufficient delivery of **extension services** in agriculture, fisheries, and livestock also present a key constraint to effective absorptive and adaptive capacities. Government institutions lack human resources and necessary assets to support pest & disease control, soil management, and other important capacities. Several department officials admit that in order to provide better support, they would more resources and facilities, which is constrained by budget limitations.³⁹ Department officials recognize that they rely on international NGOs or Local NGOs to provide technical support to some villages. One factor is that services are not tailored to help people manage risk. In recent years, Myanmar's government placed significant emphasis on hybrid rice varieties. Given its high cost and low-value, better value would be gained from enhancing extension support and diffusion mechanisms of effective on-farm soil and water management strategies coupled with improved access to a larger variety of seed varieties. *"We understand that it is not always good to continuously grow the same type of seed for three years especially after the Nargis, and we have requested the government to provide us different hybrid seeds. We don't know why they cannot provide us though they said they would do," a focus group discussion with smallholders in Ohe Ei Ting, Mawlamyinegyun.*

It is difficult to envision a realistic future for agriculture in the Delta without a fundamental change to the way disaster risk management is carried out. Serious **Investments** must be made **in risk mitigation infrastructure**, including their operation and maintenance in a future of increased storm-surge events and flooding. The seriously poor state of existing structures, some of which are over a century old was recently highlighted, *"During field visits it was also observed that poor water tightness of the sluice gates of the polders create too high salt concentrations of the water. This seriously affects farming in the serviced areas. In addition, inundation of farms occurs due to poor drainage caused by uncontrolled sluice gates in wet season."*⁴⁰

V. Program Implications

The STRESS process identified opportunities to better support individuals, households, and communities to absorb, adapt and transform in the face of shocks and stresses.

³⁸ Myanmar Agriculture in 2011, Old Problems and New Challenges, Harvard Kennedy School, Ash Center 2011

³⁹ Field Trip Notes, in both Laputta and Bogale/Mawlamyinegyun in mid December 2015.

⁴⁰ Vulnerability and Resilience Assessment of the Ayeyarwaddy Delta, Myanmar. the Delta Alliance. 2015

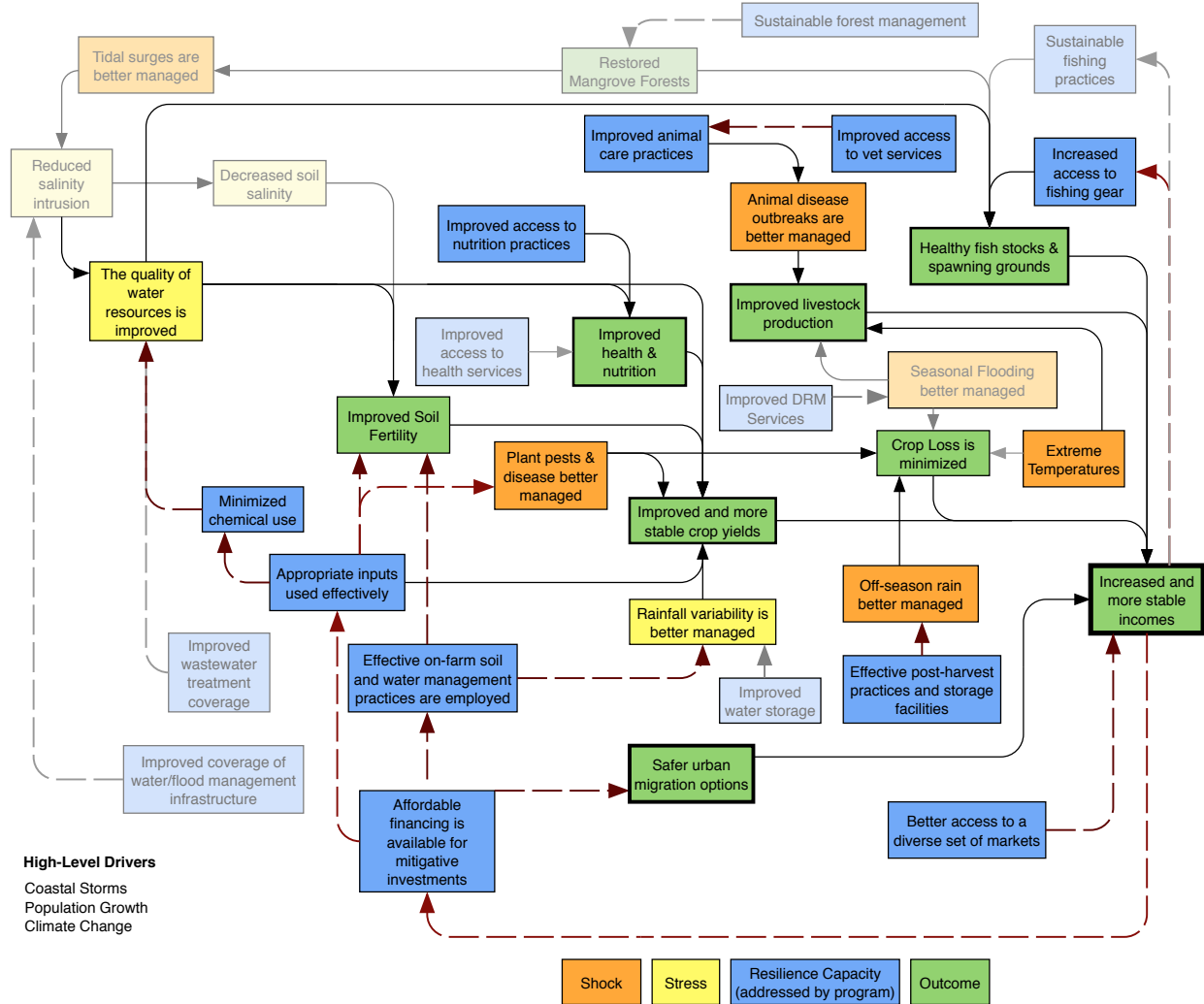


Figure 6, Resilience capacities that address some of the shocks and stresses (shown in faded color) are beyond the scope of Delta-3 programs. This implies that while progress in improving the function of productive resources and the stability and upward trajectory of high-level wellbeing outcomes can be made, some of the key factors that influence them will be absent. To fully increase the resilience of the system would require additional complementary programming or investments.

Some opportunities are beyond the scope of the Delta 3 programs. This includes many of strategies such as **investments in flood protection infrastructure, spatial planning, water resources management systems, wastewater management, and disaster risk management.** But the importance of these transformative changes *cannot* be understated because of the profound set of risks the Delta is exposed to. Climate and development trends indicate a high likelihood, that, unless flood protection and salinity intrusion control measures are enhanced, the lives and livelihoods in the Delta will be impacted with increasing frequency and severity.

Resilience Capacity	Scale	Expected Result	Key Stakeholders
Flood Protection Infrastructure	Watershed	The impact of salinity intrusion, storm surges, and flooding is reduced	DRD, MoAI, NWRC, ADB, WB, donors,
Spatial Planning	Watershed	The productivity of Natural resources and ecosystem services is improved including the essential role of mangrove forests	DRD, MoAI, MoECaF,
Water Resources Management	Watershed	The quality and quantity of water resources is improved	WRUD, MoAI, NWRC, MWRI, DRD
Wastewater Treatment	Municipal	The quality and quantity of water resources is improved	Municipal Authorities, WRUD, MWRI, DRD

Disaster Risk Management	Watershed	Systems (such as early warning) are in place that reduces the impact of shocks, mitigates their impacts, and helps people recover quickly	Administrative authorities, DRD, DMH, NWRC
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Table 4, Some important transformative capacities are beyond the scope of Delta-3 programs. Many of these occur at the watershed scale, which requires engagement with state and national level stakeholders.

Importantly, interventions should focus on helping people shift from *reactive* to *proactive* thinking. This means that interventions should focus on *awareness, access, networks, and decision-making*.

- **Awareness** – Project stakeholders are more aware of shocks and stresses, their interactions with one another and development constraints, and their impacts on supporting resources, livelihoods, and wellbeing outcomes. Support mechanisms that better coordinate the delivery of decision-supporting information to beneficiaries (see Figure 5). Equip stakeholders with the means to effectively monitor resources in order to support more effective planning and management decisions. Mainstream more functional and appropriate information systems into each set of development activities

Recommended Indicators: people who are aware of the specific shocks and stresses that impact their livelihoods, people who are aware of existing sources of information regarding shock and stresses, people who regularly access sources of information on resources health (soil, water, etc.)

- **Access** – Improve access of beneficiaries to appropriate and affordable resources, or resilience capacities that can be employed by stakeholders to reduce their exposure to or the impact of shocks and stresses (see Figure 5).

Recommended Indicators: people with increased knowledge of effective absorptive and adaptive practices, people with increased participation in governance, people with increased access to financial services that are effective for preventing or responding to shocks and stresses, number of different types of inputs available in the market (e.g. seeds, fertilizer, etc.)

- **Networks** – Improve the social capital, or relationships, of stakeholders. *Bonding* (within communities) and *Bridging* (across communities) social capital is employed to to diffuse strategies and practices. *Linking* social capital (between people and institutions) improves the inclusive delivery of supporting services and participatory and accountable governance systems.

Recommended Indicators: people that borrowed food, money or productive assets when a shock occurred, people that learned an absorptive or adaptive strategy from a neighbor, people that learned an absorptive or adaptive strategy from someone in a nearby community, people who participated in government decision-making or engaged with government officials

- **Decision-making** – Interventions are designed to stimulate the use of resources to prevent and respond to shocks and stresses through effective resilience strategies. Stakeholders proactively adopt risk management behavior rather than waiting for support to be provided.

Recommended Indicators: people who factored in their awareness of shocks and stresses in livelihood decisions, people who modified their livelihood strategy to either prevent or respond to a shock or stress, people who modified their selection of livelihood strategies to better spread their exposure to risk, people who monitor their productive resources (e.g. soil or water), market actors and institutions who are monitoring productive resources, institutions who are monitoring access to absorptive and adaptive capacities

Many proactive resilience-building strategies, particularly those focused at the on-farm or local scale can be (or already are) incorporated into Delta-3 program activities with both stakeholders directly but also indirectly with government service providers and market actors. These activities primarily involve fostering shifts in the way people and communities invest and manage their resources. In part, they seek

to limit the negative contributions that unsustainable farming and fishing practices have on key resources, but also to enhance the function of those resources to function better under shifting and uncertain climate conditions. These strategies form a portion of the complete integrated set of actions necessary to enhance resilience in the Delta. It is important to note that in order to realize increased income stability and growth over the long-term, these must be coordinated with the other interventions identified through the STRESS systems analysis.

Absorptive Pathways

Delta-3 interventions can help people and communities better prepare for, respond and ultimately reduce the negative effects of recurrent and unpredictable shocks and stresses by better managing on-farm soil and water, integrated pest management strategies, and access to supporting financial services.

Resilience Capacity	Scale	Expected Result	Key Stakeholders
Soil-water Management	On-farm	Increased nutrient and water retention	DoA, producer groups, seed suppliers, FLEs,
Integrated Pest & Weed Management	On-farm	Reduced vulnerability to pests and plant disease	DoA, producer groups, seed suppliers, FLEs,
Post-harvest Management	On-farm	Reduced post-harvest losses and increased quality	DoA, producer groups, seed suppliers, FLEs,
Animal Care Practices	household	Reduced vulnerability to disease	Animal Health Workers, DoL,
Financial Services	Village	Increased use of capital to invest in absorptive capacity and deal with shocks (floods, pests, disease, etc.)	MFIs, Agric. Banks/ MADB, Money lenders, Community savings groups, Village funds Value-chain actors, Cooperative Dept., DRD

Table 5, The program can enhance the ability of beneficiaries to access and employ absorptive capacities that are related to program objectives. Tailoring support in these ways will help people develop livelihood strategies that minimize their sensitivity to shocks and stresses.

Increasing the extension support farmers receive is a major component of both Delta 3 programs. The technical content development process for both programs should include soil-water management, integrated pest management, weed management, and post-harvest management strategies. These will need to be tailored to the smallholder context in saltwater, mixed, and freshwater systems. As resilience capacities, technical support should focus on providing a longer-term perspective on how farmers can proactively plan for and realize improved and more stable productivity. This requires that farmers are aware the threats they face, the characteristics of their soil, water, and environment that protect them against those risks, and what they can do to more actively monitor and nurture them. Delta 3 programs already plan to enhance access to post-harvest management strategies, included increased access to proper storage facilities by facilitating rental agreements.

The two Delta 3 programs have different approaches to non-farm livelihoods. The WHH-GRET program is focused on horticulture, livestock production, aquaculture, and small-scale business; all at small-scale and with support focused on landless and vulnerable households. Thus, there is opportunity to enhance livestock animal care practices, including better use of veterinary services to manage animal disease.

Delta 3 programs both aim to increase access to financial resources, though in different ways. The WHH program primarily aims to link people with MFIs and CBOs. The MC program is primarily concerned with linking Farmer Producer Enterprises (FPEs) with LIFT partner financial institutions but also developing contract arrangements between FPEs and millers. Either way, financial resources can be used to enhance resilience by ensuring they are tailored for investments in absorptive capacity; that increase water productivity, effective weed and pest management, animal care, and post-harvest management strategies.

Adaptive Pathways

Delta-3 interventions can help people and communities adapt to to the increased risk brought on by climate and development trends by building their capacity to improve long-term **soil productivity** and

effectively diversify livelihood strategies. As with absorptive capacity, it is critical that interventions must be designed to help people shift from a reactive to a proactive mindset.

<i>Resilience Capacity</i>	<i>Scale</i>	<i>Expected Result</i>	<i>Key Stakeholders</i>
Soil Productivity	On-farm	Increase the availability of key nutrients over the long-term and manage the load of chemical pollutants	DoA, producer groups, seed suppliers, FLEs,
Diversification	Village Tract	Households choose to engage in a set of livelihoods options that are exposed to different kinds of risk	DoA, producer groups, input suppliers, FLEs, MFIs, Cooperatives Dept.,

Table 6, The program can enhance the ability of beneficiaries to access and employ adaptive capacities that are related to program objectives in several ways. Tailoring support in these ways will help people proactively modify conditions and practices in anticipation of or as a reaction to shocks and stresses.

Supporting extension services should include soil management practices to help farmers establish better strategies for maintaining and enhancing key nutrients and minimizing chemical pollutants. This is essential to the long-term viability of crop production and water resources in the Delta. This should include appropriately simple methods for monitoring soil quality and developing more quantitative means for the application of chemicals.

It is essential for people and communities to have the ability to shift their livelihood strategies as conditions change. Delta 3 programs can enhance effective livelihood strategy diversification by increasing options within both on- and off-farm options. Market linkage interventions should provide farmers with more choices and the ability to make informed decisions about which set of inputs (i.e. seed, fertilizer, etc.) can help them better manage risk in the short, medium, and long-term. Both Delta 3 programs already intend to improve access to non-farm livelihood strategies, which will provide the best way to diversify into the most dissimilar risk profiles compared to crop production and fishing. The MC program will work with landless households to provide migration options are a safer option, rather than add additional risk.

In order to ensure financial services and products enable adaptive capacity, the program will support enhanced informal savings and loans groups for both on and off-farm activities, and foster stronger links to formal financial services – primarily cooperatives and microfinance institutions. While working on financial service access, the program will also engage vulnerable populations to increase their basic financial literacy, enabling them to take advantage of financial services specifically for adaptive livelihood shifts.

Transformative Pathways

There are opportunities, though somewhat limited, for Delta 3 programs to enhance transformative capacity, or at least, lay the groundwork for important improvements including more inclusive and responsive **governance systems, extension services, and access to appropriate sources of information.**

<i>Resilience Capacity</i>	<i>Scale</i>	<i>Expected Result</i>	<i>Key Stakeholders</i>
Governance	Village	Government support is better tailored to the actual needs of the community	DoA, producer groups, Administrative authorities, CBOs
Extension Services	Village	People have greater access to absorptive and adaptive capacities	DoA, producer groups, input suppliers, FLEs
Natural Resources Monitoring	Household	A shift towards evidence-based decision-making promotes increased adoption of improved management strategies	DoA, producer groups, FLEs

Table 7, The program can enhance the ability of beneficiaries to access and employ transformative capacities that are related to program objectives in several ways. Tailoring support in these ways will help people proactively modify conditions and practices in anticipation of or as a reaction to shocks and stresses.

There is opportunity to introduce mechanisms for improved governance. For example, the WHH program includes a set of activities that aim to give increased voice to farmer groups in wider forums including policy discussions. The program also supports wider dialogue through the Bogale Agriculture Technical Working Group. These activities will bring together the voices of beneficiaries, governmental authorities and civil society facilitating dialogue and coherent approach for advocacy at local or regional level. Implementing partners can advocate for improved policies, regulations, and enforcement systems that enhance resilience. Ideally, this advocacy is voiced directly by public and civil society organizations.

Support to community-based and private sector mechanisms for extension services can also be viewed as transformative capacity if they help people manage risk effectively. To support access to absorptive and adaptive capacities, extension services should be tailored to promote effective soil-water management, integrated pest management, nutrient cycling, and animal care practices. They should also help farmers understand the tradeoffs between the use of different types of inputs, including seed varieties they can make more informed choices as conditions change. It is also important that private and community-based extension models are monitored and regulated by government actors, such as extension officials from the MoA or MoL.

There are also opportunities to start introducing improved information collection, monitoring, and sharing systems. These can begin by establishing simple soil or water measurement methods for use within extension services. For examples, the use of simple rain-gauges could help farmers monitor rainfall to help manage soil-water more effectively. Regular checks of soil nutrients could help them better apply chemical fertilizers more effectively.

VI. Conclusion

The STRESS process revealed how communities in Delta 3 program areas face a range of constraints within the context of their food security system. These constraints are aggravated by and in turn contribute to ecological and economic shocks and stresses, which further impede their livelihood strategies. For example, storms and floods, exacerbated by climate change, degrade soil and water productivity for agriculture. These adverse conditions, combined with poor quality and high costs of inputs, and limited agricultural extension services, lead to unsustainable farming practices that advance the stress of soil infertility. Soil infertility reinforces land susceptibility to frequent shocks such as erosion and disease outbreaks, further reducing soil productivity and placing communities in a negative feedback loop towards reduced agricultural productivity and income.

In order to achieve and sustain food security gains in the Delta, communities must be able to better prepare and respond to shocks and stresses. This means being able to access natural, human, financial, social and physical resources, and proactively apply these through a range of strategies that contribute to resilience. In Myanmar, access and effective application of these resilience capacities is restricted by many factors, including weak governance, poor access to information, and inadequate risk mitigation infrastructure. This assessment identified a range of absorptive, adaptive, and transformative capacities that are needed to manage risk more effectively. Delta-3 programming can tackle these challenges in several ways, but primarily at local and township levels. This work must be complemented by landscape-scale efforts that reduce the increasing risks introduced by climate change and rapid development.