SCENARIOS FOR BUILDING LOCAL RESILIENCE PAKOKKU TOWNSHIP CLIMATE CHANGE VULNERABILITY ASSESSMENT (2016-2050)

SUMMARY FOR POLICY MAKERS

Myanmar Climate Change Alliance

MONREC

GCCA+ THE GLOBAL CLIMATE CHANGE ALLIANCE PLUS INITIATIVE

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Center for Climate Systems Research

'Climate Change Vulnerability Assessment of Pakokku Township, Magway Region, Myanmar, 2016-2050: Scenarios for Building Local Resilience

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CLIMATE CHANGE VULNERABILITY ASSESSMENT OF LABUTTA TOWNSHIP, AYEYAWADY REGION, 2016-2050: SCENARIOS FOR BUILDING LOCAL RESILIENCE

SUMMARY FOR POLICY MAKERS

EXECUTIVE SUMMARY

In 2016 the Myanmar Climate Change Alliance, comprised of UN-Habitat, UN-Environment and the Ministry of Natural Resources and Environmental Conservation, in collaboration with WWF and Columbia University conducted a detailed climate change vulnerability assessment of Pakokku Township.

Pakokku is located in the western part of the central dry zone, on the west bank of the Ayeyawady River. 290,139 people live in Pakokku Township, just over 30 per cent of whom live in the town itself. Pakokku has a mostly flat topography, except for some low mountains in the western area of the township, and is characterized by a hot, dry climate. Vulnerability relating to water is the predominant challenge in the township. Areas by the river experience floods, while away from the river drought and access to water is a chronic problem.

The study analyses current vulnerabilities, and by projecting changes in climate, anticipates further vulnerabilities in the future up to 2050. On this basis, it proposes scenarios that describe potential impact of climate change, and issues recommendations for adaptation to avoid the worst case future scenario. It also describes the expected outcomes and results, and prioritized activities that communities identified during the assessment.

The study projects changes in climate for the township, to a 25-kilometre spatial resolution. Projections show an increase in temperatures by as much as 2.7°C by 2050, with up to 17 more hot days per year.

The assessment shows that decision-makers in Pakokku Township will need to plan for variable rain, with increases concentrated in the monsoon season, less groundwater availability in dry areas, greater flood risks near the Ayeyarwady, and more frequent and more severe extreme heat events.

In current conditions, the study demonstrates, Pakokku Township is insufficiently resilient to the present climate conditions, and its vulnerability will increase greatly because of the projected future changes in climate if no adaptation actions are taken. This is mainly due to the current socio-economic; infrastructure and ecological system conditions, and the expected impact of climate change on these systems.

The interplay of these underlying vulnerabilities with ongoing and future changes in the climate will, if not urgently addressed, leave the people of Pakokku more vulnerable to disasters and slow on-set changes. The effects will be seen through more frequent loss of assets and potentially lives, lower incomes that will drive poverty, increased migration, worse outcomes for women and a declining public health situation. Housing and basic service conditions, especially in access to water, will also worsen, driven by changes in the climate and degraded ecosystems.

The assessment presents three possible adaptation scenarios by 2050:

A

Most likely / least desirable

The business as usual scenario, in which authorities and communities do not recognize the urgent need to address different aspects of vulnerability. Therefore, changes in climate have an exponential effect on the three systems analysed in this report; socio-economic, infrastructure, ecological and ultimately affect people's lives, livelihoods, health, and safety by 2050. In this scenario, insufficient planning capacities and governance, negate mid to long-term planning. Decisions are taken to respond to short-term needs; such as building infrastructure and houses in flood prone areas. Under this scenario, livelihoods, infrastructure and environmental conditions will not allow people to improve living conditions in the township. In addition, projected changes in the climate will interact with and exacerbate the existing vulnerabilities and as they do, new, unforeseen vulnerabilities may also emerge.

B

Currentlyunlikely/desirable

The resilience is built to maintain current living standards scenario, in which the township and communities recognize the urgent need to take action, but also recognize investment, time, economic, technical and skill constraints. In this scenario, an adaptation plan is adopted, and activities that can be implemented without large investment are consistently undertaken, such as the protection of the environment; improving skills and access to credit for more resilient livelihoods and incomes; improvement of water harvesting, among others. Under this scenario, decisions on land-use and town-planning would need to take into account current and projected climate risks, to prevent hazardous situations, such as infrastructure being constructed near flood-prone areas and the need to clean drainage infrastructure inter alia. In this scenario, the township and communities can plan their adaptation needs considering climate constraints, and communicate them to the districts, states and regions, NGOs and development partners. This scenario is the minimum required to prevent increased vulnerability, and to enable continued development.

C

Currently very unlikely / very desirable

Resilience is built that enables economic and social development despite changes in climate by 2050, considering the different vulnerabilities of both men and women, in which effective, strategic planning, resources, coordination, and time is assigned not only to maintain basic safety conditions, but to achieve development goals. Based on this assessment, the first of its kind in Pakokku, planning work that follows is strategic, and guides the township planning, the budget request to the district and other authorities. It requests investment from national authorities and international partners, to achieve three main results: **1) To achieve a greener healthy environment that supports the living standards of Pakokku in a sustainable manner despite changes in climate, 2) A diversified, inclusive and resilient economy, to enhance the economic conditions of the township; 3) A resilient infrastructure and connectivity, that protects and enables people.** In this scenario, efforts are sustained in an inclusive manner over a long period of time, and by a number of actors, but particularly the local and national government.

PURPOSE, PRINCIPLES AND METHODS OF THE ASSESSMENT

The purpose of this assessment is to inform the Pakokku Township, district, regional and national authorities, as well as the development cooperation, of the expected consequences of climate change and, on this basis, to help them to plan and act to adapt to climate change.

Five overarching principles guide the assessment:

- **Simplicity,** to ensure ease of replication in other townships
- **Measurability** and availability of data, to ensure ease of update and replication
- **Inclusiveness,** to ensure participation of communities
- **Comprehensiveness,** to ensure relevance of the findings
- **Spatial relevance,** to guide actual adaptation interventions
-

To respect these principles, the assessment uses the following:

- **Open-source or widely available software,** such as Q-GIS.
- **Data available at either national or local level,** is easily obtained upon written request. The assessment does not use satellite imagery. Although this creates limitations in developing flood modelling, for example, it enhances the replication potential of this work.
- **Data from the Census 2014,** disaggregated at village-tract and urban ward level, as a key source of information. In addition to being a vast source of information and insight, future census will provide actual monitoring of changes in the structure of the townships, which can be reanalysed in the future. Census data can also be easily accessed for each township;
- **Participatory approach,** involving communities throughout the whole township through simple questionnaires, community focus groups and participatory mapping;
- **Studying the three main systems that define the township; ecological, socio-economic, and infrastructure.** Climate change causes impacts on all three of these systems in Pakokku. A simple analysis of extreme natural hazards does not help to understand the extent to which the township will need to adapt. Hence, the assessment is designed to analyse system-wide issues and the interaction between systems.
- **Identification of the current and future spatial structure of the township,** which is essential to support planning and interventions for adaptation spatially
- **Equal participation of men and women** and, where possible, using gender disaggregated data
- **Representative engagement of young and old people**, and consideration poverty drivers such as a lack of access to educational opportunities
- **Engagement of the national government and the township** throughout the process, to ensure ownership of the results and replication

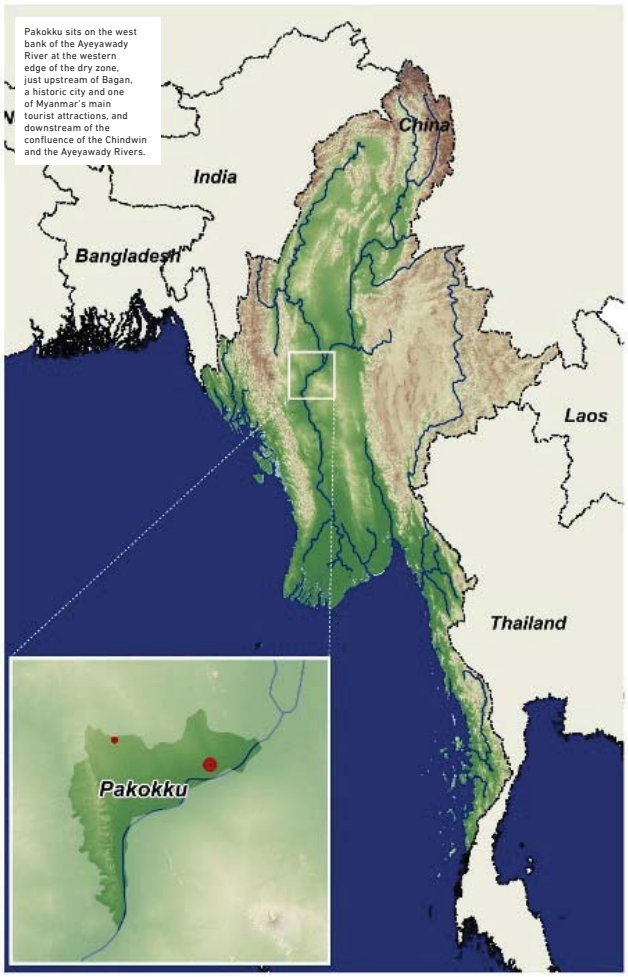
The methodology works as follows:

- **It establishes a basis for analysis by describing the context and key socio-economic, ecological and infrastructure features and the spatial structure of the township.** This generates insights on the current situation and sources of vulnerability. A vulnerability index is presented, which gives an account of the most vulnerable locations in the township;
- **It analyses, through both data analysis and community risk mapping, the exposure of people and assets to recurrent natural hazards** and their potential for rapid and slow on-set disaster;
- **It overlays downscaled projections of climate change** for the township on the current conditions analysed in the assessment and studies how these new climatic conditions will affect people and assets in the township;
- **It defines future scenarios that may materialize without adaptive action** and contrast them with potential adaptive pathways, which inform adaptation planning.

1

TOWNSHIP PROFILE

Pakokku sits on the west bank of the Ayeyawady River at the western edge of the dry zone, just upstream of Bagan, a historic city and one of Myanmar's main tourist attractions, and downstream of the confluence of the Chindwin and the Ayeyawady Rivers.



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Climatic features, natural hazards and observed impacts

- **A shorter monsoon season** results in water shortages for agriculture, drinking water, and livestock.
- **Higher temperatures** result in faster evaporation of fertilizers impacting nutrient cycling in soil and lowering agricultural yields.
- **Severe heat** affects livestock health and agricultural productivity.

Ecosystem conditions

- **A history of deforestation and land degradation have reduced the ability of the surrounding ecosystem to provide critical services,** reducing crop productivity and yields.
- A naturally **highly seasonal, dry climate, and poor water quality limit water security in the township,** making it highly vulnerable to any reduction in water availability or quality driven by climate change.
- Combined, these conditions have **resulted in highly variable, low crop yields that are likely to further decline** with increasing temperatures and changes in rainfall patterns.

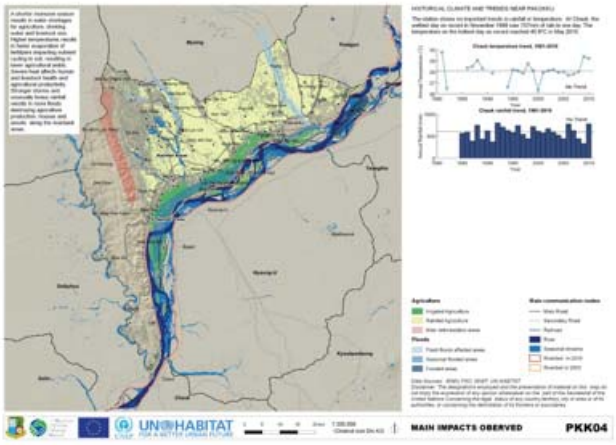


Figure 2. Main environmental impacts observed in Pakokku in 2016

Infrastructure Conditions

- **Housing construction is vulnerable to strong winds and floods,** mainly in communities along river bank areas.
- **Freshwater availability will worsen** due to the lack of infrastructure for water storage and management at community level.
- **Disaster and climate resilient protection services coverage is very limited.**
- **Poor transport communication infrastructure is highly vulnerable to hazards,** reducing people's mobility in rural areas.
- **The lack of climate-sensitive land-use planning increases communities' vulnerability to future hazards.**

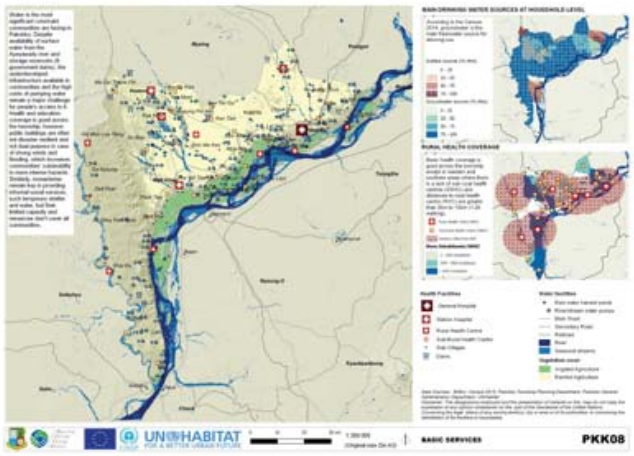


Figure 3. Basic services infrastructure in Pakokku

Socio-economic Conditions

- **There is very high youth migration, with a sex imbalance.** This results in fewer young, skilled and capable workers, an unusual sex ratio and a high number of female-headed households.
- **Relatively few people have completed education beyond grade-5 level, and virtually none have vocational training.** This makes it hard to attract high value-added, labour intensive industry to the township.
- **Household incomes, especially in agriculture, are very low.** This limits flexibility to prepare for and respond to climate hazards and slow onset changes.
- **Industry is the most valu**able sector, and is less climate vulnerable than agriculture, but does not create jobs.
- **Low levels of education, low incomes and high migration are mutually reinforcing.**

Sector	MMK (million)	%
Agriculture	84175.6	16.87
Fishery	16694.8	3.35
Industry	156707.1	31.41
Services	114295.8	22.91
Trade	105451.5	21 . 13
Total	498944.9	

Table 1: Economic breakdown in Pakokku

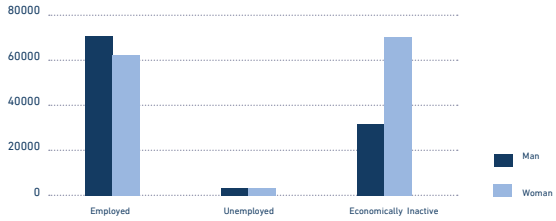


Figure 4. Labour force participation in Pakokku

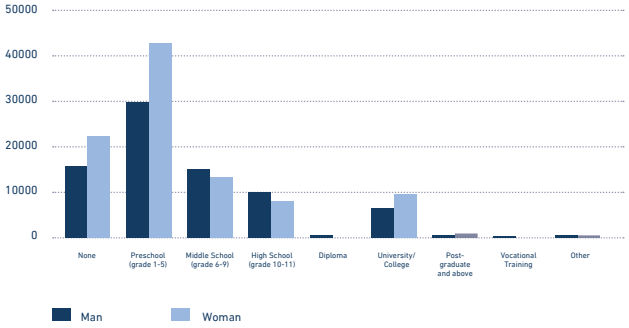


Figure 5. Level of education completed people over 25 (Census, 2014)

Spatial Structure of Pakokku

- **Pauk and Magway provide main socio-economic functions to western areas and southern areas respectively, while Mandalay represents the closest city for labour migrants and market supplies.**
- **Western areas of the township show the lowest levels of socio-economic and infrastructure development,** covering only basic health and education services and some basic needs. These areas concentrate 30 per cent of the total population and appear to be rather isolated.
- **Pakokku Town and Myit Chay are the two main clusters of settlements of the township** covering the highest levels of socio-economic functions and connectivity and provide the greatest number of social and basic services.
- **Kamma and Lan are considered nodal towns or important centres of socio-economic activity** to rural areas located strategically at township's border crossings.
- **Three primary corridors along the main routes of road transport networks are crucial** to support the economy of the township, enabling connectivity among the two main clusters and nodal towns.

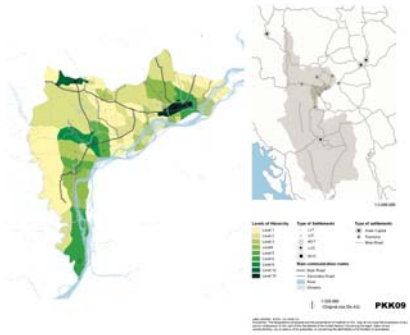


Figure 6. Spatial Distribution and type of settlements

Current Vulnerability Index

- **Village tracts along the western border of the township and those located by the river have the greatest levels of vulnerability.**
- **Areas by the river** have higher incomes and greater average incomes, but have the greatest exposure to hazards because of their location. Meanwhile, inland areas face very challenging access to water for both drinking and irrigation.
- **Vulnerability levels are high throughout the township,** with especially high levels of vulnerability defined above. This means that actions to adapt to climate change are needed throughout the township, with an initial focus on the highly vulnerable village tracts.

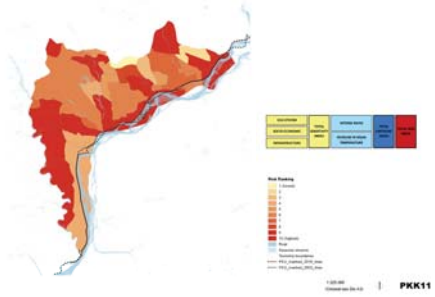
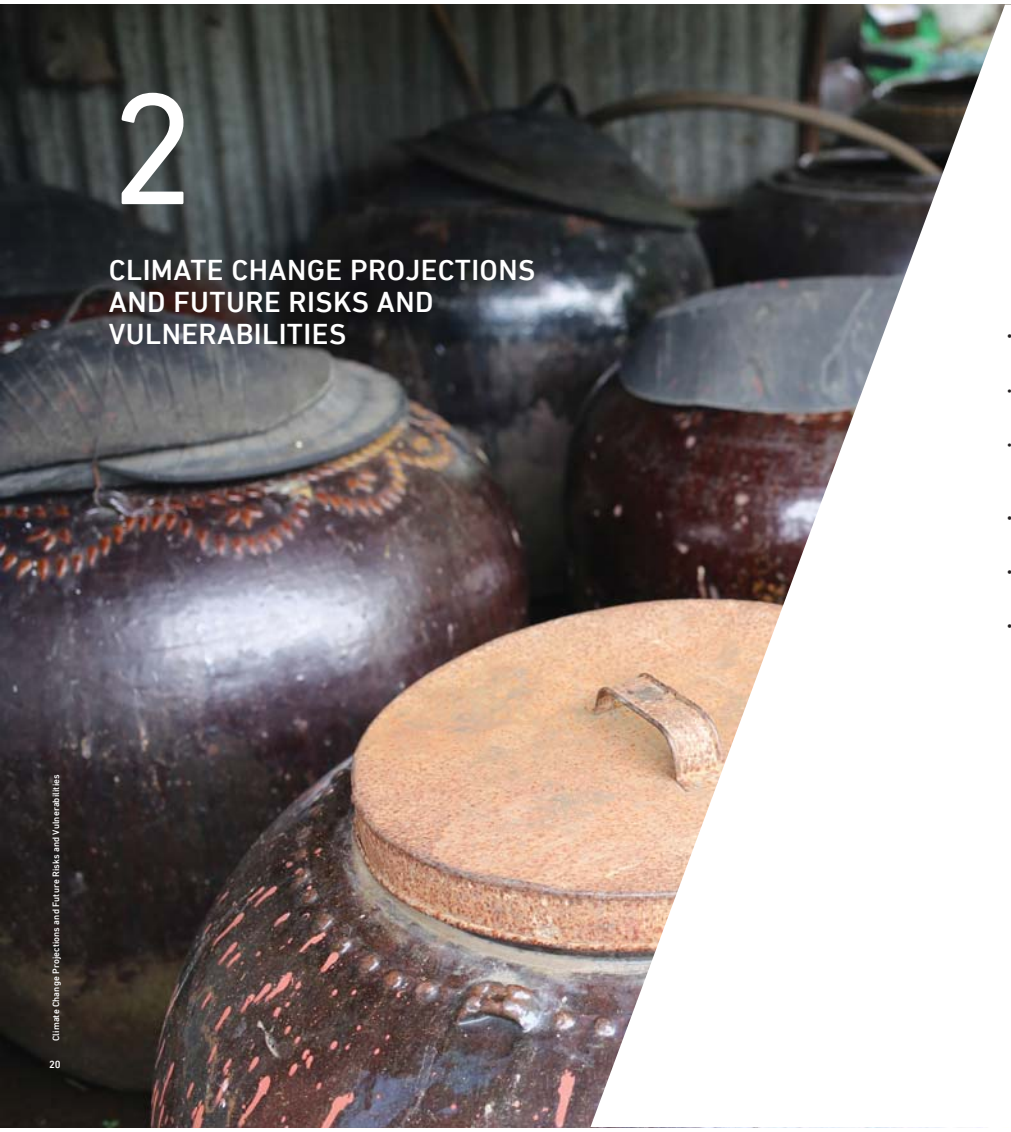


Figure 7. Vulnerability



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CLIMATE CHANGE PROJECTIONS AND FUTURE RISKS AND VULNERABILITIES

Climate Change Projections and Future Risks and Vulnerabilities

- **The temperature in Pakokku is expected to rise over the coming decades; annual average temperatures could rise by 1.2-2.7°C.**
- Warming in the hot season (March-May) and cool season (November-February) is projected to slightly exceed warming in the wet season (June to October).
- **The number of extreme heat days in Myanmar is projected to increase.** By mid-century, extreme heat days during March to May are projected to occur at a frequency of 4-17 days per month, relative to a historically-defined rate of 1 per month.
- **Climate models suggest an increase in total rainfall for Pakokku,** with more rain during the wet season.
- **In the cool season, climate models suggest that Pakokku may be more likely to see a decline in rainfall, than an increase.**
- **Decision-makers will need to plan for warmer temperatures, more frequent extreme heat days, greater amounts of wet season rain, decreased cool-season rainfall, and uncertain rainfall during the hot season.**

		Annual		Hot Season March to May		Wet Season June to October		Cool Season November to February	
		Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Pakokku	Temperature	1 .2+˚C	2 . 7+˚C	1 . 5+˚C	3 . 1+˚C	1 . 0+˚C	2 . 3+˚C	1 . 3+˚C	2 . 9+˚C
	Rainfall	%6+	%23+	%15-	%17+	%9+	%28+	%27-	%9+
Regional – Central Dryzone	Temperature	1 .2+˚C	2 . 7+˚C	1 . 5 +˚C	2 . 9 +˚C	1 . 1 +˚C	2 . 3 +˚C	1 . 3 +˚C	2 . 9+˚C
	Rainfall	%8+	%22+	%12-	%14+	%9+	%26+	%19-	%6+
Myanmar	Temperature	1 .3+˚C	2 . 7+˚C	1 . 4+˚C	2 .9+˚C	1 . 1+˚C	2 . 4+˚C	1 . 3+˚C	2 . 8+˚C
	Rainfall	%6+	%23+	%7-	%19+	%6+	%27+	%12-	%11+

Future Impacts

The assessment created a 'pathway to impact' graphic, which shows the primary and secondary impacts that will occur due to changes in the climate and resultant hazards by 2050. It also shows the complex interrelationship between hazards and impacts, including how a given primary impact can cause multiple secondary impacts.

The graphic shows that multiple hazards can cause some impacts. For example, crop failure and pests can result from all five of the hazards identified. By understanding this relationship, we can begin to see which people are more likely to be vulnerable; farmers are highly vulnerable because the crops on which they depend for their livelihood can be impacted by numerous hazards. Secondary impacts consider the broader, knock-on effects; so, crop failure would cause worsening nutritional outcomes, because many farmers keep a substantial amount of their crops for household consumption.

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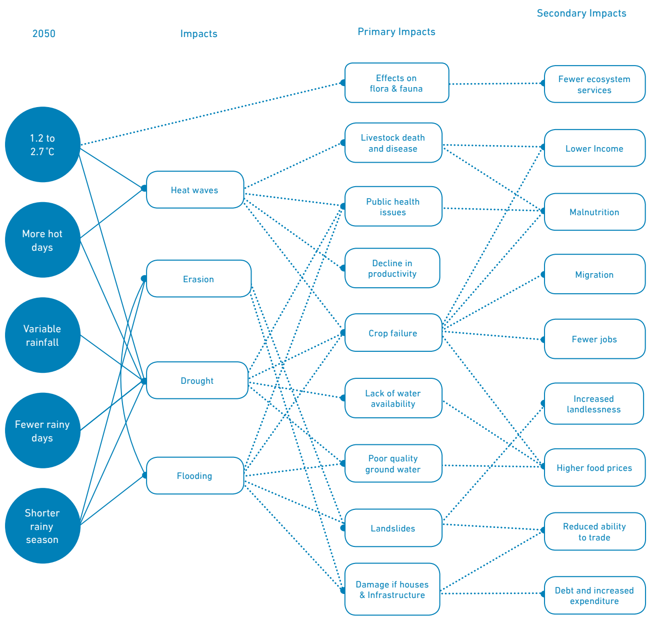


Future risks profile and vulnerabilities

This section of the assessment assumes that business will be conducted as usual, meaning that no adaptation actions will be taken. As such, the future vulnerabilities presented here are not a projection or a forecast of the situation in ecosystems, infrastructure, or socio-economics in 2050, but are a possible scenario if no actions are taken.

i. Increased risks of rapid on-set disasters

The purpose of this assessment is to inform the Pakoku Township, district, regional and national authorities, as well as the development cooperation, of the expected consequences of climate change and, on this basis, to help them to plan and act to adapt to climate change.

- The changes in climate will result in increasingly intense hazardous events. **The threat to people's safety and of loss of life from destructive events will increase, as current infrastructure, planning, and productive methods are not able to withstand increasingly severe hazards.** This is because there will be greater risks of rapid on-set disasters from floods and inundation, intense rain, cyclones and tropical storms, storm-surges, and heat-waves.

Increase in mean temperature of 2.7°C - with peaks in the hot season of up to 39.4 °C

+ 2˚C Warmer

Hazard	Main Projected Impacts
Heat waves	Crop failure and low yields; Livestock health impact; Human health impact, Decline in worker's productivity Heightened
Reduced water availability	Severe water shortages, resulting in lack of consumable water and water for irrigation
Cyclones/ strong winds	Damage to land and crops; Damage to housing and infrastructure; Damage of ecosystems and ecosystem services; Loss of lives and livelihoods; Saline intrusion in agriculture fields; and Impact to people's mobility Displacement of people

Changes in precipitation patterns, with rainfall projected to change by -15% to +17% in the hot season; and -27% to +9% in the cold season

+/- Rainfall

Hazard	Main Projected Impacts
Intense rains	Flash floods and intense surface runoff and soil erosion resulting in damage of crops Enhanced problems during La Niña due to excessive water levels
Flooding/ storm surges	River floods, flash floods, and urban flooding, with characteristic effects on people and assets; Severe inundation of land; Damage of ecosystems and ecosystem services; Damage to land and crops; Damage to housing, assets and infrastructure; Loss of lives and livelihoods; Impact to people's mobility Displacements leading to potential conflict over land
Longer, hotter dry season	Heat waves and urban heat island effect; Reduced water availability; Human health impact; and Livestock health impact

ii. Increased risks of slow on-set disasters and negative effects on key sectors

Future vulnerabilities that are likely to emerge or worsen under projected future climate change under a 'business-as-usual' (BAU) scenario, which will have profound effects on the way communities benefit from eco- system services and this in turn will affect productive systems, particularly agricultural productivity, access to water, and mobility.

The capacity of the population to benefit from agriculture and incomes in the agriculture sector will decline sharply by 2050

- If these ecosystem trends continue unabated in the coming decades, **a significant portion of the population in Pakokku will be forced to either migrate or adapt through alternative livelihoods,** as the township will only be able to support a much lower percentage of agriculture-based livelihoods.
- **Some irrigated areas along the river will still sustain agriculture production, though with significantly lower productivity** due to increasing temperatures, highly variable water flows, and increased frequency and intensity of extreme events like strong storms and winds, droughts, and floods.
- **Agriculture in rain-fed areas, where productivity is already highly variable, will be even lower,** as soil productivity declines due to increasing desiccation and soil moisture loss, highly variable and shortening rainy season, and extreme events that damage crops.
- **Some rain-fed farmers will be able to adapt, especially with access to groundwater, but with unsustainably high pumping costs, many will be forced to migrate to urban areas.**
- **The number of people depending on rain-fed agriculture will decrease by 2050,** especially in western and central areas of the township where freshwater sources for irrigation will reduce crop production
- **Communities along the riverbank will face more floods, landslides and intense runoff due to the projected increase in intense rains, which will result in more frequent damaged crops and water infrastructure for irrigation.**

+ 2.7°C Warmer

Hazard	Eco-system service	Main projected impacts
Higher average temperatures cause big changes in	Soil	Increasing temperatures will result in more frequent, intense, and in some cases longer dry spells, reducing soil moisture and **increasing erosion** for already degraded, loose, sandy soils, **reducing agriculture productivity.**
	Freshwater	Higher temperatures will **increase evaporation for surface waters, leading to reduced water availability,** especially during the dry season and for rain-fed areas. Even where groundwater is available, already high salinity levels in many aquifers will further reduce water availability.
	Crops	**Increased temperatures alone will limit crop productivity, reducing already low yields, especially in rain-fed areas,** and regardless of water availability and soil impacts that will further decrease productivity.

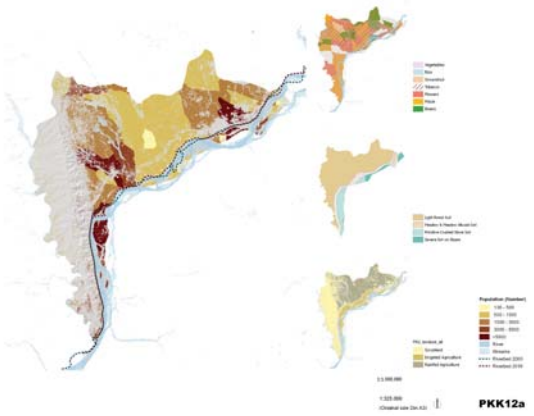
Days of rain

Hazard	Eco-system service	Main projected impacts
Shorter rainy season	Soil	Increased soil alkalinity primarily caused by using saline groundwater for irrigation, and reduced soil moisture due to longer dry spells will reduce soil quality and increase erosion, increasing desertification.
	Freshwater	Water shortages that affect crop production will increase in frequency as the number of rainy days decreases and evaporation increases. Groundwater recharge rates will likely decline with fewer rainy days in the dry season, which could potentially increase salinity concentrations in some aquifers and further limit water availability.
	Crops	A shorter rainy season will further limit already low crop productivity, especially in rain-fed areas, in combination with impacts on soils, evaporation, and reduced water availability.

+ Intense rainfall

Hazard	Eco-system service	Main projected impacts
Shorter rainy season	Soil	Intense rains following lengthier dry periods increase runoff rate and soil erosion, increasing desertification.
	Freshwater	WSevere inundation will further damage water infrastructure such as pumps, shallow dug wells and tube wells, irrigation systems, and storage. ponds
	Crops	Increasingly frequent and intense storms and resulting floods will significantly reduce already highly variable yields, increasing the risks of production and reducing reliance on agriculture for livelihoods.

FAO, 2014, IWMI, 2013
IWMI, 2013, FAO, 2014



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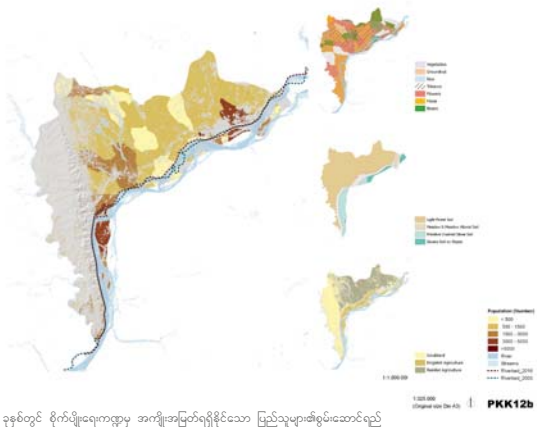

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Fewer people are likely to have access to freshwater for drinking water use by 2050

- Change in precipitation patterns results in **more frequent heavy rains and winds that increase exposure to flooding in communities** located along the riverbank and seasonal streams. Meanwhile, intense runoff and soil erosion caused by more intense rains results in more water facilities damaged.
- **Access to freshwater for drinking use is dependent on surface and sub-surface sources:** rainwater harvested in storage ponds, flows from the Ayeyawady River, and groundwater aquifers.
- **Water quality and availability will depend on both natural sources and direct human impacts on the larger surrounding dry zone landscape, including deforestation upstream** that can increase sedimentation rates in the Ayeyawady River.
- **A lack of water access for drinking is also likely to further worsen health indicators,** including maternal health, as well as migration.

The capacity of the population to have access to surface freshwater for drinking use relies mainly on **three eco-systems services (surface freshwater, geology and vegetation cover)** that will be highly impacted by the projected Climate Change:

+ 2.7°C
Warmer

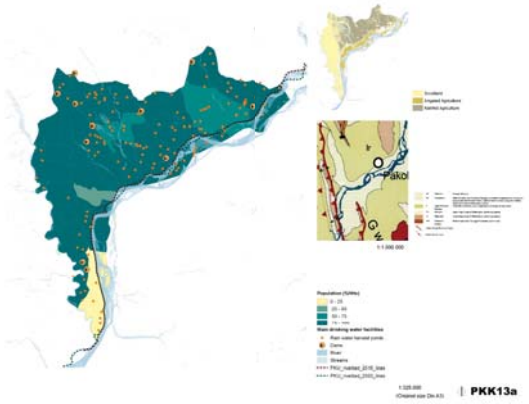
Hazard	Eco-system service	Main projected impacts
Higher average temperatures correlate with heat waves and extreme high temperatures	Type of vegetation	Higher temperatures will lead to even greater evaporation and aridity, as water availability and soil moisture decline, limiting vegetation growth, which will limit groundwater recharge and flood retention services.
	Groundwater sources	Though considerable apparent groundwater supplies exist within the zone, problems of salinity, calcium and even arsenic contamination, as well as poor knowledge of where subterranean resources are located, will continue to limit the scale of water supply. Unsustainable extraction could result as surface water becomes less available.
	Surface water	Availability will decline as evaporation increases.

Days of rain

Hazard	Eco-system service	Main projected impacts
Shorter rainy season	Type of vegetation	Increase desertification as soil moisture declines and less water is available for vegetation growth, limiting groundwater recharge and flood retention.
	Groundwater sources	Fewer rainy days will result in reduced recharge during the wet season, reducing availability during the dry season. FAO,2014
	Surface water	Less time for rainwater harvesting and storage, reducing availability, especially toward the end of the dry season.

+ Intense rainfall

Hazard	Eco-system service	Main projected impacts
More heavy rain, less useful and more damaging	Type of vegetation	Loss of vegetation cover, increased runoff rate, and soil erosion, damaging water storage facilities.
	Groundwater sources	Decreased sub-surface flow and recharge as most flows run-off downstream rather than recharging local aquifers.
	Surface water	Reduced availability, as flows from intense rainfall events are difficult to capture and can even damage storage infrastructure. Uncontrolled livestock watering, the absence of periodic desilting, or a failure easily damage small ponds to maintain the spillways so that over-topping occurs during periods of heavy rains (FAO,2014).



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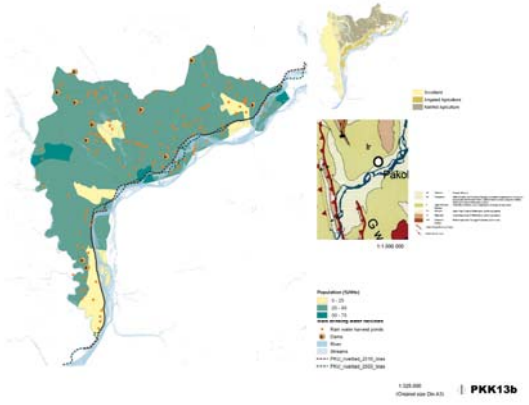

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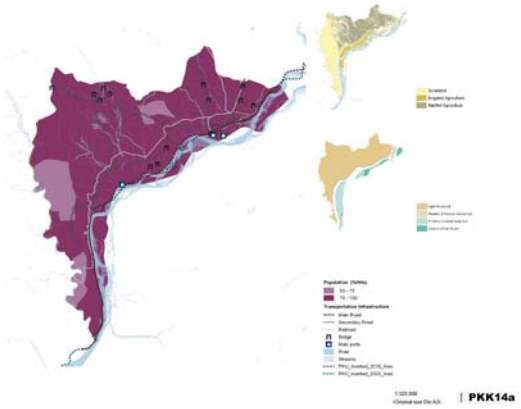
People's mobility and communication is expected to be reduced especially in riverbank and south-western areas of the township by 2050

- Pakokku town has a good transportation infrastructure, consisting of water, road, railway, and air transport facilities.
- National paved roads and a railway connects Pakokku town to neighbouring townships. A network of secondary and tertiary unpaved roads provides transport communication to rural settlements, however **stronger storms and unusually heavy rainfall results in more floods reducing population's mobility especially in riverbank communities.**
- Changes in the Ayeyawady River bed during the period from **2003 to 2016 show that floods have affected more than thirty per cent of the population living in riverbank areas.**

Access to transportation services depends mainly on the interaction of two main eco-system services (type of vegetation and soil) that are already highly impacted by climate change:

+ Intense rainfall

Hazard	Eco-system service	Main projected impacts
	Type of vegetation	Landslides in riverbank areas damages vegetation cover and destroys roads and harbours/port facilities
	Type of soils	Large quantities of rain falling over short periods will result in more flooding and erosion



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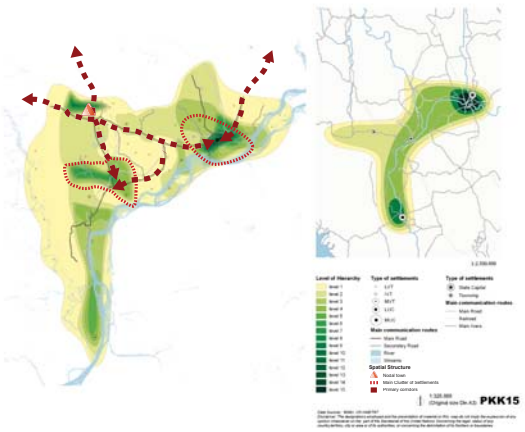

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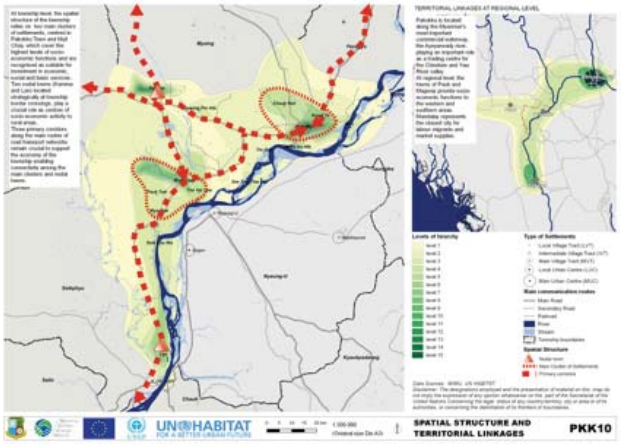
3

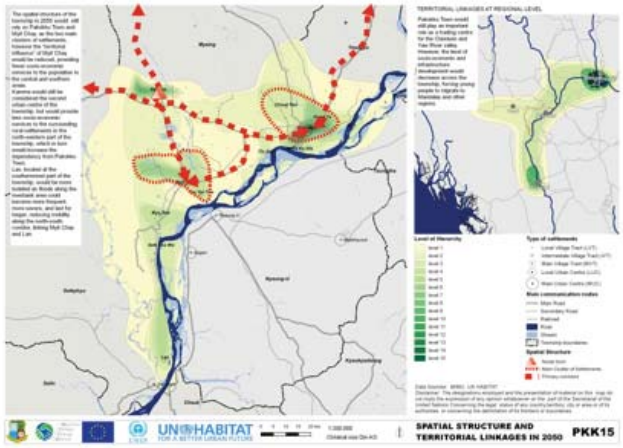
SCENARIOS FOR PAKOKKU 2050

This assessment arrives at three broad scenarios of the future. These scenarios can help local and national government to plan for actions that will increase Pakokku's resilience to the impacts of climate change. Planning actions based on scenarios is in-line with the IPCC pathways approach and is a common way that governments and industries use to plan for the future.

Scenario A. Business as usual scenario

- If business is conducted as usual, meaning that adaptation measures are not implemented and unsustainable resource – primarily water – use continues, incomes remain low and migration rates are high, **Pakokku will not be able to support current and expected population growth at the same living standard as in 2016.**
- **Pakokku will experience lower incomes because of a lack of irrigation, less predictable rainfall, and resultant lower access to water in the dry zone.** This is because agriculture and livestock are highly dependent on access to water. In the riverbank areas, while potential will remain for higher incomes due to greater water availability, partial and total losses of crops is likely to increase due to flooding, and as such people in these areas incomes will be at risk.
- **Migration will continue at least at present levels and will likely increase as incomes decline (in dry areas) and are more at risk (in riverbank areas).** Migration is especially likely to increase if this is combined with present levels of and access to education.
- **Water availability will decline.** Projections show that there will be higher temperatures, declining rainfall and fewer rainy days because of climate change that will cause ground water levels to decrease.
- If current trends continue, **floods along the riverbank area could become more frequent, more severe, and last for longer.**





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Scenario B. Resilience is built to maintain current living standards

Pakokku in 2050 maintains current living standards by undertaking some adaptation measures, however, it broadly continues its present development trajectory

- To maintain present levels of development, increased water access for the dry areas would be essential. In the short term, measures could include better capture and storage of water at the household level. In the medium term, networks of reservoirs, with appropriate management structures in place, would help to ensure more consistent, year-round access to drinking water. In the longer term, some investment in, at the very least, maintaining the current infrastructure would be needed, and ideally extended and enhanced to ensure continuity of water supply for agriculture.

- These improvements in water access would reverse consistent declines in livelihoods and prevent further levels of indebtedness among livestock herders. However, to maintain present living standards, other adaptation measures are advisable: Improving soil fertility management; Veterinary services; Improving credit facilities through both revolving funds and micro-lending.

- Such measures would be necessary to curb rates of outward migration. Linked to this, improving the access to education beyond the grade 5 level, including technical and vocational training, will further enhance the skill levels of the township and make it easier to attract higher value-added industry.

- If present flooding trends continue, livelihoods and assets in the riverbank area will continue to be threatened. To prevent this, and to maintain current conditions, some flood prevention measures will be required.

Scenario C: Resilience is built that enables economic and social development, despite changes in climate by 2050, considering the different vulnerabilities of men and women

Pakokku in 2050 sustains and continues people's socio-economic development through a diversified economy, improved access to water and healthy, functioning ecosystems.

- To continue and improve its development trajectory in a way that is resilient to changes in the climate, Pakokku will require improved access to better quality water, both for drinking and irrigation purposes.
- To ensure economic development that is resilient to climate change, Pakokku's economy will need to move towards a situation where there is greater value-addition in township, with a greater share of industry and services, and more people employed in these sectors. This will be complex; more skilled people are required and infrastructure will need to at the very least maintain functionality year-round, and industry especially will need to be more labour intensive.
- Protecting flood prone areas, including parts of Pakokku town, from flooding is vitally important to resilient, sustainable development in Pakokku. This will require, as an initial step, a cost-benefit analysis type study of ecosystem and infrastructure options to protect the riverbank and defend people and assets from floods.

Conclusions and recommendations: Planning for Adaptation in Pakokku

- Building resilience to climate change in Pakokku township is a great and urgent challenge, on which life, welfare and prosperity of hundreds of thousands of people depends.
- The frequent floods and ongoing droughts in Pakokku provide a reminder of the sensitivity of Pakokku to severe hazards and slow-onset changes. However, this assessment calls the attention of authorities and development partners to the fact that the effects of changes in climate on productive, social, ecological, and infrastructural systems of the township will greatly affect liveability and viability of Pakokku over the next years, as well as increase the risk of further disasters. In these conditions, the vulnerability of people – particularly women, children, and disabled people – will greatly increase.

Key findings

The study unveils three main broad findings:

1. **Decision makers will need to plan for both rapid on-set disasters, particularly floods, as well as slow-onset changes, especially in heat, droughts, and water availability.**

2. **Severe and wide-ranging vulnerabilities exacerbate these climate related threats, and are deeply interrelated with them.**

    - **A fragile and fast degrading ecosystem:** Despite its dry climate, and loose, sandy soil, the central dry zone had historically been a productive agricultural centre. The Ayeyarwady Dry Forests are critical to retaining this productivity, but current deforestation, agricultural practices and cutting for fuel and building materials represents a serious threat to their continued survival.
    - **An economic and productive structure largely based on climate-sensitive agriculture and fisheries** with insufficient technical skills to diversify production and employment.
    - **High migration rates,** with a high sex disparity; male migrants outnumber their female counterparts by three to one. This has resulted in 30 per cent of households in Pakokku being female headed. Agricultural value chains also largely take place outside the township, meaning that there is little capacity to create value chains in-township that will help to create wealth, raise incomes and reduce poverty, an issue that is caused and exacerbated by a lack of skills resulting from minimal vocational training.

3. **These vulnerabilities must be tackled holistically, to generate co-benefits and enable adaptation. However, this requires effective strategic planning, resources, coordination, and time**

    - The response to this necessitates effective strategic planning, resources, coordination, and time. This assessment, the first of its kind in Pakokku, and the planning work that follows it, represents a step towards achieving resilience and sustainable development, but the efforts should be sustained over a long period of time, and by a number of actors, but particularly local and national government. If no actions are taken, we are likely to see Scenario A, business as usual unfold, which will make life and livelihoods very challenging in the township.

Based on these findings, **the study concludes that urgent adaptation planning is required to avoid Scenario A, and strive to achieve at the very least Scenario B, while aspiring to create the conditions for Scenario C.**

Policy Recommendations

Policy recommendations, derived from the findings of the assessment are as follows:

1. **It is crucial that healthy ecosystems are maintained and enhanced in Pakokku.** Ecosystem services, as they represent a source of livelihood, cultural, spiritual, physical health and safety for a large number of people in Pakokku. Actions must focus, among others, on:

    a. **Preservation and expansion of forest cover.** Without this protection, communities will lose the multiple benefits of forests, including soil fertility, flood and erosion protection and food and other non-timber forest products.

    b. **Protecting and improving sources of water** for both human and agricultural use.

    c. **Improving land management** by, for example, taking steps to improve soil management, reducing use of harmful chemicals, increasing the use of organic fertilizers and improving knowledge of farmers and communities more generally on land management.

    d. **Reducing natural resource exploitation** through improved knowledge.

2. **It is essential to protect the productive capacity of agriculture, on which so many livelihoods depend, from increasing heat and declining water availability, while generating more employment in less climate sensitive sectors**

    a. **Enhance and diversify skills of people, both men and women, and especially younger people,** to increase employability in different sectors in Pakokku and elsewhere, as some migration can't be avoided. Vocational training is also important as levels of technical qualifications are extremely low at present;

    b. **Strengthen the productive system, especially in agriculture,** through improved techniques, seeds, and water-efficient irrigation techniques. Meanwhile, enhanced access to credit will enable farmers and livestock herders to make investments and diversify their incomes.

    c. Increase opportunities for new industries or enterprises and promote investment, including through loans and other incentive schemes. This involves a large involvement of national, regional and district authorities, as well as development partners, and requires careful planning to be feasible.

    d. Utilize the potential of women's contributions to household livelihoods. For more efficient and sustainable interventions, it is essential to enhance understanding of gender roles in relation to productive capacities.

3. **Infrastructure must continue to function and protect people during extreme heat, droughts and floods**

    a. **Spatial planning in any new infrastructure, settlement expansion or any other infrastructure and development is climate-sensitive.** This means that planning should consider current and future risks related to floods, extreme heat, drought and water shortages.

    b. Housing and other public buildings should be designed, and, where possible, retrofitted to offer greater protection from extreme heat and floods.

    c. Housing safety also includes improved sanitation, and, crucially, the capacity to harvest water safely with improved techniques.

    d. Community capacities are improved to collect and manage water, in the context of increased water scarcity resulting from a shorter monsoon, variable and erratic rainfall, and increased evaporation.

    e. Transport and connectivity infrastructure should be planned and maintained in such a way that all people have access to markets, schools and hospitals during floods, droughts and heat.

4. Planning for adaptation may benefit from i**mproved local governance,** meaning that priorities are captured and communicated at the township, district and regional levels.

5. **Awareness of climate change impacts and their implications is highly strategic,** cost-effective and important, and it should therefore be a focus of any intervention in Pakokku.

Local Adaptation and Resilience Planning: A way forward

Between April and August 2016, the MCCA team extensively studied the vulnerabilities to climate change in Pakokku Township. Consultations were conducted in a participatory manner with all village administrators, and covered the entire township with meetings clustering different villages in focus groups. In addition, the team conducted specific consultations on gender issues, and with the Township Administration.

In the process, potential adaptive measures were identified to counter, prevent and mitigate the current and future impact of climate change. These were grouped under the eco-system, the infrastructure and connectivity and socio-economic actions. An exercise of prioritization was conducted. The activities prioritized were organized as follows:

1. **Outcomes to be achieved by 2050 or before,** these outcomes are systemic and therefore interconnected, and recognize that ecological, socio-economic and infrastructure and connectivity systems must be addressed together, to be beneficial and ensure adaptation. This means that improving infrastructure, without protecting and enhancing the eco-system services deriving from mangroves, for instance, will not generate resilient communities.

2. **Expected Results.** Under each of the three outcomes, specific expected results are to be achieved that will contribute to achieve the overall three systemic outcomes

3. **Activities.** Each of these outputs contains a set of activities. As they are prioritized, they are ranked for their adaptation capacity value, the difficulty and cost involved and time involved.

Strategic Outcome	Outcome	Activity	Category	Cost	Feasibility	Acceptance	Adaptation effectiveness	No regret	Speed	Score	Strategic Value	
A diversified, inclusive and resilient economy, to enhance the economic conditions of the township;	Information, skills, knowledge and technolgy have been improved to combat	Training on climate smart agriculture	Planning and capacity building	3	3	5	5	4	3	23	75	
		Training on soil fertility management	Planning and capacity building	4	3	3	5	4	3	22	75	
		Vocational training	Training and capacity building	2	3	4	3	4	4	20	100	
		Develop CSOs	Management	5	4	4	4	5	3	25	50	
	Increased investment and access to finance to maintain and imporve production in agriculture and livestock	Permanent pastures	Nature based	1	3	3	4	4	3	18	50	2e
		Mechanised farming	Investment	2	3	4	4	3	4	20	50	2f
		Long term loans for agri	Investment	4	4	5	4	4	3	24	100	2b
		Irrigation for agriculture	Investment	1	3	2	4	5	1	16	25	2a
		Seed production farm (includes livestock species)	Investment	2	3	4	3	3	1	16	50	2d
		Agricultural inputs - drought resistant	Investment	2	4	5	4	4	4	23	75	2c
	Investment in new industries has increased	Loans for micro industry for landless people	Investment	4	4	5	5	4	3	25	100	3b
		Loans for small medium enterprise/industry	Investment	3	3	4	5	4	3	22	100	3a
		Value chain analysis	Research and analysis/investment	5	3	4	5	5	5	27	75	3c
		Insurance for homes in the urban area	Investment	1	2	2	2	4	3	14	50	3d

Strategic Outcome	Result		Action	Category	Cost	Feasibility	Community readiness	Adaptation effectiveness	Benefit anyway (no regret)	Speed	Score	Strategic measures	
Resilient infrastructure and connectivity, that protects and enables people	E1. All people Public and private facilities and services are protected in Pakkoku agains A2 natural hazards	1.1	Studies on spatial location risk areas		5	5	5	5	5	5	30	100	
		1.4	Improve design of housing to protect from floods and heat weaves		4	5	5	4	5	4	27	100	
		1.6	Improve storage to protect food , crops and animals from floods		3	4	5	5	5	4	26	100	
		1.9	Willingness to pay for retrofitting study		5	4	4	5	5	3	26	100	
		1.10	Participatory planning		5	4	4	4	5	4	26	100	
		1.3	Improve management of infrastructure		2	4	5	5	5	3	24	100	
		1.5	Improve radio access and broadcast		3	4	5	4	5	5	26	100	
		1.11	Improve design of stables to protect animals from heat waves		3	4	4	4	5	4	24	100	
		1.2	Building shelters than can also be used as schools/community centres		2	4	5	4	5	3	23	100	
		1.7	Roads and bridges to improve access		2	3	5	4	5	3	22	100	
		1.8	Improve construction techniques		3	5	5	5	5	4	27	100	If on the job t
		1.12	Improve shelters to protect elder people from heat waves		2	4	4	4	5	5	22	100	
	E2. Access to water in Pakokku is ensured	2.3	Improve water management at community level		4	5	5	5	5	4	28	100	
		2.5	Strategic water networking between village tracts (emergency reservoir)		4	4	5	5	5	4	27	100	
		2.6	Improve Network of water harvesting at household level		4	4	4	4	5	4	25	100	
		2.1	Participatory planning		5	4	4	4	4	3	24	100	
		2.2	Improve water capture and storage at community level		3	4	4	4	4	4	23	100	
		2.3	Improve WHs level water management		5	5	5	5	5	5	30	100	Increased - th
		2.7	Drip irrigation schemes		3	4	4	4	5	3	23	100	
		2.9	Improve stream and river catchment areas		3	4	4	4	5	3	23	100	
		2.10	River basin management		1	2	5	5	5	2	20	100	
		2.8	Build irrigation channels		1	2	3	3	5	2	16	100	
	E3. Land is protected of erosion and floods	3.1	Flood and erosion control plans		4	4	4	4	5	3	24	100	Ok with all act
		3.4	Studies on river floods (hydrodynamics)		3	4	4	4	5	4	24	100	
		3.2	Embankments		1	2	4	4	5	2	18	100	
		3.3	Green infrastructure to protect from river/stream erosion (bamboo embankment)		3	4	4	4	5	3	23	100	

Myanmar Climate Change Alliance

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THE GLOBAL CLIMATE CHANGE ALLIANCE PLUS INITIATIVE

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