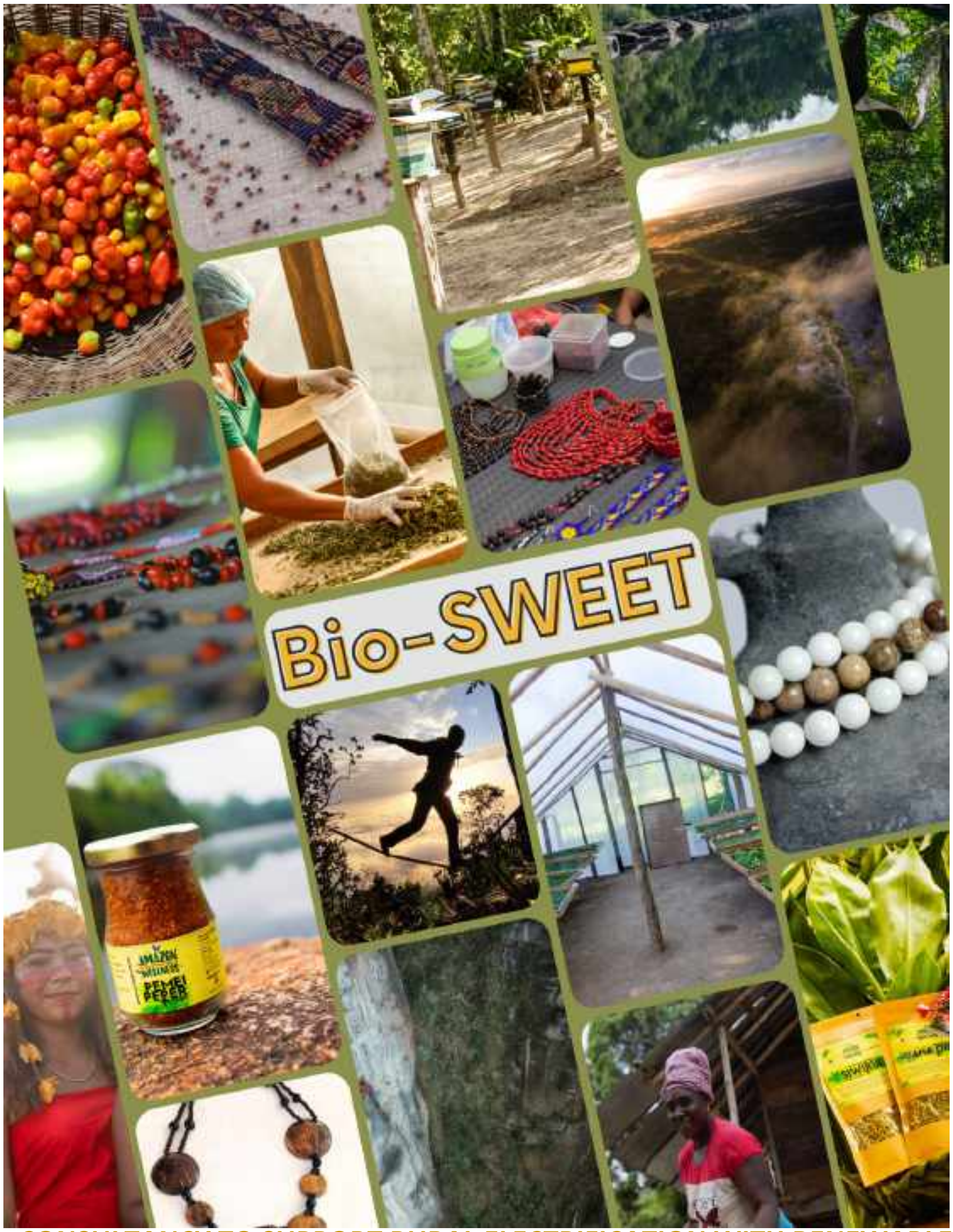

CONSULTANCY TO SUPPORT RURAL ELECTRIFICATION WITH RENEWABLE ENGERGY, POTABLE WATER, AND TELECOMMUNICATIONS IN SURINAME

Prepared by ACT on behalf of Energie Bedrijven Suriname (EBS) and Ministerie van Natuurlijke Hulpbronnen (MNH)

ABSTRACT
The study presents a qualitative Disaster risk and Climate Change assessment and diagnosis based on the available information. Identification of gaps that need to be addressed in the future.

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Paramaribo, 11 April 2024

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1 Introduction

1.1 Background Information

This report presents the results of the “BIO-ECONOMY EMPOWERMENT IN SURINAME’S INDIGENOUS COMMUNITIES THROUGH ACCESS TO WATER, ENERGY, AND TELECOMMUNICATIONS (BIO-SWEET)’ against the disaster and Climate Change Risk Assessment

The project aims at promoting a just, clean and sustainable energy transition by increasing access to electricity, water, telecommunications services in rural areas and by promoting the decarbonization of the electricity sector. The general objective of the first operation is to promote the socio-economic development of villages in the Amazon rural areas of Suriname. The specific objectives are to: (i) provide villages in the Amazon rural areas of Suriname with reliable access to renewable energy-based electricity, potable water supply, and telecommunication systems and (ii) foster the development of a bioeconomy in the Amazon rural areas of Suriname with a gender and diversity perspective. This report addresses **the Disaster risk and Climate Change risk analyses.**

IDB

The Inter-American Development Bank (IDB) is the main source of financing for sustainable, social, economic and institutional development in Latin America and the Caribbean. The bank will facilitate an energy, water and telecommunications project for the sustainable development of Indigenous peoples in south Suriname in Alalapadu, Apetina, Sipaliwini, Kwamalasamutu, Kawemhakan, Kumakapan, Pelelu Tepoe, Palumeu, Amotopo and Coeroeni.

The project phases include:

1. Information gathering in 2022 and 2023
2. Preparation and planning in 2023 and 2024
3. Project start in 2025.

The assessment phase was conducted in close collaboration with the Ministry of RoS and Ministry of NH, as well as the VIDS, TTA as contractor and sub-contractor ACT-Suriname.
Amazon Conservation Team Guianas (prior known as Amazon Conservation Team Suriname) was hired as a subcontractor by Trama Tecno Ambiental (TTA) in the information gathering process for supporting the initial engagement strategy in 10 previously mentioned indigenous villages in South-Suriname. The report prepared by ACT-Guianas under that consultancy assignment served as a key output deliverable for Trama Tecno Ambiental (TTA).

Trama Tecno Ambiental (TTA)

Trama Tecno Ambiental is a global consulting and engineering company with headquarters in Barcelona, Spain. Since its founding in 1986, fully committed to a sustainable energy development, TTA has been providing specialized services in distributed generation through renewable energies, energy management and efficiency, rural electrification, self-generation, integration of renewables in buildings, sustainable architecture, as well as, specialized training, education and technological development related to its activities.

The Amazon Conservation Team Guianas (ACT-G) is a nonprofit organization that is dedicated to protecting the Amazon rainforest. ACT-Guianas aims to achieve this via partnerships with the local native Indigenous and Tribal peoples of Suriname, the traditional inhabitants and users of the rainforest. Respect for, and integration of, their traditional cultural knowledge is crucial for the protection of their land’s ecosystems.

1.2 Objectives

The objective of the Disaster risk and Climate Change (qualitative risk) assessment is threefold:

- To conduct a comprehensive qualitative assessment and diagnosis of disaster and climate change risks based on the available information, including historical data, scientific projections, and expert insights. This assessment aims to identify and understand the potential hazards, vulnerabilities, and exposure to natural disasters and climate-related impacts.
- To identify gaps in current risk management strategies and practices that may hinder effective disaster preparedness, response, and adaptation efforts. By pinpointing these gaps, the assessment seeks to inform decision-makers about areas where additional measures or improvements are needed to enhance resilience to disasters and climate change.
- To document a comprehensive risk narrative that synthesizes the findings of the qualitative assessment and diagnosis. This narrative serves as a valuable tool for stakeholders, policymakers, and communities to understand the complex nature of disaster and climate change risks and their potential impacts. By documenting the diagnosis in a clear and accessible manner, the aim is to foster greater awareness, dialogue, and action towards building resilience and mitigating risks.

1.3 Scope of Work

The geographic scope is limited to ancestral Trio and Wayana lands (10 villages) refers to the specific territories inhabited by the Trio and Wayana indigenous peoples in Suriname, entailing approximately 7.0 ha. These lands are primarily located in the southern part of Suriname, in the interior rainforest region near the borders with Brazil, extending in the directions of Guyana and French Guyana.

1.4 Methodology

The results presented in this report are based on secondary literature provided by the consultancy team that assessed Energy, Water, Telecommunications and Bio-economics demands and technical feasibility studies in 10 Indigenous Villages in South Suriname. The Disaster and Climate Change Risk Assessment Methodology of the IADB were followed to determine measures to be taken with a corresponding mitigation plan. The methodology was followed for phase 1 and phase2.

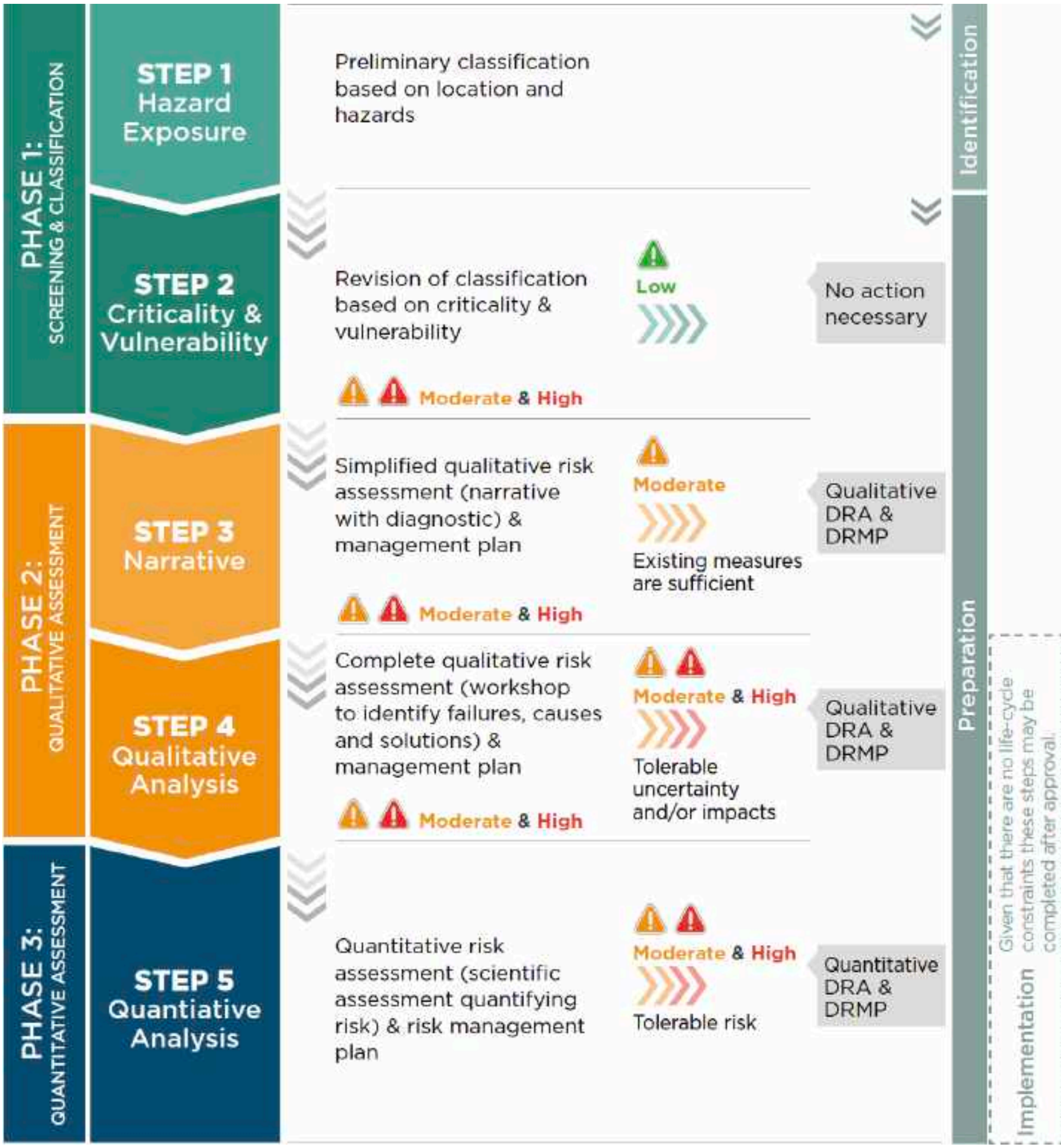


Figure 1 IDB Disaster and Climate Change Risk Assessment Methodology

2 Results

2.1 Disaster Risk Assessment (DRA)

Several factors contribute to Suriname's particular vulnerability to the effects of Climate Change. It's dependence on fossil fuels, presence of forests susceptible to decay, fragile ecosystems, and the significant portion of its population (87%) residing in low-lying coastal areas, where most economic activities are concentrated, heighten the risks. Various sectors face the threat of losses and damages from both gradual shifts and extreme weather events associated with Climate change.
For Suriname to achieve sustainable development, it is imperative to integrate Climate change and its impacts into national policies and laws. However, a lack of in-depth studies on the potential subnational-level climate scenarios or sector-specific impacts across different districts hampers evidence-based decision-making.

The project area comprises 10 Indigenous Villages in the southern region of Suriname and mirrors the country's typical weather and climate patterns. Situated between 2 to 7 degrees north of the Equator, the area boasts a warm and humid tropical climate. While mean air temperatures in the northern regions remain consistently between 25 to 27.5°C throughout the year, the southern regions experience slightly cooler temperatures, averaging around 23 to 25°C.
Suriname has two distinct rainy seasons: a major one from May to July, during which most of the country receives 250 to 400mm of rainfall per month, and a minor one from November to January, with around 150 to 200mm of rainfall per month. Inter-annual climate variations in this region are influenced by the El Niño Southern Oscillation (ENSO), occurring approximately every 2 to 7 years and lasting 9 to 12 months, sometimes extending up to 2 to 3 years. El Niño episodes typically bring drier conditions and warmer temperatures between June and August, while La Niña episodes result in wetter conditions and cooler temperatures during the same period.

The average wind speed is 1.3 Beaufort, with peak speeds occurring during the dry seasons, reaching 1.6 Beaufort in February and a secondary peak in September and October. Specific wind speed details for the study area are not available. Humidity levels range from 70 to 100 percent, which is considered extremely high.

Table 1 Historic and Future climate trends in Suriname

Variables	Historical trend	Future trend
Mean, maximum, and minimum daily temperature	These indicators are similar throughout the country and slightly lower in the south. In the north, temperatures are increasing, while in the south they are decreasing.	Daily mean, minimum, and maximum temperatures are projected to increase in the entire country, although less at the coast and more in the southwest.
Frequency of hot days and hot nights	The frequencies of these days are very homogeneous throughout the country.	The frequencies of the two increase throughout the country.
Frequency of cold days and cold nights		The frequencies of these two decrease and cold days and nights almost disappear.
Accumulated yearly precipitation	Precipitation shows a strong increasing trend throughout the country.	Yearly accumulated rainfall is expected to decrease strongly. In general, the decrease could surpass 20% of the historical average.
Number of rainy days per year	These are more frequent on the coast, the center and southwest of the country, and less so on higher grounds towards the southeast.	The number of rainy days decreases, especially on the coast.
Maximum precipitation in five days	These indicators are even across the entire country.	Both indicators increase greatly for all locations. This, together with the decrease in the number of rainy days, points to a change of rain regime towards fewer but more intense precipitation events.
Maximum precipitation in one day		
Short dry season precipitation	The interior is rainier than at the coast, increasingly so. However, in general precipitation is more even and seasons are less pronounced.	These seasons become drier throughout the country.
Dry season precipitation		
Short rainy season precipitation		
Rainy season precipitation		This season becomes drier at the coast but wetter in the interior.
Maximum daily winds	These are highest just off the coast and over the higher ground in the southeast. They show a descending trend.	Wind indicators are projected to vary little. The main patterns visible in the historical map change very

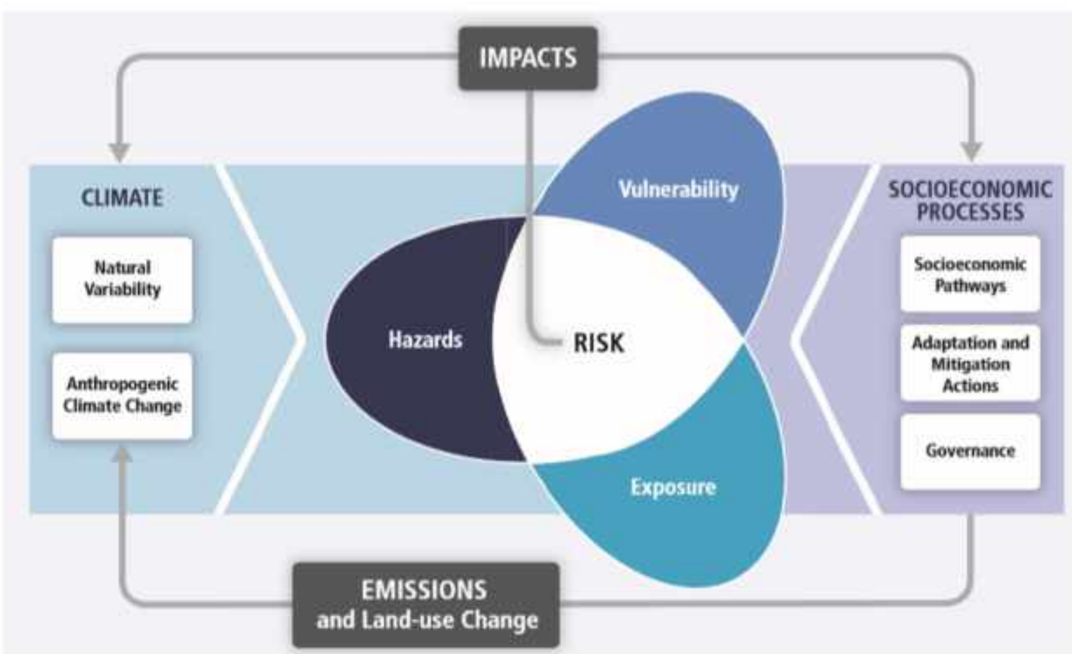
(Source: IDB, 2019)

Climate risks can arise from gradual shifts in climate parameters like precipitation and temperature, as well as from extreme occurrences such as floods and droughts. Notably, human-induced climate change exacerbates natural climate variability, potentially amplifying both gradual shifts and extreme events. The susceptibility and exposure to climate risks are influenced by various socioeconomic factors, including income levels, educational attainment, governance structures, access to public services, and the implementation of adaptation measures aimed at reducing exposure and vulnerability.

Intergovernmental Panel on Climate Change (IPCC) defines risk as "the potential for consequences where something of value is at stake and where the outcome is uncertain (…) Risk results from the interaction of vulnerability, exposure, and hazard" (IPCC, 2014a). Moreover, the IPCC (2014a) defines vulnerability, exposure, and hazard as follows:

• Vulnerability- The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (…)
• Exposure- The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.
• Hazard- The potential occurrence of a (…) physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (…)

It's crucial to recognize that exposure and vulnerability to climate risks are intertwined. Exposure cannot exist without hazards, and vulnerability is contingent upon exposure. Risk emerges as a consequence of the interaction between hazards, exposure, and vulnerability, manifesting as impacts that feedback into the existing climate hazards and socioeconomic systems responsible for exposure and vulnerability (IDB, 2021).



Source: IPCC (2014b)

Figure 2 Climate risk is the product of climate hazards, exposure, and vulnerability

Data collection in the project area of 10 IP villages has been incidental, or limited to continuous data collection of selected parameters, insufficient to address Hazard and Climate Change topics.
In general, the vulnerability of Indigenous and Tribal Peoples is compounded by the socio-economic marginalization, limited quality education and health care, limited infrastructure and (tele)communication facilities and limited food security as experienced during the floods of 2006, and nearly every few years after negatively influence their adaptability and resilience capacities.
Most Vulnerable Groups: Women, elders and children are the most vulnerable group amidst hazards and climate impacts.

Table 2 Historic and Future climate trends in Suriname

	Historical (1990-2014)	Future (-2094)
Risk	Paramaribo, Sipaliwini, and Wanica are the districts most at risk, and Coronie and Nickerie those least at risk.	
Hazards	Paramaribo and Wanica face the most climate hazards, and Nickerie the least.	Nickerie will remain the district with the least hazards. Sipaliwini will become one of the districts with the most hazards.
Exposure	Commewijne and Paramaribo are the most exposed districts due to their exposed agriculture, water, and forestry sectors (Commewijne) as well as infrastructure sector (Paramaribo). Brokopondo is the least exposed district due to its little-exposed agriculture and infrastructure sectors.	
Vulnerability	Sipaliwini and Brokopondo are the most vulnerable districts due to their vulnerable agriculture and infrastructure sectors. Coronie is the least vulnerable district due to its less vulnerable forestry and infrastructure sector.	

(Source: IDB, 2019)

Historical findings suggest the following actions:

- In Paramaribo and Wanica, safeguarding infrastructure assets like roads and bridges against climate hazards, particularly sea-level rise and intense precipitation events such as flooding, is essential;
- In Commewijne, protecting agricultural land and livestock, as well as the livelihoods dependent on them, from the adverse effects of climate change is crucial. Given the significant mangrove cover in Commewijne, attention is warranted concerning sea-level rise and increased erosion;
- However, ***in Sipaliwini*** district and Brokopondo, enhancing infrastructure (roads, safe airstrips etc.) would contribute to improving the response time in times of disasters when providing, crucial goods and services to residents in need;

Historical intermediate impacts include:

i. Elevated precipitation leading to floods can directly result in losses in plant yield and damage, subsequently causing intermediate impacts such as increased plant disease incidence, land erosion, and nutrient depletion. These effects are exacerbated in regions reliant on riverine transport, where floods may disrupt river navigation, necessitating more costly alternative transportation methods.
ii. Conversely, reduced precipitation and increased temperatures causing droughts can directly diminish plant yield. Furthermore, droughts can compound yield losses through additional intermediate impacts like increased wildfires and reduced artificial irrigation. Sustaining production in such conditions entails adopting new measures to protect against wildfires and provide irrigation, thereby increasing production costs. Similar to floods, droughts are particularly challenging in areas reliant on river transport, where they can render rivers unnavigable.

Regarding fisheries, rising precipitation and temperatures negatively impact water quality in rivers, leading to oxygen depletion. This depletion, alongside high-water temperatures in freshwater swamps and rainforest creeks, results in the mortality of certain aquatic species.

2.1.1 Results Phase 1- General

In order to describe the Hazard exposure in South Suriname, the following indicators should be addressed:

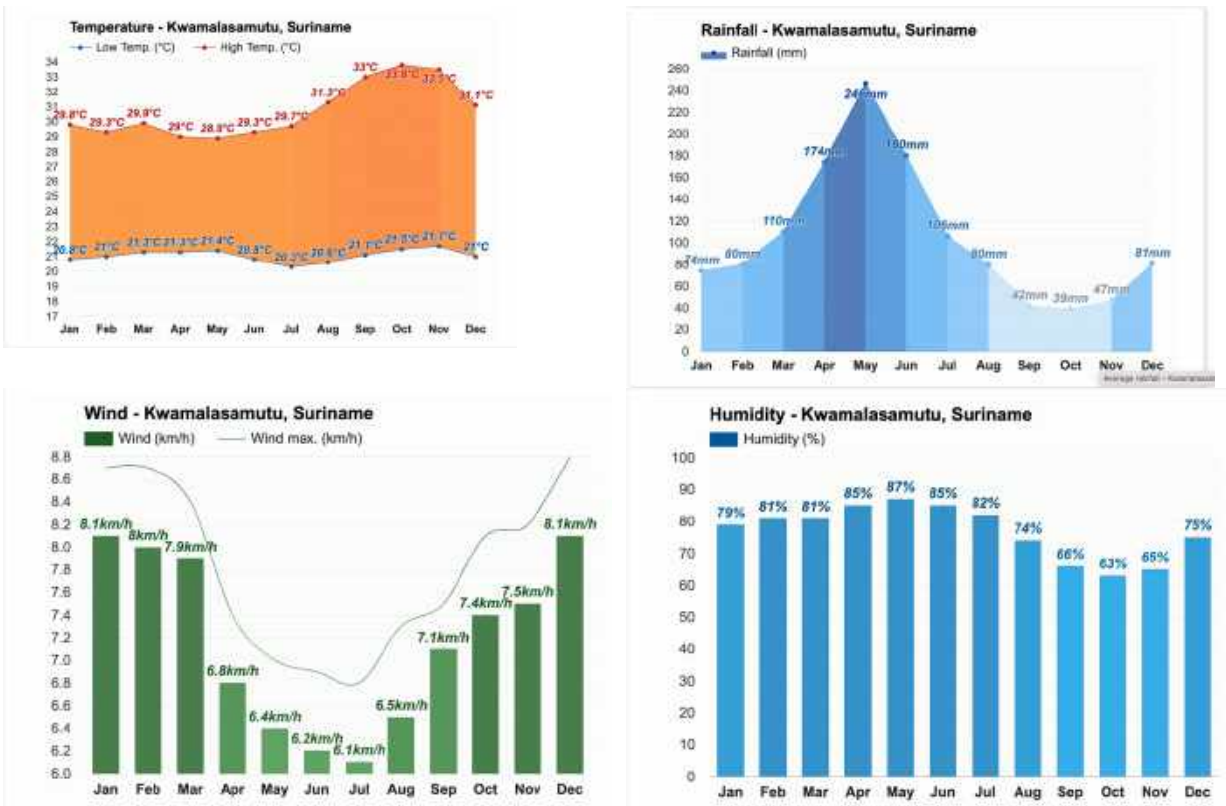
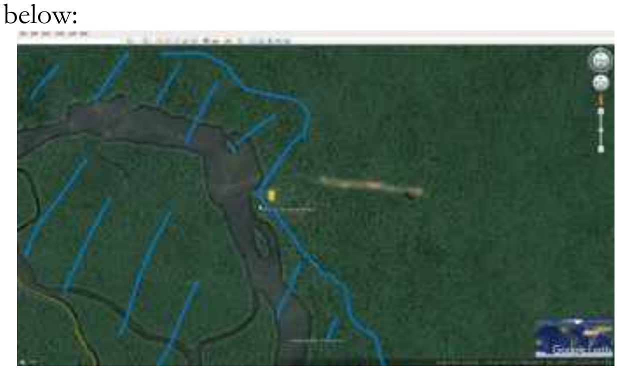


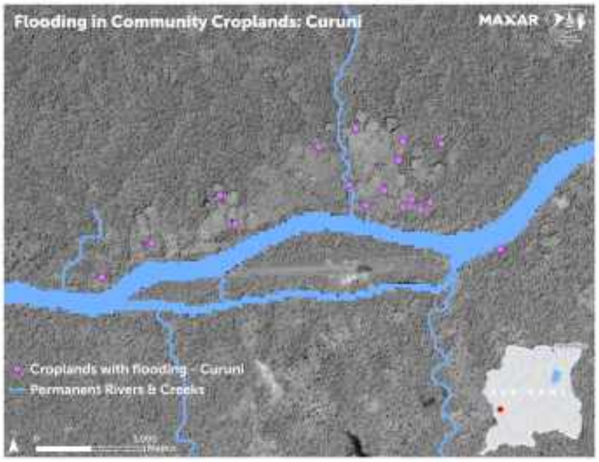
Figure 3-6 Average Temperature, Rainfall, Wind and Humidity in measured in Kwamalasamutu (World Atlas.com)

Severe rainfalls, followed by droughts and incidentally strong wind cause the most damage to the remote communities of South Suriname and physical structures build.
The data collected during the most recent flooding (2022) that led to inundation of riverine areas, is presented below:

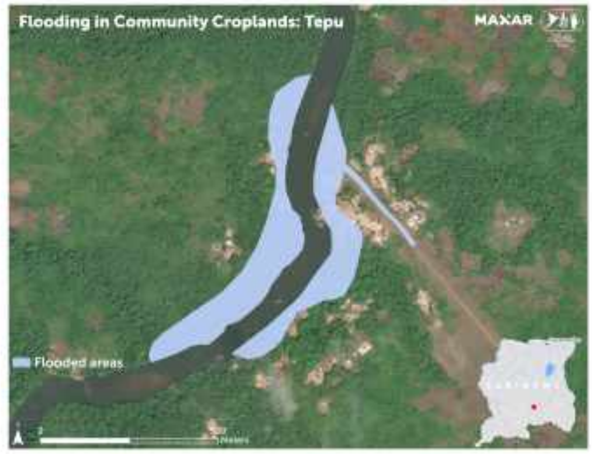


Amotopo

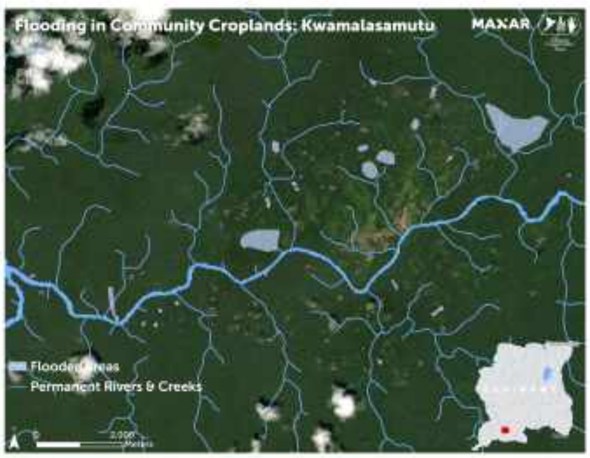
Palumeu



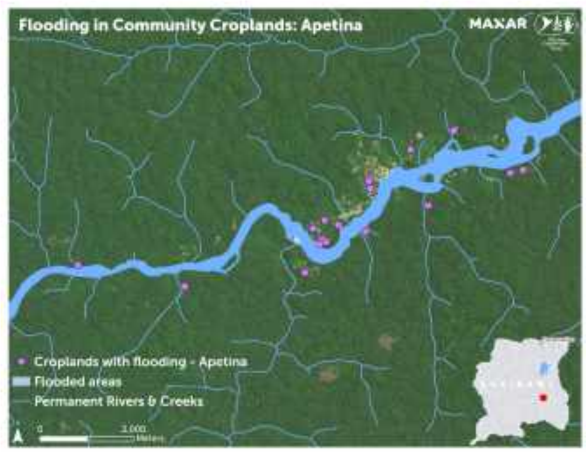
Curuni



Tepu



Kwamalasamutu



Apetina

Map 1-8 Flooding zones in the 8 of the 10 IP villages in south Suriname

The table below discusses hazards in relation to the project design.

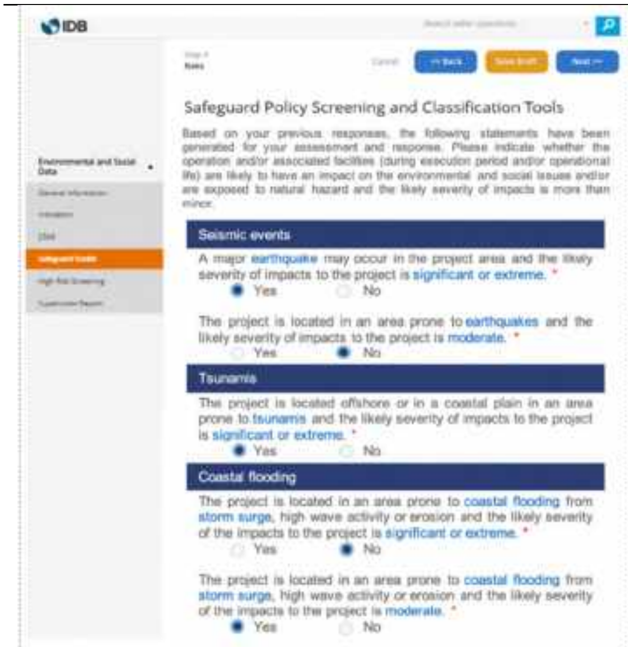
Table 3 Key Hazard Information vs Project

Hazard	Considerations	Project design
Riverine flooding	The characteristics of this historic event is mapped and discussed with communities.	The maps are a guidance to mindfully design higher grounds for installations that need to remain dry. Additional training to locals to handle possible hazards. Automatic data logger in the water systems (river, creek) to monitor from distance how the level fluctuates.
Impact of hurricane wind	This was not done, but can be with usage of satellite images	All infrastructural work in the project should include a buffer zone, to minimize damage caused by falling trees or other wind induced destruction. Additional training to locals to handle possible hazards.
Fires	Early warning systems (Global Forest Watch), which the rangers have access to for further populating with data (additional data layers). The 2019 Amazon Fires didn't reach Suriname	Buffers from infrastructure (vegetation fire) to minimize damages caused by fires. Signs around premises. Additional training to locals to handle possible hazards.
Drought	Precipitation is measured at Kwamalasamutu, but water levels in the rivers are not automatically recorded and shared with authorities.	Buffers from infrastructure (vegetation fire) to minimize damages caused by fires. Signs around premises. Additional training to locals to handle possible hazards.

2.1.2 Results Phase 1- Screening and Classification Toolkit

Using the Toolkit guidelines, the project can be classified as:

Table 4 Table 4: Ranking Hazards (STEP1)



Hazards		Ranking of class impact
Riverine flooding	The project is located in a flooding prone site. Especially water, energy and bio-economic infrastructure. But also, insufficient energy generation with cloudy situations.	**Significant**
Impact of hurricane wind	The project is exposed to wind (sever winds may occur). Buffers around the telecom towers and other construction work is required.	**Moderate**
Fires	The project infrastructure out of the immediate sight, may cause additional risks when fires are involved.	**Low to Moderate**
Drought	The project site may suffer under extreme low water levels to provide 24x7 water. Bio-economic models may not produce to the full capacity.	**Low to Moderate**

Overall the project critical vulnerability is **Low**: The magnitude of the impact will be on less than 2,000 people, with no casualties expected. Water levels and damage in general won't exceed the 5m structures.

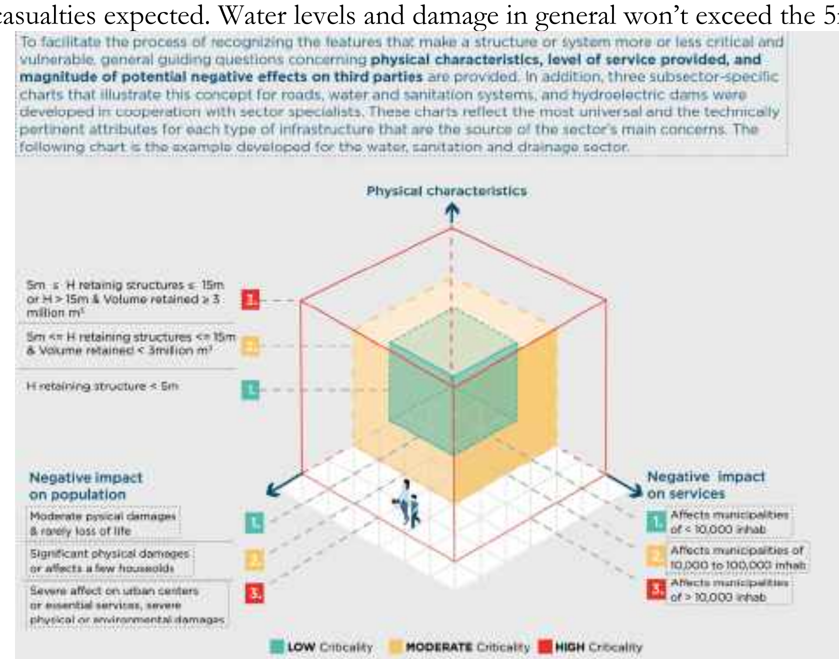


Figure 4 Ranking the Critically Vulnerability (STEP2)

2.2 Narrative Criticality & Vulnerability

The indicators for exposure and vulnerability were selected based on the relevant sectors impacted on.

- Food security and sovereignty;
- Education;
- Health (sanitation);
- Transportation;
- Communication;
- Energy;
- Income.

Table 5 Disaster and Climate Change Narrative (STEP3)

When gathering data and beginning to assess what risk considerations have been included in the design of an operation, questions should be asked at the level of the specific project and should be tailored to its circumstances. In general, these should address past event occurrences, existing studies, if and how specific hazards, climate change, and vulnerabilities have been (or are planned to be) assessed, and what gaps exist. The following is an example of questions for a road rehabilitation where mudslides, earthquakes, and landslides have been preliminarily identified as potential threats:

Existing studies

- Are there any previous risk studies for the existing assets? (Have the impacts from hazards on the operation, and those from the operation on the risk conditions in the area, been assessed?)

Hazard evaluation

- Have the local meteorology, hydrology, and climate change been studied, and how? (Are there gauge data? Have global/regional climate models been consulted? Are there official standards for the use of climate projections?) Have the existing climate projections been verified?
- Have the local geology and seismicity been characterized, and how? (Have the existing slopes been studied? Does the road cross active faults? It there a seismic catalogue for the area?)

Design considerations

- Has climate change been considered in the pavement design of the road, and how?
- What are the hydrologic and hydraulic parameters used for the designs of the bridges, culverts and longitudinal drainage? (Analysis methods, design return periods, flood frequency analysis, climate change)
- Have slope stabilization measures been studied for the mountainous section of the road?
- What seismic design standard has been used for the bridge design? (Is there a local design code?)

Response systems

- Is there an early warning system in place in the city, or is one planned for mudslides and rains?
- Has a business continuity or contingency plan been developed to ensure the continuation/rapid recovery of the service provided? Is there redundancy?

-

Health-

<u>*Water Sanitation*</u>

The communities in South Suriname have, with an exception of Sipaliwini (village) no access to secured 24x7 potable water. During *floods of extreme droughts,* the system will be deprived (low water level) of the ideal situation to pump and store water in tanks on top of a constructed tower. During flooding – the water current often damages the floating system in the river. Water from Sipaliwini river is pumped and treated (filtered) to the level of potable quality. The system runs on solar energy. With excessive rainfall, the energy system won't be able to charge optimal.

In Tepu, the village wide system was flooded damaging the entire system (small solar/battery house), and the well created to filter surface water and pump the water to tanks for the distribution. The entire water reservoir was contaminated. These riverine constructions are prone to flooding and even indirectly from severe winds (falling of trees). Water shortage leads to even poorer sanitation situation in the villages.

In Kwamalasamutu, fossil fuel driven water purification and storage distribution system based partially on gravity exist. The water source is a creek, that provides year-round water. The challenge here is that due to extreme weather patterns/hazards, fuel can't be transported to the villages in the south. None of the villages have waste water treatment and waste water disposal systems.

Food security, sovereignty & income generation (bio-economics)
Farms are mainly for subsistence, led by women and in certain phases supported by the males. Some household do operate the farms jointly (male and female). Farms may be inundated and lead to rotting of crops, immediately or gradually when soils are saturated. Farm produce is not only for the family and relative within the village, but also supports the children and other family members living in the city. Farm surplus, game meat and fish, together with NTFP products will regularly send out to the city to provide food (or additional income) to the family members outside, with some financial return to the village. Food shortages will be noticeable for a longer period of time after normalization sets in. The cultivation calendar is usually followed to start farming again. The aftermath of flooding is longer when food security is considered.

Access to farms and collection of NTFPs are temporary impossible due to flooding. If farms and collection areas are dry, then often strong currents will challenge peddling to these sites for food harvesting/collection. Limited households and crops are cultivated in the villages, which cumulative leads to malnutrition of locals. Fishing and hunting are in general not possible, due to the more direct needs of protecting the family, where needed evacuation to higher grounds. Villages are partly flooded in addition to adjacent grounds, impacting on water sources, sanitation and hygiene.
The inundated resources are also input for small businesses in the villages, e.g. essential oils, herbal tea, honey and propolis, jewelry and tourism.
During droughts, crops suffer from several diseases and pests. Leaf cutter ants are a major problem in most of the villages.
In Palumeu, the METS tourism establishment was partially flooded. Due to cumulative challenges (COVID19), this site was abruptly closed. Field supplying the herbal tea production were flooded for longer periods and remained accessible for a while, whilst the entire drying facility was flooded in Kwamalasamutu. The production of the Tukha fabric was marginally in production, due to several other urgent matters that needed addressing in the village.
Production of honey was extremely low. The bee boxes are spread throughout the villages (home gardens) and were flooded. No major damages were reported, however due to limit blossoms and nectar available, harvesting of honey was not recommended.
Healthcare facilities: Some were flooded, and needed assistance to periodically provide services.

Education
The primary schools were closed (partially flooded and damaged), but also difficult to reach and keep operated.

Energy, transportation and communication
When fuel can't be transported to the communities (safety issues- landing and taking off on laterite airstrips), energy generation will not be possible. Heavy rainfalls may cause sheet and gully erosion, clearing out the surface with saturation of the airstrips. In addition, when rainfalls extend, and the weather is cloudy, solar energy will be limited available.
Communication will become challenging. Towers of Telesur will eventually stop signally when batteries are depleted, radio telecommunication, VSAT and even more advanced systems depending on Energy won't optimally function. Isolation may be at risk. Energy generating systems should be placed on higher grounds to minimize damage.

Droughts and Wind
In general droughts are a big problem in Indigenous communities and surrounding environments, when fire management is not adequately implemented. In and outside villages – fires damaged many structures in the past. Fires are practices to prepare the farming calendar. It eases the clearing phase, destroying weeds and suppresses diseases and pests for a smooth initial growth of crops. Due to burning, rapid nutrients become available for crops to benefit from. As a cultural practice, it keeps/opens up the accessibility of certain areas (savannas), improves the safety when traveling (snakes), and improves wildlife to graze from the young grasses that regenerate, making hunting for game meat easy.

Wind is often supporting the fire to expand or change directions. Strong wind, can also result in "sibi busi's and trees falling on structures. In construction of water, energy, telecommunication systems and expanding/developing of bio-economic production units, these risks should be addressed in suffice.

Traditional Knowledge
A study conducted by Smith, 2013, indicated recorded that Trios use 52 indicators to detect seasonal change in the forest, of which 16 for the dry season and 36 for the rainy season. These indicators are the basis of their seasonal calendar. This calendar distinguishes several phases in each season.
Wayanas are expected to have their traditional knowledge on the subject as well to determine environmental and climate/weather changes. These knowledge systems can be used to analyze weather and climate risks. With training and use of tools, western and traditional measurable indicators can assist in preventing, adapting and mitigating risks.

Table 6 Contingency Plan (STEP 4)

	Design considerations	**Response**
Flooding	Locations- on higher grounds and design modified to building on poles- where possible.	Setup an early warning system, build local capacity and install equipment. Establish strategic partners to engage locals, formal authorities and NGOs.
Drought and Fires	Ensure buffers to minimize risk of spontaneous and ill management fires- design systems that cope with extreme low water levels. (for potable water and energy supply)	Refresh earlier fire prevention and management training in all villages. Capture Traditional Knowledge on prevention and mitigating of impacts based on earlier experiences. Combine local and western knowledge systems. Setup an early warning system, build local capacity and install equipment. Establish strategic partners to engage locals, formal authorities and NGOs.
Wind	Create and maintain buffers for damage from severe wind.	Setup an early warning system, build local capacity and install equipment. Establish strategic partners to engage locals, formal authorities and NGOs.

Table 7 Qualitative Disaster and Climate Change Risk Assessment (STEP5)

Guidance	Responses
• Was the level of protection determined through a standard engineering design process, such as the use of formal intensity, duration, and frequency (IDF) curves provided by local, state, or federal agencies or authorities? • What opportunities were available during the design process to consider other climate information in the DRA? • Did the design process allow for the use of alternative procedures such as revised IDF curves that reflect future climatic conditions based on an analysis/synthesis of climate model output? If so, examine the methods and approaches.	In the design phase, guidance from communities and national authorities will be leading. Where gaps are observed, international websites/institutes may provide indicative statistics. Designing phase allows for incorporation of methods, approach and data from other parties. No models and assumptions were made for the near future. However, the flooding maps provided significant justifications.

3 Disaster Risk Management Plan (DRMP)

Conditions for a well-developed and implement Disaster Risk Management Plan and alignment with existing administrative and legislative framework:

- Roles and responsibilities among collaborating entities need to be clearly defined. The National Environment Authority (NMA) should emerge as a robust coordinating body ensuring that functions are carried out cohesively. Therefore, this authority should be created as soon as possible.

- Enhanced cooperation is essential between governmental bodies, research institutions, and among themselves, particularly in terms of information sharing.

- Increased funding for research and development, including studies on the impacts of climate change, is imperative.

- It is highly advisable to conduct further investigations into the shifting patterns of the Inter-Tropical Convergence Zone (ITCZ) and the El Niño Southern Oscillation (ENSO) cycle, and their repercussions on precipitation and temperature patterns.

- Conducting an economic analysis of climate change effects in Suriname would aid in understanding the specific sectoral impacts from an economic perspective and lay the groundwork for developing a cost-benefit analysis of adaptation measures.

- Initiatives aimed at raising public awareness and educating the populace about the consequences of climate change.

- The government should foster closer collaboration with the private sector, leveraging technological solutions to mitigate climate change impacts and safeguarding assets.

- Improvements to the institutional framework of Disaster Risk Management Plan (DRMP) are necessary, alongside the development of a strategy for disaster risk financing and insurance.

- Expansion of climatological observation networks, with the installation of additional observation stations to ensure continuous data collection across space and time, is warranted. Utilization of automatic recording instruments in remote areas should also be considered.

- Enhancements in data storage and dissemination are crucial, necessitating the adoption of a consistent and open file and data format.

Table 8 Disaster Mitigation Measures

Projects	Hazard	Likeability	Stakeholders Engagement	Capacity building	Disaster risk and mitigation Measures
Water utility plan	Flood	Nearly every other year	Selection of villages to provide consistency data from massive South Suriname, is possible: Strategic partnering and building of capacity with: *Community monitor or rangers Commissions installed in villages with Life Plan (Kwamalasamutu, Sipaliwini, Alalapadu). Ongoing development process in Curuni and Amotopo* *Trijana: Cooperation for all 10 IP villages in South Suriname* Medical Mission and Amazon Conservation Team Guianas present in most of the 10 villages. Build on inter-Ministerial Working group engaged in Life Plan process to expand with NCCR and Public Health (BOG), Red Cross to design institutional early warning systems. Trijana and local (village level) commissions created for monitoring of several topics.	-Decide and sign off on relevant protocols to collect data, use the best instrument, share repository for data, in order to operationalize early warning system. -Train all relevant parties. -Lesson learned from elsewhere to modify structures. - Provide instruments - Undertake a workshop with relevant stakeholders to analyze possible failure modes and identify possible risk reduction measures and complementary works, analyze risk exacerbation or transfer to third parties, identify if further studies are needed.	- Build plan on higher grounds; -Ensure that source is not contaminated during floods; -Water quality is monitored to determine health risks; -Back up systems promoted and maintained from the start: Rainwater harvesting and the advantages; -Monitor expansion of villages vs risk management; -1x annual inspection by city staff to ensure compliance with guidelines to minimize risks.
	Drought	Nearly every other year			-Design system that can handle low and extreme low water levels; -Monitor the source and determine critical point; -Where possible- promote hybrid rainwater harvesting and potable water distribution system; -Awareness raising regarding efficient and responsible water use- monitor infrastructure on leakages etc.; -Increase awareness on uncontrolled fires in the drought and risks on damages/destruction; -1x annual inspection by city staff to ensure compliance with guidelines to minimize risks.
	Wind	Incidental			-Maintain safety buffer for natural vegetation to be uprooted and destroy construction; -1x annual inspection by city staff to ensure compliance with guidelines to minimize risks.
Energy Utility plan	Flood	Nearly every other year			Same as above
	Drought	Nearly every other year			Same as above
	Wind	Incidental			Same as above
					Same as above
Communication Towers	Flood	Nearly every other year			Same as above
	Drought	Nearly every other year			Same as above
	Wind	Incidental			Same as above
Bio-economic models	Flood	Nearly every other year			Same as above
	Drought	Nearly every other year			Same as above
	Wind	Incidental			Same as above

4 Conclusion and Recommendations

The magnitude of this project is unknown for South Suriname and therefore this initial assessment will have to be updated during the project cycle structures, guidelines and capacity building to prevent and mitigate Disaster and Climate Change risks.
The project therefore provides opportunities for South Suriname and the nation as a whole to strengthen existing institutions and further integrate communities' participation in evidence based monitoring and early warning systems.
This project is also providing a pilot experience to draft or revisit existing regulations and legislations towards sharing responsibilities for the safety of investment for the greater cause.

The project is beyond a conventional design, and will be a pioneer in establishing, building on and further strengthening of partnerships, inclusion of locals in networks with wider portfolio than safeguarding a utilities project. The model tested here should in worse case scenarios lead to a short response time after a disaster occurred.

5 Appendix 1: Example of data collected during Flooding in Apetina/Palumeu

	Mo. 6 june 2022
Flooded village past	Apetina en Palumeu
Flooded villages present	Palumeu
Potential flooding villages	Apetina en Palumeu
What relief assistance is provided	Apetina: Food Parcels in the planning. Will be transported on 13th and 14th of June, 2022 Palumeu: Foodparcels needed.
Which villages received assistance	Apetina will be assisted 2nd week June 2022. Palumeu in need
Which organisation provided assistance	ACT-S will be providing assistance to Apetina
How many households received assistance	Apetina: 128 households Palumeu: 80 household
Response of the assistance provided	Apetina yet to be received. Palumeu still in discussion internally (villagelevel)
How was the distribution organized	The organization of the distribution will be done by Pija and ACR's (Apetina), Palumeu will be done by the Rangers with the captain
What do households need in addition	Awareness on disaster relief/Actions in case of flooding
What is the current health situation	Apetina no comment, Palumeu has difficulty to maintain their daily household activities as the waterlevel gets high and no sight to where to bath and wash dishes. Some outdoor 'laterines' get flooded and creates a onhygienic environment to such as above.
What is the water accessibility	NO potable water accessibility in Apetina and remote villages, NO potable water in Palumeu.
How is the acces to food	Acces to food is mediocre due to the agricultural plots being flooded. Fish difficult to high waterlevel. (both villages)
What is the situation with regards to school, teachers and education	Schools have been closed due to flooding. Pathways to school muddy and onhygienic. Low to no pathway maintenance. (both villages)

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