



ADAPTATION FUND

AFB/PPRC.36/Inf.21
15 September 2025

Adaptation Fund Board
Project and Programme Review Committee
Thirty-sixth Meeting
Bonn, Germany, 7-8 October 2025

PROPOSAL FOR COSTA RICA, PANAMA



ADAPTATION FUND

ADAPTATION FUND BOARD SECRETARIAT TECHNICAL REVIEW OF PROJECT/PROGRAMME PROPOSAL

PROJECT/PROGRAMME CATEGORY: Regional Project Concept

Countries/Region: Costa Rica, Panama

Project Title: Enhancing Climate Change Adaptation Capacity in Central America with Focus on Costa Rica and Panama: Improving Hydroclimatic and Early Warning systems and integrating with Water Resources Management

Thematic Focal Area: Disaster risk reduction and early warning systems

Implementing Entity: World Meteorological Organization (WMO)

Executing Entities: Regional Committee for Water Resources (CRRH), Global Water Partnership (GWP), World Meteorological Organization (WMO)

AF Project ID:

IE Project ID:

Reviewer and contact person: Mahamat Assouyouiti

IE Contact Person:

Requested Financing from Adaptation Fund (US Dollars):

Co-reviewer(s): Linda Ogallo

<p>Technical Summary</p>	<p>The project Enhancing Climate Change Adaptation Capacity in Central America with Focus on Costa Rica and Panama: Improving Hydroclimatic and Early Warning systems and integrating with Water Resources Management aims to improve climate change adaptation capacity and resilience to droughts and floods in Central America through the strengthening of hydroclimatic and early warning systems and the integration of the knowledge generated in the planning and management of national and regional water resources, according to the pillars of risk management. This will be done through the four components below:</p> <p><u>Component 1:</u> Hydrometeorological observing, monitoring, and data management infrastructure improved for risk awareness and Early Warnings (USD 8,866,000).</p> <p><u>Component 2:</u> Enhanced and sustained hydrometeorological forecasting available to communities and users (USD 4,490,000)</p> <p><u>Component 3:</u> Flood and drought management and risk mitigation enhancement from regional to local level (USD 3,620,000).</p>
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	<p>Requested financing overview: Project/Programme Execution Cost: USD 1,825,050 Total Project/Programme Cost: USD 20,781,050 Implementing Fee: USD 2,078,105 Financing Requested: USD 22,859,155</p> <p>The proposal includes a request for a project formulation grant and/or project formulation assistance grant of 150,000</p> <p>The initial technical review raises some issues, such as the absence of an initial gender analysis, need for further clarity on the other participating countries in central America, cost effectiveness, strengthening alignment with national policies and standards, the environmental and social impacts / risks identified, in compliance with the Environmental and Social Policy and Gender Policy of the Fund, discrepancy in the project funding requested as is discussed in the number of Clarification Requests (CRs) and Corrective Action Request (CAR) raised in the review.</p>
Date	August 18, 2025

Review Criteria	Questions	First Technical Review Comments August 16, 2025
Country Eligibility	1. Are all of the participating countries party to the Kyoto Protocol and/or the Paris Agreement?	Yes
	2. Are all of the participating countries developing countries particularly vulnerable to the adverse effects of climate change?	Yes, but further information is needed Both countries are developing countries particularly vulnerable to the adverse effect's climate change Both <u>Panama</u> and <u>Costa Rica</u> are exposed to drought and floods. The background mainly focuses on Central America while the countries of focus, <u>Panama</u> and <u>Costa Rica</u> are only mentioned briefly. CAR1: Please submit LOEs in the re-submission for all the participating Central American countries participating in this proposal.
Project Eligibility	1. Have the designated government authorities for the Adaptation Fund from each of the participating countries endorsed the project/programme?	Yes. As per the Endorsement letter dated July 1, 2025 for Panama, July 24, 2025 for Costa Rica.

	<p>2. Does the length of the proposal amount to no more than fifty (50) pages for the project/programme concept, including its annexes?</p>	<p>No. CAR2: Kindly revise the concept to no more than fifty (50) pages including its annexes.</p> <p>CAR3:</p> <ol style="list-style-type: none"> 1. Since this is a first submission of the fully developed proposal, kindly resubmit a clean version without the track changes and comments. 2. In addition, kindly translate Figure 3, and other Spanish words across the document to English. <p>Note: To improve the presentation of the document.</p> <ol style="list-style-type: none"> 1. Kindly ensure all tables are numbered for easier reference. 2. Kindly also ensure that document formatting and punctuation across the proposal done.
	<p>3. Does the regional project / programme support concrete adaptation actions to assist the participating countries in addressing the adverse effects of climate change and build in climate resilience, and do so providing added value through the regional approach, compared to implementing similar activities in each country individually?</p>	<p>Yes, but further information is needed. The project aims to strengthen institutional infrastructure at regional, national and sub-national levels, to improve risk awareness and early warning. It contributes to the themes of disaster risk reduction and early warning systems and transboundary water management.</p> <p>CAR4: Kindly provide a detailed Theory of Change to clearly illustrate the logical connections between activities, outputs, and outcomes. Ensure that the proposed activities are directly aligned to addressing the threats anticipated under the projected climate scenarios. In addition, project outcomes described in the table on page 7 are not included in section A on the description of the project/programme components. Please clarify and/or correct.</p> <p>CR1: Kindly include the project outputs in the description of the project components from pages 11-18, and a description of the activities to be undertaken under each output.</p>

	<p>4. Does the project / programme provide economic, social and environmental benefits, particularly to vulnerable communities, including gender considerations, while avoiding or mitigating negative impacts, in compliance with the Environmental and Social Policy of the Fund?</p>	<p>Unsure.</p> <p>On page 22 a breakdown of the beneficiaries is included. 2,106,000 people (918,000 in Costa Rica and 1,188,000 in Panama) will benefit from drought and flood management and contingency plans, including participatory and inclusive plans for vulnerable communities and end users. 550,988 inhabitants in vulnerable communities will have access to early warning systems designed inclusively, with products and services tailored to their needs and training to utilize them effectively. The project will define the percentage of women, youth, elderly, indigenous people, Afro-descendants, and people with disabilities participating in activities to strengthen social inclusion and gender equity.</p> <p>An initial gender analysis is however not included.</p> <p>CAR5: Please incorporate an initial gender analysis that outlines the distinct needs, capacities, roles, and knowledge resources of women and men, and/or highlights how evolving gender dynamics could contribute to sustainable transformative change.</p> <p>CAR6: Please provide beneficiary information for ‘Central America’.</p>
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	<p>5. Is the project / programme cost-effective and does the regional approach support cost-effectiveness?</p>	<p>Yes, but further justification is needed.</p> <p>The project is adopting a cost-effectiveness approach by reducing potential damage to infrastructure, housing, crops, and livestock, thereby safeguarding critical assets. Timely early warnings are expected to lower response and recovery expenditures by minimizing reliance on costly post-disaster interventions. In addition, improved water resource management will enable more efficient allocation and optimization of use. Finally, data-driven planning will strengthen decision-making processes, reduce risks, and enhance overall resilience.</p> <p>CAR7: However, kindly provide a sound justification for the cost-effectiveness of selected measures, including alternative options to the proposed measures, and estimates of the evaluation where possible. Consider using a comparative table showing cost effectiveness of each measure compare to alternative option or Business as usual.</p>
	<p>6. Is the project / programme consistent with national or sub-national sustainable development strategies, national or sub-national development plans, poverty reduction strategies, national communications and adaptation programs of action and other relevant instruments? If applicable, it is also possible to refer to regional plans and strategies where they exist.</p>	<p>Yes, but further clarification is needed.</p> <p>The concept includes a table of the relevant national and regional plans and strategies, given for each country.</p> <p>CAR8: Kindly revise the table 1 and 2 with an English translation of the proposed national and regional strategies and plans.</p> <p>CR2: Kindly include any national meteorological plans and related documents for the participating countries.</p>

	<p>7. Does the project / programme meet the relevant national technical standards, where applicable, in compliance with the Environmental and Social Policy of the Fund?</p>	<p>Yes, on page 29.</p> <p>However further information is required.</p> <p>CR3: Kindly also include the relevant gender laws that the project will be aligned with in ensuring inclusion of vulnerable communities to in Part II section F of the proposal.</p>
	<p>8. Is there duplication of project / programme with other funding sources?</p>	<p>No.</p> <p>The proposal lists on planned, ongoing and recently completed project that are complimentary and could possibly overlap in table 3.</p> <p>CR4: Kindly list the project identified as “various” in row # 6.</p>
	<p>9. Does the project / programme have a learning and knowledge management component to capture and feedback lessons?</p>	<p>Yes.</p> <p>Component 4, <i>output 4.2.2 Knowledge management and community of practice on climate-resilient flood and drought management established</i>. The project intends to create a regional digital platform that functions as a repository of data, tools, case studies and lessons learned.</p>
	<p>10. Has a consultative process taken place, and has it involved all key stakeholders, and vulnerable groups, including gender considerations in compliance with the Environmental and Social Policy and Gender Policy of the Fund?</p>	<p>Yes, on page 36.</p> <p>However further information is required</p> <p>Institutions consulted include ministries, universities, basin committees, and civil society organizations and summed up on page 36. There were no institutions or stakeholders representing any vulnerable groups who participated in the consultations.</p> <p>CR5: Please include evidence of the consultation with any institution representing vulnerable groups and indigenous populations and how this has been taken account into the proposal design.</p>

	<p>11. Is the requested financing justified on the basis of full cost of adaptation reasoning?</p>	<p>Yes, but further clarification is needed.</p> <p>The project is meant to lead to reduction of economic losses from disasters related to droughts and floods; Improved water resource management for agriculture, energy, and drinking water and optimization of public investment by shifting focus from reactive to preventive measures.</p> <p>CAR9: Please confirm that there is no co-financing expected and that AF funding will be able to deliver its outcomes and outputs regardless of the success of any other leverage or co-financing.</p>
	<p>12. Is the project / program aligned with AF's results framework?</p>	<p>Yes, but further clarification is needed.</p> <p>Component 1 in table 5 is stated to align to Fund Outcome Indicator 4.2 Physical infrastructure improved to withstand climate change and variability-induced stress. However, none of the outputs described under this component are in climate proofing of infrastructure.</p> <p>CAR10:</p> <ol style="list-style-type: none"> 1. Please indicate which outputs and activities will contribute to the fund indicator of improving infrastructure to withstand climate change and variability-induced stress. 2. At Part II Section B, please indicate the alignment with the results areas of the fund. 3. Please rationalise the figures for the components which is currently presented at \$18,956, 000 in Project/Programme Components and Financing table and as \$11, 517,000 in table 5.

	13. Has the sustainability of the project/programme outcomes been taken into account when designing the project?	<p>Yes, but further justification is needed. The project promotes sustainability by strengthening institutions and building capacity, integrating adaptation measures into public policies and governance systems, and exploring innovative financing mechanisms such as trust funds, public–private partnerships, and regional alliances.</p> <p>CAR11: please clarify and strengthen the project scalability beyond the AF funding. Ref. review sheet during Pre-concept note.</p>
	14. Does the project / programme provide an overview of environmental and social impacts / risks identified, in compliance with the Environmental and Social Policy and Gender Policy of the Fund?	<p>No, on page 40.</p> <p>The project is classified as Category C. The project assumes no risks and table 4 on the comparison with the 15 principles of the adaptation fund is not filled correctly.</p> <p>CAR12: In Table 4</p> <ol style="list-style-type: none"> 1. In the second column on ‘No further assessment required for compliance’ use a check mark ✓ where no assessment is required and leave blank where an assessment is required. 2. In the third column ‘Potential impacts and risks – further assessment and management required for compliance’: kindly categorise the level of risk; describe possible risks that could arise considers all potential direct, indirect, transboundary, and cumulative impacts and risks that could result from the proposed project/programme; and how the project plans to mitigate the risks. <p>CR7: Kindly elaborates in section L on the gender-specific cultural and/or legal context in which the project/programme will operate. Also see CAR4.</p>
	15. Does the project promote new and innovative solutions to climate change adaptation, such	<p>Unsure, on page 16.</p>

	<p>as new approaches, technologies and mechanisms?</p>	<p>Most of the solutions presented as innovations are difficult to evaluate as innovative as they are described in a general way. The use of crowdsourcing for community monitoring of drought impacts is innovative but the concepts stated that it will be evaluated.</p> <p>CR8: Kindly clarify if crowdsourcing is going to be used in the project or is still being considered and might not be used.</p> <p>The project concept also states that software and the guides created through of the 3rd HydroHub innovation call results, will be incorporated, but the solutions to be incorporated are not stated.</p> <p>CR9: Kindly elaborate on the innovative software and guides to be incorporated into the project.</p>
<p>Resource Availability</p>	<p>1. Is the requested project / programme funding within the funding windows of the regional projects/programmes?</p>	<p>Yes, but further clarification needed</p> <p>CR10: The CN cover page indicates a total amount of \$13,932,655 requested and a PFG of \$120,000. However, the project amount breakdown in table (page 7-9) indicates a different amount of \$22,859,155. Please revise the document an align the project amount breakdown with the funding request of \$13,932,655.</p>
	<p>2. Are the administrative costs (Implementing Entity Management Fee and Project/ Programme Execution Costs) at or below 10 per cent of the project/programme for implementing entity (IE) fees and at or below 10 per cent of the project/programme cost for the execution costs?</p>	<p>Unsure</p> <p>The Implementing Entity Management Fee are at 8.0% however, WMO is acting as an Executing Entity as well and how much of the Programme Execution Costs being allocated to WMO is not indicated.</p> <p>CAR13: Please revise the project fees and executing cost after addressing CR9 above.</p> <p>CAR14: Kindly indicate how much of the Programme Execution Costs will be allocated to WMO.</p>

		CAR15: IN the PFG application form please clarify what LOA is and include the IE fee.
Eligibility of IE	1. Is the project/programme submitted through an eligible Multilateral or Regional Implementing Entity that has been accredited by the Board?	Yes. Accreditation Expiration Date: 30 March 2027
Implementation Arrangements	1. Is there adequate arrangement for project / programme management at the regional and national level, including coordination arrangements within countries and among them? Has the potential to partner with national institutions, and when possible, national implementing entities (NIEs), been considered, and included in the management arrangements?	n/a at concept stage
	2. Are there measures for financial and project/programme risk management?	n/a at concept stage
	3. Are there measures in place for the management of for environmental and social risks, in line with the Environmental and Social Policy and Gender Policy of the Fund? Proponents are encouraged to refer to the Guidance document for Implementing Entities on compliance with the Adaptation Fund Environmental and Social Policy, for details.	n/a at concept stage
	4. Is a budget on the Implementing Entity Management Fee use included?	n/a at concept stage
	5. Is an explanation and a breakdown of the execution costs included?	n/a at concept stage
	6. Is a detailed budget including budget notes included?	n/a at concept stage
	7. Are arrangements for monitoring and evaluation clearly defined, including budgeted M&E plans and sex-disaggregated data, targets and indicators, in compliance with the Gender Policy of the Fund?	n/a at concept stage

	8. Does the M&E Framework include a breakdown of how implementing entity IE fees will be utilized in the supervision of the M&E function?	n/a at concept stage
	9. Does the project/programme's results framework align with the AF's results framework? Does it include at least one core outcome indicator from the Fund's results framework?	n/a at concept stage
	10. Is a disbursement schedule with time-bound milestones included?	n/a at concept stage



ADAPTATION FUND

CONCEPT NOTE FOR REGIONAL PROJECT/PROGRAMME

PART I: PROJECT/PROGRAMME INFORMATION

Title of Project/Programme: Enhancing Climate Change Adaptation Capacity in Central America with Focus on Costa Rica and Panama: Improving Hydroclimatic and Early Warning systems and integrating with Water Resources Management

Countries: Costa Rica, Panama, Central America

Thematic Focal Area¹: Disaster risk reduction and early warning systems

Type of Implementing Entity: Multilateral Implementing Entity

Implementing Entity: World Meteorological Organization (WMO)

Executing Entities: Regional Committee for Water Resources (CRRH), Global Water Partnership (GWP), World Meteorological Organization (WMO)

Amount of Financing Requested: 13,932,655 (in U.S Dollars Equivalent)

Project Formulation Grant Request: Yes No

Amount of Requested financing for PFG: 120,000 (in U.S Dollars Equivalent)

Letters of Endorsement (LOE) signed for all countries: Yes No

NOTE: LOEs should be signed by the Designated Authority (DA). The signatory DA must be on file with the Adaptation Fund. To find the DA currently on file check this page: <https://www.adaptation-fund.org/apply-funding/designated-authorities>

Stage of Submission:

This proposal has been submitted before including at a different stage (pre-concept, concept)

This is the first submission ever of the concept note

In case of a resubmission, please indicate the last submission date: N/A

¹ Thematic areas are: Food security; Disaster risk reduction and early warning systems; Transboundary water management; Innovation in adaptation finance.

Project/Programme Background and Context:

According to the World Meteorological Organization (WMO) [1] [2.b], the years 2023 and 2024 were marked by unprecedented heat, making them the hottest years ever recorded, with 1.45 °C and 1.55 °C above pre-industrial levels, respectively. The transition from La Niña to El Niño conditions, as well as the positive phase of the Indian Ocean Dipole (IOD), contributed to this extreme heat and various weather effects, from torrential rains and floods to droughts. This translated into drier-than-normal conditions for river flows around the world, a trend that has been observed in 2022 and 2021 [2].

Central America² is a highly exposed, vulnerable region strongly impacted by climate variability and change. Deep economic, ethnic and social inequalities are exacerbated by climate change, affecting the most vulnerable groups to the greatest extent. High levels of widespread poverty, weak water governance, unequal access to drinking water and sanitation services, and lack of infrastructure and financing reduce adaptive capacity, increasing and creating new vulnerabilities in the population (high confidence) [5][6].

Many extreme events have already affected the Central American region and are expected to intensify, including rising temperatures and aridity, sea-level rise, coastal erosion and acidification of oceans and lakes. This leads to coral bleaching and increased frequency and severity of droughts in some regions; with the consequent decrease in water supply, which has an impact on agricultural production, traditional fisheries, food security and human health (high confidence level) [5][6].

The countries of the Central American region consistently occupy the top positions in the world ranking of risk due to extreme events (high confidence). Hydrometeorological events are the most frequent extreme events with the greatest impact (high confidence) [5][6]. These include increased frequency and severity of droughts, with a consequent decrease in water supply, affecting agricultural production, traditional fisheries, food security and human health (high confidence). In Central America, on the one hand, 10.5 million people live in the so-called "Corredor Seco" (dry corridor), a region with a prolonged dry season and now more erratic rainfall patterns [6]. Increasing water scarcity affects and will continue to affect food security, human health and well-being. On the other hand, flood impacts mainly affect agriculture and poor urban neighborhoods and are responsible for the majority of disaster-related deaths. Hydrometeorological factors, such as tropical storms, hurricanes, and torrential rains that cause flooding, interact with social, political, geopolitical, and economic factors (high confidence).

The average annual temperature in 2024 for Central America was the highest ever recorded, with 0.96 °C above the average for the period 1991-2020 (with anomalies between 0.77 and 1.09³); and 1.44 °C warmer if we compare it to the reference period 1961-1990 (with anomalies between 1.26 and 1.63 °C²) [3.b]. The data at the national level reveal these positive anomalies, since from the data from the monitoring stations, anomalies of the average air temperature in situ between +1°C and +3 °C are observed. [3.b]

With warming of about 2°C, climate-related changes in food availability and diet quality are estimated to increase nutrition-related diseases and the number of undernourished people, affecting between tens (in low-vulnerability and low-warming conditions) and hundreds of millions of people (in high-vulnerability and high-warming conditions); especially among low-

² "Central America" refers to the region composed of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama.

³ Depending on the six datasets used by the assessment of WMO.

income households in low- and middle-income countries in Central America (high confidence level). The risks of climate change for cities, settlements and key infrastructure will increase considerably in the medium to long term with increased global warming, especially in places already exposed to high temperatures, along coasts or with high vulnerability (high confidence) [6].

In relation to precipitation, most of Central America recorded below-normal rainfall in 2023, between 20 and 40%, particularly for the cases of Panama and Honduras. The opposite is the case in Costa Rica (and some areas of Guatemala), for which rainfall was between 10 and 40% above normal. In 2024, above-normal rainfall between 20% and 30% was recorded in Guatemala and El Salvador and between 10% and 30% in Costa Rica, Honduras and Nicaragua [2.b].

The drought affected several countries in the region during 2023. The effects of La Niña during the first quarter and El Niño during the second half of the year contributed to precipitation deficits, above-average temperatures and recurrent heat waves, causing severe droughts in several countries. According to the WMO, towards the end of November 2023, much of Panama's territory was affected by severe to extreme drought; Nicaragua, Guatemala and El Salvador presented severe drought conditions; and Costa Rica also detected some places with severe drought conditions (as reported by the National Meteorological Institute) [3].

Hydrometeorological and climate-related events pose multiple risks to society. It is estimated that more than 90% of disasters are related to this type of event. In the period 1994-2022, 321 events were recorded⁴ in the region, causing damages of \$21.7 billion USD, affecting 35.7 million people, of which about 25 thousand lost their lives (Fig. 1) [8]. Additionally, in a study conducted in 2024 based on data contained in the EM-DAT international disaster database between 2000 and 2020, it was found that various areas in Central America recorded the highest number of people per km² affected by climate-related disasters and extreme events⁵ [7].

According to the World Bank (WB), Costa Rica (CR) has almost 7% of its surface exposed to three or more threats, which translates into the eighth highest exposure to economic risk in the world. According to Panama's third National Communication on Climate Change (PA), the country ranks fourteenth among the countries with the highest exposure to multiple hazards, with 15% of its surface area and 12% of its total population exposed to two or more hazards. Exposure to multiple hazards, such as floods and droughts, is more relevant in the three transboundary basins shared by both countries: Changuinola, Sixaola and Chiriquí. Recent events, such as droughts in 2018-2019, hurricanes Eta and Iota in 2020, and floods in 2022, have highlighted the precarious position of Central American countries, particularly Costa Rica and Panama.

⁴ Including hydrological (different types of floods and landslides), meteorological (storms and extreme temperatures), and climatological (droughts and forest fires).

⁵ The following phenomena were included in this study: drought, tropical cyclones, flash floods, river floods, forest fires, heat waves, landslides.



Fig. 1. Impacts of climate-related disasters in Central America between 1994 and 2022. Source: EM-DAT.

Commented [LS1]: Se requieren letras más grandes

Loss and damage from disasters are a great financial burden for Central American countries and reduces or nullifies efforts and resources in favor of sustainable development. From the point of view of subsectors, these impacts are even more relevant: in the period 2008-2021, disaster losses – of which a significant proportion correspond to damaged infrastructure – represented more than 70% of energy investments, a third more than the amount invested in water and sanitation, almost double the expenditure on telecommunications, and they were about a fifth of the total invested in transportation (Fig. 2) [10].

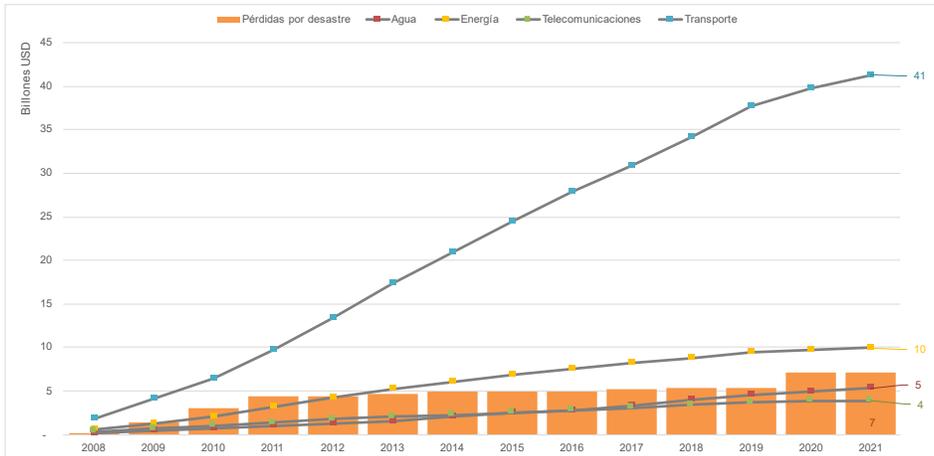


Fig. 2. Disaster losses and public investment in infrastructure by subsector in Central America (Data accumulated in the period 2008-2021). Source: Infralatam.

In this context, it is much more important and a priority to have accurate and timely hydrometeorological information that facilitates and allows better decision-making related to the protection of the population and its property. Multi-hazard Early Warning Systems (MHEWS) are a proven, effective and feasible climate adaptation measure that saves lives and provides at

least ten times the return on investment. A 24-hour advance notice of an imminent dangerous event can reduce subsequent damage by 30% [11].

The "Early Warning for All" (EW4ALL) initiative announced by the United Nations Secretary-General on March 22, 2022, seeks to ensure that all people on Earth are protected by Early Warning Systems (EWS) within five years. Its 2023-2027 action plan, launched in November 2022 and supported by a joint declaration signed by 50 countries, specifies the path to be followed to achieve the proposed goal, prioritizing the necessary actions and investments. Its achievement will only be possible with modern science, sustainable networks of systematic monitoring, international exchange of quality data, advanced supercomputing power, forecasts based on impacts, as well as advances in telecommunications and connectivity. This means there is a need to strengthen National Meteorological and Hydrological Services (NMHSs), National Disaster Risk Management Agencies (NDRAs) and emergency preparedness measures, as well as improving and deepening the understanding of risk at all time scales [12].

In the Americas and Caribbean region, only 37% of countries reported having MHEWS in 2022, although there has been an increase from 2015 (23%). This lower coverage suggests that increased efforts to implement MHEWS are needed [13].

Current situation

With the support of WMO and the Inter-American Development Bank (IDB), and in close collaboration with NMHS and sectoral users of information at the national level, a detailed national assessment of the hydrometeorological value chain was carried out in both countries in 2021 and 2022.

This exercise resulted in strategic roadmaps to improve the delivery of hydrological services at the national level (see Annex 1). The needs identified are numerous and ambitious, but in particular the lack or inadequacy of coverage of national-scale hydrometeorological data production and integrated databases, localized and operational TSS, and limited institutional monitoring, planning and governance, in particular in relation to droughts and floods, as well as the lack of awareness among stakeholders.

To have these valuable planning instruments, together with the recently created Institute of Meteorology and Hydrology of Panama (IMHPA) and two consolidated and recognized institutions not only in Costa Rica but in Central America (National Meteorological Institute of Costa Rica (IMN) and the Costa Rican Institute of Electricity (ICE)), as well as the recent change of government administrations in both countries, it opens a window of opportunity for the joint development and implementation of capacity-building initiatives to strengthen the provision of hydrometeorological services, particularly linked to droughts and floods. The existence and willingness of the Regional Committee on Water Resources (CRRH) of the Central American Integration System (SICA) to support and facilitate not only the implementation, but also to contribute to the integration and extension of national benefits and results at the regional level throughout Central America represents an additional added value. In addition, WMO and its partners, such as the Global Water Partnership (GWP), also bring added value to enhancing capacities around hydrometeorology and water resources management through the different technical outputs, methodologies, standardizations, knowledge-management platforms, networks of experts and results of their associated drought and flood management programmes.

It is clear that without rapid, deep and sustained mitigation measures and accelerated adaptation, loss and damage will continue to increase, disproportionately affecting the most vulnerable populations in Central America (high confidence) [5].

Project/Programme Objectives:

The objective of the project is to improve climate change adaptation capacity and resilience to droughts and floods in Central America through the strengthening of hydroclimatic⁶ and early warning systems and the integration of the knowledge generated in the planning and management of national and regional water resources, according to the pillars of risk management. This will be achieved by:

- (1) Strengthen monitoring capabilities of meteorological, hydrological and climatic variables through the improvement of monitoring and data systems that allow the collection, interoperability, exchange and integration of data at the regional and national level;
- (2) Strengthen forecasting capacities of meteorological, hydrological and climatic hazards through the improvement of knowledge generation and informed decision-making at the regional and national levels, based on a solid monitoring network strengthened in component 1;
- (3) Conceptualize, develop and implement a Central American Flood and Drought Management (CAFDMC) (virtual) within the CRRH to strengthen regional coordination of flood and drought management, and improve risk knowledge and multi-hazard early warning capacities at regional, national and local scales, focusing on vulnerable people through pilot projects, and ensuring that National Drought and Flood Plans are developed and implemented;
- (4) Improve hydroclimatic governance, including institutional capacity and stakeholder awareness for the strengthening of integrated drought and flood management at the regional (through the CRRH), national (through the NMHS of Costa Rica and Panama) and local (through the pilot projects in basins), helping decision-making processes at the three scales, ensuring better inclusive policy tools and the training needed to sustain long-term activities.

In this way, the implementation of this initiative from an integrated point of view at the national, binational and regional levels, will not only strengthen institutional arrangements and tools at different scales, but will also favor the generation, availability, access and provision of services, information and accurate and timely data according to the general needs of the population and particular needs of end users at the institutional level and in priority communities; specifically related to drought and flood management. This integrated and effective approach will also contribute financially by achieving economies of scale in joint implementation, as well as by addressing limited institutional budgets and bureaucratic processes at the national level.

⁶ The terms "hydroclimatic", "climatic" and "hydrometeorological" are used interchangeably in this document when referring to data, products and services that support risk management and adaptation to climate change. This decision responds to a practical and technical need to efficiently communicate the integrated and complementary nature of these systems of observation and analysis, whose conceptual boundaries often overlap in practice. As the project comprehensively addresses the generation, use and articulation of data and services in the three domains – climate, water and (meteorological) weather – for decision-making, planning and early warning, the terminological flexibility allows to reflect the interdependent nature of the technical components of the project.

Project/Programme Components and Financing:

Project Components	Expected Outcomes	Expected Outputs	Countries	Amount (US\$)	Commented [LS2]: Se pueden agregar más montos aquí
1. Hydrometeorological observing, monitoring, and data management infrastructure improved for risk awareness and Early Warnings	1.1 Integrated observation, monitoring and data management systems provide inputs for risk knowledge and Early Warning	1.1.1 Duly designed and modernized (and/or instrumented) hydromet monitoring networks in priority basins integrated at national and regional level for their long-term functionality and sustainability	Costa Rica, Panama and Central America	1,640,000	
		1.1.2 Meteorological, hydrological and climate database management systems developed and implemented at national and regional levels	Costa Rica, Panama and Central America	1,660,000	
		1.1.3 Radar information integrated into national and regional monitoring networks to refine early warning products	Costa Rica, Panama and Central America	4,050,000	
	1.2 Hydrometeorological and climate data at national and regional scales available for product and service generation	1.2.1 Hydrometeorological and climate data and information integrated into national and regional databases	Costa Rica, Panama and Central America	116,000	
		1.2.2 Structures established to integrate, process and disseminate data at national and regional levels according to end-user needs at public and sectoral levels	Costa Rica, Panama and Central America	1,400,000	
		2.1 Enhanced and sustained mechanisms for flood and drought risk knowledge for use by communities and users	2.1.1 Agreed and established flood and drought risk assessment mechanism; and a baseline risk assessment defined in the priority basins	Costa Rica and Panama	330,000
2. Institutional set-up and processes for risk knowledge and Early Warning	2.1 Enhanced and sustained mechanisms for flood and drought risk knowledge for use by communities and users	2.1.2 Developed and agreed flood and drought impact assessment and monitoring methodology; and an established regional impact database	Costa Rica and Panama	300,000	
		2.1.3 Socioeconomic benefit (SEB) analysis performed to show the benefit of hydrometeorological information	Costa Rica, Panama and Central America	240,000	
		2.2 Enhanced and sustained hydrometeorological forecasting available to communities and users	2.2.1 Products and services defined and developed in a participatory manner with communities and end-users, both at the basin level (for floods) and at the national/basin level (for droughts)	Costa Rica and Panama	620,000
	2.2.2 Products on hydrological status and outlooks (sub-seasonal to seasonal) for priority basins generated in accordance with	Costa Rica and Panama	1,000,000		

Project Components	Expected Outcomes	Expected Outputs	Countries	Amount (US\$)	Commented [LS2]: Se pueden agregar más montos aquí
		international guidelines and end-user needs at sectoral level			
	2.3 Dissemination of flood and drought alerts available to communities and users	2.3.1 Last-mile-focused warning communication and dissemination structures established, implemented and connected to local and national flood contingency plans and drought plans	Costa Rica, Panama and Central America	2,000,000	
3. Flood and drought management and risk mitigation enhancement from regional to local level	3.1 Strengthened regional coordination of flood and drought management and policy	3.1.1 Regional Flood and Drought Management Virtual Centre established at CENTROCLIMA with the support of NMHSs, managing and providing harmonized risk knowledge, data and information, as well as developing national capacity	Costa Rica, Panama and Central America	1,160,000	
		3.1.2 Regional institutional arrangements and working groups established under the Regional Flood and Drought Management Virtual Centre	Costa Rica, Panama and Central America	70,000	
	3.2 Users make decisions based on established national planning for flood and drought and response capacity for communities is strengthened	3.2.1 National drought plans established and/or supported for implementation, under an inclusive approach	Costa Rica and Panama	180,000	
		3.2.2 National flood plans established, under an inclusive approach	Costa Rica and Panama	170,000	
		3.2.3 A decision support system for integrated water management implemented at the national scale	Costa Rica and Panama	240,000	
	3.3 Vulnerable communities more resilient against flood and drought	3.3.1 Community flood management plans in place, including contingency plans, in vulnerable communities	Costa Rica and Panama	100,000	
		3.3.2 Community-based climate-resilient drought risk management plans established for vulnerable communities	Costa Rica and Panama	100,000	
3.3.3 Pilot projects in priority basins implemented to reduce the risk of drought and floods in the most vulnerable communities, prioritizing nature-based solutions		Costa Rica and Panama	1,600,000		
4. Enabling environment for building resilience to floods and droughts	4.1 Enhanced governance framework and gender mainstreaming for integrated	4.1.1 Framework for the sustainability of hydrometeorological services integrated into national legal and planning instruments, including ministerial decrees	Costa Rica, Panama and Central America	200,000	

Project Components	Expected Outcomes	Expected Outputs	Countries	Amount (US\$)	Commented [LS2]: Se pueden agregar más montos aquí
	drought and flood management	4.1.2 Policy and governance mechanisms and instruments to strengthen institutional capacity and coordination are integrated at all stages of the hydrometeorological chain	Costa Rica, Panama and Central America	100,000	
		4.1.3 Gender action plans, indicators and training developed and implemented	Costa Rica, Panama and Central America	100,000	
	4.2 Enhanced institutional capacity and stakeholders' awareness for integrated drought and flood management	4.2.1 Comprehensive training and education programme for all stakeholders developed and implemented at regional, national and local levels	Costa Rica, Panama and Central America	1,280,000	
		4.2.2 Knowledge management and community of practice on climate-resilient flood and drought management established	Costa Rica, Panama and Central America	300,000	
6. Project/Programme Execution cost				1,825,050	
7. Total Project/Programme Cost				20,781,050	
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (if applicable)				2,078,105	
Amount of Financing Requested				22,859,155	

Projected Calendar:

Milestones	Expected Dates
Start of Project/Programme Implementation	07-2026
Mid-term Review (if planned)	12-2028
Project/Programme Closing	06-2031
Terminal Evaluation	09-2031

PART II: PROJECT / PROGRAMME JUSTIFICATION

A. Describe the project/programme components, particularly focusing on the concrete adaptation activities, how these activities would contribute to climate resilience, and how they would build added value through the regional approach, compared to implementing similar activities in each country individually.

This project is structured in relation to the pillars of risk management, taking into account the main obstacles encountered in the previously integrated strategic roadmaps (see Annex 1):

- insufficient hydrometric data coverage and collection, including the need for data exchange at an appropriate scale for the effective delivery of hydrometric services;
- limited governance and lack of an enabling environment for institutional effectiveness, including multisectoral coordination and exchange of data and information;
- limited government funding and budgets;
- insufficient hydroclimatic information for sustainable sectoral planning, development and management, and in particular of the water sector and hydrometeorological extremes (droughts and floods), as well as early warning; and
- insufficient institutional support for regional hydrometeorological operations, caused by deficiencies and lack of regional tools, methodologies and products.

In this sense, the project is made up of 4 components: 3 complementary technical components and a transversal component (see Fig. 3).

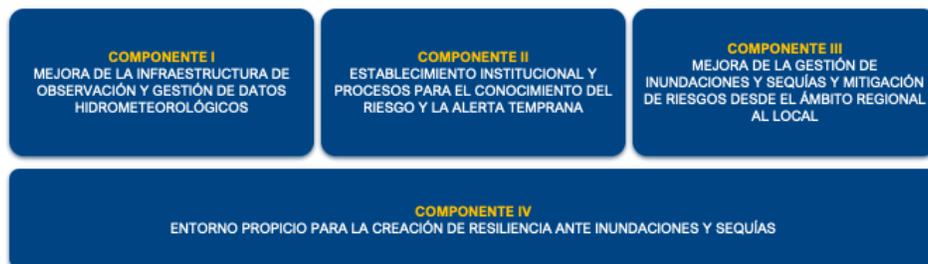


Fig. 3. Project components.

The project will focus on three geographical scales: regional, national and priority basins. At the regional level, the work will be integrated under the framework of the CRRH and this institution will be both in charge of providing regional products and the main support for NMHSs in technical, systematization and training terms, and in institutionalizing generated products. At the national level, NMHSs (i.e., IMN and ICE in Costa Rica and IMHPA in Panama) will be strengthened to modernize and expand their observing infrastructure and to be able to provide timely and quality data, information, and services in line with the needs and priorities established in the national context, they will also be the coordinators with other national institutions of efforts at the national level. At the level of priority basins, the work will be carried out in basins that have been selected by national institutions, which are (see Annex 2 for more detail on the selection of basins):

- Costa Rica: Tempisque River Basin and Pirris-Parrita-Candelaria River Basin.
- Panama: La Villa River Basin and Tonosí River Basin.

Each component is explained below:

Component I: Hydrometeorological observing, monitoring, and data management infrastructure improved for risk awareness and Early Warnings.

This component links directly to the first of the project's specific objectives. Detecting and monitoring hazards such as droughts and floods implies improving not only the quality of data (in quantitative and qualitative terms) but also its access in a timely manner for decision-making. The availability of high-quality data is the foundation of the hydrometeorological value chain, essential for the development and provision of hydrometeorological and climate products and services. This is why this component focuses on both monitoring and data management systems.

Outcome 1.1 Integrated observation, monitoring and data management systems provide inputs for risk knowledge and Early Warning

It is a priority to strengthen monitoring networks, as well as to develop capacities in NMHSs to maintain and improve them. To this end, a diagnosis of the current state of the observation networks and the different actors involved will be carried out, in order to integrate a detailed action plan for the optimization and modernization of the monitoring networks in consideration of several levels; that is, a regional reference core network with national components, as well as subnational and/or local project-specific networks. Previous review efforts will be taken into account, which must be updated.

This plan will integrate not only information on the type, number and location of the necessary monitoring stations, but also the technical specifications of the associated instruments, including telecommunications; as well as a strategy for its operation and maintenance. As a result of this plan, the basins will be instrumented with additional automatic stations (up to 4 per basin) in order to generate the necessary data as per the required monitoring network.

This plan will also give particular consideration to the data and information needs for the development and implementation of the two pilot projects in vulnerable communities (expected result 3.3). This information will also be relevant in relation to the provision, installation and operation of 10 automatic hydrometeorological stations planned for the pilot basins in both countries. This plan will be reviewed and updated in the third year in the light of progress made and in consideration of new needs (if any). In the case of Costa Rica, since a WB project⁷ is on the horizon where it is planned to strengthen the hydrological network, we will work with them to coordinate the recommendation of the location of stations.

An important element within this Outcome is to generate an operation and maintenance strategy, which will be associated with a sustainability strategy that will include both the institutional and personnel part, as well as the identification and implementation of effective financing mechanisms complementary to the fluctuating budgets of government institutions (such strategy will be used as input to the activities of Outcome 4). Public-private partnerships can be an efficient alternative in this regard. Likewise, being able to establish adequate mechanisms and protocols for the calibration of equipment and having batches of spare parts are important elements that will be considered in this plan. In addition, the plan will include

⁷ Program for the development of resilient infrastructure and territorial development: This program will be financed by the WB and executed by the CNE of Costa Rica. Its objective is to increase access to disaster-resilient infrastructure with an emphasis on the intervention of territories with vulnerable populations, particularly people in conditions of poverty and social exclusion. About 15,000,000 USD are considered for the hydrological area.

training needs of specialized professional and technical personnel at the service of the operation of the networks (in conjunction with Component 4).

In this Outcome, the use of citizen science to support hydrometeorological observations can also be considered, if the quality and accuracy of the data collected and the capacity to process the large amounts of data that this may imply can be both ensured.

As part of this outcome, radar information will be integrated into national and regional monitoring networks to refine early warning products. This will be achieved by conduct feasibility and sustainability assessments for radar installations in both countries. Based on the assessments, procurement and installation of one radar per country will be performed (an X-band radar in Costa Rica covering the two pilot basins of the project, and a complementary radar in Panama covering the transboundary basin, Sixaola, to be integrated with its existing C-band infrastructure). The radars will be integrated into their national radar mosaics, as well as to the regional radar mosaic to improve precipitation monitoring, flood forecasting, and early warning services, especially the issue timely and accurate warnings. The information generated from the radars will support monitoring and prediction of extreme weather events in general and of floods in particular (e.g. flash floods, urban and coastal floods) and will be integrated into a regional mechanism for sharing data, knowledge, and products, which will be useful, among other benefits, to improve Numerical Weather Prediction in Central America and forecast skills.

Costa Rica and Panama have been operating weather radars more than 8 years and financing the operation from their national budgets. The same experience and capacity will allow regional sustainability of nowcasting capabilities and will ensure, data and information sharing for high-end radar data. With regards to radar information, regional cooperation will be ensured, especially through Costa Rica's WMO Regional Specialized Meteorological Centre for Severe Weather Information Centre (RSMC SWC), as well as through CRRH's CENTROCLIMA.

Outcome 1.2 Hydrometeorological and climate data at national and regional scales available for product and service generation

Measurements alone are not enough: data must be collected and shared in real time to feed forecasting models, be analysed by operational centres and generate the products and/or services needed for decision-making and planning processes. Likewise, its permanent availability is essential to ensure its use by other sectoral users in the generation of secondary and/or specialized products in accordance with their particular needs.

A diagnosis of the data and information needs of the different institutional users in different sectors and in general will be carried out, taking into consideration their current and expected capacities and requirements in the future. This diagnosis will support a strategy to modernize and strengthen the NMHS in terms of monitoring, operation, maintenance, training, equipment and required maintenance coverage. Likewise, an analysis will be made of the platforms and elements already developed by the WMO, the CRRH and national institutions so that they can be easily optimized. In addition, data integration and processing activities will include data rescue, quality control (including homogenization).

Based on the results of this diagnosis, the design and implementation of a hydrometeorological and climate database management system (DBMS) will be carried out, with a component at the regional level integrated in turn by two national components. Taking advantage of the systems available in the WMO context, such as the MCH system (Meteorological, Climate and Hydrological Database Management System) or the WIS-WHOS

system (WMO Hydrological Observing System, within the framework of the WMO Information System), a basic version of the DBMS will be installed and complemented by specific modules developed and implemented in accordance with the needs of integration and processing of the data by the different institutions identified. If it is necessary to meet requirements and needs not covered by the available systems, alternatives will be explored under the same principles of collaboration and integration.

The DBMS will facilitate the integration of data from the different monitoring networks. Fig. 4 shows schematically how the communication between the different parties involved in the management of the DBMS would be.

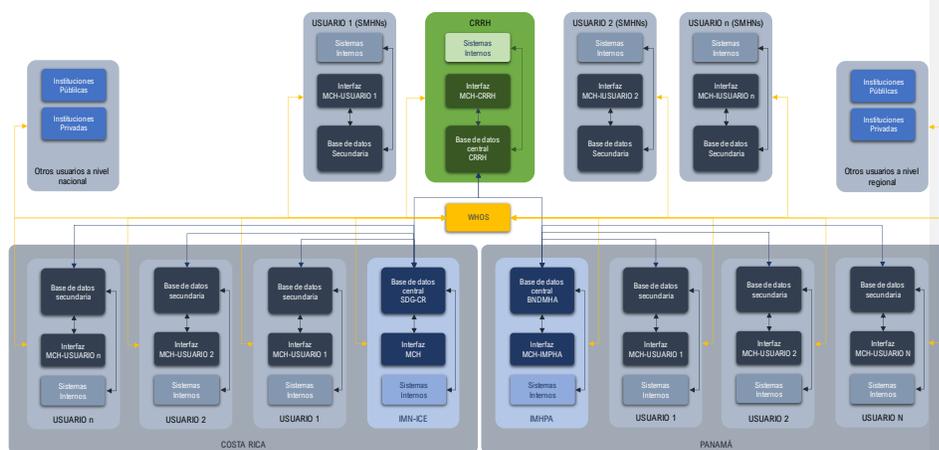


Fig. 4. Intercommunication scheme of the database management system.

The DBMS will be implemented in both the NMHS and the CRRH. In the case of the CRRH, this work will be done within the CENTROCLIMA platform. The project will include the acquisition of computer equipment (including software). Once the DBMS has been implemented, the need to develop complementary modules in accordance with the needs of other user institutions will be analyzed.

In addition to this DBMS, it is also necessary to complement it with the historical information that is still stored on paper today. The project will support the tasks of scanning and digitizing the information, for which the corresponding volumes located in the SNMH must also be known. In addition, pending the expansion and modernization of observing networks, it is possible to leverage datasets from global sources (such as CHIRPS) to complement ground-based observations.

An important element that must be carried out for the use of data, particularly in the generation of climate products, refers to the review of the quality and homogeneity of the data. The development of a system and associated procedures for such purposes shall be a priority for the revision of the climatological data series.

Data management requires dedicated state-of-the-art equipment, so the project will also provide three batches of equipment: one at the regional level for the CRRH and two at the national level for Costa Rica and Panama.

In Panama, IMHPA, the Ministry of Environment, the National Civil Protection System (SINAPROC) and the Ministry of Agricultural Development (MIDA) will be direct beneficiaries of this project component, using a more robust database for their early warning tasks. In Costa Rica, the integration of data in open-source formats will strengthen the current operational capacities of Costa Rican specialized institutions (IMN, ICE and DA) in coordination with the National Emergency Commission (CNE) and the National Technical Commission of the ENSO Phenomenon (COENOS) for the timely attention of droughts and floods. The stored data will be standardized according to WMO specifications and linked to the international context, including observational data products, climate change indices, drought indices, among others. Governance policies are adopted to ensure compliance with regulations related to hydroclimatic data management and information technology governance, which requires a seamless integration of people, processes, and technologies that are constantly updated.

Component II: Institutional set-up and processes for risk knowledge and Early Warning.

This component aims to improve capacities for (i) risk knowledge and assessment (particularly related to droughts and floods); for (ii) hydrometeorological and climate forecasting; and for (iii) early warning and communication and dissemination of products and services to end users.

Knowledge of the impacts and risks associated with these extreme hydrometeorological phenomena, together with the detection, monitoring, and forecasting of their occurrence, and complemented by the design and implementation of communication structures and dissemination of information and alerts, constitute the central elements of an Early Warning⁸System. The activities that correspond to this component will seek to strengthen the current operational capacities of the SHMNs in coordination with the agencies in charge of risk management of both countries and the CRRH will ensure that CEPREDENAC is linked for any methodological support from the regional level.

Outcome 2.1 Enhanced and sustained mechanisms for flood and drought risk knowledge for use by communities and users

A methodology will be developed to evaluate the risk associated with the occurrence of droughts and floods, which will be applied at the basin level (only in the case of floods), as well as at the national and regional level for both floods and droughts, in order to establish an evaluation baseline.

In relation to the knowledge of the impacts of droughts and floods, a methodology will be developed to facilitate their evaluation and monitoring. This methodology will be integrated considering existing national regulations, protocols and related documents and international best practices, and will be carried out in a participatory manner taking into consideration not only the public and private spheres at the sectoral level, but also vulnerable communities. For the purposes of its application in order to integrate a regional database (with local and national components), this methodology will be validated at national and regional level to facilitate its formalization at the level of SICA institutions and adoption at national level with direct applications in Costa Rica and Panama.

⁸ The fourth element, according to the United Nations Early Warning for All initiative, "preparedness and response capabilities", will be specifically addressed at the level of pilot projects in vulnerable communities, as part of component III.

In this same sense, the above-mentioned activities will be supported by existing databases (such as DESINVENTAR), for both the evaluation of risk and for knowledge of impacts.

In addition, an exercise will be carried out to analyze and assess the socioeconomic benefits of the use of hydrometeorological information in general, as well as on the different products and services that would be generated in the Regional Center for Flood and Drought Management (CRGIS). This information would be of vital importance in order not only to generate awareness of the importance of the information, but also to support and favor the efforts in relation to the allocation of budgets and financing that allow the adequate maintenance of the operations of the NMHSs and specifically of the CRGIS.

Outcome 2.2 Enhanced and sustained hydrometeorological forecasting available to communities and users

Emergency management, as well as decision-making and planning in sectors that are closely dependent on climate, involves not only knowing and anticipating the occurrence of hydrometeorological and climatic phenomena, but also understanding what this can represent in terms of their impacts. This represents not only the need to improve the detection, monitoring and prediction capacities carried out by NMHSs, but also involves interdisciplinary work that allows understanding the succession of consequent hazards through their impacts. The participation of the ANGR and civil protection, as well as the different sectoral actors, will be essential in this process, in such a way as to facilitate the generation of optimal products and services that allow the phenomena to be managed from a multi-hazard perspective and provide the best empirical basis to make appropriate decisions on the infrastructure necessary to protect the population and promote economic development.

In this regard, adjusted methodologies for forecasting droughts and floods that take into account impacts will be developed and applied, taking into account the local (vulnerable communities), national, binational and regional levels. In the case of Costa Rica, some progress has already been made in this area; however, it is necessary to strengthen the achievements obtained to date and to standardize the methodologies to be applied jointly and at the regional level.

In a complementary way, work will also be done for the design and generation of climate products and services necessary at sectoral levels, with special attention to droughts and floods. The working groups to be developed and implemented in the context of the CRGIS as well as those that are already organized as part of the regional climate and hydrological forums will be fundamental not only in facilitating contact with end-users, and in the process of building them, but also in monitoring their use.

This means that, in this Outcome, activities will be undertaken to ensure the wide dissemination and communication of the results obtained and the importance of hydrometeorological information and early warning of droughts and floods.

Outcome 2.3 Dissemination of flood and drought alerts available to communities and users

In particular terms of water resources and related sectors, the project also considers the design and implementation of products and services that allow a better knowledge of the current state of water resources and their forecast or perspective in the short (days) and medium

(months) term. This will be done both at the national level and at the vulnerable communities level in the identified priority watersheds, which will ultimately support the capacity for preparedness and recovery from floods.

Through the project, EWS for floods and droughts will be proposed or improved, integrating timely and reliable data for decision-making into their services, for the benefit of the most vulnerable communities in the selected priority basins. This system will integrate the 6 principles of adaptation to build climate resilience, as follows:

- 1) Ensure resilience through inclusive development;
- 2) Facilitate the adaptation of people;
- 3) Adapt land use and protect critical public goods and services;
- 4) Enhancing people's capacity to cope with and recover from crises;
- 5) Anticipate and manage macroeconomic and fiscal risks;
- 6) Ensure effective implementation through prioritization and continuous monitoring.

As part of the EWS, work will be done on the development of specific products derived from the monitoring and forecasting of floods and droughts; that is: thresholds and protocols for early warning, products derived from local resolution, didactic materials for the dissemination of information on droughts and floods; as well as the development of a GIS (collaborative) platform that includes dashboards that will deploy information on the current state and forecasts of water resources, drought, and floods.

The activities of this Outcome will seek to strengthen the current operational capacities of specialized institutions, NMHSs in coordination with risk management agencies, as well as the creation of products such as water bulletins and drought monitoring, reinforcing the stages of drought effects (meteorological, hydrological, and socio-economic) of existing climate bulletins.

Component III: Flood and drought management and risk mitigation enhancement from regional to local level.

This component aims to improve the management and mitigation of drought and flood risks at the regional and local levels to achieve three outcomes:

- Strengthening regional coordination of policies and management of floods and droughts
- Establishment of national flood and drought planning and strengthened response capacity
- (Vulnerable communities more resilient against floods and droughts)

This will be mostly achieved through the establishment of a virtual centre for monitoring and managing floods and droughts.

Within the considerations for community activities, both national and international guidelines and manuals will be taken into account to integrate the gender perspective, intergenerationality⁹, interculturality¹⁰, indigenous, Afro-descendant and disabled minorities.

Outcome 3.1 Strengthened regional coordination of flood and drought management and policy

⁹ Intergenerationality refers to the relationships and interaction between people of different generations within a society. It is a concept that highlights the importance of coexistence, the exchange of knowledge and experiences, and solidarity between young and old.

¹⁰ Interculturality is the social phenomenon in which two or more cultures relate to each other on equal terms, without any one point of view predominating over the others. This type of relationship favors dialogue, understanding, integration and the enrichment of cultures.

Commented [TA3]: the example of an ANADIA project carried out in Mali could be interesting for this component of the project (it included a workshop in the villages and communities at risk, development of solutions with the participation of the community, etc.).

Commented [LS4R3]: It will be taken into account, thank you

Component 3 has as a fundamental element the creation of a Regional Flood and Drought Management Virtual Centre (CRGIS) whose purpose is to manage and provide harmonized knowledge, tools, data and information on drought and flood risks for Central American countries, piloting with Costa Rica and Panama, and as a mechanism to create and improve the national capacities of the respective Meteorological and Hydrological Services (NMHS). This implies the establishment of institutional arrangements (laws, protocols and standards, among others) at the Central American region and national local level in Costa Rica and Panama for the operation and maintenance of the CRGIS and the ad hoc working groups for drought and flood response. The project will strengthen the installed human, material and technological capacity of the CRGIS and the respective NMHSs.

It is worth mentioning that the CRGIS will be embedded within the CENTROCLIMA platform of the CRRH to take advantage of the technological infrastructure that is already in place and will contribute to its sustainability.

Outcome 3.2 Users make decisions based on established national planning for flood and drought and response capacity for communities is strengthened

The information produced by the CRGIS will not only serve to provide timely and early warning of flood and drought risk, strengthening the response capacity to these phenomena, but also to feed national planning for the attention of these phenomena in a differentiated manner. The creation and implementation of the respective national planning of Costa Rica and Panama (and regional with a focus on transboundary basins) will be using the methodologies of the WMO, UNCCD, UNDRR, and international best practices. The design, revision and/or updating of the plans will be approached from the perspective of having a long-term strategic vision for effective integrated management of floods and droughts, as a starting point for the definition of concrete measures at the national level and facilitating institutional coordination for their implementation.

To strengthen the planning and emergent response to droughts and floods, the project also considers the development, acquisition and implementation of decision support systems with a national approach considering the integrated water resources management strategy. Possible examples of systems include the IDB's HydroBID and the WMO HydroSOS. Likewise, the dissemination of information and the sharing of knowledge about these phenomena are also tasks contemplated through the realization and legal formalization of the Hydrological and Climate Forums at least twice a year at the transboundary, national and local levels.

Outcome 3.3 Vulnerable communities more resilient against flood and drought

To make vulnerable communities resilient to both phenomena, the formulation of community-developed community plans is considered, for communities in priority basins selected by the countries. These plans will consider international best practices with roadmaps, specific actions and protocols, among others, considering Nature-based Solutions (NbS). Best practices observed by the implementing institutions with respect to the inclusion of vulnerable communities will be taken into account, ensuring community participation, with gender and interculturality focus.

The component also considers the implementation of drought and flood community plans in pilot projects in the selected basins, prioritizing NbS, strengthening local governance structures, and taking advantage of the elements generated in this and the other components, such as

information, data, institutional arrangements, infrastructure, methodologies, protocols, products and services, and training.

Component IV: Enabling environment for building resilience to floods and droughts

This component aims to achieve the result of improved institutional capacity, stakeholder awareness and gender mainstreaming for integrated drought and flood management. In addition, within this component, it seeks to ensure national financial resources for the maintenance of the hydrometeorological networks and for the continuity of the services generated through this project.

Outcome 4.1 Enhanced governance framework and gender mainstreaming for integrated drought and flood management

The legal and institutional evaluation will be carried out to develop a roadmap and implement it to incorporate the mechanisms (including coordination ones) or translate them into ministerial decrees, presidential decrees or national regulations; and to develop and formalize technical cooperation and institutional coordination agreements, which will allow the establishment of the Framework for the Sustainability of Hydrometeorological Services integrated into national legal and planning instruments, including ministerial decrees. Further information on the mechanisms to be explored for long-term sustainability is provided in section K of this document.

Technical cooperation and institutional coordination agreements will be developed and formalized, including coordination and operation protocols for existing policy and governance mechanisms and instruments to strengthen institutional capacity and coordination at all stages of hydrometeorology.

Gender action plans will be developed and implemented in the area of floods and droughts that consider training with a gender approach and indicators in accordance with the criteria of the different United Nations organizations.

Outcome 4.2 Enhanced institutional capacity and stakeholders awareness for integrated drought and flood management

The comprehensive training, education and training program will be developed and implemented for the different actors involved, including specific topics of the different components of the project (including the gender approach) in various modalities (face-to-face, blended and online) for all stakeholders at regional, national and local levels. Trainings will be aimed both at the technical staff of the beneficiary institutions of the project, and at the community level to ensure the appropriation and correct functioning of the systems.

The strategy and action plan to manage knowledge on climate-resilient flood and drought management will be developed. Likewise, actions will be implemented to support knowledge management and the community of practice on climate-resilient flood and drought management. For the development of the community of practice, it is proposed to make use of the platform that GWP has developed, including its link with CENTROCLIMA. All the knowledge products generated through the project can be hosted on this platform, including case studies, technical notes, training materials. In the same way, a community of practice will be designed according to the needs of the beneficiaries of the project, which will be hosted on the aforementioned virtual platform.

The realization of this component involves the development of studies, forums, materials for dissemination and dissemination, face-to-face, hybrid and online workshops, exchange of experiences in the region and beyond, alliances with local or international universities and training centers, and national and international consultancies.

Activities

In the next phase of the project proposal, the activities considered in each of the Outcomes mentioned in this section will be presented in more detail. These activities have already been defined and their descriptions are being refined with the national institutions.

B. Describe how the project /programme would promote new and innovative solutions to climate change adaptation, such as new approaches, technologies and mechanisms.

Coordination and flow of information

The most important mechanism within the project is the articulation between the regional, national and basin (local) geographical scales, adopting a "top-down/bottom-up" flow where the information from the different scales feeds back in both directions. This ensures that information flows not only from the regional to the national to the local level, but that the local scale can transmit information that validates what is received from the national level, in addition to actively participating in the decision-making process and having direct access to feed back into national and regional forecasting systems. While the top-down approach provides strategic vision, guidance, and resources, the bottom-up approach ensures that solutions are inclusive, tailored to local needs and conditions.

In terms of regional coordination, since we work with the WMO, the GWP-CAM and the CRRH, once the project is completed, the results and experiences acquired can serve as an example to be replicated in other basins both in the participating countries and in other countries at the regional level, also cooperating with other regional partners.

Observations and data exchange

The project focuses on ensuring that the data and information necessary to generate products and services that will be used to protect the population and their property from droughts and floods, as well as to facilitate decision-making and national and basin-level planning processes. Currently, in both countries, data and information collection is carried out in a fragmented manner by different institutions, without complete integration or systematic exchange between institutions in the necessary times and formats. This prevents their proper use not only in the hydrometeorological field, but also in economic sectors that require them for the fulfillment of their mandate (such is the case of institutions linked to the agricultural sector, civil protection, water and sanitation sector, among others). The project seeks to solve this obstacle by creating a national database for each country, accessible to all institutions that require it.

The collection and availability of data and information will allow the creation of products and services that do not currently exist, but that are essential to comply with institutional mandates. This includes the directorates in charge of water management, such as the Water Directorate in Costa Rica and the Water Security Directorate in Panama, which need this data for calculations of water availability and balance, among other needs, thus articulating the actors who generate information with the users of said information. In addition, this data will be crucial for daily operations in emergency response and short-, medium- and long-term planning, with the aim of facing droughts and floods in a preventive manner and with a risk management vision.

The implementation of free and open-source technical solutions for the integration and use of hydrometeorological and climate data and information at the national and regional levels will allow the necessary data management infrastructure to be shared among all national institutions (in addition to NMHSs). This is an innovative approach as they save NMHSs expenses on database systems and interoperability. In addition, these systems are provided by the WMO and have been implemented in several countries, so there is already a community of practice that can be enriched with new members.

Products and services

Work will be done on the design and implementation of products and services in accordance with the needs of communities vulnerable to droughts and floods, considering both the protection of their population and the prediction of phenomena within the framework of socioeconomic development. In addition, the necessary warning mechanisms and protocols will be ensured, as well as the development of capacities so that the dissemination of information from the regional and national level to the end user at the basin level is effective for decision-making and planning formulation with a risk management approach.

The project promotes innovation at the national and regional levels through the activities and applications of climate and hydrological forums (mechanism for the generation and regional transfer of knowledge associated with climate and water) with new products and services for regional preventive and proactive care that benefits the entire region, transferring information and knowledge to the productive and social sectors in basins, national and regional. The activities of the forums for the application of the results of the climate and hydrological forums serve as a mechanism for disseminating information. In addition, there is a transfer of agrometeorological, meteorological, and hydrological data, which are strengthened through "agroclimatic technical tables" and hydrological forums, under the fundamental principle that data-based agriculture can increase production, especially in vulnerable regions and communities threatened by climate change.

Likewise, the creation and implementation of a virtual center based on the CENTROCLIMA platform of the CRRH for the management of droughts and floods is innovative technologically and operationally. This tool, based on satellite information interpreted and calibrated with data from land observations integrated at the Central American region, national and pilot basin levels, will lay the foundations for gradually extending the methodologies and capacity building to the rest of the countries within SICA.

Finally, it is worth highlighting as innovative the approach of work at the basin level (both national and transboundary) for the generation of drought and flood plans.

Sustainability

Another innovative aspect of the project is to support services from the aspect of governance and public policy. It will require the development of methodologies, standards, the generation and publication of mechanisms and public policy instruments for dealing with drought and floods, as well as governance and legal ones, including inter-institutional coordination and collaboration agreements at the national and regional levels, as well as the design and implementation of action and communication protocols. and knowledge management. This harmonization involves a diagnosis of the legislation and regulations in force in the two countries and adjustments for joint implementation in the transboundary basin and within the respective countries.

Social component

The institutions of the countries have asked that not only the gender perspective and youth be taken into consideration for the development of community activities, but also criteria of intergenerationality and interculturality, together with the considerations of indigenous, Afro-descendant and disabled minorities. These concepts are innovative to be taken into account in the context of adaptation as they promote harmonious coexistence between generations and between cultures, promoting community resilience and inclusiveness and creating dialogue and exchanges of information.

Experiences of implementers

The replication and use of innovative elements that have been the result of calls for innovation by the WMO HydroHub initiative will be promoted. In this sense, the feasibility of making use of the results (both of the software and the guides created) of the 3rd HydroHub innovation call¹¹, financed by the IDB, which was successfully completed at the beginning of 2025 and which aimed to improve hydrometric monitoring through the improvement and use of Large-Scale Particle Image Velocimetry (LSPIV) technology, will be analyzed.

In addition, the implementation of innovative GWP approaches to the use of crowdsourcing will be evaluated, allowing community monitoring of drought impacts.

C. Describe how the project/programme would provide economic, social and environmental benefits, with particular reference to the most vulnerable communities, and vulnerable groups within communities, including gender considerations. Describe how the project/programme would avoid or mitigate negative impacts, in compliance with the Environmental and Social Policy of the Adaptation Fund.

The project includes a socio-economic analysis (Outcome 2.1 Output 2.1.3) and identification of reliable mechanisms (e.g. a framework for sustainability integrated into legal and planning instruments) to ensure political commitment and corresponding public funding for the provision of hydrometeorological and water resources information to support decision-making (Outcome 4.1). The analysis will be based on documentation and processes already in place at the country level. For example, for both countries, information is available through the DESINVENTAR platform. In Panama, there is a document on the Monitoring and Evaluation System for Loss and Damage due to Extreme and Slow Progress Events (2023) that will serve to identify more granular costs and make use of the indicators that are already monitored there so that the project is consistent with national planning. The analysis will show in more detail the social, economic and environmental benefits at the regional, national and pilot basin levels and will take into account existing analyses at the national level as well as at the regional level (such as the case of the GWP-CAM document on benefits of action versus cost of inaction). At this stage, it is considered that the sum of all the parts of the project will bring the expected benefits. In the preparation phase of the full project note, the benefits for each component are considered.

The cascade of benefits is expected to derive from the following: by improving the meteorological monitoring network and strengthening its respective data management, it will be possible to access a better analysis and quantification of risks as well as the behavior of the hydrological cycle with respect to, above all, droughts and floods. This will result in better products for all sectors of the population that depend on hydrometeorological information. The

¹¹ Final report available at: https://wmo.int/sites/default/files/2025-05/WMO%20HydroHub_Innovation%20Call_LAC_Final%20_Report_April2025.pdf

availability of products will ensure that (1) sectors can make informed decisions regarding water resource management and (2) the population can be alerted in a timely and accurate manner regarding droughts and floods. Thus, it will increase the resilience of livelihoods and economic activities, promoting national development and growth and in particular of priority basins.

Based on the above, some benefits and corresponding figures are presented. All the figures expressed here will be refined at the project proposal stage to define the baseline at the beginning of the project.

Beneficios sociales

From the social point of view, through the products and EWS generated by the project (especially components 1, 2 and 3), it is expected to have an impact on the improvement of the quality of life, the reduction of waterborne diseases, improve the risk management capacity at the community level, and improve the understanding of hydroclimatic information. Likewise, the project is expected to improve (especially through component 4) inclusion and equality, social integration, as well as empowerment in decision-making and increasing capacity for emergency management. All this in order to reduce marginalization and vulnerability and increase the resilience of the population and its water security.

At the population level, the project is expected to have an impact on:

- 2,106,000 people benefited (918,000 in Costa Rica and 1,188,000 in Panama) with drought and flood management and contingency plans. Including those plans prepared in a participatory and inclusive way in vulnerable communities and with end users.
- 550,988 inhabitants in vulnerable communities who will have an early warning system, designed in an inclusive and participatory manner, with products and services according to their needs and with training to take advantage of them. Timely information for vulnerable communities for decision-making to mitigate impacts and plan for prevention & harm reduction.
- Of these amounts, in the next phase it will be defined (according to an analysis of heads of households, members of Basin Commissions, gender perspective, vulnerability, etc.) what percentage of the population will receive training, planning for flood and drought care, as well as information for timely decision-making. For example, the number of women, young people, the elderly, indigenous people, Afro-descendants and people with disabilities in the selected basins participating in the activities planned within the project will be defined. In this way, it will be possible to determine the strengthening of social inclusion and gender.

As a breakdown of the above data, the following is available at the national level:

- Drought: 936,000 inhabitants. Considering that in 2014 and 2019 approximately 8% and 12% of the population was affected by drought in Costa Rica and Panama respectively ([DESINVENTAR](#)), then it could be said that 408,000 inhabitants of 5.1 million inhabitants in Costa Rica and 528,000 inhabitants of 4.4 million inhabitants in Panama would benefit.
- Floods: 1,170,000 inhabitants. 10% of the population of Costa Rica (according to the CNE) and 15% of the population of Panama (according to SINAPROC) are in areas at risk of flooding. This means that 510,000 inhabitants in Costa Rica and 660,000 inhabitants in Panama can benefit.
- Sub-seasonal to seasonal hydrological forecast: more than 2,106,000 inhabitants. This figure will have to be more clearly defined in the next phase. At the moment it is considered that it benefits all the inhabitants who suffer from drought and floods but it is worth mentioning that, indirectly, it can benefit the entire population of Costa Rica and Panama thanks to the support to sectors such as hydroelectric, agriculture, navigation, other sectors of the population susceptible to impacts by floods and droughts.

For products in specific pilot basins, it is expected to reach a population of:

- Costa Rica:
 - Tempisque River: 326,953 inhabitants approx.

- Pirris-Parrita River: 22,000 inhabitants approx.
- As of 2022 figures, according to Costa Rica's INEC, 25.6% of the total population (not from the basins) are under 17 years of age and 9.6% over 65 years of age
- Panama:
 - La Villa River: 162,076 inhabitants in the districts that contain the basin (INEC, 2023).
 - 21% are older adults, 22% are under 18 years of age, 3% are indigenous, 26% are Afro-descendants and 6% are disabled people.
 - Tonosi River: 8,959 inhabitants in the districts that contain the basin (INEC, 2023).
 - 24% are older adults, 21.5% are under 18 years of age, 5.5% are indigenous, 37.8% are Afro-descendants and 6% are disabled.
- Transboundary:
 - Sixaola: 31,000 inhabitants approx (2016).

In addition, there will be benefits at the institutional level:

- for NMHSs, which will be able to strengthen their capacities and provide better products and services to their users
- for the other institutions involved (linked to the occurrence and impacts of extreme hydrometeorological and climatic phenomena), which will be able to improve their planning and development of services for their users, taking as inputs the products generated through this project.

Economic benefits

Having relevant information on climate and hydrology in general, and in particular on droughts and floods, will facilitate decision-making in the planning and more efficient management of water resources for various purposes, increasing the resilience of livelihoods and economic activities, promoting national development and growth and in particular of priority basins.

Some of the areas where economic benefits will be seen are:

- Disaster risk reduction: reduction of direct and indirect economic damage to the population and productive sectors, through timely and accessible early warnings, including vulnerable economic groups and sectors, such as subsistence agriculture and livestock.
 - Direct: fewer hectares damaged, fewer heads of cattle killed, greater number of population with assured water, reduced number of sick people and less damage to infrastructure in general.
- Drinking water: better allocation of volumes for consumptive uses that allow for the adoption of adaptive practices and more effective use.
- Public investment: There will be an optimization of the national budget with respect to hydrometeorological phenomena, droughts and floods. With the planning and preventive measures based on the products and services generated in the project, they will result in a reduction in investment expenditure that will be reduced to preventive measures instead of corrective measures. As an example, in 2025, the government of Panama will allocate 10 million USD to address a water crisis in the La Villa River.
- Agricultural, forestry and livestock production: Almost 24000 ha of sugarcane are grown on the Tempisque River and about 25% of the national rice is produced. In addition, 78% of the water in the basin is used for irrigation and 17% for agro-industrial use (Water Department-MINAET). The project will provide timely scientific elements for the dates of planting, agricultural insurance, growth and sale of livestock or decision for the design, rehabilitation and construction (or reconstruction) of infrastructure.
- Energy: In Costa Rica, hydroelectric energy production was 8,412 GWh and represented 67% (ICE, 2025) of total energy. In 2024, Panama's hydroelectric power supply was 7,797 GWh and represented 60% (CND, 2025) of the total supply, but in certain months it can represent up to 86% of total energy. Taking into account an average cost of 0.07 USD per kWh, we have that the economic value of hydroelectric power production in both countries is

1,135 million USD. The products derived from the project will provide greater certainty of storing water safely in flood conditions and of having a more adequate operating policy under drought events.

- Navigation: In the specific case of the Panama Canal, in 2023, the Canal's direct contributions were of a magnitude of 3% of Panama's GDP (Panama Canal Authority, ACP).
- Infrastructure: An analysis of the infrastructure at risk in the pilot basins will be carried out.
- Tourism: Tourism in Costa Rica reached the figure of 5,400 million USD in 2024 (Costa Rican Tourism Institute, ICT). 50% of Costa Rica's total investment in tourism is made in the province of Guanacaste, where the Tempisque basin is located. This means that the value of tourism in the basin is around 2,700 million USD. In the case of Panama, the figure reaches 6,000 million USD in 2024 at the national level (Panama Tourism Authority, ATP).

Environmental benefits

Through the dissemination of timely drought, flood products and sub-seasonal and seasonal hydrological forecasting, it is expected to achieve a reduction in damage to protected natural areas, bodies of water and riverbeds, which translates into the protection of aquatic systems. The information will also help to define NbS to be included in the plans that are generated at the basin level and at the national level.

Emphasis will be placed on the care of environmental services such as: the mitigation of greenhouse gas emissions (fixation, reduction, sequestration, storage and absorption); the protection of biodiversity for its conservation and sustainable use, for the protection of ecosystems and ways of life; the protection of water for urban, rural or hydroelectric use; and for natural scenic beauty for tourism and scientific purposes. As an example, the payment per hectare of forest within payment plans for environmental services in Costa Rica is between 164 and 2,629 USD per hectare (National Forest Financing Fund, FONAFIFO). In the case of Panama, as an example, it is considered that 16.4 million USD per year derives from flows from the existing forest in the Panama Canal Basin.

Likewise, with planning in selected basins and water resource management, it is expected to better manage the environment and identify and value the environmental services derived from better management of water resources, including environmental flows. It will also be possible to prevent soil degradation and desertification, as well as even reduce forest fires.

D. Describe or provide an analysis of the cost-effectiveness of the proposed project/programme and explain how the regional approach would support cost-effectiveness.

The project represents a cost-effective investment by combining four interrelated components (monitoring, forecasting, regional management and governance) that generate tangible and sustainable socio-economic benefits mentioned in the previous section (C). With a total investment of US \$11,545,000, the project prioritizes strategic investments in strengthening the hydrometeorological network, operation of SAT, hydrometeorological data management, generation of information for decision-making, capacity building and institutional strengthening. This investment is expected to result in significant savings through:

- Direct harm reduction (infrastructure, housing, crops, and livestock),
- Decreased response and recovery costs,
- Optimization of water use,
- Better decision-making based on data and relevant and timely information.

As mentioned above, a socio-economic benefits analysis will be developed. This exercise will help estimate benefit-cost figures that quantify, for every dollar invested in monitoring,

analysis and dissemination of drought and flood information, the savings in maintenance, emergencies and avoided losses, among other items. In addition, knowledge management and replicability of good practices (through learning communities, including at the basin level) will reduce operating costs, since it will not be necessary to duplicate effort or investment in processes or technologies in different communities or countries.

The EWS developed from this project integrate reliable and timely data for decision-making, which represents one of the most cost-effective measures to reduce damage due to hydrometeorological events. This strategic investment allows us to anticipate impacts and significantly reduce the costs of response, recovery and economic losses.

National commitments

National governments will provide in-kind and/or financial resources in addition to the activities supported by the Adaptation Fund, which will facilitate greater impact and progress in reducing vulnerability to drought and floods. National public procurement standards (value for money) will be adopted and structured cost-benefit evaluations will be integrated for each component. Therefore, the cost effectiveness of the project is based on the recognition at the national and local levels of the importance of preventive care for drought and floods, based on data management, timely warning, and community and national participation in planning. The project will seek the social and economic profitability of its activities.

Likewise, it is expected that the resources of the Adaptation Fund and national budgets will not be the only ones within the project, as they will help to mobilize other national private financial funds, and local human and material resources, such as:

- Complementary private investments and leverage by creating synergies for the protection and prevention of damage to economic activities mainly at the national level
- Active participation of local institutions, economic sectors and beneficiaries (communities) in the selected watersheds

Resource Management

International (WMO), Central American and national standards will be adopted to ensure the quality of data and products, optimize processes, and coordinate people, technologies and policies in an up-to-date and effective manner.

Operationally, the resources of the Adaptation Fund will be managed with fiscal rigor and in accordance with regulations, including national and SICA, guaranteeing efficiency and value for money. It will seek to effectively use resources and seek to ensure that the operating costs derived from the project, even if limited, are sufficient for implementation without sacrificing the expected products and results.

Regional focus

The regional approach from the beginning allows not only access to knowledge, techniques and practices that support the national level from the regional level, but the efforts in the project will also pay off by having organizations such as the WMO and the CRRH that will be able to extend the scope of the project at the regional level to all of Central America by storing and managing the knowledge acquired. reviewing the best practices of the project, refining processes and activities and mobilizing resources to achieve such extension. These activities will be carried out especially in component 4.

The main factors taken into account that favor the regional approach on two national projects are:

- Economies of scale: it is allowed to concentrate and share resources reducing the costs per country for the operation of technical solutions, training, purchase of equipment, etc. In addition, the institutional and technological infrastructure already existing in the region (for example, CENTROCLIMA) is used¹².
- Institutional synergies: existing regional expertise and structures are leveraged and implementation is accelerated. Central America already has an important regional integration, led by SICA and that includes hydrometeorological services through the CRRH. Likewise, the WMO, the CRRH and GWP already have experience in implementing projects for Central American countries, so this effort is being used to support at the national level.
- Training and knowledge management: training carried out with a regional focus can serve to standardize and standardize practices, as well as generate/strengthen communities of practice on issues related to the project. In addition, knowledge management will facilitate technology transfer and the exchange of good practices between institutions and communities.
- Operability: By taking a regional approach, it is ensured that efforts are taken into account throughout the region to avoid redundancies/duplications at the national level and optimizing maintenance, commissioning and use of technologies and methodologies, allowing the sharing of operation and maintenance costs, reducing national costs. An improvement in data and information interoperability systems is also ensured.
- Institutionalization of impact risk analysis: Although there are initiatives at the national level, the use of impact risk analysis is not widely used and through the project its institutionalization and replication can be supported.
- Replicability and sustainability: the results of the project can be conserved and replicated regardless of personnel changes in each country, in addition to reducing dependence on support or not from specific people at the national level. In addition, there are more possibilities to obtain additional financing once the project is completed by having a regional impact instead of a national one. Finally, it is expected that the scope of the project can be expanded to other Central American countries as additional funding sources are identified, being able to make use of the materials, lessons learned, expertise, etc. already generated within this project.

The implementation of this project is very significant because it addresses a number of key issues for Costa Rica and Panama, but also for the Central American region, so the replicability of the approach, outputs and expected results can contribute to neighboring countries. For example, the study of the measurement network will provide the essential elements to detail an acquisition plan for the priority basins and for the proper implementation of hydrometeorological services and early warning systems that can be replicated in other countries in the region.

E. Describe how the project/programme is consistent with national or sub-national sustainable development strategies, including, where appropriate, national or sub-national development plans, poverty reduction strategies, national communications, or national adaptation programs of action, or other relevant instruments, where they exist. If applicable, please refer to relevant regional plans and strategies where they exist.

The project is fully aligned with national and subnational strategies and plans for sustainable development and adaptation to climate change in Costa Rica and Panama, as well as with relevant regional frameworks. This coherence ensures that their interventions contribute to the

¹² The CRRH's CENTROCLIMA platform allows NMHSs to access climate data, severe weather products, as well as meteorology, hydrology and climate portals and other specialized products, optimizing technical resources at the regional scale.

achievement of goals already prioritized by governments, thus strengthening institutional, social, economic and environmental sustainability.

Regional level

The project is in line with a number of regional frameworks promoted by SICA, including:

- Plan de Acción Regional de Adaptación al Cambio Climático en Centroamérica
- Política Centroamericana de Gestión Integral del Riesgo 2015–2030
- Estrategia Centroamericana de Desarrollo Rural Territorial 2010–2030
- Estrategia de Agricultura Sostenible Adaptada al Clima para la Región SICA 2018–2030

These regional strategies prioritize integrated water resources management, adaptation to extreme weather events such as droughts and floods, agricultural resilience, and capacity building and climate governance. The project contributes to these priorities through actions that:

- They strengthen national and local early warning and climate monitoring systems.
- They support, with the products to be developed, adaptive territorial planning and the reduction of social vulnerability
- Promoting effective transboundary cooperation in the Sixaola Pilot Basin

National level

In the first instance, both Costa Rica and Panama have included within their Nationally Determined Contributions (NDCs) commitments related to the improvement of the TSS, integrated watershed management, access to agroclimatic information and the implementation of financial mechanisms for adaptation. This project advances directly in these priority areas, ensuring synergies with international commitments under the Paris Agreement. More specifically:

- In Costa Rica, the project aligns with Costa Rica's Determined Contribution (NDC2020),¹³ which prioritizes climate resilience through actions in vulnerable sectors such as water resources, agriculture, and coastal zones. It responds directly to the objectives of the National Strategy for Adaptation to Climate Change (ENACC), promoting integrated risk management, ecosystem-based adaptation and the strengthening of local capacities.
- In Panama, the project is consistent with Panama's Second Nationally Determined Contribution (NDC2),¹⁴ which incorporates an adaptation approach that prioritizes water security, the resilience of rural communities, the strengthening of infrastructure in the face of extreme events, and climate risk management. It is aligned with the National Climate Change Strategy (ENCC) and with the adaptation component of the CRC2, which contemplates the improvement of resilient infrastructure, the strengthening of monitoring systems and the reduction of social vulnerabilities. It also contributes to the objectives of the National Development Plan with Social Inclusion, supporting communities in conditions of poverty through NbS and adaptive territorial planning.

¹³The NDC2020 focuses on increasing the resilience of communities to climate change. It includes improving water management and infrastructure to reduce vulnerability to extreme events such as droughts and floods. In addition, sustainable agricultural practices and ecosystem restoration are promoted to mitigate the impacts of droughts and floods. In addition, it promotes international collaboration to implement innovative climate actions. <https://cambioclimatico.minae.go.cr/contribucion-nacionalmente-determinada-ndc-de-costa-rica/principales-elementos-de-la-ndc-2020/>

¹⁴ The CRC2 is based on an integrated approach to adaptation and mitigation, under the principles of climate justice, equity and common but differentiated responsibilities, through a just transition that safeguards water security, with active participation based on human rights and gender equality. At the same time, NbS are integrated. Adaptation and mitigation actions complement each other to build resilience. [Segunda-Contribucion-Determinada-a-Nivel-Nacional-de-Panama-CDN2.pdf](#)
[Environmental-Social-Policy-approved-Nov2013.pdf](#)

In both cases, in addition to the NDCs, there are other related short- and long-term climate policy instruments for which the results and outputs of the project have a direct and indirect impact.

In Costa Rica, the project is consistent with the National Disaster Risk Management Plan, which is updated every five years and is harmonized with the Sendai Framework and the Paris Agreement. In this sense, it strengthens risk governance based on an ecosystem and intersectoral approach, integrating NbS and community participation mechanisms. The project also supports the implementation of the National Development and Public Investment Plan 2023-2026, which promotes sustainable and inclusive territorial development, with special emphasis on populations exposed to climate threats such as droughts and floods. Tab Tab. 1 shows which national instruments are taken into account in the different components of the project.

Tab. 1. Instrumentos de Política Nacional de Costa Rica y su relación con los componentes del proyecto.

Componente del Proyecto	Instrumentos de Política Nacional Relacionados
1. Mejora de la infraestructura de observación, monitoreo y gestión de datos hidrometeorológicos para el conocimiento de los riesgos y la Alerta Temprana	- National Adaptation Plan (NAP) 2022–2026 - National Climate Change Adaptation Policy 2018–2030 - National Water Resources Management and Watersheds Program
2. Establecimiento institucional y procesos para el conocimiento del riesgo y la Alerta Temprana	- National Adaptation Policy- NDC2020 - National Development and Public Investment Plan 2023–2026 - National Disaster Risk Management Plan - Law No. 8488 on Emergency Management and Risk Prevention
3. Mejora de la gestión de inundaciones y sequías y mitigación de riesgos desde el ámbito regional al local	- National Drought and Flood Plan - National Risk Management Policy - ENACC - National Disaster Risk Management Plan - National Program for the Management of Water Resources and Watersheds - SINAC Strategy for the Conservation and Sustainable Use of Water Resources 2021-2026 - National Drinking Water Policy 2017–2030 - Law No. 8488 on Emergency Management and Risk Prevention
4. Entorno propicio para la creación de resiliencia ante inundaciones y sequías	- NDC2020 - NAP 2022–2026

In Panama, the project is aligned with Panama's National Water Security Plan and also takes into account the legal and institutional framework around risk management and climate action, including inter-institutional cooperation agreements such as the one established between the Ministry of Agricultural Development (MIDA) and IMHPA, which facilitate technical exchange and the integration of agrometeorological and hydrological data. Tab Tab. 2 shows which national instruments are taken into account in the different components of the project.

It should be noted that Panama, as one of the few carbon-negative countries, recognizes that adaptation is an essential pillar of its climate strategy, and this project contributes directly to this goal.

Tab. 2. Instrumentos de Política Nacional de Panamá y su relación con los componentes del proyecto.

Componente del Proyecto	Instrumentos de Política Nacional Relacionados
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1. Mejora de la infraestructura de observación, monitoreo y gestión de datos hidrometeorológicos para el conocimiento de los riesgos y la Alerta Temprana	<ul style="list-style-type: none"> - Plan Nacional de Seguridad Hídrica 2015–2050 - Sistema de Monitoreo y Evaluación de la Adaptación al Cambio Climático - CDN2 (componente de monitoreo) - Plan Nacional de Gestión Integral de Residuos 2017–2027
2. Establecimiento institucional y procesos para el conocimiento del riesgo y la Alerta Temprana	<ul style="list-style-type: none"> - Política Nacional de Cambio Climático al 2050 - CDN2 - Estrategia Nacional de Cambio Climático - Plan Nacional de Seguridad Hídrica 2015–2050 - Índice de Vulnerabilidad y Plataforma Nacional de Transparencia Climática
3. Mejora de la gestión de inundaciones y sequías y mitigación de riesgos desde el ámbito regional al local	<ul style="list-style-type: none"> - Plan Nacional de Sequías - Estrategia Nacional de Cambio Climático - Plan Nacional de Acción Climática - Plan Nacional de Seguridad Hídrica 2015–2050 - Plan Nacional de Cambio Climático para el Sector Agropecuario (PNCSSA) - Plan Energético Nacional 2015–2050 y Agenda de Transición Eléctrica 2020–2030
4. Entorno propicio para la creación de resiliencia ante inundaciones y sequías	<ul style="list-style-type: none"> - Plan Nacional de Desarrollo con Inclusión Social - Plan Nacional de Género y Cambio Climático - Estrategia Nacional por el Empoderamiento Climático (ENACE) (sección sobre empoderamiento climático) - CDN2 - Estrategia Nacional de Desarrollo Socioeconómico Resiliente - Acuerdo de Cooperación MIDA–IMHPA

Local level

At the subnational (local) level, the project aligns with the specific management priorities of each prioritized watershed. In Costa Rica, the Tempisque and Parrita basins have monitoring networks, environmental flow studies, and wetland conservation projects promoted by MINAET to strengthen and expand efforts through the development of early warning systems, hydroclimatic governance, and adaptive planning based on local platforms. In Panama, the La Villa and Tonosí River basins have instruments such as the Municipal Water Resilience Plans, Territorial Environmental Planning Plans (POAT) and MiAMBIENTE-CCAD projects, which integrate monitoring, conservation and community participation.

Full alignment with the Management Plans of the basin organizations for the selected basins will be sought, in addition to seeking to reinforce these plans with the results of the project.

F. Describe how the project/programme meets relevant national technical standards, where applicable, such as standards for environmental assessment, building codes, etc., and complies with the Environmental and Social Policy of the Adaptation Fund.

The proposed project is consistent with the Environmental and Social Policy of the Adaptation Fund, as well as with the regulations and policy instruments of Costa Rica and Panama. An analysis of the national texts fully reflects the rules of the Adaptation Fund, which will be demonstrated by evaluations and feasibility studies of how the project adheres to them in the project preparation phase. The project proposes the development of articulated national protocols for the proper operation and functioning of the CRGIS. It is also expected to be updated through decrees or other political instruments to create policy and governance mechanisms and instruments for preventive and reactive attention to droughts and floods.

National regulations

In Costa Rica, the project is aligned with the Organic Law of the Environment (Law No. 7554) and current technical regulations, complying with the guidelines established by MINAE (including its Water Directorate and Climate Change Directorate), the National Meteorological Institute (IMN) and the National Emergency Commission (CNE). All infrastructure activity or equipment installation will follow the requirements of the National Environmental Impact Assessment System (SETENA), the CFIA building codes, and will be coordinated with the National Multi-Hazard Early Warning System. The project also contributes to the fulfillment of the National Policy for Disaster Risk Management and Climate Change 2020–2030, the National Strategy for Adaptation to Climate Change (ENACC) and the goals of the Nationally Determined Contributions (NDCs), especially in water resilience and ecosystem-based adaptation.

In Panama, the project complies with the provisions of the General Environmental Law (1998) and the Environmental Impact Assessment System (SEIA), following the technical guidelines of the Ministry of Environment (MiAMBIENTE), including its Climate Change Directorate and the Water Security Directorate, as well as the Institute of Meteorology and Hydrology of Panama (IMHPA). Activities with physical components, such as monitoring stations or data systems, will comply with the Panama Building Code and environmental permitting and licensing procedures. In addition, coherence is ensured with key instruments such as the National Drought Plan, the Action Plan for Integrated Water Resources Management (PAGIRH 2022–2026) and the priorities of the Government's Strategic Plan 2024–2029 in terms of sustainability and risk reduction.

In both countries, the proposed actions respect international standards such as those established by the World Meteorological Organization (WMO) and regional standards such as SICA and the Escazú Agreement, guaranteeing interoperability, data governance and early warning mechanisms with a rights-based approach. For example, in the case of Panama, aspects related to data in the cloud will be done in accordance with the specifications of the National Authority for Government Innovation (AIG), which offers IMHPA space in its computing cloud. In addition, the development and updating of national protocols articulated with decrees or other policy instruments is foreseen, to strengthen coordination and response to droughts and floods. The use of tools such as the Municipal Risk Management Guide of Panama and other official methodologies will make it possible to identify and prioritize vulnerable communities in each territory. In this context, the project not only complies with current regulations, but also strengthens the institutional and technical capacity for its effective application, generating synergies with processes already underway and contributing to the resilient development of priority basins.

Vulnerable communities

National guides will be used for the identification of vulnerable communities, as is the case of the National Risk Management Policy of Costa Rica and the Municipal Guide of Disaster Risk Management in Panama. In the specific case of the correct integration of indigenous communities, existing documentation will be taken into account, for example: the Planning Framework for Indigenous Peoples (MPPI) of Costa Rica, the Guide for the Institutional Care of Indigenous Peoples of Costa Rica, the Comprehensive Development Plan for Indigenous Peoples of Panama and the Environmental and Social Management Framework (ESM) of Panama.

Early Warning Systems

Likewise, the project contemplates the strengthening and expansion of the EWS as a key technical measure for adaptation and risk reduction in pilot basins. These actions will be aligned with the regulatory frameworks of each country: in Costa Rica, they will be integrated

into the development of the National Multi-Hazard Early Warning System led by the CNE; and in Panama, they will be linked to the guidelines of the National Drought Plan and the EWS systems identified in the national inventory carried out with the support of UNESCO. The interventions will be developed in accordance with national and international standards in interoperability, risk communication and community participation, ensuring their sustainability and accessibility to vulnerable populations.

Environmental and Social Policy of the Adaptation Fund

The project complies with the Environmental and Social Policy of the Adaptation Fund, as it has been designed to avoid negative impacts on the environment and communities, focusing on strengthening institutional capacities, improving monitoring and warning systems, and integrating climate information into decision-making. These actions do not involve large-scale physical interventions and, on the contrary, generate concrete benefits for the populations most vulnerable to droughts and floods, promoting more inclusive and effective risk management.

Since its formulation, a participatory approach has been contemplated that ensures the inclusion of various actors. In the next stages, more participation will be sought, especially women, rural and indigenous communities. In addition, an Environmental and Social Management Plan will be developed to identify and manage possible risks, as well as a participatory mechanism and/or process in the communities neighboring the pilot basins, taking into account in particular the gender perspective and vulnerable groups, indigenous and peasant, through citizen participation actions for decision-making and respecting their human rights. In addition, the project recognizes and respects the principles established in the United Nations Declaration on the Rights of Indigenous Peoples, in particular the right to full and effective participation, and prior, free and informed consultation. All this seeks to ensure that the project is implemented in a responsible, transparent manner and with long-term sustainable benefits.

For more details on the 15 principles of the Adaptation Fund's Environmental and Social Policy, please see Tab. 4 of section L.

G. Describe if there is duplication of project/programme with other funding sources, if any.

At this time, no duplication with other projects or sources of funding is identified. From its pre-concept phase, this proposal was developed through an exhaustive mapping of relevant national and regional initiatives in Costa Rica and Panama, in order to guarantee synergies, avoid redundancies and maximize impacts. This process included virtual and face-to-face consultations (2024–2025) with key national actors, such as NMHSs, NDMAAs, as well as regional actors (CRRH and GWP-CAM).

In Panama, the lessons learned from the project "Adaptation to climate change through integrated water resource management" implemented by Fundación Natura with the support of the Ministry of Environment and MIDA were taken into account. This project strengthened local and national capacity for decision-making based on climate data, improved the management of priority watersheds (Chiriquí Viejo and Santa María), and promoted knowledge exchange platforms.

This new proposal does not duplicate that effort, but rather complements and expands it, by focusing on the improvement of Early Warning Systems (EWS), the integration of hydrological and climate information at different levels, and the strengthening of institutional and community capacities in new priority watersheds. As a lesson learned, the current project incorporates from the design commitments for the post-project maintenance of monitoring stations and institutional frameworks to ensure sustainability.

In Costa Rica, the project "Program for the Development of Resilient Infrastructure and Territorial Development", financed by the WB for USD 500 million, is in the preparation phase. While it also seeks to reduce the vulnerability of exposed populations, its focus is on the reconstruction and planning of disaster-resilient physical infrastructure. This project is complementary to the Adaptation Fund, since it does not contemplate the strengthening of hydroclimatic warning or monitoring systems, so both are articulated synergistically in the risk management cycle: one in structural prevention and the other in early warning and data-based planning.

At the regional level, other relevant initiatives are identified, such as:

- The project under preparation by IFAD and the Adaptation Fund on early warning services in agriculture. This proposal focuses only on the agricultural sector, while the current project has a multisectoral approach and strengthens capacities at the national and regional levels to improve decision-making in sectors such as drinking water, hydropower, risk management, and food security. In the event of geographical coincidence, coordination mechanisms will be established to ensure interoperability between the hydrometeorological monitoring networks of both projects.
- The Green Climate Fund's regional proposal implemented by CABI, FAO and CCAD on Ecosystem-based Adaptation (EbA) in the Dry Corridor and drylands of the Dominican Republic. Although it addresses water security, it focuses on ecosystem restoration and improvement of agricultural landscapes, while the current proposal acts on risk planning based on climate and hydrological information.
- Tab Tab. 3 shows a couple of more identified projects.

Tab. 3. Projects and programs in execution and/or planning in the region.

	Project Name	Objective	Synergy/Comments
1	Panama: Adaptation to change through integrated water resource management in Panama implemented by the Natura Foundation of Panama. In Execution	Establish climate-resilient water management to improve food and energy security at the national level, through an integrated, community-based approach in the Chiriqui Viejo and Santa Maria River basins.	The lessons learned from the experience in strengthening national and local capacity with databases derived from monitoring (EWS) and decision-making to reduce risks associated with climate change and from the knowledge exchange platform, will undoubtedly serve as the basis for the project.

2	<p>Costa Rica: Program for the Development of Resilient Infrastructure and Territorial Development. Investment: BM. Executing entity: ONE. Approved March 2025</p>	<p>Increase access to disaster-resilient infrastructure with an emphasis on the intervention of territories with vulnerable populations, particularly people in conditions of poverty and social exclusion.</p>	<p>The project proposal for the World Bank focuses on the design and construction of water infrastructure, among other types, an aspect not contemplated in the project for the Adaptation Fund. These works are complementary to the planning and establishment of an EWS for floods and droughts. In other words, an adequate synergy is generated between both projects for the management of risks due to hydrometeorological phenomena.</p>
3	<p>Multi-hazard impact-based forecasting and early warning services for increased climate change adaptation investments in Costa Rica, Panama, and the Dominican Republic. Investment: Adaptation Fund. Implementer: IFAD in preparation – Pre-concept Note</p>	<p>Improve the climate resilience of Research-operations in agricultural, livestock, agroforestry, and agrotourism activities in vulnerable areas of Costa Rica, Panama, and the Dominican Republic through the generation and use of climate information in decision-making and improved access to credit and technical assistance to adopt climate change adaptation practices.</p>	<p>Hydrometeorological observations and networking and modelling for enhanced multi-hazard EWS at specific sites will contribute to generating experiences and data that will serve at the national level for the project.</p>
4	<p>Costa Rica and Panama: Ecosystem-based adaptation and transformational measures to increase resilience to climate change in the Central American dry corridor and drylands of the Dominican Republic. Investment: Green Climate Fund (GCF) Implementer: CABEL. Executors: CABEL, FAO and CCAD.</p>	<p>Address the impacts of climate change at the landscape and household levels in priority watersheds by promoting Ecosystem-Based Adaptation (EbA) strategies based on improving the conditions of forests and agroforestry systems in prioritized watersheds and promoting efficient technologies for the use of water and resources in rural communities.</p>	<p>The generation of experiences and knowledge in local ecosystem restoration projects through EbA to improve water security conditions in the face of future climate variability, optimize hydrological flow and rainwater infiltration into groundwater reserves, as well as the use of innovative and efficient technologies to reduce water demand in the dry corridor. They will be used to design national and local planning for drought measures, which is a relevant component of the project.</p>
5	<p>Costa Rica: Improving Climate Services for Infrastructure Investments (CSI). Investment: GIZ Beneficiaries: Investors, planners, operators, owners and users at the national level of infrastructures resilient to climate change, through the use of Climate Services.</p>	<p>Support in the provision and use of Climate Services, integration of the use of these Services in infrastructure planning, climate risk analysis of infrastructure and international exchange and transfer of knowledge.</p>	<p>Information and experiences can be shared regarding climate data and integration into planning processes at the national and regional levels. The information generated by the Adaptation Fund project can serve as inputs for the resilient infrastructure planning expected in the GIZ project.</p>

6	<p>Costa Rica: Various climate projects. Investors: Adaptation Fund, GIZ. Beneficiaries: Local Communities (including development associations, farmers, fishermen, and citizens); Institutions and Local Governments (Municipalities, ministries, and conservation systems); Specific Sectors: Agricultural, fisheries, and infrastructure sectors.</p>	<p>Improve the resilience of communities and ecosystems to climate change through the implementation of adaptation and mitigation measures, capacity building, and sustainable infrastructure development.</p>	<p>Collaborate in the development and creation of hydrometeorological and climate information as well as seek to ensure that training programs can be multi-purpose. Several of the projects can serve as leverage with the government and Ministries to cause the necessary impact for the improvement of climate governance and sustainability.</p>
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H. If applicable, describe the learning and knowledge management component to capture and disseminate lessons learned.

The project contemplates a comprehensive learning and knowledge management strategy, designed to capture, systematize and disseminate lessons learned throughout its implementation. This strategy is incorporated into Component 4, which includes capacity building, with a cross-cutting focus on gender, social inclusion and attention to the most vulnerable actors.

Regional and national level

Knowledge management will be led by WMO, SICA CRRH and GWP-CAM, in close coordination with the national institutions of Costa Rica and Panama. This work will include:

- Production of specialized materials (manuals, technical catalogs, protocols, e-learning platforms such as Moodle and other didactic resources). Materials available in Spanish and adapted to the Central American context will be used.
- Collaboration with local universities and academic centres to ensure the contextualisation and sustainability of the knowledge generated.
- Integration of results into regional and global knowledge-sharing platforms, including GWP and WMO initiatives.
- Generation of case studies
- Development of face-to-face and virtual training
- Exchanges of experience
- Creating a Community of Practice

In addition, the documentation of experiences will be promoted through case studies, good practices and technical publications that allow replicability and scalability in the region.

Local level

Learning will be a central axis in the implementation of the pilot projects in selected basins. Communities will be actively involved from the design phase to implementation and evaluation, with activities including:

- Participatory consultations for drought and flood planning (Outcomes 3.2 and 3.3).
- Community training for the maintenance and operation of Early Warning Systems (EWS) (Outcome 2.3).
- Co-design of products and services based on data and information, such as risk assessments, vulnerability assessments and adaptation plans.

- Knowledge transfer along the hydrometeorological value chain: including disaster risk, hazard detection, observation, monitoring, analysis and forecasting, the dissemination and communication of warnings, and appropriate preparedness to respond to alerts.
- Transfer of cultural and ancestral knowledge, particularly in indigenous and Afro-descendant communities, respecting and leveraging their wisdom for climate risk management.

A local capacity-building program will be established to foster community resilience, promoting tools such as NbS and citizen empowerment. This program will adopt an intersectional and intergenerational approach, ensuring respect for human rights and the inclusion of women, young people, and people in vulnerable conditions.

Communities must have the culturally appropriate knowledge to assess risk situations, as well as individual, family and community responses to them. The central purpose is to integrate risk management as a fundamental aspect of their coexistence and daily life.

Institutional strengthening and technical training

Through WMO Regional Training Centres (RTCs)¹⁵ and with the support of specialists, international organizations (GWPs and their community of practice) and academic centres, capacities will be developed (in particular with regard to droughts and floods) and hydrometeorological data development and management. These capacities will strengthen the human resource in its competencies and skills, including the adoption of elements such as the integration of a documentary collection, constituted with those documents or publications of a technical nature, as well as based on the experiences of the human resources trained through the project.

Some specific actors that will support in this context are:

- University of Costa Rica (UCR): Collaboration to lead training in meteorology.
- A Panamanian institution to be identified: Strengthening of that institution to assume the role of CRF in hydrology, with the aim of ensuring post-project sustainability.
- Faculty of Engineering and Water Sciences of the National University of the Litoral (FICH-UNL) in Argentina: Cooperation for technical support in the development of content and training in hydrology for Central America, taking advantage of its previous experience with the WMO in Spanish-speaking countries.

Linking with EW4All

The learning strategy will be aligned with the four pillars of the UN's EW4All initiative, which are (1) "Disaster Risk Knowledge", (2) "Detection, Observation, Monitoring, Analysis and Forecasting", (3) "Warning Dissemination and Communication" and (4) "Preparedness and Response Capabilities". These pillars will guide the design of educational materials, training sessions and community engagement, reinforcing the preparedness of national and local systems to implement early action in the face of extreme hydrometeorological events. It will coordinate with institutions leading each of the four pillars mentioned above: UNDRR (pillar 1), WMO (pillar 2), ITU (pillar 3) and IFRC (pillar 4).

Sustainability of knowledge

Finally, the project will seek to institutionalize the knowledge generated, integrating it into regulatory frameworks, public policies, and academic curricula. The creation of a regional digital platform that functions as a repository of data, tools, case studies and lessons learned

¹⁵ A WMO RTC is an institution or a coordinated group of institutions that provides training in meteorology, hydrology and related sciences to meet the needs of the Region. It is established to satisfy the requirements expressed by more than half of the Regional Association Members who cannot be satisfied by existing facilities.

accessible to all stakeholders will also be encouraged. This platform will be linked to CENTROCLIMA.

I. Describe the consultative process, including the list of stakeholders consulted, undertaken during project/programme preparation, with particular reference to vulnerable groups, including gender considerations, in compliance with the Environmental and Social Policy of the Adaptation Fund.

The project is based on the Roadmaps developed between 2021 and 2023, which assessed current capacities and identified priorities for strengthening hydrometeorological services in Costa Rica and Panama. The consultation process carried out for this activity was carried out in conjunction with the Inter-American Development Bank and involved the NMHS of both countries, as well as the institutions that use their services, in the foreground. While the roadmaps cover improvements at the national level, the project addresses specific needs identified in these plans, taking into account several of the recommendations set out therein for the conceptualization of this project. This request arises from the country's urgent need to address the growing challenges related to droughts and floods exacerbated by climate change, given the associated risks and increasing losses in recent years.

During the formulation of the preconception and concept note, relevant information was integrated in a timely and regular manner from stakeholders from both countries and the region through a series of bilateral and group technical meetings, a virtual regional meeting, and face-to-face consultation workshops in the two countries part of the project. The objective of the meetings was to ensure the participation of key national and regional stakeholders, which served to integrate relevant information from the countries and pilot basins, discuss the documents, as well as resolve comments and concerns during the design of the project.

A summary of the different meetings that served as consultation is presented below:

- Face-to-face workshops in Panama and Costa Rica respectively to validate the information of the roadmaps for the strengthening of hydrometeorological services in both countries [July and September 2022]
- Bi-monthly follow-up meetings and generation of the pre-concept note [2023]
- Regional Technical Consultations: Several virtual sessions were held with the participation of representatives from the two countries, the CRRH, GWP-CAM and the WMO regional office. The objective of the meetings was to identify common priorities, reconcile and agree on the objectives and expected results of the project, as well as the participation of regional actors in the implementation of the project [2023-2024]
- Adhoc meetings to follow up and discuss the preparation of the concept note [January to July 2024]
- Clarification meetings for the concept note and collection of information for the concept note [August to December 2024]
- Biweekly technical meetings: Virtual meetings with the technical team of the two countries, with the aim of sharing progress in project design, data and information collection, securing national and regional priorities, and conducting technical consultation [January to March 2025]
- National consultations (the results of which are reflected in this document):
 - The face-to-face workshop in Costa Rica was held from February 12 to 14, 2025 and included the following Institutions:
 - National Emergency Commission
 - Water Directorate of the Ministry of the Environment
 - Costa Rican Institute of Electricity
 - National Meteorological Institute

- Regional Committee on Water Resources of the Central American Integration System (CRRH-SICA)
 - Global Water Partnership- Central America
 - WMO Regional Office for Central America and the Caribbean
- The face-to-face consultation workshop in Panama was held from February 17 to 19 and included the following institutions:
 - Civil Aeronautics Authority
 - Panama Canal Authority
 - Institute of Agricultural Innovation
 - Government Innovation Authority
 - Panama Maritime Authority
 - La Villa River and Tabasará River Basins Committee
 - Natura Foundation
 - National Institute of Aqueducts and Sewers
 - Inter-American Institute for Agricultural Cooperation
 - Meteorological and Hydrological Institute of Panama
 - Ministry of Environment (Directorates of Climate Change, Water Security and International Cooperation)
 - Ministry of Agricultural Development
 - Ministry of Economy and Finance
 - Ministry of Government via the National Civil Protection System
 - University of Panama
 - Technological University of Panama
 - Regional Committee on Water Resources of the Central American Integration System (CRRH-SICA)
 - Global Water Partnership- Central America
 - WMO
- Virtual Concept Note Validation Meeting with Both Countries [June 2025]

For the next phase of project note generation, the same institutions will be consulted, as well as vulnerable groups, basin committees and specific beneficiary sectors. Among other materials, GWP's "A Guide for Multi-Stakeholder Partnerships in Water Management" and "Gender in Climate Change and Water" and WMO and GWP Flood and Drought Associated Programmes' documents will be leveraged to integrate community aspects, which provide practical guidance for establishing and strengthening multi-stakeholder partnerships in water management. as well as guidance for gender perspective and community actions. Special attention will be given to maintaining an open and respectful dialogue, using strategic communication to engage external audiences, choosing appropriate communication channels, recognizing and addressing water-related conflicts, promoting joint vision and scenario building, involving vulnerable sectors and with special attention to a gender perspective.

J. Provide justification for funding requested, focusing on the full cost of adaptation reasoning.

To address the growing challenges related to climate change, funding of nearly US\$14 million is requested to implement adaptation measures in Costa Rica, Panama, and at the regional level. This financing is crucial to cover the full costs of providing information, products, and services for climate adaptation. These costs are divided into the following in two categories:

- Adaptation Infrastructure: Strengthening of the hydrometeorological monitoring network, establishment of national hydrometeorological databases and start-up/modernization of SAT.
- Non-Structural Measures: training and awareness-raising programmes for vulnerable communities and development of drought and flood management policies and plans at the national and local levels. Activities at the local (basin) level to generate knowledge on adaptation and resilience

Adaptation Costs and Expected Benefits

The costs of the proposed activities are justified by the expected benefits to vulnerable communities and strategic economic sectors, including:

- Reduction of economic and human losses from disasters related to droughts and floods.
- Reduction of costs for disaster response.
- Improvement of water resource management.
- Improving the resilience of communities and economic sectors.
- Protection of critical infrastructure and natural resources.
- Facilitation of replicable models for other basins in both countries and at the regional level.

Panama and Costa Rica have seen an increase in environmental disasters with significant human and material losses. Panama ranks 14th in vulnerability to disasters worldwide, highlighting the need for improved risk management. Costa Rica has a modern disaster risk management framework, but still faces challenges from extreme weather events. According to the EM-DAT database, from 1970 to 2011, 69.7% of disasters in Central America have been caused by hydrometeorological events. In Panama, events such as ENSO have caused significant losses in agriculture, with economic impacts reaching USD 40 million in some years. Costa Rica also faces similar challenges, with drought and flood events exceeding its response capacities.

Sustainability and Long-Term Support

The requested funding will not only cover a portion of the immediate costs of adaptation but will also ensure the long-term sustainability of the initiatives. Monitoring and evaluation mechanisms will be implemented to ensure the effective use of funds and the continuity of adaptation measures, especially seeking advocacy at the political level and the establishment of financing mechanisms at the national level.

The governments of Panama and Costa Rica, together with technical and financial partners, are committed to the implementation and sustainability of these measures. This project is based on the Roadmaps developed for the strengthening of hydrometeorological services between 2021 and 2023, which identified the priorities and capacities needed to face the challenges of climate change.

Benefited sectors

The economies of Panama and Costa Rica are deeply intertwined with their natural environments, making them susceptible to climate impacts. Both countries face significant risks due to extreme hydrometeorological events, rising sea levels, and changes in rainfall patterns, which affect water availability and agricultural productivity. As a result, Costa Rica and Panama need robust adaptation measures to protect their economic stability and growth.

Key sectors such as agriculture, mining, tourism, high-tech manufacturing, and logistics are vulnerable to climate change. For example, copper mining operations, maritime facilities, and banana production in Panama are at risk due to extreme weather events and rising sea levels. Similarly, coffee and banana exports and high-tech manufacturing in Costa Rica depend on stable infrastructure and supply chains, which can be disrupted by hydroclimatic events.

K. Describe how the sustainability of the project/programme outcomes has been taken into account when designing the project/programme.

One of the main objectives of the project is to ensure the sustainability of the activities once the project is completed. Component 4 is created explicitly for this purpose. Overall, the sustainability of the project will be supported by: (i) the active participation of all regional, national and local actors in the decision-making and implementation of project activities; (ii) strengthening the institutional and technical capacity of the CRRH as well as of Costa Rican and Panamanian and local actors at the basin level; (iii) increased public awareness of the benefits of planning, prevention and early warning; (iv) collecting, analysing and disseminating the results generated through the project; and (v) updating and harmonizing public policies, standards and protocols in the event of disasters caused by droughts and floods.

Regional support

Among the most influential factors in the project, in terms of sustainability, is the integration of the CRRH and GWP-CAM as project partners. Regional integration provides greater clarity, continuity and credibility to the different parties involved, including potential new investors. Likewise, knowledge is conserved and is not susceptible to loss with national changes of government or administration and, since knowledge will also be stored at the regional level, it can be supported with constant training through other regional programs once the project is completed. Finally, economies of scale are supported and the project's efforts can be replicated in the region, involving countries that have already been trained and fostering closer ties between nations in the region. For more information, see section D under "Regional Focus".

Pilot projects

Another way in which the project takes sustainability into account is through work in pilot basins. The aim is to work with local actors so that they get involved in the project. Basin/community-level engagement and the possible inclusion of citizen science to support hydrometeorological observations will be beneficial in supporting sustainability, as involving communities increases awareness of climate and hydrometeorological hazards, as well as integrating them into other parts of the hydrometeorological value chain in a way that better understands how the observations allow them to make informed decisions about resource management and to reduce impacts from floods and droughts. In addition, working at the local level ensures that technical knowledge reaches them and provides them with tools so that they can pass it on to more local actors. As an example: in Costa Rica it is considered that there will be access at the municipal level to a municipal risk management fund which will come from allocating municipal surpluses to disaster prevention. If municipalities are an active part of the generation of information and risk management, it will be better understood how funds can be used for the adaptation of communities and the mechanism will be taken care of. The plans created within the framework of the project may serve as a basis for the participating municipalities to access this fund.

Institutionality

All key partners have been involved during the preparation of this concept note and the proposed activities are in line with the different national plans and strategies, as well as SICA. In this sense, institutional sustainability will be reinforced by having the main institutions involved taking ownership of the project. This appropriation is already being noticed with the efforts to create this concept note, especially with the organization of both virtual and face-to-face national consultation meetings.

Public policies and financing mechanisms

The project takes into account an extensive series of conversations that have been held with national and regional actors to identify financial and governance mechanisms that will be explored during the project in support of sustainability. Examples of these mechanisms include:

- Trust funds: made up of contributions from different sources to guarantee continuous resources for the operation and maintenance of activities.
- Royalties: pecuniary obligations linked to the provision of a specific service. As an example, in Panama, the IMHPA is financed mostly by a fee paid by the electricity transmission companies.
- Public plans and policies: once documents of this type are endorsed by governments, the allocation of resources for their implementation is facilitated.
- Political advocacy: raising awareness among the political class about the benefits provided by hydrometeorological services helps to more easily propose and approve laws and public policies that support such activities. This activity will be linked to (and will be dependent on) generating an analysis of socioeconomic benefits of the services provided with respect to hydrometeorological information, especially floods and droughts.
- Public-private partnerships: seeking this type of alliance can result in win-win where resources, experiences, capacities, etc. are shared.
- Regional alliances: during the planning and execution of the project, regional actors such as the Spanish Agency for International Development Cooperation (AECID), the IDB, WB, among others, will be consulted to analyze and identify ways to give continuity to specific project activities under programs that these actors are promoting.

As an accompaniment to the search for the implementation of the mechanisms mentioned above, national documentation on public investment will be analyzed to ensure correct alignment. Some examples of the documents to be analyzed are Costa Rica's National Development and Public Investment Plan 2023-2026 (PNDIP), Panama's Public Investment Plan 2025-2029 and their respective General Methodology Guide for the Formulation and Evaluation of Public Investment Projects, which prioritize aspects such as adaptation and climate change.

L. Provide an overview of the environmental and social impacts and risks identified as being relevant to the project/programme.

The project is designed to achieve significant environmental, social and economic benefits. Thus, one of its strengths is the high degree of empowerment of local and national authorities, as well as local civil society organizations in the selected basins, through the bodies already existing in the countries such as basin organizations and municipal emergency committees.

Environmental and social risks were preliminarily assessed according to the 15 principles set out in the Adaptation Fund's Environmental and Social Policy. During the preparation of the proposal, a full assessment of environmental and social risks will be conducted, and mitigation measures for the identified risks will be designed, in accordance with the Adaptation Fund's social and environmental standards.

A preliminary assessment conducted at the concept note stage (Tab. 4) classified the project in Category C since the project is not expected to generate any adverse environmental or social impacts.

Tab. 4. Quick screening of the environmental and social policy principles of the Adaptation Fund.

Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks – further assessment and
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		management required for compliance
<i>Compliance with the Law</i>	The project will adhere to existing national and transboundary laws, policies, and guidelines while implementing the project activities. SICA's guidelines, protocols, and frameworks will be respected.	-
<i>Access and Equity</i>	The project will ensure impartial and equitable access to its benefits by including representatives from vulnerable groups in the respective capacity development activities. A compendium of materials will be made available at the community level.	-
<i>Marginalized and Vulnerable Groups</i>	Marginalized/vulnerable groups are a special target in terms of EWS and dissemination of warnings in the project. The project aims to provide community members with adequate information and explanations about the implemented activities.	An assessment on ensuring marginalized and vulnerable groups participation will be performed
<i>Human Rights</i>	The proposed activities do not or will not violate any of the established human rights. On the contrary, it will seek access to information for all.	-
<i>Gender Equity and Women's Empowerment</i>	The proposed activities will seek access to information and co-development ensuring gender equity.	A Gender Assessment will be performed
<i>Core Labour Rights</i>	The project will be implemented and managed in accordance with labor laws of both countries respectively and following SICA protocols and guidelines.	-
<i>Indigenous Peoples</i>	All population groups in the area will be consulted and involved during the design and implementation of the project activities, including indigenous and afro-descendant communities.	An analysis will be carried out, in order to understand the traditional knowledge with regards to climate, water and land.
<i>Involuntary Resettlement</i>	No direct involuntary resettlement will result from proposed project activities. The project will provide best practices for resettlement in terms of policies and measures in case the governments seeks such approach to reduce risk.	An assessment regarding population living in risk areas will be performed during the project.
<i>Protection of Natural Habitats</i>	There are no potential direct risks to the protection of ecosystems, their natural habitats and biological diversity through project activities. Through the products and plans generated, it will promote their conservation and environmental assets will be considered for risk maps.	-
<i>Conservation of Biological Diversity</i>		
<i>Climate Change</i>	The project will not have any negative impact on climate change. Through the products generated, it will promote adaptation to it and raise awareness.	A SEB analysis will be conducted during the project, highlighting the benefits towards climate adaptation rather than adverse impacts to climate.
<i>Pollution Prevention and Resource Efficiency</i>	The project activities are not expected to result in water, air, and soil pollution.	An assessment on disposing of waste from hydromet networks will be considered as part of an Operations and Maintenance (O&M) strategy in Output 1.1.1
<i>Public Health</i>	The project is not expected to have a negative impact on public health. Through the products generated, it will promote public health.	A SEB analysis will be conducted during the project, highlighting the benefits towards public health rather than adverse impacts to it.
<i>Physical and Cultural Heritage</i>	The project does not affect the physical and cultural heritage. Through the products generated, it will promote their conservation.	Some of the pilot basins include natural heritage sites. A SEB analysis will be conducted during the project, highlighting the benefits for the

		conservation of such heritage rather than adverse impacts to it.
<i>Lands and Soil Conservation</i>	The project will promote the conservation of soil resources and land, including the selection of natural and environmentally friendly solutions.	Countries have expressed their utmost concern about land and soil conservation and will advocate for policies that support conservation practices based on resulting hydrometeorological products. Such policies will be developed during the project.

PART III: IMPLEMENTATION ARRANGEMENTS

WMO will be the implementing entity for the project. In this sense, it will be responsible for the functions of general management, as well as issuing the necessary guidelines, monitoring compliance with the technical and financial aspects of the project, and supervise the project in general. It will also ensure the alignment of results with global initiatives. Such is the case of the EW4All initiative, where the WMO will coordinate with the institutions involved (UNDRR, IFRC, ITU) to ensure that the EWS are addressed in a systemic manner.

For the above purposes, it will rely on its extensive network of experts, as well as WMO constituent bodies such as the technical commissions, the research council and the regional association for North America, Central America and the Caribbean (RA IV), ensuring compliance with international standards and guidelines, also following guidelines established by the region and making available the best practices and recommendations necessary for the success of the project. WMO will also coordinate any interaction with strategic partners such as the IDB and donors in other projects.

The overall implementation of the project will depend mainly on the CRRH, in conjunction with WMO and GWP, who will carry out those activities that are closely related to their technical programmes and regional and global initiatives, thus providing added value.

The executing agencies of the project will be responsible for executing the activities in accordance with the directives of the countries in accordance with the project, including the preparation of technical specifications and terms of reference, technical, financial and execution reports, in addition to carrying out procurement and contracting. A brief description of the executors is:

- WMO is the authoritative voice of the United Nations system on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources, and contributes to improving hydrological services in its Member countries through a number of initiatives. In addition, WMO is leading Pillar 2 of the EW4All initiative, "Risk Detection, Observation, Monitoring, Analysis and Forecasting". As such, this project will align with this and other WMO initiatives.
- The CRRH, as a SICA agency specialized in water, weather and climate issues, and with 57 years of uninterrupted operation, is a central element, together with the NMHS, that will contribute to the coordination and unification of national results, to an adequate implementation of the regional component and to save the knowledge and lessons learned for future use and/or replication in the region. giving continuity to the training efforts carried out within the project. The CRRH will serve as a liaison with other SICA agencies, such as the Coordination Centre for Disaster Prevention in Central America and the Dominican Republic (CEPRENAC) and the Central American Commission for Environment and Development (CCAD).

- The Global Water Partnership (GWP) is a multilateral action network of more than 2,800 partner organizations from more than 180 countries dedicated to working for equitable and efficient water resources management for a sustainable and climate-resilient world. GWP's global Secretariat is the Global Water Partnership Organisation (GWPO), an intergovernmental organization based in Stockholm, Sweden. GWP operates on a regional and national scale through its 13 Regional Water Partnerships (RWPs). GWP Central America (GWP-CAM) is one of these RWPs, based in Honduras, with 155 partners in the region and National Water Associations established in each of the six countries. GWP is a collaborating partner of WMO in the Integrated Drought Management Programme (IDMP), which supports governments and other stakeholders at all levels in the implementation of integrated drought management by providing policy, technical and management guidance and sharing scientific knowledge and best practices. It also maintains close coordination with the national institutions that govern water/climate management, as well as coordination agreements with SICA instances, such as the CRRH.

The CRRH will lead Components 1, 2 and 3 and will integrate and manage a Project Execution Unit (PEU), in charge of the procurement and contracting processes, as well as the integration of technical and management reports, in addition to ensuring and supporting the correct development of the project in a timely manner. To this end, it shall maintain a close relationship and coordination with the other implementers (WMO and GWP), as well as with the NMHSs and, through them, with the different counterparties and final beneficiaries in each case. The PEU will be composed of a regional coordinator and national technical specialists who will follow up on the activities to be implemented and will be the focal point for each country, hired by CRRH and the NMHSs respectively.

The GWP-CAM will lead the implementation of Component 4 in coordination with WMO and the CRRH. In addition, it will provide support in terms of training, training and technical assistance, support capacity building activities, the preparation of policy instruments, the inclusion of the gender approach and the use of existing networks to facilitate the participation of stakeholders in the water sector and water-related sectors. This will contribute to the spread of the benefits of the project in both countries and ensure that the project activities are closely linked to national needs and contexts, while maintaining the benefits of a regional approach.

The agreements and mechanisms already established and in force between the different executors and with the different countries linked to inter-institutional coordination and project implementation will be used. Where appropriate, the CRRH has already established mechanisms and protocols that facilitate the coordination and implementation of multilateral funds with multiple beneficiaries.

At the national level, NMHSs (IMN and ICE in the case of Costa Rica and IMHPA¹⁶ in the case of Panama) will be responsible for coordinating with other national institutions (e.g. Climate Change Directorates and Civil Protection Services), ensuring the effective implementation of activities on the ground with the assistance of CRRH, WMO and GWP-CAM technical experts, as well as WMO technical units.

¹⁶ In consideration of the mandates and installed capacities, the institutional framework of the IMHPA, (Law 209 of April 22, 2021 and regulated by Executive Decree 2 of March 7, 2022), directing the technical and administrative tasks of the IMHPA necessary for the proper performance of the functions of the Institute is one of the functions of the General Directorate. Consequently, for the purposes of this Project, it is the responsibility of the General Directorate or whoever it designates, to be the liaison with the beneficiary institutions and the decision-making for the execution and implementation of the project. In the event of requiring approval by the IMHPA Board of Directors through a Board of Directors Resolution, the General Directorate will be responsible for this procedure.

To facilitate the development of activities at the national level and ensure their harmonization, it is envisaged that NMHSs will establish a national execution team (including the specialists who will be part of the PEU). This team will consider the creation of working groups for the different areas of the project as needed, including for activities at the local level (pilot basins), where local communities (particularly through their basin organization) will play a key role in ensuring ownership of the pilot activities in the project and data collection. The General Directorates of the NMHS will be supported for the execution of the project by the PEU, which will be created for the purposes.

A Project Steering Committee (PSC) will be created whose role will be to oversee and validate the implementation of project activities in line with the expected results. It will be composed of representatives of the implementer, implementing partners and NMHSs of both countries. The representatives of the NMHS of both countries will oversee informing their respective boards of directors and/or committees (IMHPA Board of Directors and CONAHYME) about the progress of the project.

Strategic partners will be sought and identified throughout the project, according to the activities, especially related to public policies, governance and socio-economic benefit analysis. One of these strategic partners will be the Inter-American Development Bank, which will provide advice on financial sustainability after the project is completed and other activities within its competence in the areas of climate change and water and sanitation.

The diagram that outlines the implementation structure of the project can be seen in Fig. 5.

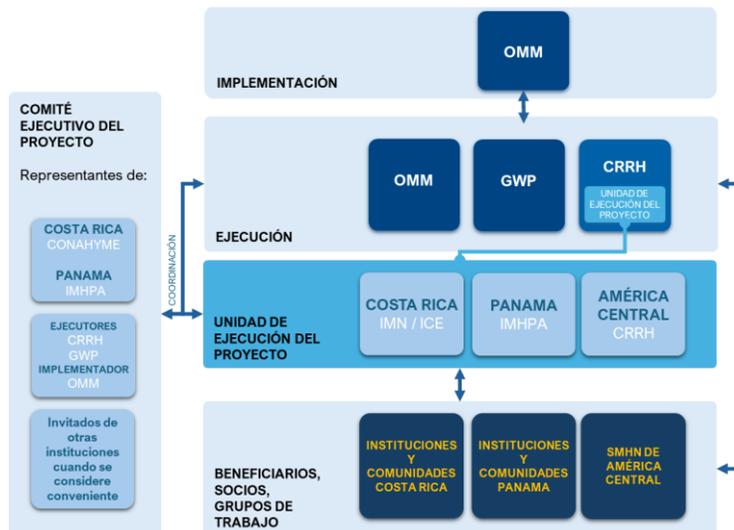


Fig. 5. Diagram of the project execution structure.

Demonstrate how the project/programme aligns with the Results Framework of the Adaptation Fund

The objective of the project is to improve climate change adaptation capacity and resilience to droughts and floods in Central America through the strengthening of hydroclimatic and early warning systems and the integration of the knowledge generated in the planning and management of national and regional water resources. This gives the countries the capability to manage and adapt to climate-related risks. The Adaptation Fund Results Framework Outcomes 1, 2, 3, 4, 7 and 8 are covered by the project (although Outcomes 5 and 6 might also be indirectly covered through policies and plans depending on specific results of some activities). Tab. 5 provides the links between each component, outcome and output and the Adaptation Fund's Results Framework.

Tab. 5. Alignment of the project components, outcomes and outputs with the Results Framework of the Adaptation.

Project Objective(s) ¹⁷	Project Objective Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amount (USD)
Component 1. Hydrometeorological observing, monitoring, and data management infrastructure improved for risk awareness and Early Warnings	To be defined in the project proposal phase	Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses	2.1. Capacity of staff to respond to, and mitigate impacts of, climate related events from targeted institutions increased	4,316,000
		Outcome 4: Increased adaptive capacity within relevant development sector services and infrastructure assets	4.1. Responsiveness of development sector services to evolving needs from changing and variable climate 4.2. Physical infrastructure improved to withstand climate change and variability-induced stress	
		Outcome 8: Support the development and diffusion of innovative adaptation practices, tools and technologies	8. Innovative adaptation practices are rolled out, scaled up, encouraged and/or accelerated at regional, national and/or subnational level	
Component 2. Institutional set-up and processes for risk knowledge and Early Warning	To be defined in the project proposal phase	Outcome 1: Reduced exposure to climate-related hazards and threats	1. Relevant threat and hazard information generated and disseminated to stakeholders on a timely basis	3,390,000
		Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses	2.1. Capacity of staff to respond to, and mitigate impacts of, climate related events from targeted institutions increased	
		Outcome 4: Increased adaptive capacity within	4.1. Responsiveness of development sector services to evolving needs from changing and variable climate	

¹⁷ The AF utilized OECD/DAC terminology for its results framework. Project proponents may use different terminology but the overall principle should still apply

Project Objective(s) ¹⁷	Project Objective Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amount (USD)
		relevant development sector services and infrastructure assets		
Component 3. Flood and drought management and risk mitigation enhancement from regional to local level	To be defined in the project proposal phase	Outcome 1: Reduced exposure to climate-related hazards and threats	1. Relevant threat and hazard information generated and disseminated to stakeholders on a timely basis	2,330,000
		Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses	2.1. Capacity of staff to respond to, and mitigate impacts of, climate related events from targeted institutions increased	
		Outcome 3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	3.1. Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses	
			3.2. Percentage of targeted population applying appropriate adaptation responses	
Component 4. Enabling environment for building resilience to floods and droughts	To be defined in the project proposal phase	Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses	2.1. Capacity of staff to respond to, and mitigate impacts of, climate related events from targeted institutions increased	1,535,000
		Outcome 3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level	3.1. Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses	
		Outcome 7: Improved policies and regulations that promote and enforce resilience measures	7. Climate change priorities are integrated into national development strategy	
		Outcome 8: Support the development and diffusion of innovative adaptation practices, tools and technologies	8. Innovative adaptation practices are rolled out, scaled up, encouraged and/or accelerated at regional, national and/or subnational level	

Project Outcomes(s)	Project Outcome Indicator(s)	Fund Output	Fund Output Indicator	Grant Amount (USD)
1.1 Integrated observation, monitoring and data management systems provide inputs for risk knowledge and Early Warning	To be defined in the project proposal phase	Output 4: Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts, including variability	4.1.2. No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by sector and scale)	2,800,000
		Output 8: Viable innovations are rolled out, scaled up, encouraged and/or accelerated.	8.1. No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated	
1.2 Hydrometeorological and climate data at national and regional scales available for product and service generation	To be defined in the project proposal phase	Output 2.1: Strengthened capacity of national and sub-national centers and networks to respond rapidly to extreme weather events	2.1.2 No. of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale)	1,516,000
		Output 8: Viable innovations are rolled out, scaled up, encouraged and/or accelerated.	8.1. No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated	
2.1 Enhanced and sustained mechanisms for flood and drought risk knowledge for use by communities and users	To be defined in the project proposal phase	Output 1.1: Risk and vulnerability assessments conducted and updated	1.1. No. of projects/programmes that conduct and update risk and vulnerability assessments (by sector and scale)	870,000
2.2 Enhanced and sustained hydrometeorological forecasting available to communities and users	To be defined in the project proposal phase	Output 2.1: Strengthened capacity of national and sub-national centers and networks to respond rapidly to extreme weather events	2.1.2 No. of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale)	1,520,000
2.3 Dissemination of flood and drought alerts available to communities and users	To be defined in the project proposal phase	Output 1.2: Targeted population groups covered by adequate risk reduction systems	1.2 No. of early warning systems (by scale) and no. of beneficiaries covered	1,000,000
		Output 4: Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts, including variability	4.1.1. No. and type of development sector services modified to respond to new conditions resulting from climate variability and change (by sector and scale)	
3.1 Strengthened regional coordination of flood and drought management and policy	To be defined in the project proposal phase	Output 2.1: Strengthened capacity of national and sub-national centers and networks to respond rapidly to extreme weather events	2.1.1. No. of staff trained to respond to, and mitigate impacts of, climate-related events (by gender)	630,000
3.2 Users make decisions based on established		Output 2.1: Strengthened capacity of national and sub-national	2.1.1. No. of staff trained to respond to, and mitigate impacts of, climate-related events (by gender)	500,000

Project Outcomes(s)	Project Outcome Indicator(s)	Fund Output	Fund Output Indicator	Grant Amount (USD)
national planning for flood and drought and response capacity for communities is strengthened	To be defined in the project proposal phase	centers and networks to respond rapidly to extreme weather events	2.1.2 No. of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale)	
3.3 Vulnerable communities more resilient against flood and drought	To be defined in the project proposal phase	Output 1.2: Targeted population groups covered by adequate risk reduction systems	1.2 No. of early warning systems (by scale) and no. of beneficiaries covered	1,200,000
		Output 3.1: Targeted population groups participating in adaptation and risk reduction awareness activities	3.1.1 No. of news outlets in the local press and media that have covered the topic	
		Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and disseminate knowledge and learning	3.2.1 No. of technical committees/associations formed to ensure transfer of knowledge 3.2.2 No. of tools and guidelines developed (thematic, sectoral, institutional) and shared with relevant stakeholders	
4.1 Enhanced governance framework and gender mainstreaming for integrated drought and flood management	To be defined in the project proposal phase	Output 2.2: Increased readiness and capacity of national and sub-national entities to directly access and program adaptation finance	2.2.1 No. of targeted institutions benefiting from the direct access and enhanced direct access modality	345,000
		Output 7: Improved integration of climate-resilience strategies into country development plans	7.1. No. of policies introduced or adjusted to address climate change risks (by sector) 7.2. No. of targeted development strategies with incorporated climate change priorities enforced	
4.2 Enhanced institutional capacity and stakeholders' awareness for integrated drought and flood management	To be defined in the project proposal phase	Output 2.1: Strengthened capacity of national and sub-national centers and networks to respond rapidly to extreme weather events	2.1.1. No. of staff trained to respond to, and mitigate impacts of, climate-related events (by gender) 2.1.2 No. of targeted institutions with increased capacity to minimize exposure to climate variability risks (by type, sector and scale)	1,190,000
		Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and disseminate knowledge and learning	3.2.1 No. of technical committees/associations formed to ensure transfer of knowledge	
		Output 8: Viable innovations are rolled out, scaled up, encouraged and/or accelerated.	8.1. No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated 8.2. No. of key findings on effective, efficient adaptation practices, products and technologies generated	

PART IV: ENDORSEMENT BY GOVERNMENTS AND CERTIFICATION BY THE IMPLEMENTING ENTITY

A. Record of endorsement on behalf of the government¹⁸

The endorsement letters should be attached as an annex to the project/programme proposal.

H.E. Carlos Isaac Perez Mejia Viceministro de Gestión Estratégica Ministerio de Ambiente y Energía Email: vicegestionestrategica@minae.go.cr , cperez@minae.go.cr , cambioclimatico@minae.go.cr	Date: July 24, 2025
Mr. Juan Carlos Monterrey Director of Climate Change Ministry of Environment Email: jmonterrey@miambiente.gob.pa , acardenas@miambiente.gob.pa	Date: July 1, 2025

¹⁸ Each Party shall designate and communicate to the secretariat the authority that will endorse on behalf of the national government the projects and programmes proposed by the implementing entities.

B. Implementing Entity certification Provide the name and signature of the Implementing Entity Coordinator and the date of signature. Provide also the project/programme contact person's name, telephone number and email address

<p>I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans (Costa Rica: "Política Nacional de Adaptación al Cambio Climático 2018-2030" and "Plan Nacional de Adaptación al Cambio Climático de Costa Rica 2022-2026"; Panama: "Plan Nacional de Adaptación (NAP)" and "Plan Nacional de Acción Climática (PNAC)") and subject to the approval by the Adaptation Fund Board, <u>commit to implementing the project/programme in compliance with the Environmental and Social Policy of the Adaptation Fund</u> and on the understanding that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme.</p>	
<p><i>Moyenda Chaponda</i> Moyenda Chaponda Implementing Entity Coordinator Development Partnerships Office, WMO</p>	
<p>Date: June 2025</p>	<p>Tel. and email: +4122 730 8646 mchaponda@wmo.int</p>
<p>Project Contact Person: Luis Roberto Silva Vara</p>	
<p>Tel. And Email: +41 22 730 8488 lsilvavara@wmo.int</p>	



July 24th, 2025
DVGE-078-2025

To: The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org

Subject: Endorsement for Project Fortalecimiento de la capacidad de adaptación al cambio climático en América Central, con especial atención en Costa Rica y Panamá: Perfeccionamiento de los sistemas hidroclimáticos y de alerta temprana y su integración para la gestión de los recursos hídricos.

In my capacity as designated authority for the Adaptation Fund in Costa Rica, I confirm that the above national grant proposal is in accordance with the government's national priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in the Costa Rica.

Accordingly, I am pleased to endorse the above grant proposal with support from the Adaptation Fund. If approved, the project will be implemented by World Meteorological Organization (WMO) and executed by Regional Committee for Water Resources (CRRH), Global Water Partnership (GWP), World Meteorological Organization (WMO).

Sincerely,

Carlos Isaac Pérez Mejía
Vice Minister of Strategic Management

cc: Mr. Franz Tattenbach, Minister of Environment and Energy of Costa Rica, MINAE
Mr. Werner Stolz, Director of the National Meteorological Institute, IMN-CR
Archivo / Consecutivo

Carta de Endoso del Gobierno

Panamá, 1 de julio de 2025
DCC-416-2025

Para: La Junta del Fondo de Adaptación
c / o secretaria del Fondo de Adaptación
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

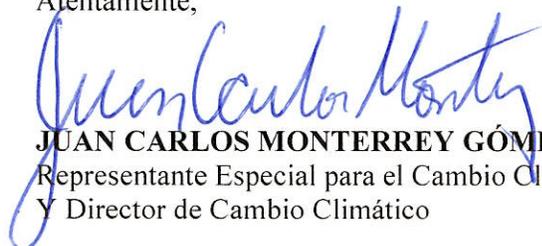
Asunto: Aprobación de la propuesta: "Fortalecimiento de la capacidad de adaptación al cambio climático en América Central, con especial atención en Costa Rica y Panamá: Perfeccionamiento de los sistemas hidroclimáticos y de alerta temprana y su integración para la gestión de los recursos hídrico".

En referencia a la carta DM-N-1134, de fecha 4 de diciembre de 2024, como Autoridad Designada para el Fondo de Adaptación de la República de Panamá, apruebo presentar la nota conceptual para el proyecto regional **"Fortalecimiento de la capacidad de adaptación al cambio climático en América Central, con especial atención en Costa Rica y Panamá: Perfeccionamiento de los sistemas hidroclimáticos y de alerta temprana y su integración para la gestión de los recursos hídrico"**. La propuesta está totalmente alineada con las prioridades nacionales y regionales del gobierno en la implementación de actividades de adaptación para reducir los impactos adversos y los riesgos que representan las inundaciones y sequías en el país.

La presente es también para expresar el consentimiento del gobierno en la implementación del proyecto arriba mencionado por parte del Comité Regional para los Recursos Hídricos (CRRH), la Asociación Mundial para el Agua (GWP), la Organización Meteorológica Mundial (OMM); y la implementación local bajo el Instituto de Meteorología e Hidrología de Panamá IMHPA en estrecha colaboración con el Ministerio de Ambiente de Panamá.

Aprovecho la oportunidad para reiterarle el testimonio de mi más distinguida consideración

Atentamente,


JUAN CARLOS MONTERREY GÓMEZ
Representante Especial para el Cambio Climático
Y Director de Cambio Climático

JCM/km
Km



Letter of Endorsement by Government

Panama, July 1st, 2025
DCC-416-2025

To: The Adaptation Fund Board
c/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

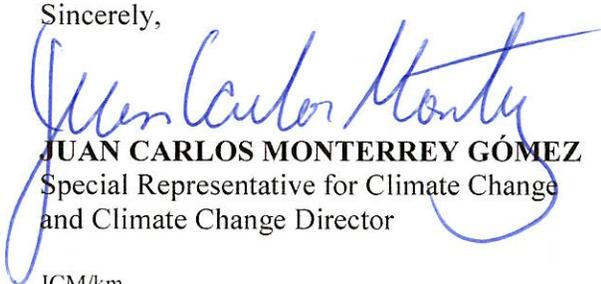
Subject: Endorsement letter for the Concept Note of the proposal “Enhancing Climate Change Adaptation Capacity in Central America with Focus on Costa Rica and Panama: Improving Hydroclimatic and Early Warning systems and integrating with Water Resources Management”.

Referring to the letter DM-N-1134, dated December 4, 2024, as Designated Authority for the adaptation fund, I hereby endorse to submit the concept for the regional project “**Enhancing Climate Change Adaptation Capacity in Central America with Focus on Costa Rica and Panama: Improving Hydroclimatic and Early Warning systems and integrating with Water Resources Management**”. The proposal is fully aligned with the government’s national and regional priorities in implementing adaptation activities to reduce adverse impacts and risks posed by floods and droughts in the country.

This is also to express the consent of the government in the implementation of the above-mentioned project by the Regional Committee for Water Resources (CRRH), Global Water Partnership (GWP), World Meteorological Organization (WMO); and the local implementation of the Institute of Meteorology and Hydrology of Panama (Instituto de Meteorología e Hidrología de Panamá IMHPA) in close collaboration with the Ministry of Environment of Panama.

Please accept the assurances of my highest consideration

Sincerely,


JUAN CARLOS MONTERREY GÓMEZ
Special Representative for Climate Change
and Climate Change Director

JCM/km





Revised PFG Submission Form¹ (additions in red)
Project Formulation Grant (PFG)

Submission Date:

Adaptation Fund Project ID: ?????

Country/ies: Costa Rica, Panamá, Central America

Title of Project/Programme: Enhancing Climate Change Adaptation Capacity in Central America with Focus on Costa Rica and Panama: Improving Hydroclimatic and Early Warning systems and integrating with Water Resources Management

Type of IE (NIE/RIE/MIE): Multilateral Implementing Entity

Implementing Entity: World Meteorological Organization (WMO)

Executing Entity/ies: Regional Committee for Water Resources (CRRH), Global Water Partnership (GWP) and WMO

A. Project Preparation Timeframe

Start date of PFG	March 2025 (depending on the approval)
Completion date of PFG	March 2026

B. Proposed Project Preparation Activities (\$)

List of Proposed Project Preparation Activities	Output of the PFG Activities	US\$ Amount	Budget note ²
<u>Pre-concept stage</u>			
	Full descriptions of: - scope of interventions in the countries, - mechanisms of interventions, - institutional interactions, -inclusion of gender and vulnerable groups, -		

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¹ As presented in AFB/PPRC.33/40 Annex 1.

² The proposal should include a detailed budget with budget notes indicating the break-down of costs at the activity level. It should also include a budget on the Implementing Entity management fee use.

	coordination with other projects in the region		
<u>Sub-total</u>		<u>\$30,000</u>	
<u>Concept note stage</u>			
1.A. Technical assistance for integration of draft version of concept note	Concept note (draft)	\$5,000	2 consultants (hydromet specialist + water resources specialist).
1.B. Technical assistance for preparation and development of consultations with counterparts	Consultation materials and document with conclusions and information	\$10,000	2 consultants (hydromet specialist + water resources specialist).
1.C. Counterpart consultations	Onsite consultations with counterparts carried out	\$20,500 + LoA	LoA with countries + travel expenses
1.D. Technical assistance for integration of final version of concept note	Concept note (final)	\$10,000	2 consultants (hydromet specialist + water resources specialist).
2.A. Technical assistance for organization and development of project preparation workshops with counterparts	Workshop materials, conclusions and data & information for project document integration	\$15,000	2 consultants (hydromet specialist + water resources specialist).
2.B. Development of the project detailed-planning workshops with counterparts	Project detailed-planning workshops carried out	\$26,500 + LoA	LoA with countries + travel expenses
2.C. Technical assistance for integration of final version of the fully developed project proposal	Fully developed project proposal	\$20,000	2 consultants (hydromet specialist + water resources specialist).
		\$	-
Total Project Formulation Grant		\$150,000	-

Please describe below each of the PFG activities and provide justifications for their need and for the amount of funding required:

Activity 1.a. Technical assistance for information gathering and integration of the initial draft of the project document. Based on the general information of the pre-concept note and taking into consideration the diagnoses and scopes of the previously prepared roadmaps, as well as the updated data and information on progress and new initiatives in each country, the integration of an initial working document containing a detailed proposal of specific activities to be developed within each of the components (outputs and outcomes) will be carried out. The involvement of two consultants will be necessary: one hydromet specialist and one water resources specialist. [Honorarium: 10 days each (20 total) at US\$ 500/day]

Activity 1.b . Technical assistance for preparation and development of consultations with counterparts. Preparation of an information base and the necessary materials (presentations, graphs, diagrams, etc.) for the development of the consultations with the counterparts in each country, taking into account that the initial concept note will have been previously distributed among the different key stakeholders for their review and comments. This will also include conducting and facilitating (together with the staff of the different executing agencies) the different consultations and interactions with the counterparts, in order to integrate a document of conclusions and additional relevant information. Consultancies [Honorarium: 20 days at US\$ 500/day]

Activity 1.c. Stakeholder consultations. Consultations are planned in each country (Costa Rica and Panama) in order to include each and every one of the counterparts. The objective is to confirm their agreement on the scope of the concept note, clarify it if necessary, and gather additional information relevant to the final version. The organization and development of the consultations will be carried out in coordination and with the support of the counterparts in each country. Attached to this document is a tentative (3 day for each country) work agenda. A letter of agreement (LoA) will be formalised with countries for such purposes as well as coverage of travel expenses for the consultants and the staff of the executing agencies (2 consultants + 1 WMO staff + 1 GWP staff + 1 CRRH staff) [Per diem: 40 days US\$300/day + Travel: estimated at \$8500]

Activity 1.d. Technical assistance for integration of final version of concept note. Based on the information gathered, the comments and feedback received and the results of the national consultations with the counterparts, the consultants will update the concept note document, not only complementing the description of the project scope and its different components, but also adjusting and complementing the context information and its justification, its benefits and valuation, related risks and sustainability aspects, as well as political and organizational aspects. Once this new version has been integrated, it will be submitted again for comments and feedback to the counterparts in order to integrate the final version of the document. In this regard, the support of the two consultants previously involved is again required. They will work with the support and in coordination with the staff of the different executing agencies [Honorarium: 10 days each (20 total) at US\$ 500/day]

Activity 2.a. Technical assistance for organization and development of project detailed-planning workshops with counterparts. The consultants will prepare the necessary materials for the development of project detailed-planning workshops, taking into account the need to discuss and agree on the different technical aspects and their organization in time, as well as on the administrative and organizational arrangements necessary for implementation. Two consultants (one hydromet specialist and one water resources specialist). [Honorarium: 15 days each (30 total) at US\$ 500/day]

Activity 2.b. Development of the project detailed-planning workshops with counterparts. The development of the workshops will be carried out with the support of and in full coordination with the counterparts in each country. The consultants will be in charge, together with the staff of the executing agencies, of interacting with work teams composed of thematic focal points of the different counterparts, in order to review and discuss each and every one of the technical, administrative and organizational aspects of the project. A letter of agreement (LoA) will be formalised with countries for such purposes as well as coverage of travel expenses for the consultants and the staff of the executing agencies (2 consultants + 1 WMO staff + 1 GWP staff + 1 CRRH staff) [Per diem: 60 days US\$300/day + Travel: \$8500]

Activity 2.c. Technical assistance for integration of final version of the fully developed project proposal. The consultants will work on the basis of the information and results of the detailed project planning workshops and will work in coordination and under the supervision of the staff of the different executing agencies to integrate the final version of the fully developed project proposal. Two consultants (one hydromet specialist and one water resources specialist). [Honorarium: 20 days each US\$ 500/day]

For LLA Projects only:

If requesting additional funding for LLA projects to enable devolving decision making to the local level, please specify the activities that would directly serve to enable devolving decision making to the lowest appropriate level and enable local actors to make informed decisions on how adaptation actions are defined, prioritized, designed, and implemented:

Please provide justifications for their need and for the amount of additional funding required:

C. Implementing Entity

This request has been prepared in accordance with the Adaptation Fund Board’s procedures and meets the Adaptation Fund’s criteria for project identification and formulation

Implementing Entity Coordinator, IE Name	Signature	Date (Month, day, year)	Project Contact Person	Telephone	Email Address
Moyenda Chaponda	<i>Moyenda Chaponda</i>	29 July 2025	Luis Roberto Silva	+41227308488	lsilvara@wmo.int

Annex 1 – Roadmaps for the strengthening of hydrometeorological services in Costa Rica and Panama

Hydrometeorological value chain assessment

Between 2021 and 2023, the World Meteorological Organization (WMO), with the support of the Inter-American Development Bank (IDB), carried out two complementary assessment and planning exercises focused on the analysis of the institutional capacities associated with the hydrometeorological value chain in Costa Rica and Panama.

As a result of these exercises, structural problems related to the generation, provision and use of hydrometeorological products and services were identified. Likewise, a set of strategic actions aimed at strengthening the critical components of this value chain was defined. These actions were systematized and articulated in a roadmap that establishes the guidelines for their progressive implementation.

Key findings

The results obtained from the diagnosis and evaluation developed in close coordination with the respective national institutions in Costa Rica and Panama, provided fundamental inputs to define the strategic orientation of the roadmap, identify areas of opportunity, and establish the specific needs associated with the priority issues for the strengthening of the hydrometeorological value chain in each country.

As for the key findings that supported the definition of the general guidelines and strategic objectives of the roadmap, the following were identified.

In the case of Costa Rica:

- The National Meteorological Institute (IMN) and the Costa Rican Institute of Electricity (ICE) are the central technical bodies in meteorology and hydrology, respectively, at the national level. Both agencies face budget constraints that limit their operations and capacity for expansion. However, they have highly qualified personnel and installed technical capacities that represent a strategic resource to respond to the country's demands in these areas.
- The analysis of the current legal frameworks showed the absence of an entity with an explicit mandate to exercise the function of national authority in hydrological matters. Various institutions have partial or implicit competences related to the subject, but they are limited to their specific sectoral areas. The entities represented in the National Committee of Hydrology and Meteorology (CONAHYME) recognize the technical capacity of the ICE and have expressed their willingness for this institution to formally assume the hydrological functions at the national level. For its part, although the IMN has expressed interest in developing capacities in operational hydrology, it currently does not have the technical resources or the necessary experience to assume this role in the short or medium term.
- CONAHYME is recognized as a relevant inter-institutional coordination mechanism in the hydrological and meteorological fields. However, its scope is limited by its purely advisory nature, since its resolutions are not binding.

- There are no effective institutional mechanisms to articulate and optimize the technical capacities installed in each entity to respond in an integrated manner to the country's hydrometeorological needs. Likewise, the absence of a national regulatory framework that promotes cooperation, exchange of information and interoperability among the actors involved in the hydrometeorological value chain, as well as the efficient use of the products and services generated, is identified.

As for Panama, there are:

- The creation of the Institute of Meteorology and Hydrology of Panama, Engineer Ovigildo Herrera Marcucci (IMHPA), in April 2021, represents a fundamental strategic milestone for the strengthening of the hydrometeorological value chain in the country. However, challenges remain related to the consolidation of the operational, normative, and organizational elements necessary to ensure their proper implementation and institutional development.
- The Law that establishes the creation of the IMHPA defines specific responsibilities and deadlines for its compliance, so its implementation should be a priority in the short term.
- The National Water Security Plan (PNSH) 2015–2050 establishes a close link between its programs, lines of action and investments, and the availability of reliable and timely hydrometeorological data, information and products. In accordance with the legal framework in force in Panama, compliance with the PNSH is mandatory, which reinforces the mandate of the IMHPA in terms of the generation, management and provision of hydrometeorological information that supports decision-making in all strategic sectors of the country.

Institutional, operational and technical analysis

The evaluation of the institutional, technical and operational aspects focused on the comprehensive analysis of the capacities installed in the main institutions responsible for the hydrometeorological production chain. This analysis considered five essential components. First, aspects related to the institutional organization were examined, including its functional structure, as well as the human, material and financial resources available. Second, the elements related to hydrometeorological observation were addressed, such as the coverage and status of monitoring networks, telecommunications infrastructure and associated operational practices. Thirdly, the processes of data and information management and processing were evaluated, including the collection, storage, validation and analysis of hydrometeorological data. Fourth, existing capacities for product generation were analyzed, particularly those related to numerical modeling and forecasting. Finally, the mechanisms for providing services, the dissemination of information and the interaction with the different groups of users were reviewed.

This diagnosis made it possible to establish a baseline on the current state of institutional capacities, and provided critical inputs for the definition of specific actions within the roadmaps formulated to strengthen the hydrometeorological value chain.

Actors in the hydrometeorological sector

The institutional framework is integrated, on the one hand, by those institutions that participate directly in the generation and provision of products and services and, on the other, by the different current and potential users of the information (see Figure 1 and Figure 2).

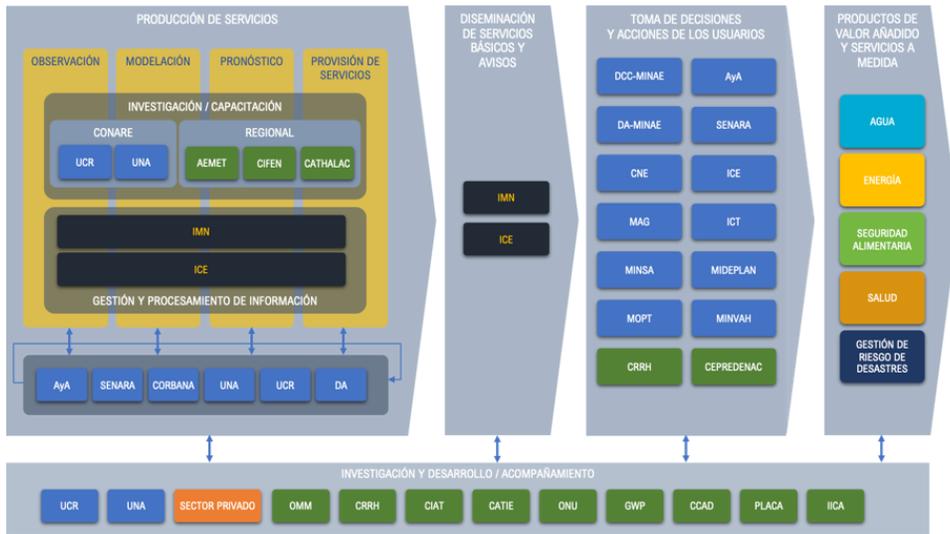


Figure 1 Hydrometeorological institutional framework in Costa Rica.

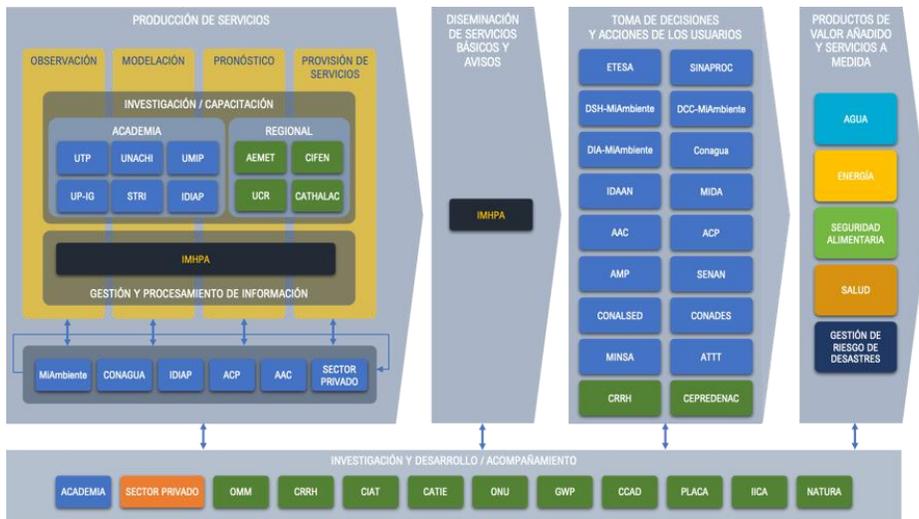


Figure 2 Hydrometeorological institutional framework in Panama.

In both cases, institutions with extensive installed (or potential) capacities are identified in the different links of the chain (IMPHA in the case of Panama, IMN and ICE in the case of Costa Rica), which are accompanied by other institutions that have some capacity, concentrated in particular areas of their attributions¹⁹; as well as by institutions that can contribute and generate added value through research and development actions, as well as contribute to the training and training of personnel²⁰.

These institutions are complemented by information users, who are the general public and a wide range of government institutions, sectors and specific user communities²¹.

In this sense, the main findings found are:

- A large number of institutions are linked to the different links in the value chain; however, there are 3 central figures due to their installed capacities in relation to the production of services (observation, modeling, forecasting and provision of products and services), as well as with the integration, management and processing of information and the dissemination of products, services and notices (IMHPA, IMN, ICE).
- Institutions with some capacity (partial or focused on their particular needs) are rather constituted as users with specific needs for information, products and services.
- Institutions linked to research, development and accompaniment are very relevant in terms of the development of national frameworks for hydrometeorological services; not only because of its technical-scientific capabilities but also because of its relationship with the different sectors of users.
- Today, the private sector could have a high potential to become a significant vehicle for the generation of added value and as an alternative for the leverage and sustainability of the hydrometeorological value chain.

Organization, structure and resources

In terms of governance, the central figures have established legal frameworks that underpin their mandates and clearly identify their areas of attribution and functions. IMN - Law No. 5222 (meteorological field), ICE - Law No. 499 (hydrometeorological field for the electricity sector); IMHPA – Law No. 209 (hydrometeorological field).

¹⁹ In the case of Costa Rica, some of these institutions are: AyA, SENARA, DA-MINAE, UCR and UNA.

In the case of Panama, the following are identified: ACP, AAC, MiAmbiente, IDAAN, IDIAP; CONAGUA, as well as in the private sector, CORBANA.

²⁰ The institutions identified in this block include, for Costa Rica: UCR, UNA; for Panama: UTP; IG-UP; UNACHI; UMIP; STRI; and IDIAP; UCR and the Spanish State Meteorological Agency (AEMET); the International Centre for Research on the El Niño Phenomenon (CIIFEN) and CATHALAC.

²¹ In the case of Costa Rica, institutions such as MINAE, specifically DA-MINAE and DCC-MINAE; MAG; CNE; Governness; SENARA; MINSNA; ICT; MOPT; MIVAH, and MIDEPLAN.

In the case of Panama: ETESA, including market agents; SINAPROC; AAC; AMP, ACP; IDAAN; DSH-MiAmbiente; MEASURE; and SENA). On the other hand, institutions that require information, products and services in their planning processes, for study purposes, or simply as information integrators, such as: DCC-MiAmbiente; DIA-MiAmbiente; CONAGUA; DISAPAS-MINSNA; CONADES; CONALSED; and ATTT, among others. It is also important to recognize the institutions that play an important role at the regional level as receivers of information that in turn also have the capacity to generate products and services that feed back into national efforts, such as the WMO, the Regional Center for Water Resources (CRRH) and the Coordination Center for Disaster Prevention in Central America and the Dominican Republic (CEPRENAC).

In relation to the organizational and personnel structure, the IMN has a staff of 83 people, of which 60 of them make up the 4 departments that carry out technical-operational tasks. For its part, the ICE, within its hydrology area, has 54 officials plus 84 meteorological observers distributed in 5 technical-operational units. In both cases, the quality and capabilities of the staff constitute an important element that contributes to institutional recognition at the national and international levels; however, a deficiency or limitation is recognized in terms of its quantity to be able to face the operational loads. In the case of the IMHPA, at the beginning of its operations in 2022 it had only 42 people assigned to 4 technical-operational areas and a general directorate. While this organizational structure does not correspond to the new attributions and responsibilities of the IMHPA, the staff is also insufficient and with a strong requirement to complement their capacities and training in order to meet the needs of all sectors in Panama.

The current budget constraints at the government level in Costa Rica and Panama strongly affect the operations of the institutions, as well as the implementation of actions to strengthen them. The budgets of the IMN, ICE and IMHPA need to complement each other. Therefore, the development and implementation of an appropriate resource mobilization strategy that facilitates the implementation of the roadmaps is indispensable.

Observation networks

As mentioned above, observation networks are one of the priority elements that need to be strengthened to improve capacities for identifying and monitoring hydrometeorological and climatic hazards and for the development of early warning systems in both countries.

As for hydrometeorological observation stations, Costa Rica has a network made up of 797 stations in total, of which 82% correspond to meteorological stations and 18% to hydrological stations; a number that can be considered high considering that the country's surface is just over 50 thousand km²; however, Their distribution does not cover the entire territory and in many cases there is not adequate coverage at the basin level²². This network is complemented by 1 radiosonde station, 1 meteorological radar ([X-Band](#))²³ and 3 atmospheric discharge detection systems.

In the case of Panama, there is a network made up of 320 stations, complemented by 1 meteorological radar ([C-Band](#)), 1 wind profiler, 2 electrical discharge networks and information from satellite images. There are also 10 present-time sensors and 3 equipment for monitoring water quality; as well as an earth station for the reception and use of satellite images and products. The coverage of the observation network in the meteorological field covers the national territory and in the hydrological field it is limited since only those basins linked to electricity generation are instrumented.

One finding is the need for a comprehensive analysis and redesign of observation networks to modernize and strengthen them, in terms of coverage, operation, maintenance and calibration, as well as to implement new networks according to other particular needs (e.g. maritime observation).

²² Bastidas, M. (2019). Framework for action for the modernization of the national network of meteorological and hydrological stations and alternatives for its financial and institutional sustainability, UNESCO, September 2019.

²³ [An additional x-band radar is currently being installed.](#)

Data management and processing

A common element identified for both Costa Rica and Panama is related to the lack of a robust data management system at the national level, which ensures the integration of observation data from the different networks established in each country, as well as the derived data; that incorporates appropriate functionalities for the management and processing of data and metadata (including data quality and homogenization) and ensures the necessary capabilities and protocols for the exchange of information between institutions and the general public. Currently, the different national institutions use heterogeneous systems and high licensing costs, which not only hinders the exchange of information, but also makes its operation, maintenance and development of complementary capacities more expensive. On the other hand, none of the systems in operation are consistent with current WMO standards for hydrometeorological and climate database management systems.

Product generation and operating conditions

Key findings include:

- The workloads are too high and there are not enough staff to cover them. It is necessary to complement the staff of meteorologists and hydrologists and distribute tasks in a more efficient way. It is necessary to re-engineer the processes and products that are produced, based on current and future needs.
- The areas of Research and Development can accompany operational practice and focus on the automation of tasks and the development of tools for efficient operations. This can free staff from routine tasks to those of greater analysis and *expertise*. The development and implementation of a forecast verification system that feeds back into operational practice for the improvement of the different products is vital in all cases.
- The automation of processes and the development of tools (which are currently carried out manually) that support and facilitate operational practice is urgent in all areas of the IMHPA. In this same sense, it is necessary to develop and implement an Integrated Weather Forecasting System (SIPM).
- The development and implementation of quality management systems in: policies and objectives, operating manuals, documented procedures, work instructions and operational processes, and external reference documents (legal requirements, conventions, regulations, standards, codes, etc.)
- The strengthening of efforts and resources to have Early Warning Systems.
- Complement and strengthen the capacities of numerical modeling of weather, climate and water resources.

Dissemination of information and relations with users

This last link is of special importance and in both countries it is insufficient and complex. Dissemination in a timely manner, in accordance with the particular needs of users, implies the establishment of adequate communication channels that allow not only knowledge of the needs to be covered, but also the understanding of the information and the way in which it can be used by users.

In this regard, it is necessary to improve the institutional frameworks or schemes for the dissemination, exchange and supply of hydrometeorological services, since they do not facilitate and promote collaboration and the strengthening of national institutions related to

hydrometeorological and climate issues, as well as with sectoral and local users for the use of scientifically based hydrometeorological and climatic products and services.

Global Hydrometeorological Value Chain Assessment

In order to have a comprehensive view of the current situation of the hydrometeorological value chain, the capacities installed at the institutional level in each country were evaluated, based on 5 qualitative level and considering the 4 components of the chain.

The elements of the chain are:

(1) Observation Capabilities, which considers aspects related to the different monitoring networks; telecommunications; related operational practices and personnel involved. It includes the different types of meteorological and hydrological networks, their equipment and transmission capacities, their maintenance and calibration, as well as the consideration of the deficiencies and needs identified.

(2) Data and information management and processing capabilities, which considers aspects related to data quality and homogenization analysis and processes, derived data, metadata, systems linked to databases, and the personnel involved; quality management procedures and systems; as well as the deficiencies and needs identified.

(3) Product generation capabilities, which considers the different aspects related to the organization and execution of operational practice, procedures, systems and tasks related to product generation, including capabilities for numerical modeling and hydrometeorological and climate forecasting and EWS. The satisfaction of internal and third-party needs (where applicable) is also considered, as well as the deficiencies identified.

(4) Capacities for the provision of services, which considers aspects related to the dissemination of information, the evaluation of products and services and the satisfaction of internal and third-party needs (where applicable); the relations with users, agreements and protocols established, as well as deficiencies and identified needs.

The quantitative levels are:

- (1) Inadequate or insufficient or requires a third party = when the institution does not have the capabilities to meet the 4 components evaluated
- (2) Requires a lot of adequacies or strengthening = when the institution has very little capacity to meet the 4 components
- (3) Requires little adequacy or strengthening = when the institution has the capacity to meet all 4 components, but its products and services do not meet WMO standards
- (4) Sufficient or minimum adequacy = when the institution has the capacity to meet the 4 components and meets the minimum recommended by the WMO
- (5) Adequate or superfluous = when the institution generates multiple products and services beyond those recommended by the WMO

This qualitative assessment is made based on the integral hydrometeorological value chain, regardless of the attributions that each institution has according to its mandate. It is not intended to rate the performance or quality of the services and products generated, nor is it intended to prejudice whether or not an institution has an obligation to create, operate and maintain a measurement network and to do so in accordance with WMO norms and standards.

Costa Rica

Among the main findings (Table 1):

- Except for IMN and ICE, the other institutions contribute little to the value chain of generation of hydrometeorological information, products and services and are basically recipients of them.
- The problem of data exchange that affects all sectors was corroborated.
- The allocated budget and the human resources in charge are also a serious risk to the process of generating, processing and disseminating hydrometeorological information.

These findings confirm the need to move towards an integrated and coordinated management of institutional capacities in Costa Rica, in order to optimize resources and respond more efficiently to the growing demands for hydrometeorological information, products and services. The current approach, characterized by fragmented and isolated efforts, entails duplication of functions and an additional burden of human, material and temporal resources that are not contemplated in institutional budgets, which limits their sustainability.

COMPONENT	IMN	ICE	SENARA	AYA	DA-MINAE	UCR	UNA	CORBANA
Observation	3	4	1	1	1	1	1	2
Information Management	3	4	2	1	2	0	0	2
Product generation	2	4	2	2	2	0	0	2
Service Provision	2	4	1	1	1	0	0	2

Table 1. Qualitative Assessment of the Hydrometeorological Value Chain in Costa Rica.

In this context, the creation of a national hydrometeorological monitoring network is proposed as a priority. This network must integrate both the existing infrastructure and that required to achieve effective coverage of the national territory, accompanied by institutional arrangements and communication mechanisms that guarantee the timely and systematic exchange of data between relevant actors.

Particular attention should be paid to the management of hydrological data, products and services, which are currently not automatically shared between institutions. This situation reinforces the need to establish a national hydrological authority with clear competences in the matter.

In addition, it is necessary to strengthen the technical capacities of user institutions in the use and interpretation of hydrometeorological information, with the aim of generating products and services that support decision-making and sectoral planning in key areas such as agriculture, water resources, energy, health, disaster risk management and transport.

Panama

The findings are (Table 2):

- The institutional needs in Panama are confirmed, mainly associated with the lack of hydrometeorological data and products that allow the IMHPA itself and the user institutions

to fulfill their mandate and attributions (agriculture, water, energy, health, disaster risk management, transportation, etc.).

- It is a priority to provide the IMHPA with sufficient human resources to be able to face the responsibilities imposed on it by its creation law.
- Hence the priority of strengthening the IMHPA in terms of observation and provision of data, as well as management and processing of information and generation of products and services.
- The Law requires the implementation of the National Bank of Meteorological, Hydrological and Agrometeorological Data (BNDMHA) as the obligatory linking instrument to carry out an exchange of basic information regardless of the signing of possible collaboration agreements for specialized products and services. Its creation and operation is a priority, expanding the capabilities and functionalities of the DH-ETESA / IMHPA data.

The results of the analysis confirm that significant institutional gaps persist in Panama, especially in relation to the availability and accessibility of hydrometeorological data and information. This situation limits the ability of the Institute of Meteorology and Hydrology of Panama, Engineer Ovigildo Herrera Marcucci (IMHPA), as well as the user entities, to effectively fulfill their sectoral mandates in key areas such as agriculture, water management, energy, health, transport and disaster risk reduction.

COMPONENT	IMHPA	ACP	AAC	AMP	IDAAN	DSH-Environment	DCC-Environment	MIDA	Conagua	SINAPROC
Observation	3	4	2	1	1	1	1	2	1	1
Information Management	2	4	2	2	3	2	2	3	1	1
Product generation	2	4	2	1	3	2	2	2	1	1
Service Provision	2	4	2	1	3	2	2	2	1	2

Table 2 Qualitative Assessment of the Hydrometeorological Value Chain in Panama.

In this context, the strengthening of the IMHPA in its essential functions of observation, management and data processing, as well as in the generation of reliable and timely hydrometeorological products and services, is established as a strategic priority. The fulfillment of this objective will allow progress towards better institutional coordination and a greater capacity to respond to climatic and meteorological phenomena of impact.

A key element in achieving this goal is the effective implementation of the National Bank of Meteorological, Hydrological and Agrometeorological Data (BNDMHA), whose creation is mandated by law. This database is the mandatory mechanism for the exchange of basic technical information, regardless of the existence of additional agreements for specialized products. Its start-up and proper operation represents a priority action to expand the capacities of the national system, consolidating the data platform currently managed by DH-ETESA and IMHPA and

ensuring a timely and standardized flow of information among the actors in the hydrometeorological sector.

Roadmaps for the strengthening of hydrometeorological services: Costa Rica and Panama

Costa Rica

In the case of Costa Rica, 3 main and complementary objectives are identified, which in turn are linked to the three proposed lines of action (Figure 3).



Figure 3 Orientation of the roadmap in Costa Rica.

Each of these lines of action contains the activities to be developed for an estimated total amount of USD 64 million, to be implemented in 5 years (see Figure 4). The two complementary planning horizons: the short and medium term, comprise the first two years, and are aimed at ensuring the current operations of the institutions, establishing the basis for the creation of complementary capacities; and the long-term, between 3 and 5 years, focuses on strengthening the provision of products and services and developing the additional infrastructure required to meet the needs derived from the national adaptation and disaster risk management plans in force.



Figure 4 Components of the roadmap for strengthening the hydrometeorological value chain in Costa Rica.

Panamá

In the case of Panamá, 2 main and complementary objectives and four proposed lines of action are identified (Figure 5).



Figure 5 Orientation of the roadmap in Panamá.

Each of these lines of action contains the activities to be developed for an estimated total amount of USD 148 million to be executed over a period of 10 years (see Figure 15), taking into account 3 complementary horizons: short term (first two years), aimed at ensuring the functions currently performed by DH-ETESA; as well as establishing the bases for the creation and strengthening of complementary capacities and the improvement of its operations; in line with the different attributions that are established by Law; the medium term (between 3 and 5 years), is aimed at complementing the capacities and operations of the IMHPA in order to improve the quality and quantity of additional products and services designed according to the particular needs in various sectors and; Finally, the long-term (between 6 and 10 years) contains actions focused on strengthening the provision of products and services in the context of a national climate services policy²⁴.

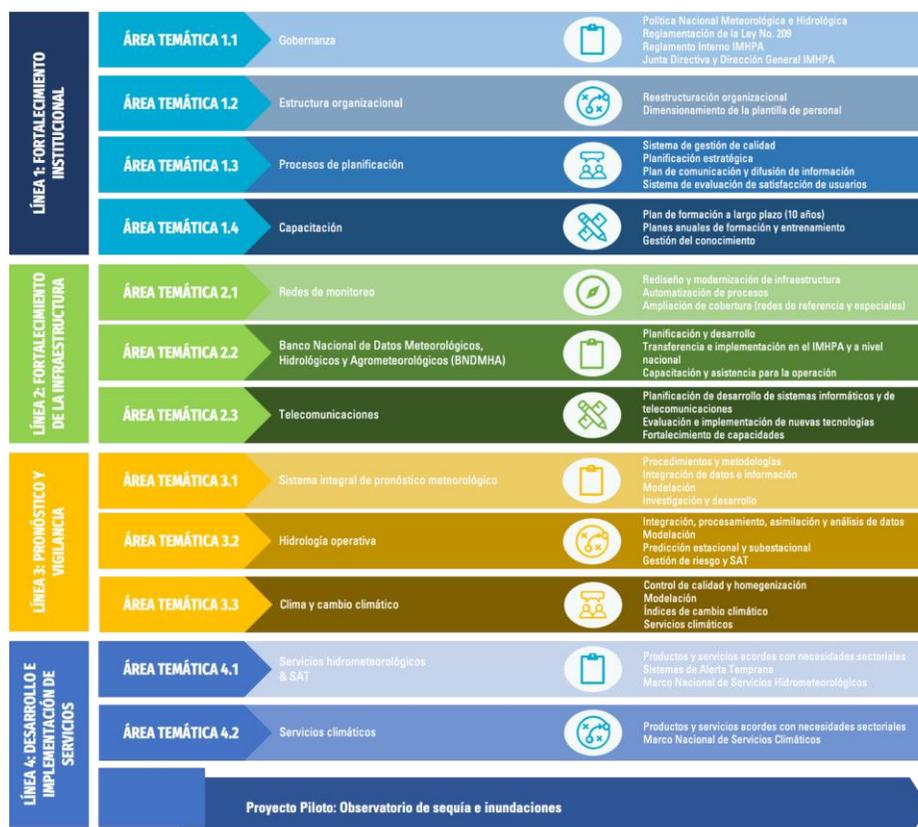


Figure 6 Components of the roadmap for strengthening the hydrometeorological value chain in Panama.

²⁴ The actions included here are closely linked to the improved capacities that will be worked on in the medium term, and which will be particularly linked to meeting the particular needs of users in various sectors, such as water, agriculture and food security, transport, disaster risk reduction and health, among others.

In addition, and to initiate the implementation of the second of the objectives, conceptual proposals and technical documents were made that were used internally in Panama for different decision-making processes. The following stand out:

- Proposal for a Legislative Regulation with the minimum elements necessary to ensure compliance with the powers conferred on the IMHPA, which was practically integrated in its entirety into the officially published Executive Decree²⁵. Contributions were made to Panama's National Meteorological and Hydrological Policy and were also incorporated as an integral part of the Regulations.
- Contributions to the Internal Regulations of the Board of Directors, approved in Board Resolution No. 1 and officially published in the Gaceta de Panamá²⁶.
- Analysis and proposal of technical-administrative structure, as a priority element of the IMHPA, as well as a dimensioning of the corresponding staff, including a description of the objective of each functional area and the personnel required in each case.
- Conceptual proposal for the development, operation and functioning of the National Bank of Meteorological, Hydrological and Agrometeorological Data.
- Proposal of procedure, ToR and evaluation criteria, for the selection of the general director of the IMHPA.
- Proposal of an induction course that facilitates the incorporation of new personnel into operations, which ensures a correct mechanism and relationships between its different areas, both technical and support

Priority elements and common institutional arrangements

The results of the evaluation and formation of roadmaps have made it possible to identify common elements for Costa Rica and Panama.

The urgent need to strengthen the observation and information management component is a priority in both cases. Likewise, the creation of national networks that favor the availability of data and information together with the development of national database management systems are priority elements to meet the needs of users.

With the same objective of building capacities for early warning adapted to the needs of users in different sectors, the development of a pilot initiative for the implementation of a drought and flood observatory at the regional level with an initial phase for both countries (Costa Rica and Panama) (Box 1) is proposed.

The main objective of the pilot project is to develop an analytical framework and methodology and implement monitoring and early warning (EAWT) technologies at the regional level considering their cost (installation and O&M), as well as the corresponding institutional and environmental implications.

Its implementation should produce for Costa Rica and Panama flood products and services useful to selected communities in basins, and drought products and services at the national and basin levels. The framework should consider the ability to sustainably maintain the operation and maintenance of the observatory, as well as react to warnings and alerts from all relevant stakeholders.

Box 1 Objective and general scope of the project to establish a regional drought and flood observatory.

²⁵ Executive Decree No. 2, which regulates Law No. 209. Gazette 29490 of March 8, 2022. <https://www.gacetaoficial.gob.pa/pdfTemp/29490/90517.pdf>

²⁶ Gazette 29498-B of March 18, 2022. https://www.gacetaoficial.gob.pa/pdfTemp/29498_B/90682.pdf

Annex 2 – Analysis of the priority basins for the project

Based on an analysis carried out by the main counterparts in Costa Rica (IMN and ICE) and Panama (IMHPA), the basins were prioritized in each case in order to identify those with the greatest feasibility of being selected for the execution of the pilot projects considered in the project.

The analysis carried out took into consideration several aspects, among which are:

- Historical impacts of droughts and floods on watersheds (loss and damage).
- Frequency of affectations
- Equipment deployed in the basin and information, studies, etc., that allow the development of information and services from these
- Potential for sustainability of the system over time, based on the main productive activities of the basin
- Basic basin governance
- Identification of sectors benefiting from information and knowledge
- Political importance and institutional visibility that the project would generate

The basins proposed for each case were finally reviewed and agreed upon in the context of the national consultation workshops that were held from February 11 to 14 in San José, Costa Rica, and from February 17 to 20, in Panama, Panama. In the case of Costa Rica, the validation was done with the institutions of CONAHYME and the CNE, while in Panama the validation was done with several actors related to the use of hydrometeorological information provided by the IMHPA (MiAmbiente, MIDA, ACP, IDAAN, SINAPROC, among others).

COSTA RICA

In the case of Costa Rica, two basins were selected: Tempisque River and Pirris-Parrita-Candelaria River.

Tempisque River

The Tempisque River basin **is located** on the Pacific Slope. This basin has an area of 3,354.83 km², which represents 6.56% of the national surface, it is made up of the confluence of the Tempisquito and Ahogados rivers.

The **delimitation of the basin** is located between the plane coordinates 232,300 - 328,800 north latitude and 340,900 - 400,175 west longitude. *Table 3* shows the main dimensions of the basin.

Eight different cantons are delimited within the basin, with the canton of Liberia covering the largest area with 1,337.65 km², followed by Santa Cruz and Carrillo with 650.84 and 509.08 km², respectively.

VARIABLE	DIMENSION
Area	3,382.07 km ²
Perimeter	365.41 km
Compactness index	1.76
Form factor	0.56
Maximum altitude	1,900 m.s.n.m
Minimum altitude	0 m.s.n.m
Average altitude	169.4 m.s.n.m
Channel length	142.19 km
Average channel slope	3.87 %
Average basin slope	10.29%

Table 3. Geographical dimensions of the Tempisque River basin (Costa Rica).

For the middle part of the basin, the classification becomes of the **tropical humid forest** type, approximately 75% of the lower part of the basin is covered by the life zone classified as **premontane humid forest transition to basal**, the remaining 25% is covered with classifications of the **tropical dry forest type and transition to humid**, as well as tropical humid forest transition to dry, tropical humid forest and transition to dry, finally in the coastal area or mouth of the Tempisque river bed in the Gulf of Nicoya, the classification is of the **premontane humid forest transition to basal type**.

In this basin, the typical climatic feature is the presence of a **Pacific precipitation regime**, which is characterized by a well-defined dry and rainy season.

The **dry season** is normally recorded between mid-December and April and the rainy season begins in May and ends in November. With a relative decrease in the amount of precipitation in the months of July and August that is known as "veranillo" and that they experience a water deficit in some years.

The **average annual rainfall** ranges from 1,500 to 4,000 mm, with an annual average of 1,500 to 3,000 mm in the upper parts, 1,500 to 2,000 mm in the middle of the area and 1,500 to 3,000 mm in the lower part. The months of September and October are usually the rainiest, contributing approximately 23% and 21%, respectively, of the average annual rainfall. The driest months are usually January and February. An annual average of 105 days with rain is recorded in this basin, with a dry season of five to six months (Station: Liberia, IMN).

The **average annual temperature** in the upper part of the basin is 22 to 24 °C, in the middle part it is 26 to 28 °C and in the lower part of 28 °C, there is an appreciable oscillation of approximately (12°C) in any month between the maximum and minimum temperature of the day. (Climatological Atlas, IMN, 2009).

Annual **evapotranspiration** in the upper part is between 1,200 and 1,300 mm, in the middle part 1,900 to 2,000 mm and in the lower part 1,600 to 1,900 mm.

The **average annual sunshine** in the upper part of the basin is 3 to 4 hours, in the middle and lower part of the basin 6 to 7 hours.

The basin, under a normal climate scenario, has a **water supply** of 8,052.22 hm³/year. The data on the flow granted and the percentage distribution by water use in the basin are presented in *Table 4*.

USE	FLOW (l/s)	PERCENTAGE
Commercial	2.15	0.01
Human consumption	35.47	0.13
Industrial	45.24	0.16
Tourism	131.18	0.47
Agricultural	278.82	0.99
Aqueducts	1,001.26	3.57
Agro-industrial	4,710.00	16.78
Irrigation	21,869.16	77.90
TOTAL	28,073.28	

Table 4. Flow granted by use in the Tempisque River basin (Costa Rica).

The **main productive and economic activities** in the area correspond to the cultivation of sugar cane, rice, grass, melon and watermelon, the latter two for export.

Tourism development within the basin area has been really thriving in the area in the last decade. Extensive livestock farming is very important in the area due to the plain topography of the basin.

Pirris-Parrita-Candelaria River

The Parrita River is a river in Costa Rica, belonging to the Pacific Slope. It is a short but plentiful river located in the Central Pacific of the country. It is born from the confluence of the Pirris and Grande de Candelaria rivers, at the height of Bijagual de Acosta, with the name of Parritilla river.

The Parrita River basin **is located** on the Pacific Slope. This basin has a drainage area of 1,288.60 km², which corresponds to 2.52% of the national surface. The delimitation of the basin is located between the plane coordinates 163,700 - 208,000 north latitude and 491,200 - 553,500 west longitude. *Table 5* shows the main dimensions of the basin.

Thirteen **cantons** are located within the limits of the basin, with Acosta being the largest with 341.72 km² (26.52% of the basin), followed by Puriscal (14.3%), Aserrí (10.7%), Dota (9.7%) and León Cortes (9.5%), as the main ones.

VARIABLE	DIMENSION
Area	1,273.35 km ²
Perimeter	207.31 km
Compactness index	1.61
Form factor	1.29
Maximum altitude	3,140 m.s.n.m
Minimum altitude	0.0 m.s.n.m
Average altitude	1,167.4 m.s.n.m
Channel length	97.46 km
Average channel slope	19.11 %
Average basin slope	39.76 %

Table 5. Geographical dimensions of the Parrita River basin (Costa Rica).

This basin has a fairly undulating topography **in its upper and middle part**, the highest part is located in the foothills of Cerro Vueltas, where the riverbeds of the Pirris and Pedregoso rivers originate. The elevation range at this point is between 2,400 and 3,140 m.a.s.l.

The upper part of the basin is located between 1,400 and 3,140 m.a.s.l., with the middle basin extending from 700 to 1,400 m.a.s.l. The lower part of the basin is in the range between 0 and 700 m.a.s.l.

In **hydrographic terms**, the Parrita River basin is irrigated at its source by the Pirris River, which is joined by the Grande de Candelaria River and the Surubres, Tigrillo, Pilas, Palma, Bijagual, Sardinal and Cacao streams. These streams are born in the canton of Parrita, on the slope of the Surubres and Aguacate rows; whose waters run from northeast to southwest and from northwest to southeast; the Pirris River runs from north to south. The Ortega lagoons are also found in the area (see *Figure 8*).

In the lower part of the basin there is part of the Parrita aquifer (average flow 1-10 l/s, thickness 20 m).

The **general geology** of the basin shows intrusive, volcanic and pyroclastic igneous rocks from the Miocene, as well as sedimentary platform rocks from the Oligocene and Miocene and shallow marine from the Miocene. In the middle part there are sedimentary rocks from the continental slope (Paleocene-Eocene and Oligocene), shelf (Eocene-Oligocene) and shallow marine rocks (Miocene), as well as intrusive igneous rocks (Upper Cretaceous) and submarine rocks (Upper Cretaceous-Eocene). While the lower part has Plio-Pleistocene continental and shallow marine sedimentary rocks and Holocene transition.

The **dry season** usually occurs from December to April and the rainy season begins in May and ends in November. With a relative decrease in the amount of precipitation in the months of July and August that is known as "veranillo" and that they experience a water deficit in some years.

The **average annual rainfall** ranges from 1,500 to 3,000 mm in the upper part, from 3,000 to 4,000 mm in the middle part and from 4,000 to 5,000 mm in the lower part of the basin. The months of September and October are usually the rainiest, contributing approximately 14% and 18%, respectively, of the average annual rainfall.

In the dry season, on average, rainfall of less than 50 mm is recorded, although there are years with zero millimeters of rainfall. An annual average of 161 days with rain is recorded in this basin, with a dry season of four months (Station: Parrita, IMN)

The **average annual temperature** is between 16 to 18 °C in the upper part, between 18 to 26 °C in the middle part and 28 °C in the lower part of the basin, if there is an appreciable oscillation of approximately (12°C) in any month between the maximum and minimum temperature of the day. (Climatological Atlas, IMN, 2009).

Annual **evapotranspiration** in the upper part of the basin is 900 mm, in the middle part 1,100 to 1,200 mm and in the lower part of the basin from 1,300 to 1,400 mm.

The **average annual sunshine** in the upper part of the basin is 4 to 5 hours, in the middle and lower part it is 5 to 6 hours of sunshine.

In terms of water supply, the basin under a normal climate scenario has a water supply of 1,526.77 hm³/year.

The data on the flow granted and the percentage distribution by water use in the basin are presented in *Table 6*.

USE	FLOW (l/s)	PERCENTAGE
Industrial	0.06	0.002
Commercial	0.45	0.01
Tourism	12.72	0.42
Human consumption	52.98	1.75
Agricultural	60.30	1.99
Agro-industrial	226.68	7.47
Irrigation	1,335.71	44.02
Aqueduct	1,345.32	44.34
TOTAL	3,034.23	

Table 6. Flow granted by use in the Parrita River basin (Costa Rica).

In terms of **socio-economic activities**, agricultural activity is predominant, with African palm as its main product, followed by rice, and to a lesser extent pineapple for export. Another of the activities that take place in the area is livestock, in addition to tourism.

The project will also use the more detailed basin analyses prepared by the IMN, the Tempisque River Basin Study²⁷ and the Parrita River Basin Study²⁸.

²⁷ [EstudioCuencas-cuencaRioTempisque.pdf](#)

²⁸ [EstudioCuencas-cuencaRioParrita.pdf](#)

PANAMA

In the case of Panama, two basins were selected: La Villa River and Tonosí River.

La Villa River (watershed 128)

The La Villa River Basin **is located** in the Azuero Peninsula between 7°51'00" North longitude and 80°33'30" West longitude, in the province of Herrera and Los Santos, with an area of 60,166.9 ha, its limits correspond to the provinces of Coclé, Los Santos and Veraguas, it is located in the districts of Chitré, Pesé, Las Minas, Los Pozos and Macaracas. It is located in the region known as "ARCO SECO", it includes a large portion of the territories included in the lower basin (< 700 meters above sea level) of the basins of the Guararé rivers in the province of Los Santos; La Villa, Parita and Santa María rivers in the province of Herrera; Rio Grande and Antón in the province of Coclé. The Dry Arc region has a tropical savannah climate and an average annual rainfall of 1,054 mm.

In the La Villa River basin, **low and intermediate slopes predominate**. The basin has an intermediate level of vulnerability, with a valuation of 56%.

Within the 1284.3 km² of the basin, in the low and medium slopes, the **development of various agricultural activities** such as rice, corn and sugar cane crops were identified. On the other hand, in the lower part of the basin, ponds for aquaculture, salt mines, mangrove forest, rocky outcrop and water surfaces were recorded.

The districts of Chitré and Los Santos are the ones with the highest degree of **vulnerability**, while the townships of Santa Ana, San Juan Bautista, Llano Bonito, Las Cabras and Sabana Grande have the highest number of floods recorded.

The consideration of the La Villa River basin (128) is based on the **impacts that frequently occur in this region due to drought or floods**. This basin extends over about 1,284.3 km² and about 117 km in length, mainly formed by the La Villa River, a peninsular river in the provinces of Herrera and Los Santos. It is the largest river by length of the Azuero Peninsula; and the eighth longest river in the Republic of Panama.

In the **rainy season, periods of drought of up to 20 days are shown**. The longest periods of drought have occurred coincidentally with the appearance of the El Niño phenomenon. This in the Dry Arc, directly affects agricultural activities, aquaculture, fishing, hydroelectric energy production, human health and indirectly the industrial and service sectors. Particularly in agriculture and livestock, El Niño has resulted in millions of dollars in losses in the last 20 years²⁹.

In its journey through Azuero from west to east, the La Villa River Basin, within the basin there are 8 districts: Chitré, Los Santos, Los Pozos, Las Minas, Pesé, Macaracas and small sections of Mariato and Las Tablas, constituting the main source of drinking water for some **162,076 people** (see *Table 7*).

Much of the **topography** is characterized by being predominated by low slopes 0°-5° and intermediate slopes 10°-15° and medium-high slopes 15°-20°. The highest slopes of 25°-30° are concentrated in the districts of Los Pozos, Las Minas, and the small sections of Mariato and Las Tablas.

²⁹ <https://sig-idaan.hub.arcgis.com/apps/0a722564d72f421798b33b902ebef781/explore>

In relation to the **availability of water**, given the precipitation in the basin (see *Figure 10*) there should not be an imbalance in the amount of water for its different uses, however the lack of vegetation cover (forest) decreases retention, detention and infiltration, generating a very high runoff, with the consequent discharge of the basin. limiting the possibilities of regulating winter flows. In addition, there is no policy on the protection of water recharge areas, nor the efficient management of water use. Consequently, the quality and quantity of water will be a determining factor in guaranteeing economic and social development, harmonized with the environment. The hydrological balance data are shown in Table 6.

The La Villa River basin has three **priority uses**: agricultural use, agroforestry systems, and forest management and conservation. Livestock is important, hence a large part of the territory is covered by natural pastures (also in stubble), which can be improved with silvo-pastoral systems. Agriculture is also important because of its exports and traditional agricultural production, the latter of which can be improved with agroforestry systems³.

DISTRICT	INHABITANTS
Chitre	60,957
Macaracas	8,965
Las Minas	6,642
Los Pozos	6,928
Pesé	13,009
Los Santos	30,028
Las Tablas	30,440
Mariato	5,791
TOTAL	162,076

Table 7. Population by district in the La Villa River Basin (Panama)³⁰.

HYDROLOGICAL REGION	AREA (km ²)	P (mm)	ETP (mm)	ETR (mm)	R (mm)	Q (m ³ /s)	q (lt/km ²)
Quebrada Piedras-río La Villa	251.3	2,348	1,118	1,024.7	1,323	10.6	42
Río Gato	160.4	1,999	1,139	1,023.2	976	5.0	30.9
Río Tebarito	85.8	2,111	1,144	1,041.0	1,070	2.9	33.9
Quebrada Salitre-río La Villa	119.7	1,666	1,171	983.5	683	2.6	21.6
Quebrada Salitre	35.0	1,665	1,151	970.9	694	0.8	22.0
Río Esquiguita	84.3	1,696	1,164	984.0	712	1.9	22.6
Río Estibaná	296.1	1,849	1,172	1,015.7	833	7.8	26.4
Quebrada Pesé-Río La Villa	107.7	1,446	1,194	948.2	497	1.7	15.8
Quebrada Pesé*	44.0	1,502	1,188	968.7	533	0.7	16.9
Quebrada Grande	68.5	1,320	1,200	864.0	456	1.0	14.5
Río La Villa (Lower basin)	121.7	1,103	1,101	793.1	310	1.2	9.8
Quebrada Rabéelo y Las Guabas	16.5	1,100	1,200	864.0	236	0.1	7.5

Table 8. Surface hydrological balance of the La Villa River basin (Panama). MiAmbiente³¹.

In terms of **forest cover and land use** in 2021, the main problem of the Dry Arc is environmental degradation, which has been induced by the misuse of natural resources. This results in the loss of the productive capacity of the soil and its degradation, due to anthropogenic causes such as migratory subsistence agriculture, with unsustainable agricultural and livestock practices. At present, a large part of this territory is covered by natural grass pastures, used in extensive

³⁰ Prepared with 2023 data from the National Institute of Statistics and Census (INEC).

³¹ <https://cuencas.miambiente.gob.pa/wp-content/uploads/2020/08/Plan-de-Ordenamiento-Territorial-Ambiental-R%C3%8DO-LA-VILLA.pdf>

livestock activities and the same amount in agricultural planting activities, mainly rice, beans, and corn.



Figure 9 Planted and harvested area, years 2011/2012 – 2022/2023. **Source**

The main **vulnerability** of a biophysical nature is related to the lack of permanent vegetation cover in the basin, its steep slopes in the upper part, the types of soils concentrated in protection and conservation, as well as climate variability **generate the possibility of suffering impacts such as drought and floods**.

In accordance with the National Environmental Strategy (1999), the **protection of the environment in priority territories stands out, among which the La Villa River basin stands out**, as well as the Diagnosis of Critical Areas Affected by Severe Drought and Desertification in Panama (2004), recognizes that in the basins of the Dry Arc there is a **severe reduction in the productivity of soil and water** resources, which is expressed in the drop in agricultural and livestock yields, soil degradation, decrease in surface and groundwater, and in general, loss of biological diversity. Likewise, the First National Communication on Climate Change (2000), for the Dry Arc, indicates yields below what was expected according to the scenario models used. Likewise, the Policy Guidelines of the National Environmental Authority 2004-2009 highlight the need to promote the country's environmental territorial planning as an immediate action for the integrated management of water resources, among others³.

The La Villa River basin is considered one of the highest priority basins for climate change adaptation in Panama, according to the "Analysis of climate anomalies for the La Villa River basin, Panama, based on RCP scenarios".³² The difference between current climatic conditions and those projected by the models, known as climatic anomalies, showed that **by the years 2050 and 2070, precipitation in the Azuero area will increase on an annual average**, since the monthly rainfall trend for a given period has been as follows (Figure 10):

³² <https://ridda2.utp.ac.pa/handle/123456789/13107>

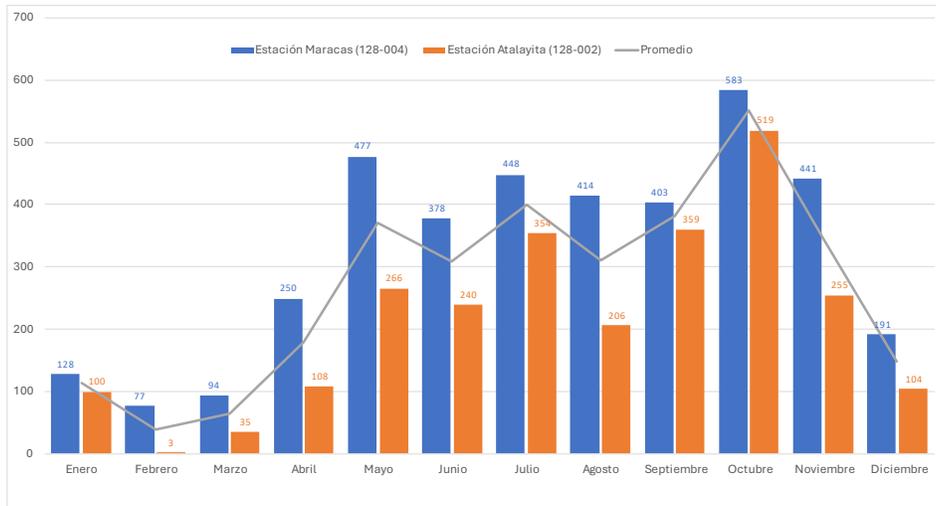


Figure 10 Average annual rainfall in the La Villa River basin (Panama). IMHPA, 2025.

On the other hand, **maximum and minimum temperatures** will increase on average by 1-2 °C, and close to 4°C by the end of the 21st century. Both climatic conditions will considerably change food production in this region of the country.

According to a scientific study carried out in the area in 2020, with data from the IMHPA, **predictions on climate change** suggest that extreme events, such as **torrential rains**, could occur more frequently and with greater intensity in the coming years. This, together with the population growth that is taking place within the areas surrounding the riverbed, contributes to the **risk factor for flooding** and increases the social and economic impact caused by these events³³.

The flood **risk** level along the basin covers 56% of the area and presents an intermediate risk level when there is intense rainfall in the rainy season. Many of these lands are used for extensive cattle ranching, production crops such as corn, rice and sugar cane, in addition to housing settlements. While 32% represent the areas of lower risk, this is due to the high slopes of the terrain.

The location of the main threats and the areas vulnerable to risks due to natural phenomena or anthropic and technological actions, as well as the appropriate mechanisms to reduce their vulnerability and safeguard the life and safety of the population: **the main threats that have been identified are pollution, floods, droughts and landslides**. It is estimated that the landslide and flood zones add up to a total of 19,990 hectares, located in a dispersed manner throughout the

³³ <https://www.senacyt.gob.pa/joven-investigador-identifica-zonas-vulnerables-a-inundacion-en-la-cuenca-baja-del-rio-la-villa/>

basin. As for the areas threatened by drought, it is also presented, quantifying in the figure of 74,000 hectares^{34,35,36}.

Río Tonosí (watershed 124)

The Tonosí River **basin** assigned with the number 124, granted by the Central American Hydrometeorological Project (PHCA, 1967 – 1972), is one of the 34 hydrographic basins nationwide that converge its waters to the Pacific Ocean. It is the peninsular basin of the homonymous river, it has a total area of about 1355 km², with a length of 91 km the Tonosí river is the main river of the basin. In this basin is the district of Tonosí.

It is **located** southwest of the province of Los Santos, (south of the Azuero Peninsula), that is, it is geographically located, north of the Earth's equator and in the western area of the Greenwich meridian, between latitudes and longitudes: north latitude: 7° 19' 42" – 7° 35' 57" and west longitude: 80° 21' 55" – 80° 43' 42". This basin drains in a southeasterly direction, crossing the Tonosí valley with an average slope of 2.03% and an average elevation of 293 meters above sea level. Its highest elevation is 850 m a.s.l. (see

Figure 11).

The Tonosí River basin **has** the following hydrographic limits:

- To the north: hydrographic basin N°128 La Villa River.
- To the south: hydrographic basin N° 122 rivers between the San Pedro and the Tonosí.
- To the east: hydrographic basin No. 126 rivers between the Tonosí and La Villa.
- To the west: hydrographic basin No. 122 rivers between the San Pedro and the Tonosí.



³⁴ <http://cuencas.cathalac.int/cuencas/cuencas-prioritarias/rio-la-villa>

³⁵ <https://cuencas.miambiente.gob.pa/wp-content/uploads/2020/08/Plan-de-Ordenamiento-Territorial-Ambiental-R%C3%8DO-LA-VILLA.pdf>

³⁶ <https://storymaps.arcgis.com/stories/7879c4dd8f914b9da69f6bf1ee8e3f94>

Figure 11 Tonosí River Basin (Panama). IMHPA, 2025.

This area is surrounded by **protected areas** including the Refugio de Vida Silvestre El Peñón de La Honda, the Coastal Zone Protected Area of the Corregimiento de La Enea, the Coastal Zone Protected Area of the Corregimiento de El Espinal, the Pablo Arturo Barrios Wildlife Refuge, the Isla Iguana Wildlife Refuge and the Forest Reserve. Animal and Fluvial or Cerro Canajagua National Park.

Topographically, the region is divided into two distinctive parts: the valley and the highlands that separate it from the central plains and that for centuries functioned as natural barriers to the colonization of the former. The mountainous periphery that isolates the valley is composed of two chains of high hills. To the west is the western chain of Azuero that crosses the peninsula from north to south and where Mount Cambutal, with 1400 meters is the highest elevation. To the north and east rises the Canajagua massif, a mountainous branch that detaches from the western chain. In this second chain, the highest elevations are those of Cerro Quema (950 meters) and Cerro Canajagua (830 meters), (Heckadon – Moreno 2006).

One of the most attractive natural characteristics that Tonosí has is that it rains more than other parts of the Azuero Peninsula. The **average annual rainfall** is 2220 millimeters, while in the rest of the province it is only 1500 millimeters. The higher humidity of Tonosí is due to the mountains that trap the humid winds of the Pacific on their journey north. However, the rainfall is poorly distributed and the rains are heaviest in a short period from September to November, causing flooding in the lowlands.

The **rains** are collected by a dense network of short rivers and streams that originate in the western chain and the Canajagua massif and that, after crossing the valley, spill their waters into the Pacific. Although in the summer, the flow of most rivers and streams decreases considerably, they do not dry up as in other parts of Los Santos and Herrera. The Tonosian rivers are not navigable, except for small boats and for short distances near their mouths.

The main tributaries of the **hydrographic network** of the Tonosí River basin:

- Río Güera, which is considered a secondary hydrographic unit (sub-basin), covers an area of 338,474 km² with a perimeter of 115,569 km. It represents 46,519% of the total area of the basin and is considered the sub-basin with the largest occupied area. Its main channel is born at 564 meters above sea level with a length of 38,473 km and its drainage network is of order six. The Güera River is divided into six tertiary hydrographic units made up of five micro-basins and one inter-basin, which are described below:
 - Quema River: This tributary, considered a micro-basin, covers an area of 84,873 km² with a perimeter of 55,768 km. It represents 11,664% of the total area of the Tonosí river basin. Its main channel is born at 499 meters above sea level with a length of 24,477 km and an average slope of 1,601 %. In addition, its drainage network is of order five.
 - Güerita River: This tributary, considered a micro-basin, covers an area of 40,788 km² with a perimeter of 37,924 km. It represents 81,5,606 % of the total area of the Tonosí river basin. Its main channel is born at 392 meters above sea level with a length of 17,139 km and an average slope of 1,273 %. In addition, its drainage network is of order four.

- Tolu River: This tributary, considered a micro-basin, covers an area of 45,677 km² with a perimeter of 33,504 km. It represents 6,278% of the total area of the Tonosí river basin. Its main channel is born at 670 meters above sea level with a length of 15,011 km and an average slope of 1,257 %. In addition, its drainage network is of order four.
- Güera Occidental River: This tributary considered a micro-basin, covers an area of 46,931 km² with a perimeter of 40,683 km. It represents 6,450% of the total area of the Tonosí river basin. Its main channel is born at 564 meters above sea level with a length of 18,447 km and an average slope of 1,296 %. In addition, its drainage network is of order four.
- Marroquín River: This tributary considered a micro-basin, covers an area of 40,737 km² with a perimeter of 35,746 km. It represents 5,599% of the total area of the Tonosí river basin. Its main channel is born at 707 meters above sea level with a length of 17,309 km and an average slope of 1,610 %. In addition, its drainage network is of order four. Ø Güera Oriental Inter-basin: this hydrographic unit considered as an inter-basin receives the waters or drainage of the five micro-basins mentioned above. It covers an area of 79,468 km², which represents 10,922% of the total area of the Tonosí river basin. 82 Guaniquito River The Guaniquito River, considered as a secondary hydrographic unit (sub-basin), covers an area of 193,290 km² with a perimeter of 78,276 km. It represents 26,565 % of the total area of the Tonosí river basin. Its main channel begins at 756 meters above sea level with a length of 29,596 km and its drainage network is of order five. The main tributaries to mention in this sub-basin are: Qda. Marroquinillo, Qda. Los Chigueros, Qda. La Pintada, Qda. La Zapatoza and others.

Another fundamental natural resource that conditions the agricultural activities of a population is the **soil**. In this sense, Azuero is poor because red soils with a clayey texture and moderate to low fertility predominate. These soils are easily eroded once the vegetation layer is destroyed. Ironically, almost three-quarters of the region's fertile alluvial soils are concentrated in Tonosí (Heckadon – Moreno 2006).

Linked to **socio-productive activities**, and according to the Gorgas Memorial Institute for Health Studies, this basin is strongly intervened by agricultural activities, especially extensive livestock and mechanized rice cultivation. Poor agricultural practices have an impact on the health of watersheds and the population that inhabits them. On the one hand, there is the elimination of vegetation cover for agricultural expansion and the excessive use of pesticides that cause the loss of habitats and diversity of aquatic fauna and contaminate water sources, limiting their use for human consumption. On the other hand, human exposure to environmental pollution by pesticides can occur due to the ingestion of contaminated food and water and continuous exposure can cause diseases such as cancer, damage to the reproductive system, nervous system and other functions of the body³⁷.

The provinces of Coclé, Herrera and Los Santos contribute approximately 5.2% of the country's Gross Domestic Product according to data from 2020, accumulating for that year a total of

³⁷ https://cieez.gorgas.gob.pa/?page_id=2176

B./1,836,628,000 between the three provinces. Out of a large national total of B./ 35,319,749,000 The Province of Coclé generated 2.6%, Herrera 1.5% and Los Santos 1.1%.³⁸

Table 9 shows some of the most important crops in the provinces of the Arco Seco and that generate concerns from authorities and producers that have already been externalized and are being translated into prevention measures such as the Drought Plans of the Ministry of Environment and the Ministry of Agricultural Development.

Rubro	Total País	Total Arco seco	% Arco seco	Venta Arco seco	% Venta Arco Seco
Melón (Unidad)	2,666,010	2,597,427	97.4	2,561,739	99.0
Sandía (Unidad)	6,294,603	4,039,088	64.17	3,952,803	97.8
Tomate Industrial (quintal)	173,962	149,388	85.8	147,259	99.0
Tomate de mesa (quintal)	103,819	20,711	20.0	19,252	92.9
Arroz en cáscara. Quintal	6,063,159	2,364,150	38.5	1,975,627	83.5
Naranja de jugo (ciento)	1,828,276	515,821	38.9	439,548	85.2
Maíz seco (quintal)	1,297,614	911,406	70.24	680.780	74.7
Maíz Mazorca (ciento)	866,523	176,964	20.0	55,034	31.1
Papaya (unidad)	1,267,629	392,829	31.0	196,912	47.6
Limón (ciento)	278,450	103,368	37.1	68,774	66.5

Table 9. Crops of greatest relevance in the provinces of the Arco Seco (Panama). OPRA, 2023³⁹.

The soils of the Tonosí River basin are classified or grouped into four classes, according to the USDA agrological class evaluation system, taking into account the following parameters and variables necessary for their evaluation:

- (1) pendiente,
- (2) erosión,
- (3) características físicas y químicas del suelo,
- (4) drenaje,
- (5) clima y otros.

The four types of soil present in the Tonosí River basin are described below (Morales 1998, IGNTG 2007):

³⁸ <https://observapanama.com/el-arco-seco-y-la-estacion-seca-2024>

³⁹ <https://observapanama.com/el-arco-seco-y-la-estacion-seca-2024/>

Class II flooring. Class II soils represent 9,613% (69,944 km²) of the total area of the basin, which are located in the central and southeastern sectors of the basin, specifically in the plains or floodplains of the Tonosí River. Additionally, these soils are located at elevations below 100 meters above sea level with slopes that do not exceed 3.00 %. These soils are native to the river plains, are arable with few limitations that restrict their use and have an agricultural vocation for rice, corn, mainly. Their texture is fine clay, they are flat, very deep, non-erodible, without stones, it has brown colors on the surface, in more humid areas the subsoil is grayish and they are considered the most fertile soils in the basin and the province of Los Santos.

Class IV soils Class IV soils represent 3,504% (25,497 km²) of the total area of the basin, which are located to the north and southeast of the basin. These soils located at elevations below 400 meters above sea level, originate from old fluvial terraces and others of limestone, and are from the Eocene and Oligocene formations. They are arable, with strong limitations alone or in combination, which restrict their use to semi-permanent and permanent vegetation, and require very careful management or both. Additionally, these soils are well to moderately drained, they are deep, except for limestone soils that are of moderate depth and stony.

Class VI soils. Class VI soils represent 21,909 % (159,408 km²) of the total area of the basin, which are located in the central and southeastern sectors of the basin. These soils located at elevations below 400 meters above sea level, are originated from sedimentary stone, fluvial terraces and extrusive igneous rocks. They are not arable, with severe limitations, suitable for pastures, forests, reserve lands, they are widely used for livestock, in which overgrazing, burning and erosion keep these soils among the most degraded in the basin and in the province of Los Santos, in addition to being very fragile (susceptibility to degradation). and they require intensive soil and water management and conservation practices.

Class VII soils Class VII soils, considered as the class of use capacity with the largest occupied area in the basin, represent 64,974 % (472,759 km²) of the total area. These soils, located in various sectors of the basin and located at elevations from 200 to 1400 meters above sea level, are not arable, have very severe limitations, and are suitable for forests, reserve lands and protection of watersheds. They are generally reddish clayey and partly stony, where the processes of physical and chemical weathering interact on the bedrock and originate in zonal soils, of the ferrasols group. They are extremely acidic, low in base exchange capacity and extremely deficient in all plant nutrients and very heavy in texture. Once the region is deforested, the soils are totally sterile, therefore, it is not a soil for agricultural purposes of any kind, but a forest environment. Half of the area of the basin is dedicated to livestock activity (agricultural use). The forest cover, considered as the second group with the largest occupied area with 28,033% (203,965 km²) of the total basin, is made up of the following categories:

- (1) natural forest,
- (2) secondary forest,
- (3) mangrove forest,
- (4) planted coniferous forest,
- (5) Planted broadleaf forest.

It is important to point out that the forest cover index of 28,033%, from the hydrological point of view, is very negative, since the processes of regulation and storage of runoff that occur in the

basin for the different times of the year, are not carried out in the best way due to the low forest cover.

Basin No. 124 concentrates the township of Tonosí, which historically is one of the townships with the highest levels of flooding nationwide.

AFECTACIONES

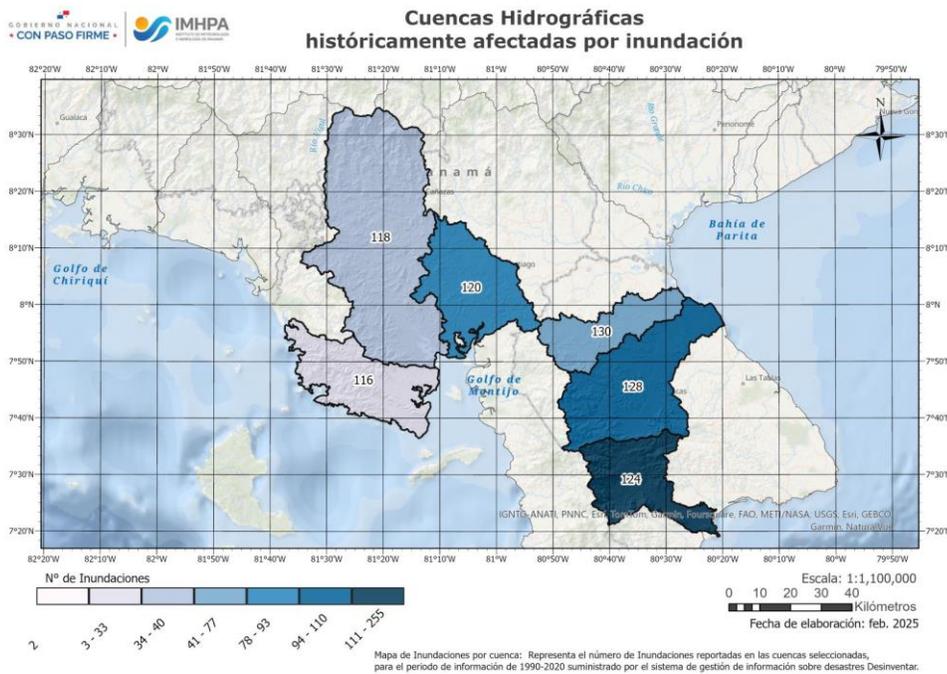


Figure 12 Watersheds historically affected by flooding. IMHPA, 2025.

According to data from the National Civil Protection System (SINAPROC) in the period 1930-2024, flooding events were reported in 67 districts of the country, with Panama, Tonosí and La Chorrera being among the most affected historically, followed by Chepo, Colón, David and Arraiján. Based on those data, IMHPA prepared a map focusing on six basins historically affected by flooding, which shows the selected two basins (La Villa and Tonosí, number 128 and 124 respectively) as the most affected (see Figure 6).

According to the Standardized Precipitation Index (SPI), during the presence of El Niño 2023, a meteorological drought situation (SPI 6) occurred. The selected basins 128 and 124 were in a very dry situation (see Figure 13).

Índice Estandarizado de Precipitación (SPI) de marzo a agosto 2023

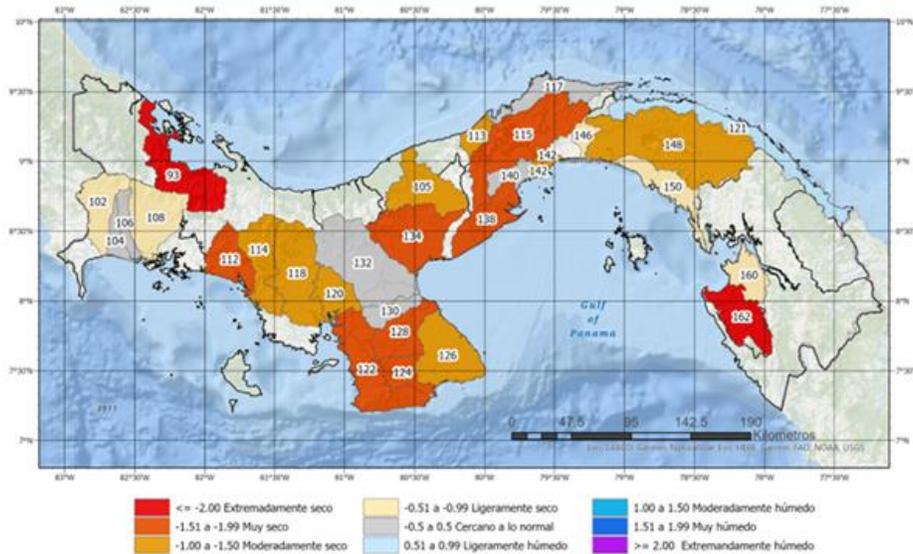


Figure 13 Standardized Precipitation Index (March to August 2023).

TRANSBOUNDARY BASIN

In the context of the project and given its relevance and transboundary nature, the Sixaola river basin has also been selected.

The Sixaola River basin is a **transboundary region shared between Costa Rica and Panama** where an important environmental continuity can be observed, as well as a cultural homogeneity typical of the Caribbean slope of the Central American region. The cultural proximity is the result of a common history of banana enclave and isolation that forged, despite specific conflicts, an environment conducive to cooperation.

The Sixaola River **delimits** the part of the border between Panama and Costa Rica that is located on the Caribbean slope. This river is born in the mountains of Talamanca, in Costa Rica, and in the Central Cordillera of Panama, to flow into the Atlantic Ocean covering an area of 2,839.6 km².

In addition to the main channel that gives the name - the Sixaola - there are the Telire, Banana, Coen, Lari and Urión rivers that intertwine in a delta in Costa Rica; the Changuinola, Yorkín, Scui, Katsi and Uren rivers in Panama; and the Gandoca-Manzanillo and San San Pond Sak wetlands that confirm a **unique and united** hydrographic system (see Figure 14).

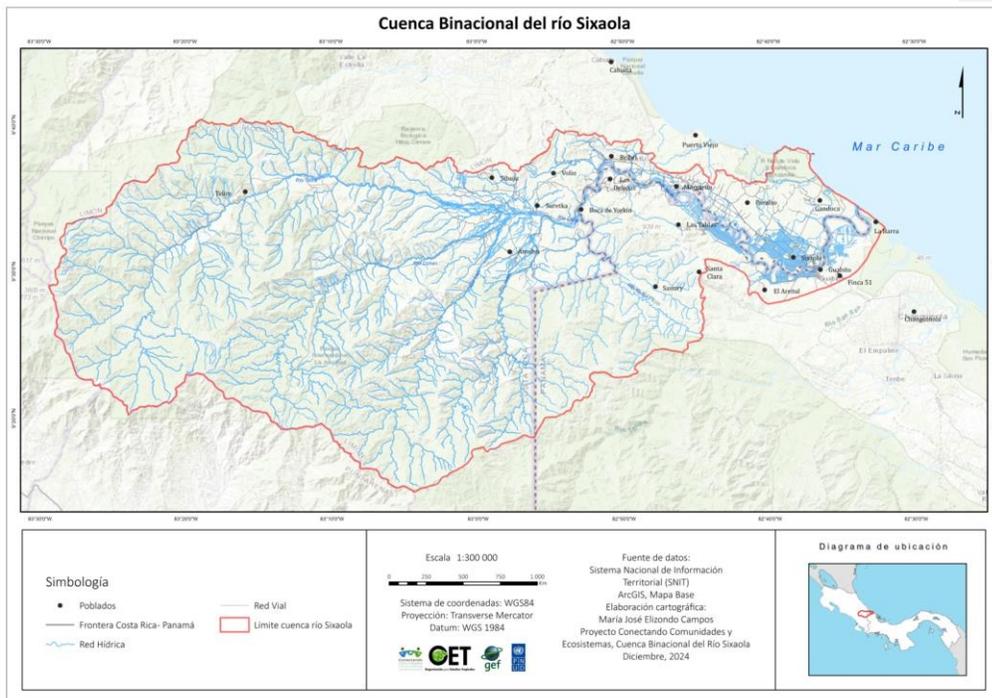


Figure 14. Transboundary basin of the Sixaola River.

The Binational Basin of the Sixaola River has an exceptional biodiversity on which more than 33 thousand people depend and a valuable ecosystem; but it is at risk in the face of serious environmental problems generated by human activity.

It is estimated that 95% of the **population** of the upper basin is indigenous, more specifically from the Bri Bri, Cabécar and Ngöbe Buglé groups, who live in conditions of poverty. In the lower basin on both sides of the border, mestizo, Chinese and Afro-Caribbean populations can be found, the latter extending throughout the Caribbean coast of Central America.

Sectors of valuable protected areas are located in the Basin: La Amistad International Park (PILA), the Gandoca Manzanillo Refuge, the San San Pond Sak Wetland, the Cahuita National Park, the Palo Seco Protected Forest and sections of the Bocas del Toro archipelago.

Most agricultural practices in the Binational Basin are intensive, with a high footprint of toxic agrochemicals and part of a model of agro-export enclaves. These unsustainable agricultural practices reduce the resilience of the land and increase the vulnerability of communities to extreme events such as flooding. A 2012 study by the ANAI Association showed that most of the Sixaola Valley was strongly altered by banana activity for decades.

The **main** transboundary environmental problem of the Sixaola Basin is the degradation of freshwater ecosystems and water resources. This affects all people's production. The main economic activity is the production of musaceae – bananas and plantains – on an industrial scale

and in monoculture. This production generates the most and most pollution due to the intensive use of agrochemicals.

Erosion removes fertile soil from agricultural land and forests, as well as sediments, which decreases the quality of river water and coastal ecosystems. **Due to erosion, deforestation on its banks and other factors, the river expands and causes damaging flooding** in the Sixaola River basin.

Costa Rica and Panama signed a **cooperation agreement in 1992** to promote transboundary development. This agreement facilitates cooperation around water, recognizing the basin approach and integrated water resources management for border cooperation. In this context, in 2007 the **Binational Commission of the Sixaola River Basin (CBCRS)** was created as the technical executing unit of a project of the Global Environment Facility (GEF), which began operating in 2009 with the following objectives:

- the coordination and development of the necessary actions for the integrated management of the Basin
- the conservation of natural resources and biodiversity
- the promotion of sustainable production
- and the strengthening of binational institutions.

Currently, the Commission is made up of representatives of 35 organizations, including both governments, the private sector and the representation of the 7 indigenous territories of the Basin.

In the Binational basin of the Sixaola River (CBRS) there are flat areas on the banks of the river that are frequently flooded. The communities of Talamanca and Bocas del Toro have historically coexisted with floods.

If these margin areas are not used intensively, frequent flooding should not pose a threat, as they are usually expected. There is a natural process of erosion through the force of wind and water. Thus, soil and rocks are transported downstream in the form of sediments through rivers.

The erosion of the selo coupled with the conditions of heavy rainfall in the region, especially in short periods, which generate a significant amount of sediment, causes the river to expand towards its floodplain causing harmful floods.

This basin is one of the most affected by the constant and serious floods, some historic in the Sixaola River (years 1928, 1935, 1945, 1970, 1975, 1988, 1991, 1993, 2002, 2005 and 2008).

Vulnerabilidad a inundaciones, Cuenca río Sixaola, 2022

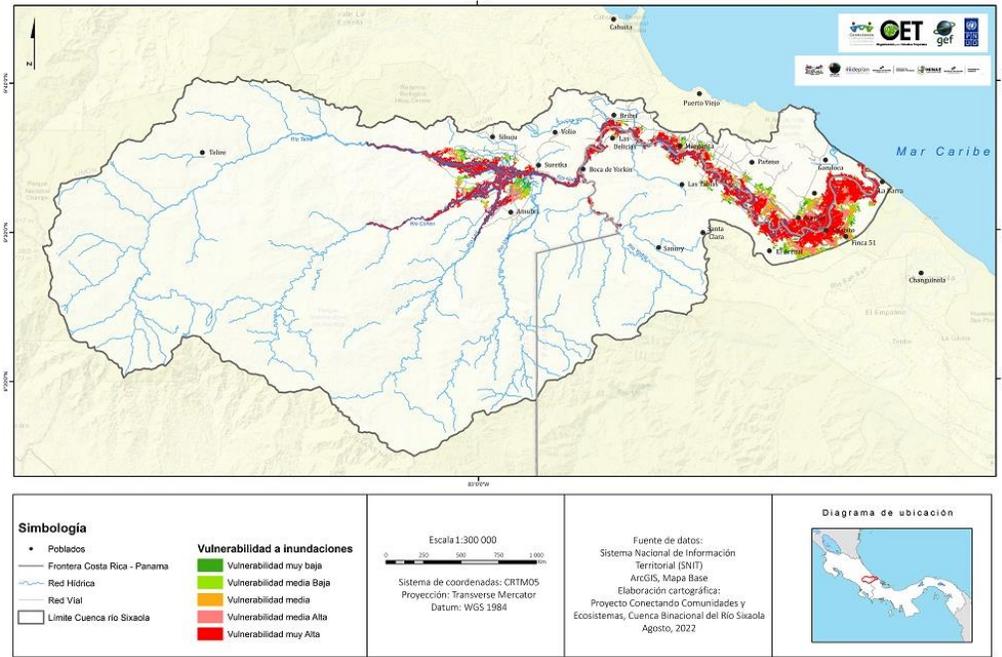


Figure 15. Vulnerability to flooding in the Sixaola River basin.

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Annex 4 – Acronyms

Acronym	Definition
AAC	Autoridad de Aeronáutica Civil / Civil Aeronautics Authority (Panamá)
ACP	Autoridad del Canal de Panamá / Panama Canal Authority
AECID	Agencia de Cooperación Internacional para el Desarrollo de España / Spanish Agency for International Development Cooperation
AEMET	Agencia Estatal de Meteorología de España / Spanish State Meteorological Agency
AIG	Autoridad Nacional para la Innovación Gubernamental / National Authority for Government Innovation (Panamá)
AMP	Autoridad Marítima de Panamá / Panama Maritime Authority
ANGR	Agencias Nacionales de Gestión del Riesgo
ATTT	Autoridad de Tránsito y Transporte Terrestre / Transit and Land Transportation Authority (Panamá)
AyA	Instituto Costarricense de Acueductos y Alcantarillados / Costa Rican Institute of Aqueducts and Sewers
IDB	Inter-American Development Bank
WB	World Bank
BNDMHA	National Meteorological, Hydrological and Agrometeorological Data Bank
CATHALAC	Centro del Agua para el Trópico Húmedo para América Latina y El Caribe / Water Center for the Humid Tropics for Latin America and the Caribbean
CCAD	Comisión Centroamericana de Ambiente y Desarrollo / Central American Commission for Environment and Development
CEPREDENAC	Centro de Coordinación para la Prevención de los Desastres en América Central y República Dominicana / Coordination Centre for Disaster Prevention in Central America and the Dominican Republic
CIIFEN	Centro Internacional para la Investigación del Fenómeno de El Niño / International Centre for Research on the El Niño Phenomenon
CND	Centro Nacional de Despacho / National Dispatch Center (Panamá)
CNE	Comisión Nacional de Emergencias / National Emergency Commission (Costa Rica)
COENOS	Comisión Técnica Nacional del Fenómeno ENOS / National Technical Commission on the ENSO Phenomenon (Costa Rica)
CONADES	Consejo Nacional para el Desarrollo Sostenible / National Council for Sustainable Development (Panamá)
CONAGUA	Consejo Nacional del Agua / National Water Council (Panamá)
CONALSED	Comité Nacional de Lucha contra la Sequía y la Desertificación / National Committee to Combat Drought and Desertification (Panamá)
CONAHYME	Comité Nacional de Hidrología y Meteorología / National Committee of Hydrology and Meteorology (Costa Rica)
CORBANA	Corporación Bananera de Costa Rica / Banana Corporation of Costa Rica
CRGIS	Centro Regional de Gestión de Inundaciones y Sequías / Regional Flood and Drought Management Center
CRRH	Comité Regional de Recursos Hídricos de SICA / Regional Water Resources Committee
DA-MINAE	Dirección de Agua del Ministerio de Ambiente y Energía / Water Directorate of the Ministry of Environment and Energy (Costa Rica)
DCC-MiAmbiente	Dirección de Cambio Climático del Ministerio de Ambiente / Climate Change Directorate of the Ministry of Environment (Panamá)

Acronym	Definition
DCC-MINAE	Dirección de Cambio Climático del Ministerio de Ambiente y Energía / Climate Change Directorate of the Ministry of Environment and Energy (Costa Rica)
DH-ETESA	Dirección de Hidrometeorología de ETESA / ETESA Hydrometeorology Directorate (Panamá)
DISAPAS-MINSA	Dirección del Subsector Agua Potable y Alcantarillado Sanitario de MINSA / Directorate of the Drinking Water and Sanitary Sewerage Subsector of MINSA (Panamá)
DSH-MiAmbiente	Dirección de Seguridad Hídrica del Ministerio de Ambiente / Directorate of Water Security of the Ministry of Environment (Panamá)
ENOS	El Niño-Oscilación Sur (fenómeno) / El Niño-Southern Oscillation (phenomenon)
ETESA	Empresa de Transmisión Eléctrica S.A. / Electric Transmission Company (Panamá)
EW4All	Early Warning for All, a UN initiative
EWS	Early Warning Systems
FAO	Food and Agriculture Organization of the United Nations
FICH-UNL	Facultad de Ingeniería y Ciencias Hídricas de la Universidad Nacional del Litoral / Faculty of Engineering and Water Sciences of the National University of the Litoral (Argentina)
GWP	Global Water Partnership
GWP-CAM	Global Water Partnership – Central America
HydroBID	Water Resources Management and Planning Simulation Tool Created by the Inter-American Development Bank
HydroSOS	WMO Hydrological Status and Outlook System
ICE	Instituto Costarricense de Electricidad / Costa Rican Institute of Electricity
ICT	Instituto Costarricense de Turismo / Costa Rican Tourism Institute
IDAAN	Instituto de Acueductos y Alcantarillados Nacionales / National Institute of Aqueducts and Sewers (Panamá)
IFRC	International Federation of Red Cross and Red Crescent Societies
IMHPA	Instituto de Meteorología e Hidrología de Panamá Ingeniero Ovigildo Hernández Marcucci / Institute of Meteorology and Hydrology of Panama
IMN	Instituto Meteorológico Nacional de Costa Rica / National Meteorological Institute of Costa Rica
ITU	International Telecommunication Union
MAG	Ministerio de Agricultura y Ganadería / Ministry of Agriculture and Livestock (Costa Rica)
MCH	Meteorological, Climate and Hydrological Data Management System
MHEWS	Multi-hazard Early Warning Systems
MiAMBIENTE	Ministerio de Ambiente / Ministry of Environment (Panamá)
MIDA	Ministerio de Desarrollo Agropecuario / Ministry of Agricultural Development (Panamá)
MIDEPLAN	Ministerio de Planificación Nacional y Política Económica / Ministry of National Planning and Economic Policy (Costa Rica)
MINAE (previously MINAET)	Ministerio de Ambiente y Energía / Ministry of Environment and Energy (Costa Rica)
MINSA	Ministerio de Salud / Ministry of Health (Costa Rica)
MIVAH	Ministerio de Vivienda y Asentamientos Humanos / Ministry of Housing and Human Settlements (Costa Rica)
MOPT	Ministerio de Obras Públicas y Transportes / Ministry of Public Works and Transport (Costa Rica)

Acronym	Definition
NATURA	Fundación para la Conservación de los Recursos Naturales / Natural Resources Conservation Foundation (Panamá)
NHS	National Hydrological Service
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological Service
PNDIP	Plan Nacional de Desarrollo e Inversión Pública / National Development and Public Investment Plan (Costa Rica)
PNSH	Plan Nacional de Seguridad Hídrica / National Water Security Plan (Panamá)
RA-IV	WMO Regional Association IV – North America, Central America, and the Caribbean
RTC	WMO Regional Training Centres
SENARA	Servicio Nacional de Aguas Subterráneas, Riego y Avenamiento / National Groundwater, Irrigation and Drainage Service (Costa Rica)
SGBD	Hydrometeorological and climate database management system
SICA	Sistema de Integración Centroamericana / Central American Integration System
SINAPROC	Sistema Nacional de Protección Civil (Panamá)
SIPM	Sistema Integrado de Pronóstico Meteorológico
UCR	Universidad de Costa Rica / University of Costa Rica
UNDRR	United Nations Office for Disaster Risk Reduction
USD	United States of America dollars
WHOS	WMO Hydrological Observation System
WMO	World Meteorological Organization