PANAMA

DIAGNOSTIC STUDY CONDUCTED BY THE CLIMATE RESILIENT FOOD SYSTEMS ALLIANCE

JULY 2024

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Background

The following diagnostic was elaborated by the Climate Resilient Food Systems (CRFS) Alliance team in collaboration with Panama's Ministry of Environment which served as the National Focal point for this exercise. The CRFS Alliance team would like to express our sincere gratitude to the Climate Change Directorate of the Panama Ministry of Environment for their invaluable support throughout this diagnostic process, providing essential documents, relevant contacts, and continuous assistance that significantly contributed to the depth and accuracy of this report.

The purpose of the country diagnostics is to analyse and enhance the resilience of food systems in the face of climate change at a national level. This is achieved by analysing existing strategies, identifying gaps, and finding entry points where the CRFS Alliance could support the country to enhance the nexus of food and climate.

The methodology for the country diagnostic involved a comprehensive desk review and stakeholder interviews. The desk review focused on the analysis of climate and food-related policies, with particular emphasis on the Nationally Determined Contributions (NDCs), UN Food Systems Pathways, and the National Adaptation Plan (NAP) project. This review provided insights into the country's climate and food security landscape. In addition to the desk review, interviews were conducted with key stakeholders from different directorates, ministries, UN agencies, and academia. These interviews provided valuable firsthand information and perspectives, further enriching the analysis.

1. Geography and Economy

Country Profile

Name: Republic of Panama

Location: Central America

Population: 4,408,581(2022)

Land Area: 75,517km2, 29.4% agricultural land

Economy: GDP per capita US$17,357.6 (2022). As of 2021, 2.7% of the country's total GDP comes from the Agricultural sector.

The Republic of Panama is a Central American country bordered by the Caribbean Sea (covering 30% of the territory). To the north, the Pacific Ocean to the south (covering 70% of the territory), Colombia to the east, and Costa Rica to the west. With Panama City as its capital, the country is administratively divided into ten provinces (Bocas del Toro, Chiriquí, Coclé, Colón, Darién, Herrera, Panamá, Panamá Oeste, Los Santos, and Veraguas) and four indigenous territories (Emberá Wounaan, Kuna Yala, Ngöbe-Buglé, and the recently established in 2020 Naso Tjër Di).

The country's topography is shaped by a mountainous corridor that traverses it from west to east: the Chiriquí mountain range, Tabasará Sierra, Central mountain range, San Blas mountain range, and Darién foothills.

With a population of 4,064,780[1] and a GDP per capita of US$17,357.6[2], Panama is considered a high-income country by the World Bank. However, persistent poverty and income inequality disproportionately affect rural indigenous territories and Afro-Panamanian populations[3].

The coastal areas along both oceans experience a humid and very humid tropical climate, while the highlands have a humid and very humid temperate climate. In the Herrera and Los Santos provinces, known as the Dry Arc, a tropical dry climate prevails, with annual precipitation below 1,500 mm, the lowest in the country. This region also faces scarcity of both surface and groundwater compared to the rest of the country. Panama's annual average precipitation is the highest in Central America, ranging from 1,100 to 5,500 mm, with a yearly average of 2,928 mm[4].

With an enormous ecosystem's biodiversity, protected areas occupy 31.8% of the land surface and 13.5% of the marine areas in the country. Includes forests, terrestrial and marine areas. This represents more than 40% of the national territory[5]. Additionally, Panama is one of only three carbon-negative countries in the world[6].

[1] Censo de Población y Vivienda de Panamá, 2023. https://www.inec.gob.pa/panbin/RpWebEngine.exe/Portal?BASE=LP2023

[2] World Bank Data, 2023. GDP per capita (current US$) 2022. https://data.worldbank.org/country/panama

[3] World Bank Data, 2023. Panama population 2022. https://data.worldbank.org/country/panama

[4] FAO, 2015. AQUASTAT Perfil de País – Panamá. https://www.fao.org/3/ca0422es/CA0422ES.pdf

[5] Ministerio de Ambiente Panamá, 2021. Panamá es un "Hot Spot" de biodiversidad. https://www.miambiente.gob.pa/panama-es-un-hot-spot-de-biodiversidad-en-el-planeta/

[6] World Bank, 2023. The World Bank in Panama. https://www.worldbank.org/en/country/panama/overview

Panama has been an independent republic since 1903 when it seceded from Colombia, which it had voluntarily joined after gaining independence from Spain in 1821. In 1904, the United States assumed control of the Panama Canal project, which was inaugurated in 1914. Stretching approximately 80 kilometres, the Panama Canal connects the Atlantic and Pacific oceans, transforming Panama into a key hub for transport and world trade. The direct contribution of the Panama Canal to Panama's GDP was 3.7% in 2022, and when considering the indirect contribution, this figure increased to 5.1% of Panama's GDP[7].

Panama's economy is primarily tertiary, with this sector contributing 67.8% to Panama's GDP in 2021 and approximately 63% of employment. The leading contributors to these figures include commerce, transportation, storage, communications, and financial activities. The secondary sector accounted for 26.1% of the GDP, encompassing manufacturing, electricity, construction, and mining[8]. Mining, particularly copper extraction, has experienced consistent growth in recent years. However, the environmental impact of mineral extraction has brought the copper mine under scrutiny. After several weeks of protests, in December 2023, the Panamanian government announced a plan to close the copper mine[9].

With a land area of 75,517 km2[10] of which 29.4% is agricultural land, the agricultural sector GDP was 2.7% for 2021[11], which includes agriculture, livestock, hunting, forestry, and fishing. Despite its modest GDP contribution, the primary sector employed 15.7% of the workforce in 2021[12]. The agricultural sector's contribution to the GDP has been steadily decreasing since the mid-20th century. It represented more than 25% in 1950, just below 15% in 1970, and further declined from the 1970s when legislation strongly promoted the service sector. It has reached approximately only 2% in the last decade[13].

2. Overview of Country Food Systems

Panama has made significant strides in reducing hunger over the last two decades, transitioning from a prevalence of undernourishment (PoU) of 27.6% in 2001 to 5.3% in 2022. This places the country below the regional average for Latin America and the Caribbean, which stands at 7.9%. However, it still slightly exceeds the average for the Central American region, where the prevalence

[7] Canal de Panamá, 2023. Infome Anual 2022. https://pancanal.com/wp-content/uploads/2023/01/Informe-2022.pdf

[8] Oficina Económica y Comercial de España en Panamá, 2022. Informe económico y comercial. Panamá 2022. https://www.icex.es/content/dam/es/icex/documentos/quienes-somos/donde-estamos/red-exterior/panama/DOC2022909564.pdf

[9] CNN, 2023. El Gobierno de Panamá anuncia el inicio del "cierre ordenado" de la minera Cobre-Panamá. 15 Diciembre, 2023. https://cnnespanol.cnn.com/2023/12/15/el-gobierno-de-panama-anuncia-el-inicio-del-cierre-ordenado-de-la-minera-cobre-panama/

[10] Instituto Nacional de Estadística y Censo – Panamá. https://www.inec.gob.pa/Archivos/P28811.pdf

[11] Instituto Nacional de Estadística y Censo – Panamá. https://www.inec.gob.pa/DASHBOARDS/PIB/PIB_ANUAL_POR_CATEGORIA

[12] Oficina Económica y Comercial de España en Panamá, 2022. Informe económico y comercial. Panamá 2022. https://www.icex.es/content/dam/es/icex/documentos/quienes-somos/donde-estamos/red-exterior/panama/DOC2022909564.pdf

[13] Ministerio de Agricultura, Pesca y Alimentación, España, 2021. Ficha sectores agroalimentario y pesquero. https://www.mapa.gob.es/es/ministerio/ministerio-exterior/america-central-caribe/fichasectores_pa1_tcm30-543059.pdf

of undernourishment is 5%[14]. Despite this progress, the cost of a healthy diet remains high for the population, and the percentage of people unable to afford a healthy diet has remained relatively constant, with 17.5% of the population in 2017 and 17% in 2021. It is worthy of note that prior to the COVID-19 pandemic, this figure was decreasing, but it picked up almost 19% of the population in 2020. Nonetheless, Panama has the second smallest figure in the subregion, averaging 22.2% of unaffordability in 2021[15].

2.1 Production

In comparison to the Latin American and the Caribbean (LAC) region, the agricultural sector in Panama is one of the smallest contributors to the national GDP (3.3% average between 2010-215, versus the regional average of 5.2% for the same period)[16]. Despite the declining trend in the contribution of agriculture to the national GDP, the gross production value of agriculture has been on an upward trajectory from 2000 to 2010[17]. Since then, it has remained relatively constant, as illustrated in Figure 1.

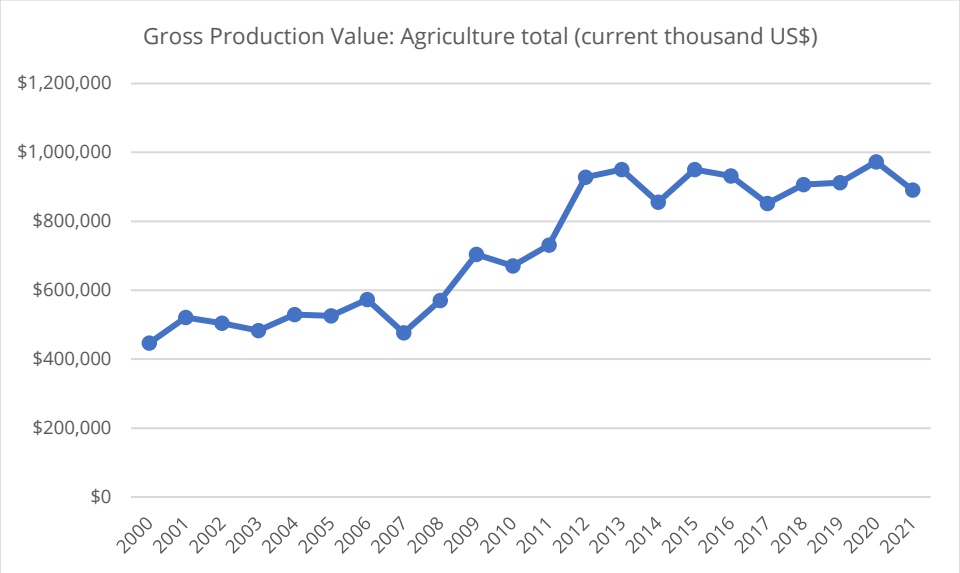

Figure 2: National Gross Production Value (current thousand US$): Agriculture total. FAOSTAT

Panama key crops include rice, sugarcane, bananas, maize (corn), and various fruits and cereals. Rice and maize are the primary crops in terms of harvested area, -as shown in Figure 2- primarily intended for domestic consumption. Sugarcane and bananas follow as major crops in terms of harvested area, predominantly earmarked for export. In terms of tons of production, sugarcane has been the major crop as shown in Figure 3.

[14] FAO, 2023. The State of Food Security and Nutrition in the World 2023. https://www.fao.org/3/cc3017en/cc3017en.pdf
[15] Ibid
[16] Ministerio de Agricultura, Pesca y Alimentación, España, 2021. Ficha sectores agroalimentario y pesquero. https://www.mapa.gob.es/es/ministerio/ministerio-exterior/america-central-caribe/fichasectores_pa1_tcm30-543059.pdf
[17] FAOSTAT, 2023.

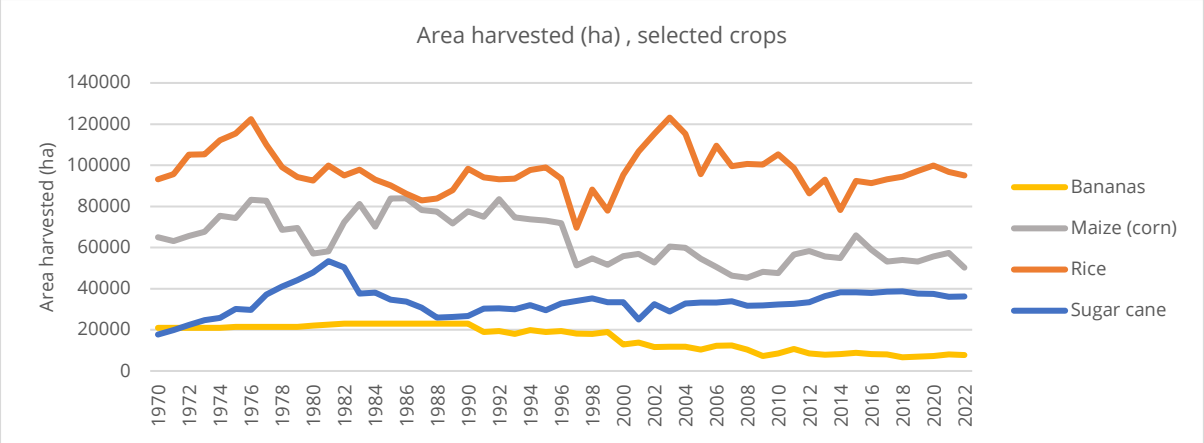

Figure 3: Area harvested in Panama (ha): Bananas, Maize, Rice, and Sugar Cane. FAOSTAT

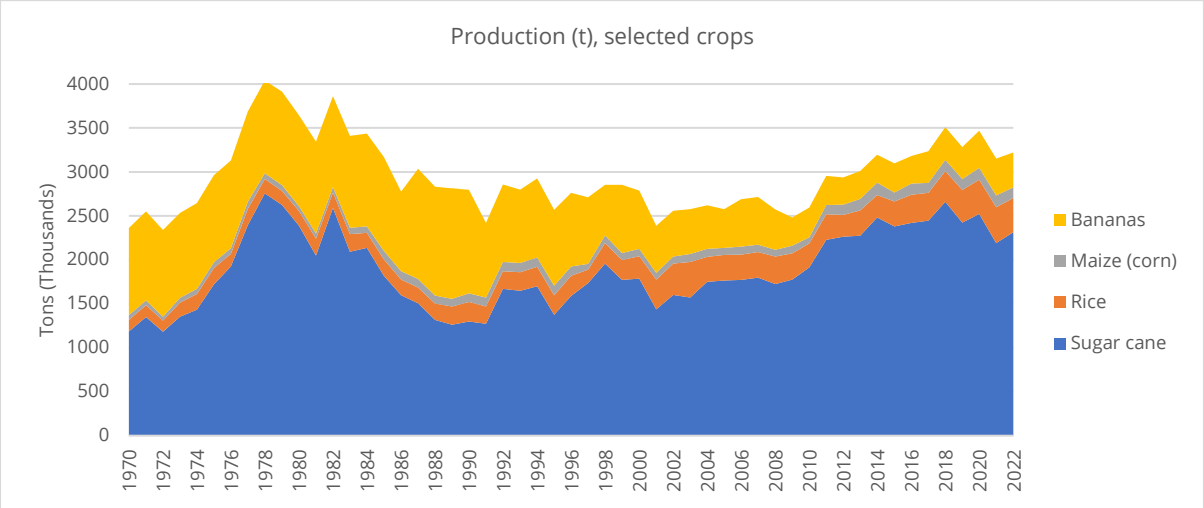

Figure 4: Production (t) Panama: Bananas, Maize, Rice, and Sugar Cane. FAOSTAT

2.1.1 Rice

The importance of rice production in Panama extends beyond mere economic implications, encompassing social and political significance and, most importantly, playing a critical role in ensuring the country's food security.[18] Regarding harvested area, rice takes the lead among other crops, with 95,053 hectares planted in 2022.

Rice production in Panama, as well as globally, holds great significance. However, transforming this production into a sustainable practice poses a substantial challenge. Rice cultivation is water-intensive, requiring approximately 5,000 litres to produce one kilogram of rice and consuming

[18] IICA, 2008. Plan de acción para la competitividad de la cadena de arroz de Panamá: hacia un mecanismo de reconocimiento de la calidad. https://repositorio.iica.int/bitstream/handle/11324/18962/BVE21108059e.pdf

7,650 m3/ha[19]. Effective water resource management is crucial to ensure the sustainability of rice farming practices.

On the other hand, rice production is a significant contributor to greenhouse gas emissions. Globally, approximately 8% of agricultural greenhouse gas emissions stem from rice cultivation, with rice production accounting for around 10% of global methane emissions[20]. This is why, in Panama, various initiatives and projects aim to enhance the sustainability of rice production. These efforts include incorporating technology and innovation and incentivising the transition towards adopting a precision farming model.

2.1.2 Sugarcane

Sugarcane cultivation is primarily geared towards sugar and alcohol production[21]. Despite occupying less than 40,000 hectares of cultivated land, sugarcane generates over half of Panama's agricultural production's economic value. It accounts for nearly 90% of the national output of industrial crops[22].

With approximately 650 producers, sugarcane cultivation is predominantly carried out in four provinces: Coclé, Chiriquí, Herrera, and Veraguas, concentrating 98% of the total production in these regions[23]. There are distinct artisanal and industrial productions of sugarcane, each with little connection to the other. Industrial production is centralised in four companies: Compañía Azucarera la Estrella S.A. (CALESA) in Coclé, Central Azucarera La Victoria S.A. in Veraguas, Ingenio Santa Rosa in Coclé, and Central Azucarera de Alanje (CADASA) in Chiriquí.

Regarding production destination, 67% is allocated for domestic consumption, while 33% is earmarked for export. The sugarcane production sector consumes substantial amounts of water resources. Concessions for water usage in agriculture in Panama are granted by the Ministry of Environment (except for the Panama Canal Watershed, where the Panama Canal Authority issues these concessions) based on Decree Law 33 of 1966 on water usage[24]. The process of acquiring water concessions has proven problematic for smallholders, as large companies hold most concessions, and the acquisition process can be complex and bureaucratic for smaller producers.

[19] Aquae Fundación, 2021. El uso del agua en la agricultura. https://www.fundacionaquae.org/wiki/5-000-litros-de-agua-1-kilo-de-arroz-el-uso-del-agua-en-la-agricultura/

[20] DW, 2023. Calentamiento global: arrozales producen el 10% del metano. https://www.dw.com/es/calentamiento-global-los-arrozales-producen-el-10-de-metano-del-mundo/a-66085018

[21] Ministerio de Desarrollo Agropecuario Panamá, 2021. Inicia la zafra de caña y con ella la exportación de azúcar cruda https://mida.gob.pa/inicia-la-zafra-de-cana-y-con-ella-la-exportacion-de-azucar-cruda/

[22] ILO, 2019. Estudio de métodos mixtos sobre el trabajo infantil en la caña de azúcar en Panamá. https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---ipec/documents/publication/wcms_677585.pdf

[23] Ibid

[24] Ministerio de Ambiente Panamá, 2015. Guía para el proceso de permisos de uso y concesiones de agua. https://cihh.utp.ac.pa/documentos/2016/pdf/Guia_para_el_proceso_de_permisos_de_uso_y_concesiones_de_agua.pdf

2.1.3 Bananas

Banana production holds significant importance in Panama for domestic consumption, particularly, as an export product. In 2022 alone, 297,943 tons of bananas were exported, equivalent to 127,753,000 USD[25]. However, compared to 2021, the exported quantity decreased by 38.9%[26].

This crop is highly vulnerable to disasters and climate change, leading to an anticipated decline in suitable banana-growing areas for the upcoming years[27]. Furthermore, banana plantations have had to adapt to changes in precipitation patterns. Some banana plantations in the country, especially those in the Western Caribbean region, which had never required irrigation before, now had to implement irrigation systems due to the lack of precipitation and resulting drought[28].

This adaptation entails significant investments and management adjustments, including the installation of irrigation systems and capacity building for the new technologies, among other factors. These changes result in an increased production cost[29].

2.1.4 Maize (corn)

Maize holds a significant position in Panamanian agriculture, recognized as one of the priority crops by the Ministry of Agricultural Development (MIDA). Despite approximately 487,600 tons of maize being consumed annually in the country, only 89,000 tons are locally produced, with the rest being imported[30].

This reliance on maize imports could be exacerbated due to climate change[31]. The anticipated effects of this phenomenon include a substantial decrease in maize yields, posing a considerable threat to the country's food security[32].

It is noteworthy that 81% of maize production comes from family farming, whose communities are acknowledged as among the most vulnerable to the impacts of climate change on the production chain[3334]. Therefore, identifying cultivars and agronomic practices with a high capacity

[25] FAOSTAT, 2023. Crops and livestock products. Export Quantity and Value.
[26] Ministerio de Economía y Finanzas, 2022. Informe Económico y Social – Al primer semestre de 2022.
[27] Molina-Millán, T., 2023. Sector agropecuario no extensivo en América Latina y el Caribe: análisis de la agricultura familiar en Centroamérica. https://scioteca.caf.com/handle/123456789/2027
[28] SIP, 2024. Bayano es parte de la solución al suministro de agua potable y operación del Canal de Panamá.
[29] GIZ, 2021. El cambio climático y sus efectos en la producción de banana. https://www.nachhaltige-agrarlieferketten.org/fileadmin/user_upload/Climate_change_and_its_effects_on_banana_production_Spanish.pdf
[30] Instituto de Innovación agropecuaria de Panamá, 2021. El Maíz en Panamá: Características, requerimientos y Recomendaciones para su Producción en ambientes con alta Variabilidad climática. https://proyectos.idiap.gob.pa/uploads/adjuntos/manual_tecnico_el_maiz_en_panama.pdf
[31] Ibid.
[32] Molina-Millán, T. (2023, April 16). Sector agropecuario no extensivo en América Latina y el Caribe: análisis de la agricultura familiar en Centroamérica. https://scioteca.caf.com/handle/123456789/2027
[33] Ibid.
[34] IDIAP, 2016. El estado de la biodiversidad para la alimentación y la agricultura en Panamá. https://www.fao.org/3/CA3449ES/ca3449es.pdf

for adaptation and resilience to climatic variability has become an immediate priority for the country. This not only mitigates the effects of drought but also brings economic benefits to farmers[35].

2.1.6 Livestock

Panama's primary livestock production and consumption is chicken (with the highest per capita chicken consumption in Latin America), followed by with beef, pork, and veal. Chicken production has experienced the largest production growth in the last decades, while cattle production has experienced some decreases in recent years[36].

Regarding its climate impact, methane is responsible for 11.24% of total emissions in Panama. Livestock farming occupies 20% of the land in Panama and has low indicators of animal productivity: less than 3000 kg milk/ha/year and 200 kg live weight/ha/year. Poor management of agricultural components such as soils, pastures, fodder, and tree cover is still a problem, as well as the management of manure, water, genetics, animal health, the registration system, and the value added to agricultural products (milk, meat and others) and the connection to markets (which is isolated and not organised according to a value chain concept).[37]

2.1.7 Fisheries

Panama's fishing sector is roughly divided by three sub-sectors: artisanal, industrial, and aquaculture. The artisanal sub-sector focuses on coastal fishing for fish, shrimp, and lobster, playing a crucial role in meeting local market demands. In contrast, industrial fishing, established in the 1960s, primarily targeted herring and anchovies for export-oriented production of flour and oil. Operating in international waters, the industrial sub-sector has diversified Panama's market offerings, employing efficient means of navigation and species capture, with a particular focus on shrimp and tuna fishing and processing. This sub-sector significantly contributes to the country's exports, emphasising high-value species for global markets. The aquaculture sub-sector is centred around shrimp cultivation, accounting for 55% of production in over 9 million hectares of agricultural areas. The substantial shrimp volumes allow Panama to export to key international markets, including the USA, Europe, and Japan, showcasing the sector's global significance[38].

Specifically, aquaculture production in Panama increased from a little less than 1,800 tons in 2000 to 10,445 tons in 2018, the 10% annual growth was higher than the sub-regional, regional and global averages and one of the highest among the countries in Central America. The 10,445 tons

[35] Instituto de Innovación agropecuaria de Panamá, 2021. EL MAÍZ EN PANAMÁ: Características, requerimientos y Recomendaciones para su Producción en ambientes con alta Variabilidad climática. https://proyectos.idiap.gob.pa/uploads/adjuntos/manual_tecnico_el_maiz_en_panama.pdf

[36] Ministry of Foreign Affairs Netherlands. 2018. Agriculture in Panama - Challenges and opportunities. https://www.rvo.nl/sites/default/files/2018/03/agriculture-in-panama-challenges-and-opportunities-2018.pdf

[37] Climate & Clean Air Coalition. 2024. Contribution of sustainable intensification of livestock. https://www.ccacoalition.org/projects/contribution-sustainable-intensification-livestock-reduction-methane-emissions

[38] Oficina Económica y Comercial de España en Panamá, 2022. Informe económico y comercial. Panamá 2022.

of aquaculture production in 2018 comprised eleven species items, primarily including whiteleg shrimp (61% of the total production), tilapias (18%), Cobia (17%) and Florida pompano (3%). Panama had a share of 0.009% of world aquaculture production tonnage in 2018 and a 0.013% share in world marine aquaculture production. From 2000 to 2018, Panama's capture fisheries production declined from over 227,000 tons to about 175,000 tons, whereas its aquaculture production increased from 1,800 tons to 10,400 tons, resulting in a decrease in total fishery production from nearly 230,000 tons to about 186,000 tons[39].

On the other hand, Panama's export of aquatic products declined from USD 260 million in 2000 to USD 160 million in 2018. The 75,000 tonnes of exports in 2018 include primarily 34,000 tonnes of fishmeal, 9,000 tonnes of shrimps/prawns and 8,000 tonnes of tunas/bonitos/billfish, as well as 8,000 tonnes of fish body oils. Regarding imports, Panama's import of aquatic products increased from USD 15 million in 2000 to USD 95 million in 2018[40].

2.2 Consumption

Various agricultural, livestock, fishing, and aquaculture systems in Panama contribute essential products and foods crucial for nutrition and agriculture. Notably, rainfed and irrigated rice production systems are among the most significant in consumption[41]. Panama stands out as one of the Central American countries with the highest per capita rice consumption, with approximately 93% of the population consuming an average of 158g of white rice daily, making rice a cornerstone of their diet[42].

Despite rice and maize occupying a substantial portion of the harvested area in Panama, domestic production falls short of meeting internal demand. Maize, where approximately 487,600 tons are consumed, is the most imported crop in Panama. 592,222 tons were imported in 2022, equivalent to 202,434,000 USD. It is noteworthy that the imported grains are primarily allocated for animal feed (88%)[434445].

Bovine milk, meat production, and porcine and poultry farming also play crucial roles in the country. The autonomous capture fishing system is also noteworthy, contributing benefits by exporting seafood products and meeting internal consumption needs[46].

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[39] FAO. 2021. Aquaculture growth potential in Panama. https://www.fao.org/3/cb3967en/cb3967en.pdf
[40] Ibid
[41] IICA, 2008. Plan de acción para la competitividad de la cadena de arroz de Panamá. https://repositorio.iica.int/bitstream/handle/11324/18962/BVE21108059e.pdf
[42] Sánchez-Galán Quintero, 2021. Analysis of the Panamanian Rice Sector: 1999-2016 https://www.revistas.una.ac.cr/index.php/perspectivasrurales/article/view/14802/23786
[43] Instituto de Innovación Agropecuaria de Panamá, 2021. EL MAÍZ EN PANAMÁ: Características, requerimientos y Recomendaciones para su Producción en ambientes con alta Variabilidad climática. https://proyectos.idiap.gob.pa/uploads/adjuntos/manual_tecnico_el_maiz_en_panama.pdf
[44] FAOSTAT, 2023. Crops and livestock products. Import Quantity and Value.
[45] IANAS, 2020. Food and Nutrition Security for Panama. Challenges and Opportunities for This Century. https://ianas.org/wp-content/uploads/2020/07/Panama.pdf
[46] IDIAP, 2016. El estado de la biodiversidad para la alimentación y la agricultura en Panamá. https://www.fao.org/3/CA3449ES/ca3449es.pdf

The evolution of the consumption of processed food products and other derivatives grew between 2014 and 2018, punctuating the growth observed in stimulant items, which increased in this period by +102.44%. Rice and its derivatives also witnessed a significant consumption increase of +52.31%. The processed categories consumed in greater volume by Panamanians are cereals and their derivatives, with rice and its derivatives leading with more than 850 thousand tons, followed by corn and its derivatives at around 790 thousand tons, and wheat and its derivatives at more than 350 thousand tons in 2018. Oats, on the other hand, had the lowest consumption figure among cereals, with an apparent consumption of almost 11 thousand tons in 2018[47].

The demand for food products in Panama is increasingly oriented towards consuming healthy, sophisticated, highly segmented, personalised, and socially responsible products. However, the offerings of agri-food Micro-, Small and Medium-sized Enterprises (MSMEs) are still quite traditional, focused on a single product, and lack innovation in labelling, packaging, or certifications. Therefore, companies in the sector face the great challenge of adapting to a new and growing demand[48].

The main trends in agri-food demand point to an increase in the consumption of fruits and other fresh foods, a rise in the consumption of fish and poultry at the expense of red meat, a reduction in the consumption of sugars, and relative stagnation in demand for cereals and fats[49].

Except for the indigenous territories, the most frequently consumed animal products (>80% of households) are eggs and chicken meat, followed by fish and seafood with 76% of households. Beef, sausages, and milk are used by more than 75% of households in urban areas and by less than 75% in rural areas. In the indigenous territories, chicken and eggs are used by about 60% of households[50].

Regarding the variety and diversity of diets, Figure 4 shows the number of products used by 75% and 50% or more of households by area of residence. The urban area presents the highest number of products used by more than 50% of households (30), while the indigenous area has the lowest number (11)[51].

[47] MICI Panama, 2021. Agroindustrias competitivas. Alimentos Procesados. (https://pnci.mici.gob.pa/storage/Publicaciones/EM%20Sub-sector%20Alimentos%20Procesados_2021.pdf)
[48] Enred, Panama. 2017. Análisis del sector Agroindustrial Panamá. (https://docplayer.es/139312988-Analisis-del-sector-agroindustrial-panama-proyecto-canal-de-empresarias-canal-de-comunidades.html)
[49] Rodrigues, M. y. (2003). La competitividad agroalimentaria de los países de América Central y el Caribe en perspectiva de liberalización comercial.Santiago de Chile: Red de Desarrollo Agropecuario. CEPAL.
[50] INCAP, 2011. Análisis de la situación alimentaria en Panamá.
[51] Ibid.

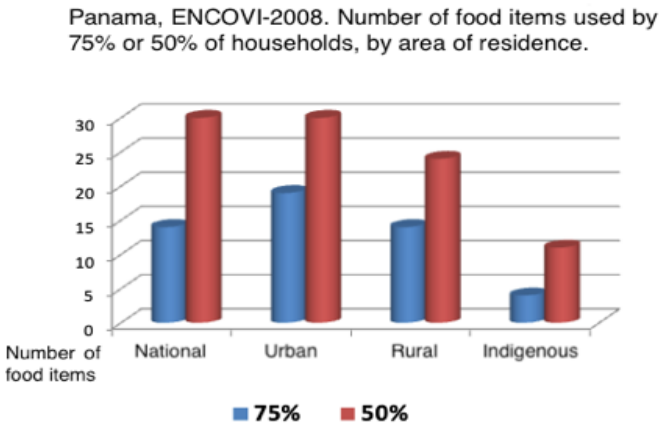


Figure 5: Number of food items used by 75% or 50% of households by area of residence. INCAP, 2011.

2.3 Distribution

The Panamanian government established the Executive Secretariat for the Cold Chain via Executive Decree No. 20 on July 2, 2009, with the purpose of planning and implementing a system to extend the shelf life of agricultural products by employing low-temperature storage. This initiative addresses losses, estimated between 10 to 60%, depending on factors like the agricultural product, location, and logistics efficiency. The focus of the program is on 24 perishable goods, including onions, lettuce, tomatoes, broccoli, beans, carrots, cassava, yams, otoes, and potatoes[52].

To facilitate this program, four collection centres, known as Post-harvest Centres, are strategically located in Volcano, Cerro Punta, and Dolega—all within the province of Chiriquí, approximately 400 kilometres from the capital. This region contributes to around 80% of the vegetable production consumed nationwide. The primary goal of this government initiative is to enhance transportation logistics for agricultural products and diminish post-harvest losses[53]. There is also another Post-harvest Centre in the Los Santos province.

Given Panama's relatively small market and less developed distribution system compared to Western countries, the marketing chain is short, with few intermediaries, as shown in Figure 5. Many distributors in Panama also operate in other Central American countries, often performing multiple roles (importer, distributor, wholesaler, retailer). A trend toward more private brands in the retail sector provides customers with additional choices, while independent grocery and convenience stores are emerging in local neighbourhoods. It's noteworthy that, in general, price takes precedence over brand in Panama, a crucial consideration in negotiations and distribution strategies[54].

[52] Bruno Zachrisson et al. 2020. Food and Nutrition Security for Panama. Challenges and Opportunities for This Century. (https://ianas.org/wp-content/uploads/2020/07/Panama.pdf)
[53] Ibid
[54] MICI Panama, 2021. Agroindustrias competitivas. Alimentos Procesados.

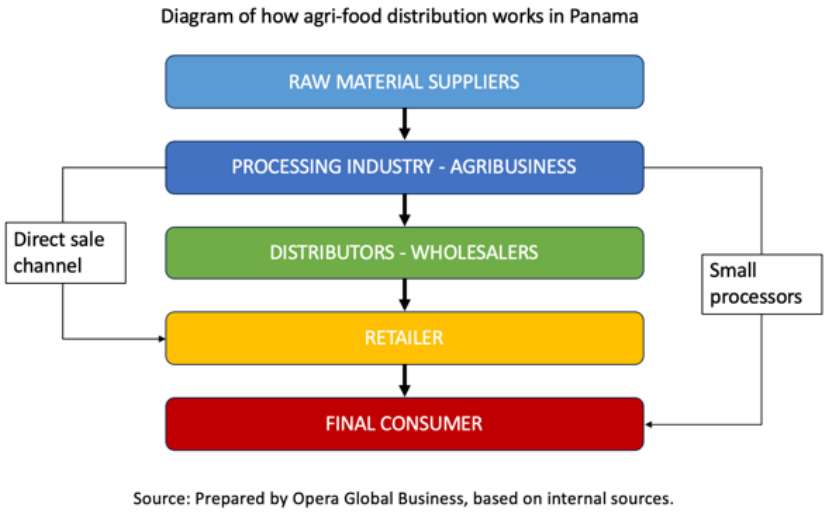


Figure 6: Diagram of agrifood distribution in Panama. MICI Panama, 2021.

Nine agrifood chains have been established, covering rice, milk, beans (including other legumes), corn, potato and onion, meat, bananas, cassava, and vegetables. Each chain has a committee comprising private sector representatives (producers from different regions, processors, input distributors, buyers, consumers, government agencies, exporting companies, retailers), along with a technical secretary, a public official appointed by MIDA. The committees operate with their own rules of procedure tailored to each chain's characteristics, developing action plans to address specific challenges within each chain[55].

2.4 Loss and waste

There is a lack of adequate technologies to produce crops in tropical conditions in most Central American countries. This has resulted in the import of inefficient foreign tools for agricultural production, which has resulted in a high percentage of losses in agricultural systems, which represents one of the main problems faced by producers.

In recent years, seasonal water deficits during the dry period have occurred, such as the climatic phenomenon of "El Niño," which mainly affects food production in the central area of the country. On the other hand, losses in agricultural production arose as a result of the decrease in river basin flows throughout the country[56].

Panama suffers from high post-harvest losses mostly due to the lack of well-established logistics services and the inadequate use of these available technology. Between 40 and 60% of national production is lost in post-harvest handling. On the one hand, this is due to the lack of a multimodal transportation system, which means that goods are transported only by truck. For example,

[55] Enred, Panama, 2017. Análisis del sector Agroindustrial Panamá. (https://docplayer.es/139312988-Analisis-del-sector-agroindustrial-panama-proyecto-canal-de-empresarias-canal-de-comunidades.html)
[56] Collado, E., Fossatti, A., & Saez, Y. 2018. Smart farming: A potential solution towards a modern and sustainable agriculture in Panama. AIMS Agriculture and Food, 4(2), 266-284.

transporting goods from Chiriquí to Panama City takes at least six hours. On the other hand, these post-harvest losses result from the lack of refrigerated storage systems for perishable foods, which leads to significant crop losses due to the climate differences between the production areas and Panama City. To improve this situation, the previous Panamanian government launched the Cold Chain (Cadena de Frío) initiative in 2010[57].

3. Climate risks and food systems

Climate change can negatively impact food value chains by inhibiting production, constraining processing and transportation, increasing trade deficits, lowering export prices, and, thus, limiting the participation of food system actors. Through a domino effect, the population's food and nutrition security might decrease while having a detrimental effect on their resilience.

3.1 Climate risks and vulnerability overview

3.1.1 Current climate and key trends

The climate change scenarios generated by the Ministry of Environment of Panama, were using 23 simulations of global climate models part of CMIP6 (Coupled Model Intercomparison Project), and observational data obtained from the country's meteorological stations with information from 1981-2022, the series obtained from these stations went through a quality control and homogenization process, for the subsequent filling of missing information using the Neyman-Scott Process Rainfall emulator tool developed by IH CANTABRIA, for precipitation, and global data from ERA-5 for temperature; with a final spatial resolution of 1km for both variables, and daily temporal resolution, using as a reference period for the calculation of the anomalies 2002-2022, in two future scenarios (SSP2-4.5 and SSP5-8.5) for three climatic periods 2041-2060, 2061-2080 and 2081-2100. The results are presented in percentile analysis: 25, 50, 75 and 95, which allows for the analysis of the uncertainty existing in the projections and at the national level.

The results were presented in the form of an anomaly, which is the difference in the value of the projections in relation to a reference period. The period 2002-2022 was used for the calculated anomalies. The results were presented as a percentage for precipitation (%) and degrees Celsius for temperature (°C). Anomalies with positive values represented increases compared to the reference period and negative anomalies represented decreases.

For the variable of precipitation, towards the year 2050, at the national level, declines are forecast ranging from -2.1% to -22% in the annual accumulated. These reductions are especially noticeable in the western regions of the country, affecting mainly provinces such as Colón, Chiriquí, Bocas del Toro, the Ngöbe Buglé County and part of Veraguas. In contrast, increases ranging from 1.7% to 15% are expected in the provinces that make up the Arco Seco, such as Herrera, Los Santos and Coclé, being more pronounced in the eastern Pacific region, in the Darién province. By 2070, declines are projected to reach -24%, keeping the Caribbean and Western Pacific regions most affected by these declines. In addition, there is a decrease in the geographical extent where

[57] Ministry of Foreign Affairs Netherlands. 2018. Agriculture in Panama - Challenges and opportunities. https://www.rvo.nl/sites/default/files/2018/03/agriculture-in-panama-challenges-and-opportunities-2018.pdf

increases are expected, concentrating in the Dry Arc region and the Eastern Pacific region, with increases of up to 21%.

By the year 2100, these trends are expected to persist in the same regions at the national level, with projections for falls of up to -26% and increases in precipitation up to 23%.

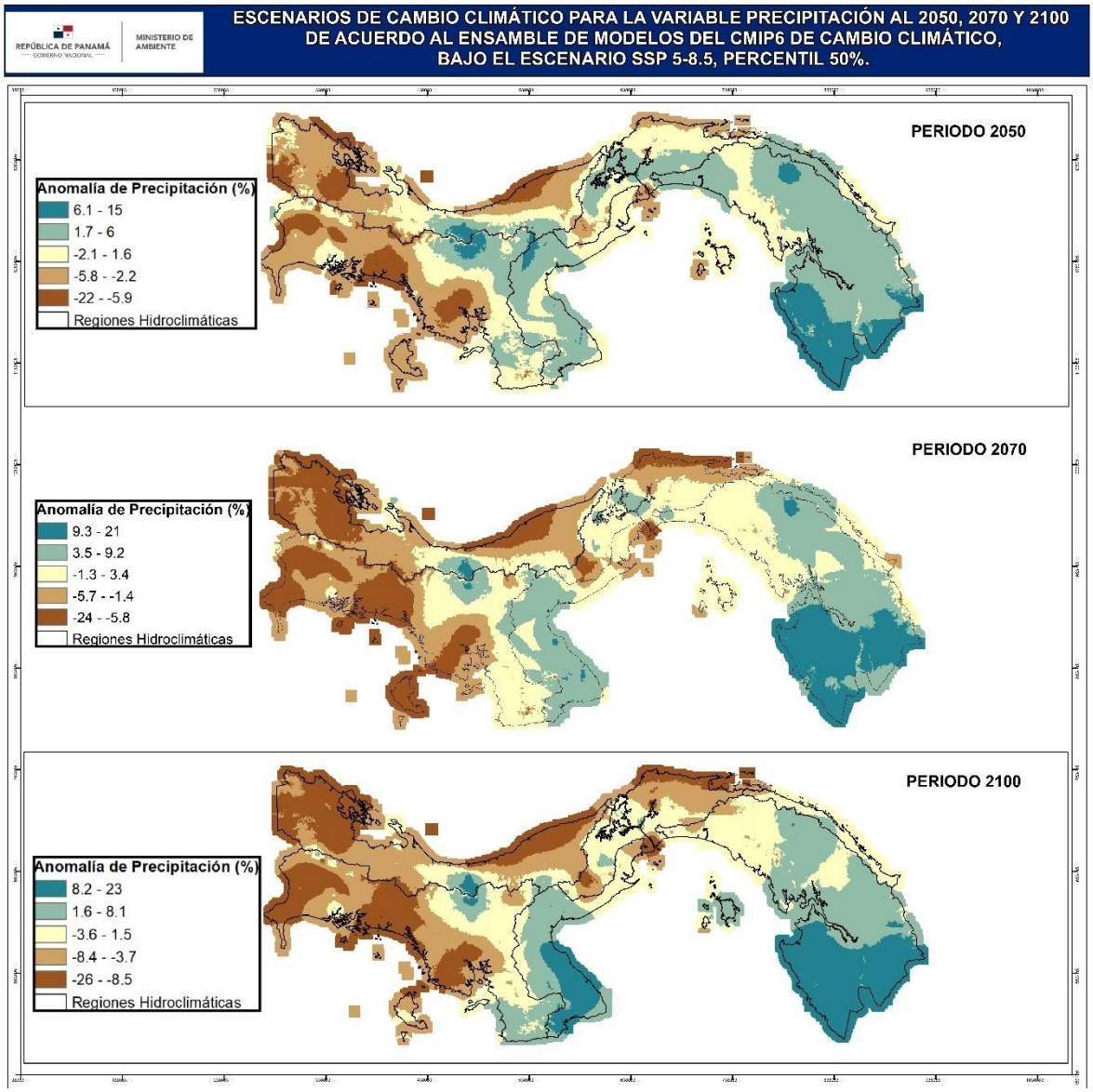


Figure 7. Climate change scenarios, for the 2050, 2070 and 2100 precipitation variable according to the CMIP6 model set, under the SSP5-8.5 scenario, percentile 50%. Source: Department of Adaptation and Resilience, Ministry of Environment, 2024.

For the peak temperatures, increases ranging from 0.33°C to 1.8°C by 2050, from 1.2 °C to 2.9°C in 2070, and from 2.4°C and 4°C at national level by 2100 are expected. The largest increases are projected in the Western Caribbean region, as well as in parts of the provinces of Los Santos and Veraguas. Moderate increases are forecast in the Western Pacific region, part of the Dry Arc, the Central Region and the eastern regions of the country.

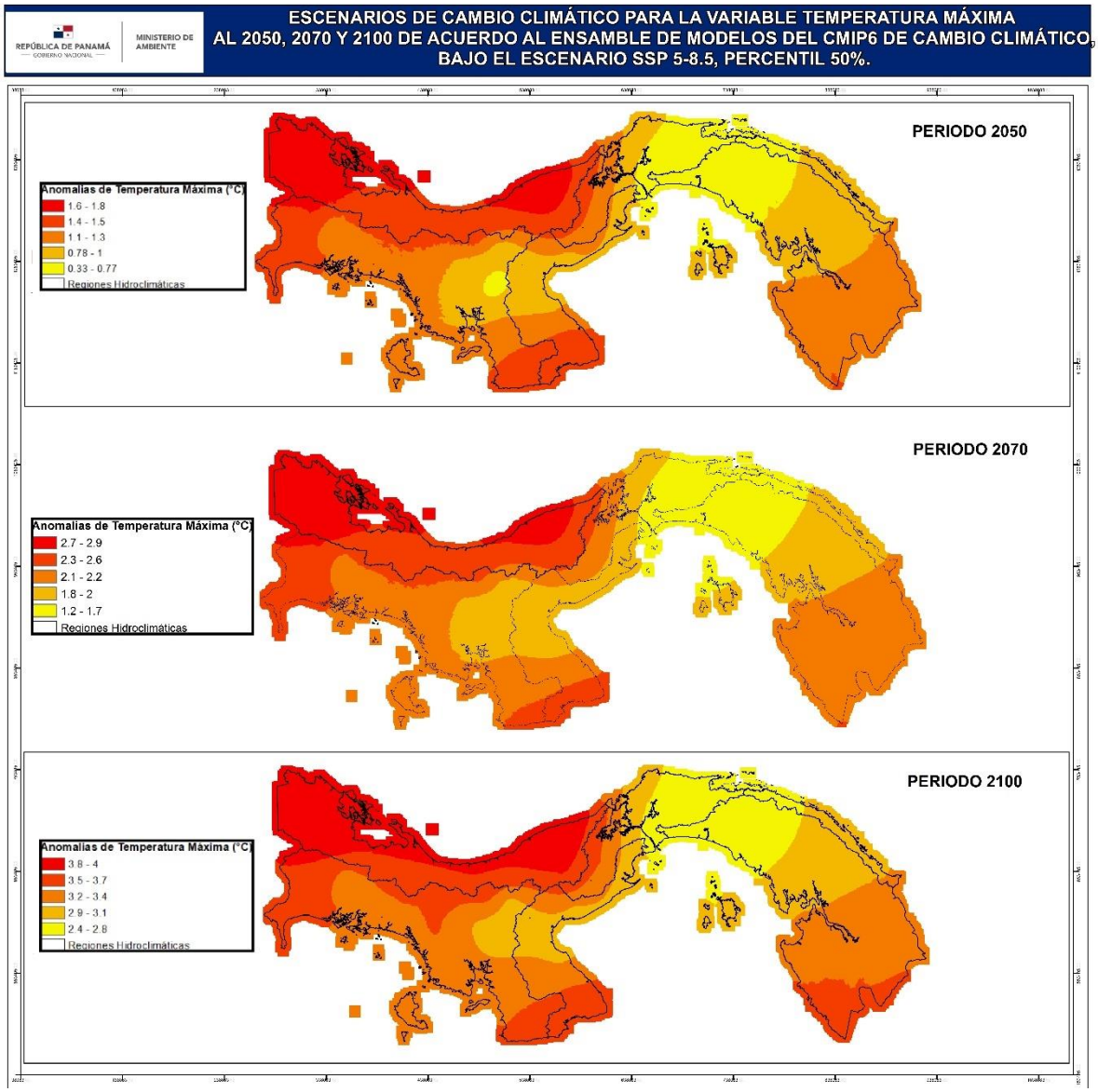


Figure 8. Climate change scenarios, for the maximum temperature variable to 2050, 2070 and 2100 according to the CMIP6 model assembly, under the SSP5-8.5 scenario, percentile 50%. Source: Department of Adaptation and Resilience, Ministry of Environment, 2024.

With regard to minimum temperatures, increases are projected at the national level from 0.64°C to 1.7°C by 2050, from 2.6 °C to 3.7°C in 2070, and 2.4°C to 4°C by 2100. The largest increases are concentrated in the provinces of Colón, Veraguas, Panama and the Ngöbe Buglé County, mean increases for Darién provinces, West Panama, the central area of the Panama Canal basin, and the smallest increase is seen for the province of Bocas del Toro and Chiriquí.

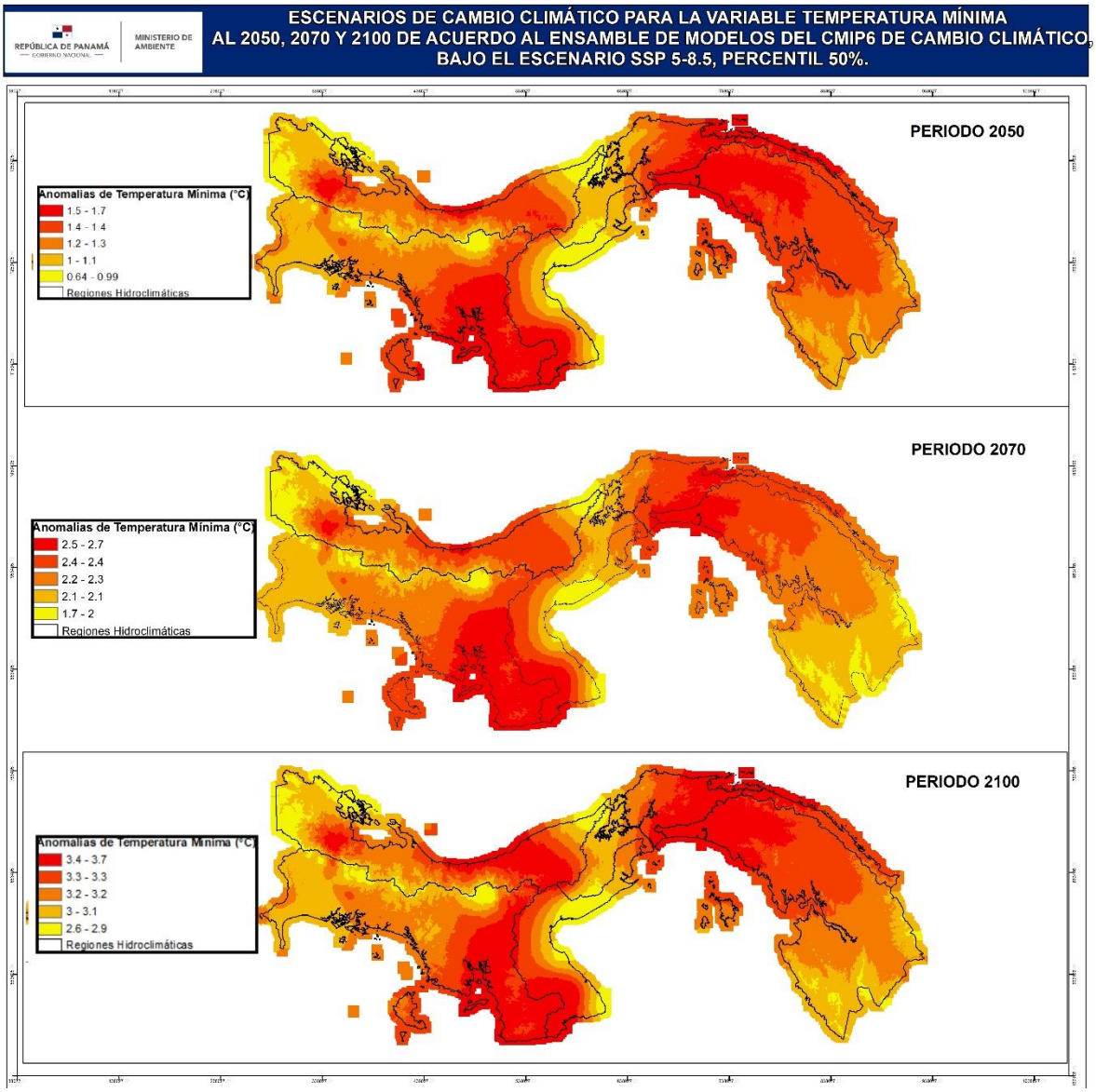


Figure 9. Climate change scenarios, for the minimum temperature variable to 2050, 2070 and 2100 according to the CMIP6 model assembly, under the SSP5-8.5 scenario, percentile 50. Source: Department of Adaptation and Resilience, Ministry of Environment, 2024.

Finally, significant variations were observed in annual precipitation clusters over time and between different regions. Overall, the Caribbean and Pacific regions are expected to experience the greatest changes in precipitation, with increases most pronounced in the Eastern Caribbean and Eastern Pacific.

Constant increases in minimum temperatures were projected in all regions over the analyzed time horizons. The most pronounced increases will be observed in the Eastern Caribbean and Western Pacific regions.

The Arco Seco and eastern regions of the country appear to be more likely to experience increases in both precipitation and temperatures, while western and central regions tend to experience decreases in rainfall and rises in temperatures.

Sea level rise

Panama's extensive coastline, totalling 1,290 km along the Caribbean Sea and 1,700 km along the Pacific Ocean, and 1,518 islands, islets, and cays. Sea surface temperatures vary significantly between the Pacific and Atlantic coasts, driven by interannual and decadal climate patterns. El Niño produces warmer sea surface temperatures and drier conditions, while La Niña produces cooler sea surface temperatures and wetter conditions. However, a trend of warmer sea surface temperatures in the East Pacific Ocean reduces thermal differences between land and sea and ultimately reduces the northward extent of ITCZ precipitation on Panama's Pacific coast[58].

Sea level rise is projected to be more pronounced on the Caribbean coast, with an expected increase of 0.93 m by 2100 compared to 0.76 m on the Pacific coast under the pessimistic scenario[59]. However, flood projections caused by sea-level rise for 2050 are mostly projected in river mouths and mangrove zones in the provinces of Chiriquí, Panama, Darién, Chame, and Coclé in the pacific and only in the insular area of Bocas del Toro in the Caribbean (Figure 10)[60].

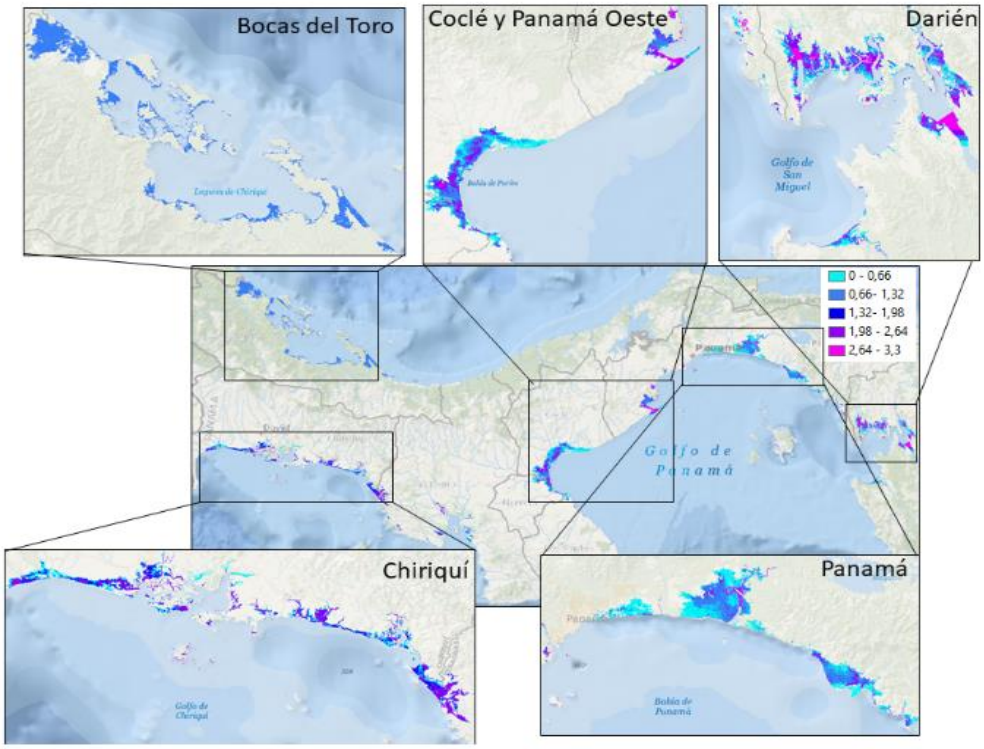


Figure 10. Extension of the flood, with the colour palette indicating the height of the water table in the horizon year 2050 in Panama for the most pessimistic case analysed: IHCantabria, 2023.

3.1.2 Main climate hazards

The following table presents an overview of the main climate hazards affecting Panama and their relevance in the country. Figure 11 illustrates the hazards along with some climate change impacts for each of the climatic regions.

[58] Ibid.

[59] IHCantabria, 2023. Evolución temporal de la línea de costa en Panamá.

[60] IHCantabria, 2023. Evolución temporal de la línea de costa en Panamá

Climate hazard	Relevance in the country
Floods	Between 1920 and 2021, Panama experienced numerous floods, particularly in the Panama Canal region and coastal areas of Bocas del Toro, Chiriquí, and Los Santos. Riverine flooding is a significant hazard in Panama[61]. Notable events like the "La Purísima" storm in December 2010 caused extensive damage, including disruptions to water supply and infrastructure, even temporarily closing the Panama Canal[62]. Floods in rural areas impact agriculture, livestock, and food security. With projected increases in precipitation and the influence of ENSO, intense floods are expected to become more frequent in the future.
Droughts	Droughts in Panama are often linked to El Niño events, with the Dry Arc region, especially Los Santos and Coclé, being highly vulnerable to prolonged dry periods and land degradation. Significant rainfall reductions during past El Niño occurrences (1982, 1998, 2015 and 2019) severely impacted river flows and even disrupted traffic along the Panama Canal. The most recent drought emergency declaration in May 2023 followed record-low precipitation levels in October. These precipitation deficits pose significant challenges to agriculture, livestock, and food security, with droughts exacerbating water stress at the end of the growing season. Moreover, such conditions increase the risk of wildfires nationwide. The understanding of climate change interactions with El Niño phenomenon is key to prevent and respond to this hazard[63].
Landslides	Landslides frequently occur in densely populated urban areas of Panama and Colón provinces[64]. With the anticipated rise in storm intensity and extreme precipitation events, the likelihood of landslides in the mountainous regions of the country is expected to escalate, as highlighted in a recent report by the Ministry of the Environment[65]. Expansion of crop areas due can impact natural ecosystems, reduce flood water drainage and destabilise slopes, making landslides more likely. Additionally, landslides can block water sources and roadways affecting food production and transportation[66].
Sea level rise, sea and salinization	Panama's coastal regions accommodate approximately half of its population. In the western Pacific, coastal flooding and erosion pose significant threats, particularly impacting Puerto Armuelles in Chiriquí. In the Dry Arc, the intrusion of saltwater impacts water resources. Along the Caribbean coast, the accelerated sea level rise endangers mangroves, wetlands, and estuaries, leading to economic and non-economic losses in Bocas del Toro. Indigenous communities in Guna Yala, situated on low-lying coral islands, face disproportionate vulnerability due to sea level rise, where sea level rise and increasingly dangerous storm surges threaten local fisheries, small- and medium- scale agriculture, and permanent habitation[67].
Heatwaves	Increasing maximum temperatures during the dry season, often leading to heatwaves, pose risks to vulnerable populations, including older adults, infants, and those with chronic illnesses. In May 2019, Panama reported high to extreme temperatures across most provinces, attributed to climate change and urban expansion in the capital. Recommendations were issued to prepare for potential heatwaves. Future climate

[61] World Bank Group, 2021. Climate Risk country profile: Panama. 3(4), 1–32.

[62] Stallard, R. F. (2023). Extreme Rainstorms and Landslides in the Panama Canal Watershed – Lessons Learned from the Storms of December, 2010. American Society of Agricultural and Biological Engineers.

[63] Ministerio de Ambiente, & UNCCD, 2020. Plan Nacional contra la Sequía de Panamá. 1–176

[64] Ministerio de Ambiente, 2018. Tercera Comunicación Nacional sobre Cambio Climático Panamá.

[65] Ministerio de Ambiente, 2021. Índice de vulnerabilidad al cambio climático de la república de Panamá.

[66] Ministerio de Ambiente, 2021. Decreto 135 de abril de 2021 sobre la adaptación al cambio climático. República de Panamá, 27927-A(29464), 140.

[67] World Bank Group, 2021. Climate Risk country profile: Panama. 3(4), 1–32.

	projections indicate a likelihood of increased frequency of heatwaves by 2070, heightening risks of dehydration and cardiovascular diseases[68].
Hurricanes and tropical storms	Panama, although typically outside the direct path of hurricanes, has experienced an increase in their impact, leading to significant flooding and landslides, particularly in the western provinces. Notable instances include Hurricane Otto in 2016 and Hurricane Iota in 2020 which resulted in two resulted in numerous casualties, property damage, disrupted infrastructure, and substantial agricultural losses. Other close encounters with hurricanes include Hurricane Beta in 2005, Nate in 2017, and Iota in 2020 2020 (Ministerio de Ambiente, 2022a).[69] The frequency and intensity of hurricanes and tropical storms might be increased by higher sea surface temperatures.

Figure 11. Main climate hazards in Panama. Compilation based on different sources

3.1.3 Impacts on and vulnerability of food systems.

Ideally, a systems approach should be used to assess how climate change affects the food sector in Panama, emphasising the interactions within the components of the system, including its enabling socioeconomic and biophysical environment. However, most of the research on climate change impacts on food systems is only focused on production. A significant knowledge gap exists around the complex ways in which climate change impacts food processing, storage, distribution, and consumption[70].

Agriculture-based food systems

According to the regional vulnerability analysis[71], the agricultural sector in Panama exhibits pronounced vulnerability in specific regions, notably in Bocas del Toro province, the central part of Ngabe Buglé, and the Dry Arc. Interestingly, Panama demonstrates the lowest vulnerability indices across Central America, as highlighted in this study. These findings align with the outcomes of the general vulnerability index developed by the Ministry of the Environment in 2021[72], which also identifies these three areas as *highly vulnerable* or *very highly vulnerable*. Nevertheless, discrepancies arise concerning the Guna Yala and the Darién Region, where vulnerability is primarily attributed to diminished adaptive capacities rather than associated with agricultural activity.

Agriculture in Panama is impacted by both short-term climate variability and longer-term climate change. On one hand, increased climate variability is expected to escalate the frequency and intensity of extreme weather events, significantly impacting agricultural production across the country. Deficits in rainfall, often exacerbated by El Niño phenomena, have led to adverse consequences for agricultural production, particularly in the province of Panama, the Ngabe Buglé Comarca, the Dry Arc region, the Veraguas savannah, Colon, and Bocas del Toro. The primary impacts identified include delays or losses in planting seasons, plant water stress, depletion of

[68] Ministerio de Ambiente, 2023. Cuarta comunicación nacional sobre cambio climático de Panamá.
[69] World Bank Group, 2021. Climate Risk country profile: Panama. 3(4), 1–32., Ministerio de Ambiente, 2018. Tercera Comunicación Nacional sobre Cambio Climático Panamá. Ministerio de Ambiente, 232.
[70] IPCC, 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate.
[71] Rodríguez Rubí, J., 2023. Análisis de vulnerabilidad agrícola al cambio climático para la región del Sistema de la Integración Centroamericana (SICA). Comisión Económica Para América Latina y El Caribe (CEPAL), 1–15.
[72] Ministerio de Ambiente, 2021. Índice de vulnerabilidad al cambio climático de la república de Panamá.

reservoirs, and increased incidence of pests and diseases[73]. For instance, in 2001, a drought event, directly impacted the production of staple crops (maize, rice, and beans), with the Dry Arc region being the most affected[74].

Conversely, extreme precipitation events across the country have resulted in crop losses, river overflow, soil erosion, and nutrient loss in crops. For example, between 2014 and 2015, the overflow of the Chiriquí Viejo River due to extreme precipitation, coupled with human casualties, led to a 60% loss in agricultural production, equivalent to over USD 100 million[75]. Additionally, increases in minimum temperatures, along with higher relative humidity levels, have contributed to a greater prevalence of pests and diseases in rice crops in Chiriquí, Veraguas, and Coclé[76].

The loss of crops due to climate variability, coupled with socioeconomic factors, has deteriorated livelihoods, employment, and agricultural income, thereby affecting other sectors such as industry and services while increasing dependence on imports.

The longer-term climate change is projected to cause an increase in temperatures, total precipitation, and more pronounced wet and dry seasons. These changes are expected to significantly affect the suitability and yields of various crops, thereby impacting food security and agricultural livelihoods in the long term[777879]. Impacts on main crops include:

- **Rice:** Global rice yields are expected to decrease significantly by 2050 (14,4%), leading to a corresponding increase in prices. The average temperature that allows the highest yields for this crop could have already been exceeded in Panama.
- **Banana:** Banana cultivation is likely to have already surpassed the optimal temperature for maximum yields, indicating evident negative effects of climate change on the crop. While increased precipitation may initially seem advantageous, surpassing optimal levels could lead to yield reductions. By 2050, all cultivated areas below 600 meters above sea level will become unsuitable for current banana varieties.
- **Maize:** Corn cultivation in Central America's dry corridor faces challenges due to reduced precipitation and altered rainy seasons. Global corn yields are projected to decline by 2% by 2050, accompanied by a significant price increase. It's likely that optimal temperatures for corn yields have already been surpassed, indicating negative climate change effects. By 2050, suitability changes could lead to significant challenges, with corn cultivation shifting towards higher altitudes in pursuit of cooler climates.
- **Coffee:** Coffee production in Central America will face a significant decline, with only 12% of departments projected to maintain yields above 0.8 tons per hectare by 2100, compared to 34% in the period 2001-2009. By 2050, suitability for coffee cultivation will shift towards higher mountain areas in Chiriquí, Bocas del Toro, and the Ngabe Buglé Comarca. Low-

[73] Ministerio de Ambiente. 2018. Tercera Comunicación Nacional sobre Cambio Climático Panamá.
[74] Ministerio de Ambiente, & UNCCD. 2020. Plan Nacional contra la Sequía de Panamá. 1–176.
[75] Ministerio de Ambiente. 2019. Estrategia Nacional de Cambio Climático, 2050. (Vol. 166, Issue 3611).
[76] CGIAR, MIDA, 2014. Estado del Arte en Cambio Climático, Agricultura y Seguridad Alimentaria en Costa Rica.
[77] Rodríguez Rubí, J., 2023. Análisis de vulnerabilidad agrícola al cambio climático para la región del SICA.
[78] Alianza Bioversity-CIAT, Fundación Natura, & Fondo de Adaptación. (2022). Zonificación edafoclimática de cultivos de Panamá.
[79] Mora, J., Ordaz, J. L., Acosta, A., & Serna, B. (2010). Efectos del cambio climático sobre la agricultura en Panamá. CEPAL, CCAD and DFID, 74.

altitude areas currently marginally productive will become unsuitable for the varieties used.

- **Beans:** The limited areas suitable for bean cultivation are expected to be further affected by climate change, with temperature increases leading to substantial reductions in suitability, impacting national production.
- Other key food products, including cassava, yam, and pumpkin, along with fruits like watermelon, lemon, and orange, are expected to maintain or potentially expand their areas of suitability.

Apart from direct losses and decreases in yields, cascading impacts have been observed and are projected to increase, including:

Pests and diseases: Warmer temperatures may exacerbate the incidence of diseases and pests in domestic crops and facilitate the spread of invasive species, affecting agricultural productivity and livelihoods[80]. For instance, the agricultural sector in the Dry Arc region has been affected by pests and diseases associated with high temperatures and humidity[81].

Disruptions to the hydrological cycle: Changes in evapotranspiration and precipitation patterns may alter the frequency and duration of droughts, which in turn could impact irrigation demand[82].

Ecosystems services: Pressure on ecosystems might affect services essential for agricultural production such as local climate regulation and pollination.

Climate-Induced Migration: Climate-induced migration could further increase, affecting both urban and rural populations' food security. Floods and coastal intrusion will be key drivers of migration, particularly in the country's insular regions[83].

Livestock-based food systems

Livestock-based systems face significant challenges due to the impacts of climate variability and change. However, there remains a gap in information regarding the anticipated impacts and necessary adaptation measures in livestock production, both on a global and national scale[84].

Precipitation patterns play a crucial role in livestock production, with droughts and floods adversely affecting pastures, cereal crops, and forage availability, thereby impacting animal food resources[85]. For instance, the severe drought experienced nationally from late 2015 to mid-2016 significantly compromised water security and livestock farming, particularly in central provinces such as the Azuero region[86].

[80] Ibid.
[81] CGIAR, & MIDA. (2014). Estado del Arte en Cambio Climático, Agricultura y Seguridad Alimentaria en Costa Rica.
[82] Rodríguez Rubí, J., 2023. Análisis de vulnerabilidad agrícola al cambio climático para la región del SICA.
[83] Ministerio de Ambiente. 2023. Cuarta comunicación nacional sobre cambio climático de Panamá.
[84] IPCC. 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change
[85] Ministerio de Ambiente. 2018. Tercera Comunicación Nacional sobre Cambio Climático Panamá.
[86] Ministerio de Ambiente, & UNCCD. 2020. Plan Nacional contra la Sequía de Panamá. 1–176.

Fishery-based food systems

In the western Pacific, areas like Puerto Armuelles in Chiriquí face coastal flooding and beach erosion, undermining the livelihoods of local fishers and disrupting coastal ecosystems. Similarly, in Panamá Oeste along the central Pacific coast, saltwater intrusion threatens water resources, jeopardizing both aquatic habitats and agricultural activities.

Along the Caribbean coast, higher rates of sea level rise endanger vital ecosystems, particularly affecting areas like Bocas del Toro in the western Caribbean. Moreover, the loss of mangroves and wetlands diminishes natural coastal defences against storms and erosion, exacerbating the vulnerability of coastal communities.

Indigenous communities in Guna Yala along the eastern Caribbean face disproportionate risks due to their reliance on low-lying coral islands. Rising sea levels and increasingly dangerous storm surges threaten local fisheries, agriculture, and permanent habitation, posing existential challenges to these communities[87].

The case of the Caribbean fisheries: Climate change is altering the distribution and size of marine species in the Caribbean fisheries, leading to shifts in community structure and coral reef health. Less mobile species on reefs or nearshore areas may become scarcer, while highly migratory species are expected to move northward in the Atlantic. Due to increasing sea surface temperatures, this movement could decrease catches for small-scale vessels in southern Caribbean states. Coastal erosion further reduces fish habitats and fishing access, impacting fish production and sustainable yields. Additionally, frequent, and severe storms pose risks to coastal fishing communities' livelihoods, including damaged infrastructure and disrupted fish market operations. Changes in the availability of high-value species may lead to conflicts among fishing sectors and coastal communities[88].

Fluctuations in temperature, rainfall patterns, salinity levels, and storm intensity also directly impact aquaculture facilities and production processes. While rising temperatures may initially boost yields, increased feed costs and temperature thresholds for farmed species could offset these benefits in the long term. Coastal proximity exacerbates vulnerability to storm surges and saltwater intrusion, placing aquaculture facilities at heightened risk of damage and production losses[89].

The post-harvest supply chain

A significant risk identified in the post-harvest supply chain is the susceptibility to extreme weather events, which can damage road infrastructure, thereby disrupting the availability and affordability of food products. For instance, hurricanes like Eta and Iota caused landslides that blocked the highway connecting Bocas del Toro province with the rest of the country for 21 days, resulting in substantial losses, particularly for banana producers, totalling around $500,000 and affecting

[87] World Bank Group, 2021. Climate Risk country profile: Panama. 3(4), 1–32.
[88] Commonwealth Marine Economies Programme, 2021. Climate change adaptation for Caribbean fisheries.
[89] Ibid.

approximately 600 producers. Other crops such as oil palm, chili, pigeon pea, cassava, and corn also suffered losses due to transportation and marketing challenges[90].

While there is a lack of scientific data specific to Panama's post-harvest supply chain, insights from other regions suggest that many impacts are relevant, especially for perishable, nutrition-dense foods susceptible to climate change effects.

The water–energy–food (WEF) nexus in Panama

Panama's water-energy-food (WEF) nexus underscores the intricate connections between these essential systems and the need to address their implications holistically. Variations in precipitation patterns and temperature can disrupt water availability, impacting both energy generation and food production. The reliance on hydropower is particularly concerning, as it constitutes 58% of the country's power demand. Despite abundant water resources, Panama faces risks of water scarcity during dry seasons, posing significant challenges to hydroelectric generation and, consequently, the nation's energy supply[91]. The 2013 energy crisis, precipitated by water scarcity, serves as a poignant reminder of this vulnerability. Additionally, intensified rainfall and flood events have damaged infrastructure in recent years, further complicating the hydropower sector's challenges[92].

In agriculture, Panama heavily relies on rainfed irrigation, with only a small fraction of land under irrigation. Hence, shifts in precipitation directly affect crop yields and food production. Rising temperatures and droughts exacerbate this issue, leading to heightened water demand from alternative sources like groundwater and irrigation systems. These systems, in turn, require energy for their operation, creating interdependencies between water and energy in food production[93].

Moreover, energy is indispensable throughout the food production process, from cultivation to distribution. Energy-intensive activities such as harvesting, processing, storage, and transportation demand significant power resources. Hydroelectricity serves as a linchpin in powering these activities, but disruptions in power supply can lead to increased food loss due to mishandling, extended processing times, compromised cold chains, and delayed transportation to retailers.

3.2 Other factors and stressors leading to non-resilient food systems

Non-climatic stressors aggravate climate risks in food systems in Panama. Climate change interacts with multi-dimensional vulnerability factors like access to public services and education. Addressing socio-economic and resource management challenges such as education, poverty, and environmental management is essential for building resilient Panama food systems and mitigating vulnerability to climate change.

[90] Ministerio de Ambiente. 2018. Tercera Comunicación Nacional sobre Cambio Climático Panamá.
[91] Ministerio de Ambiente. 2023. Cuarta comunicación nacional sobre cambio climático de Panamá.
[92] Ministerio de Ambiente, 2019. Estrategia Nacional de Cambio Climático, 2050.
[93] Rodríguez Rubí, J., 2023. Análisis de vulnerabilidad agrícola al cambio climático para la región del SICA.

4. Climate, agriculture and food systems policies and practices

4.1 Visions, goals and objectives

The National Strategic Plan State Vision Panama 2030 emphasizes climate change considerations within the strategic axis of environmental sustainability. It outlines strategies to decrease vulnerability by organizing production units and territorial planning in basins and ecosystems while fostering collaboration between government institutions and civil society actors. Furthermore, the axis of Good Life for All underscores efforts to alleviate hunger, ensure food security, and enhance nutrition, all while promoting sustainable agriculture and acknowledging the challenges posed by drought and climate change.

Responsible production and consumption are integral to the strategic axis of Growing More and Better. The Plan aims to enhance the value of national products, diversify agricultural technology, and implement stringent phytosanitary and zoo sanitary measures.

4.2 National policies, plans, strategies and commitments

National Adaptation Plan (NAP)

The development of Panama's National Adaptation Plan (NAP) is currently underway, facilitated by a Readiness project funded by the Green Climate Fund (GCF) and executed by the United Nations Environment Programme (UNEP). The NAP process aims to enhance the country's sustainable capacity and foster stakeholder engagement in effectively planning, financing, implementing, monitoring, and reporting strategic adaptation measures while disseminating knowledge about climate change adaptation.

Aligned with Panama's updated Nationally Determined Contributions (submitted to the UNFCCC in 2020), the NAP process encompasses ten adaptation themes, ensuring coherence with national climate change strategies and priorities. Specifically, a thematic plan focusing on agriculture and food security will be developed as part of this comprehensive initiative.

The main goal will be achieved through the following outcomes:

- Outcome 3.1. Adaptation planning governance and institutional coordination strengthened.
- Outcome 3.2. Evidence basis produced to design adaptation solutions for maximum impact.
- Outcome 3.3. Private sector engagement in adaptation catalysed.
- Outcome 3.4. Adaptation finance increased.

Updated Nationally Determined Contribution (NDC2) (2024)

The updated NDC includes commitments across 10 sectors and thematic areas. The following commitments are advances that are contributing to building climate resilient food systems:

- **Integrated Watershed Management**: Panama commits to developing a 'Climate Change Plan for the Integrated Management of Watersheds' and the Indicative Plan for Environmental Territorial Planning (PIOTA) for the Panama Canal hydrographic basin. These plans were developed and include adaptation and mitigation components. Additionally, an emphasis is placed on the application of nature-based solutions.
- **Marine-Coastal Systems**: Efforts include the development of a Technical Guide of Restoration Techniques for the marine-coastal systems sector. A *Community Technical Guidelines* tool was introduced in 2021, featuring a section on vulnerability analysis in coastal ecosystems.
- **Sustainable Agriculture, Livestock, and Aquaculture**: Commitments involve updating and implementing the National Climate Change Plan for the agricultural sector, restoring 30,000 hectares of degraded lands using agroforestry and 100,000 of silvopastoral systems, and establishing an agroclimatic information system. These updates demonstrate increased ambition and stronger leadership from the Ministry of Agriculture Development.
- **Circular Economy**: Panama aims to establish a circular economy centre, develop the National Climate Change Plan for circular economy, and update regulations for environmental audits and management plans. These measures will include disaster risk management, adaptation measures, and carbon footprint reduction.
- **Measurement, Reporting, and Verification (MRV):** Panama plans to establish and launch the National Climate Transparency Platform, featuring seven modules, including an adaptation monitoring and evaluation system.

National Climate Change Policy PNCC (2023)

Panama's National Policy on Climate Change emphasizes reducing climate vulnerability as a transformative goal, prioritizing public investment in vulnerable regions. A core aspect of the policy is to transform the primary sector by promoting climate-smart agriculture for food security, which involves diversification and technology adoption. Furthermore, it stresses the importance of transitioning to new market niches while developing resilient value chains. Additionally, the policy advocates for sustainable consumption and production patterns, shifting towards a circular economy to minimize waste and resource consumption[94].

National Climate Action Plan (2022)

The Plan includes actions and indicators in line with the commitments of the Updated NDC1. However, financial resources for the implementation of the plan are not specified. Among the actions stipulated by the plan, the following are relevant to building resilient food systems:

[94] Ministerio de Ambiente, 2023. Política Nacional de Cambio Climático PNCC.

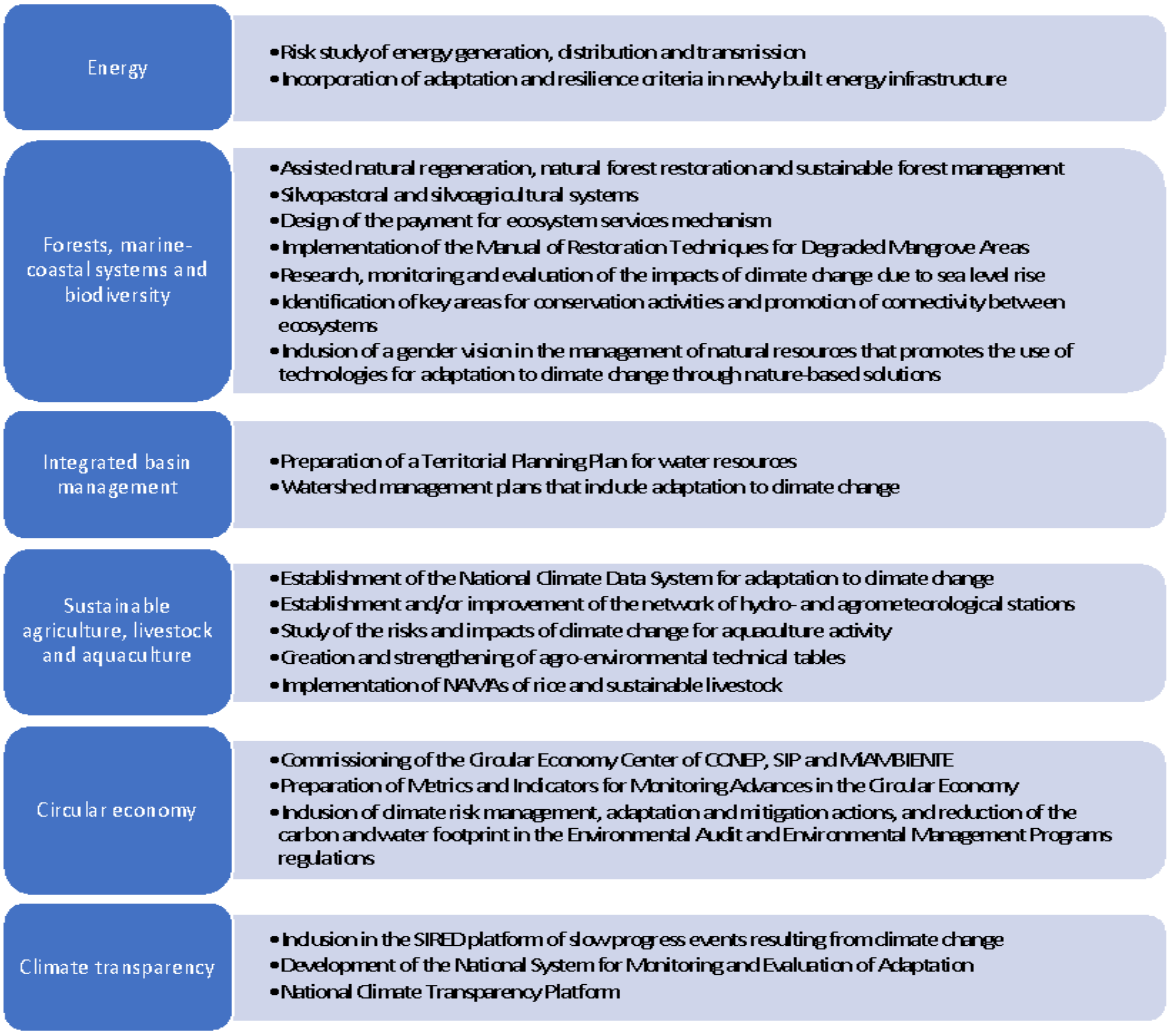


Figure 12. National Climate Action Plan. MiAmbiente, 2022

National climate change strategy, 2050 (2019)

The National Socioeconomic, Inclusive, Low-Emission, and Climate-Resilient Strategy to 2050 emerges as the roadmap to achieve the country's vision of becoming carbon-negative and building climate resilience by 2050. This strategy entails sectoral mitigation and adaptation goals for the medium and long term, developed through a participatory and inclusive process. Additionally, this effort will be aligned with Climate Change Scenarios developed for three national-level climate impacts: temperature variation, precipitation, and sea level rise.

National Gender and Climate Change Plan of Panama (2022)

The Gender and Climate Change Plan is adopted by Executive Decree No. 11 of June 16, 2022 with the objective of laying the foundations to plan, structure and promote prioritized processes of social and environmental transformation aimed at promoting inclusive sustainable development and climate resilience, especially emphasizing the incorporation of gender considerations, thus making visible all the work and efforts carried out by men and women in environmental management to achieve gender equality for a sustainable tomorrow.

Decree 135 of April 2021 on adaptation to climate change

Executive Decree No. 135 regulates the chapter of the General Environmental Law of the Republic of Panama, on adaptation to climate change. It aims to generate a national response to the events that have occurred recently such as the COVID-19 pandemic, the water deficit for the operation of the Panama Canal, the constant increase in temperatures in different regions of the country, the sea level rise, the recorded effects on the production of some strategic crops for food security and the temporary or permanent displacement of some communities due to the impacts generated by climate change, and in order to reduce the vulnerability of communities and ecosystems in the Panamanian territory95.This decree has the purpose of establishing the following components of adaptation to climate change in Panama:

- National Data System for Adaptation to Climate Change (SNDACC).
- National Climate Change Adaptation Strategy, National Registry of adaptation and resilience initiatives and Adaptation Monitoring, Evaluation and Reporting.
- National Fund for Adaptation to Climate Change (FONACC).
- National Reduce Your Footprint Program (PNRTH) - Water.
- National Build Your Resilience Program.
- Climate displaced people.
- Obligation to report and transparency.

National climate change plan for the agricultural sector of Panama (2019)

The Plan[96] aims to build a resilient, participatory, competitive agricultural sector with a low-carbon economy by adopting and implementing actions that stimulate responsible, sustainable production and consumption with competitiveness in an inclusive and equitable environment that contributes to Food Security under a changing climate. The plan integrates 15 specific objectives and 71 lines of action structured into five strategic axes:

1. Production, agricultural competitiveness and food security: Key objectives include enhancing resilience through input availability and planning, promoting sustainable production systems, and establishing efficient commercialization channels for food accessibility.
2. Sustainable management of land and natural resources: Key objectives include promoting practices like biodiversity preservation, soil conservation, efficient water use, reforestation, and integrated pest management. Additionally, it emphasizes sustainable land use planning to ensure efficient food production while enhancing the rural economy and respecting protected areas.

[95] Ministerio de Ambiente, 2021. Decreto 135 de abril de 2021 sobre la adaptación al cambio climático. República de Panamá.
[96] Plan Nacional de Cambio Climático para el Sector Agropecuario de Panamá, 2019. https://chm.cbd.int/api/v2013/documents/05B386D2-5BCD-A52D-6097-F853803CC619/attachments/205301/Plan%20Nacional%20de%20CC%20para%20sector%20agropecuadrio%20-%20CATIE.pdf

3. Research, development, innovation, and transfer: Specific activities include developing accessible technology for small producers and ensuring nutritious food availability. Additionally, the plan promotes the exchange of knowledge to enhance food security in the face of climate variability.
4. Development of technical capabilities and extension: Specific actions include promoting continuing education and awareness among producers and market agents, as well as training professionals in the sector about sustainable production and consumption practices and establishing an extension model that facilitates interaction between agricultural research, education, and practical application.
5. Institutional, economic and financial mechanisms: Specific actions include strengthening institutions for compliance with environmental and sustainable production standards and promoting coordination among relevant bodies. It also aims to develop economic and financial mechanisms to incentivize sustainable agricultural production, such as incorporating payment for environmental services, improving insurance alternatives, and streamlining credit systems.

4.2.1 Other instruments

National Water Security Plan 2015-2050: Water for all

The National Water Security Plan 2015-2050 of Panama[97] encompasses goals that directly or indirectly support the development of resilient food systems, including:

- **Universal Access to Drinking Water and Sanitation Services**: Actions under this goal indirectly enhance rural communities' adaptive capacity in food production and consumption by improving drinking water and sanitation services.
- **Water Availability for Inclusive Socioeconomic Development**: Progress towards this goal involves enhancing water availability and managing demand through projects such as improving irrigation distribution, constructing reservoirs, implementing water harvesting techniques, and enhancing knowledge management, thus benefiting agricultural water use.
- **Preventive Management of Water-Related Risks**: This goal implicitly addresses the impacts of climate change on water resources and advocates for preventive risk management strategies, including adaptation plans and early warning systems.
- **Healthy Hydrographic Basins**: Actions outlined under this goal focus on environmental and territorial planning, including measures for ecosystem conservation and restoration, as well as water quality monitoring, contributing to overall basin health.
- **Water Sustainability**: This goal emphasizes enhancing water governance through regulatory updates, institutional strengthening, and education and research initiatives.

[97] Plan Nacional de Seguridad Hídrica 2015-2050. Secretaría Nacional de Ciencia, Tecnología e Innovación (SENACYT). https://www.senacyt.gob.pa/wp-content/uploads/2018/12/3.-Plan-Nacional-de-Seguridad-Hidrica-2015-2050-Agua-para-Todos.pdf

National Plan Against Drought (2020)

The plan allocates responsibilities to various institutions, building on the National Committee to Combat Drought and Desertification (COANLSED) and the National Civil Protection System (SINAPROC). It identifies priority areas susceptible to drought, notably within the dry arc, and outlines response measures to drought. Additionally, it sets protocols for declaring and communicating drought events[98]. The plan recommends the following categories of actions to mitigate and prepare for droughts:

- Monitoring and evaluation systems for national water resources.
- Development of new and alternative water sources.
- Water conservation practices, education and public awareness.
- Legislation and planning on land use.

National Strategic Plan for Comprehensive Disaster Risk Management of Panama 2022-2030

The plan includes the climate change-related risk category and considers the available future climate change scenarios. It encompasses a program aimed at climate change and risk management, entailing the formulation of national policies and strategies geared towards adaptation. Moreover, the plan advocates for the promotion of nature-based solutions (NBS) for climate change adaptation and disaster risk reduction. Additionally, it emphasizes the establishment and institutionalization of a robust management and financing framework for projects related to comprehensive disaster risk management and climate change[99].

Technology Needs Assessment for Climate Change Adaptation

The assessment[100] was conducted for the water resources (drinking water and sanitation) sector. Improvement areas and challenges were found, and recommendations related to food security include:

- Preparation of water balances in priority watersheds as a contribution to the Integrated Management of Hydrographic Basins and Climate Change.
- Elaboration of regulations (methodology and hydrogeological procedures) to identify, delimit and classify the country's aquifers.
- Evaluation of the impact of saline intrusion on coastal aquifers and delimitation of zones vulnerable to contamination by salinization
- Identification and planning of actions for the control of avenues before floods by events of intense rain for its use.

[98] Ministerio de Ambiente, & UNCCD, 2020. Plan Nacional contra la Sequía de Panamá. 1–176.

[99] Ministerio de Ambiente, 2022. Plan Estratégico Nacional de Gestión Integral del Riesgo de Desastres de Panamá 2022-2030.

[100] UNEP, 2018. Evaluación de Necesidades Tecnológicas ante el Cambio Climático. https://tech-action.unepccc.org/country/panama/

Programas Reduce Tu Huella

Panama, through Executive Decree No. 100 of October 20, 2020, creates The National Program for the management and monitoring of low-carbon economic and social development in the country, called Programa Nacional Reduce Tu Huella (PNRTH), in order to guide Panama towards carbon neutrality by 2050, in line with the objectives of the Paris Agreement.

In general, this program consists of establishing a standardized process for identifying, calculating, reporting, and verifying information related to greenhouse gases at the corporate, municipal, and product levels.

The Programme has achieved important results, including:

- **RTH Carbon Program - Corporate:** the objective established in the first update of Panama's Nationally Determined Contributions (NDC1) was reached and exceeded, which established having at least 100 registered organizations reporting carbon footprint and to date in the third cycle of the program there are more than 130 active organizations reporting their carbon footprint.
- **RTH Carbon Program - Municipal:** the technical standard and procedure manuals were collected in draft version, training was carried out for the municipal team in (4) municipalities on issues related to the emissions quantification methodology applied in the program and the Greenhouse Gas Inventory for the year 2021 of eleven (11) municipalities in Panama, including the Energy, Transport, Agriculture, Land Use and Waste sectors.
- **RTH Carbon Program - Products:** the program's technical standard was raised, which constitutes a comprehensive framework that details the precise methodology for calculating and reporting greenhouse gas emissions through a climate declaration, and the first Pilot Project for the quantification of the carbon footprint of products for companies in the coffee and cocoa sector was initiated.

Since the beginning of the program to date, 56 workshops have been held with a reach of 1,591 people distributed nationwide, highlighting a participation by gender of: Male: 871 (55%), Female: 720 (45%).

Reduce Your Water Footprint Programme

The Reduce Your Water Footprint program was created through Executive Decree No. 135 of April 30, 2021, which regulates Chapter I of Title V of Law 41 of July 1, 1998, the General Environmental Law of the Republic of Panama, on Adaptation to Global Climate Change. This program focuses on the management and monitoring of water footprints at the organizational, municipal, and product levels in Panama, with the aim of implementing effective climate change adaptation strategies.

The growing awareness of the importance of environmental protection and the potential impacts associated with products, both manufactured and consumed, has increased interest in the

development of methods to better understand and address these impacts. One of the techniques developed in this regard is Life Cycle Assessment (LCA).

The Products component of Reduce Your Water Footprint seeks to identify, calculate, report, and verify information related to the water footprint of products at the national level. It represents an opportunity to introduce more rational and sustainable production and consumption protocols, as well as early actions in the face of future scenarios of drought and water scarcity, and to have greater water availability for alternative uses through strategic water resource management at the national level.

At the national level, there is a first experience in measuring the water footprint of agricultural crops: corn and bananas, in the watersheds of the Chiriqui Viejo and Santa Maria rivers, and a preliminary version of the Technical Standard of the Reduce Your Footprint - Water Products program, aimed at agricultural commodities.

Climate Change Adaptation Monitoring and Evaluation System in Panama

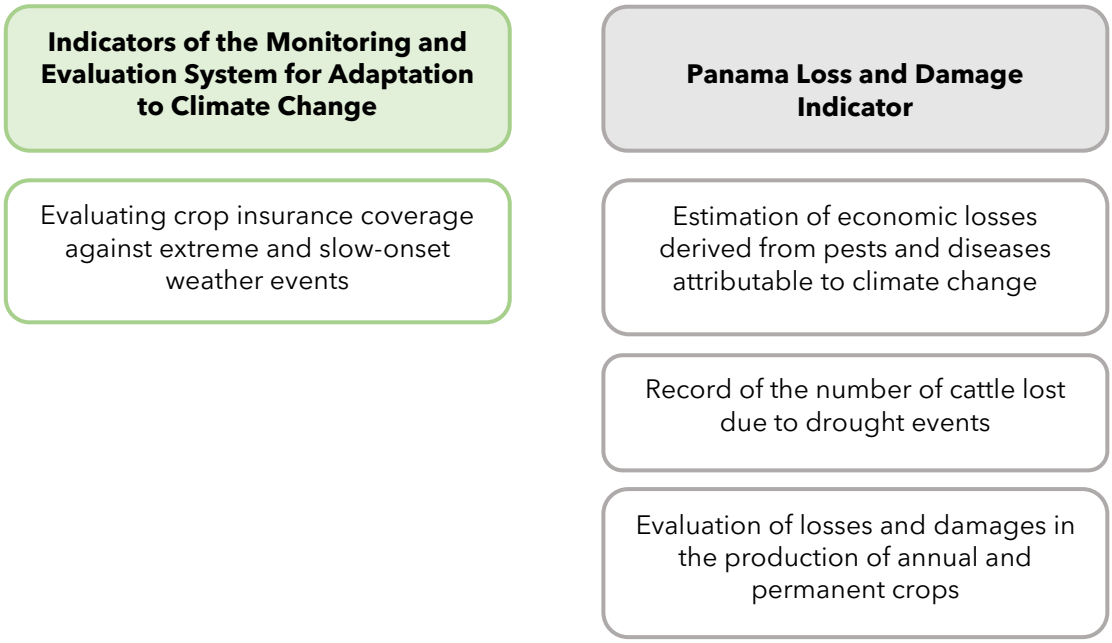
In 2021, Panama presented its first Climate Change Adaptation Monitoring and Evaluation System. This system, characterized by its hybrid approach, seeks to measure both progress in the implementation of the National Adaptation Plans (NAPs) and progress towards effective adaptation in various sectors. In this sense, it employs specific indicators for each of the sectors defined in Panama's Nationally Determined Contribution (NDC1), with the aim of quantifying the degree of implementation of adaptation plans. These sectors include:

- Sustainable Agriculture, Livestock and Aquaculture
- Resilient Human Settlements
- Biodiversity
- Forests
- Energy
- Integrated Watershed Management
- Sustainable Infrastructure
- Circular Economy
- Public Health
- Marine-Coastal Systems

Loss and Damage Monitoring and Evaluation System in Panama

In 2022, Panama complemented its robust monitoring and evaluation framework with the introduction of the Climate Change Loss and Damage Monitoring and Evaluation System. This system facilitates a systematic assessment of the losses and damages associated with climate change. These estimates would contribute to the design of public policies for risk management (prevention, reduction, transfer and emergency response) and climate change adaptation (climate resilience).

The M&E System includes specific indicators for the agricultural sector, a sector particularly vulnerable to the impacts of climate change. These indicators include:



Source: Ministry of Environment, 2024

M&E System Module in the PNTC

Introduced in 2022, the M&E Module comprises two sections within the National Climate Transparency Platform (PNTC): Adaptation and Loss and Damage. The Adaptation section encompasses 21 indicators providing information on climate change adaptation actions in Panama. In contrast, the Loss and Damage section incorporates 16 indicators to quantify the economic and non-economic repercussions, as well as the damage caused by extreme and slow-onset climate events. The M&E module serves as a valuable tool for climate information management in Panama, fostering transparency of adaptation actions and enabling informed decision-making to confront the challenges posed by climate change.

5. Institutional Arrangements and Coordination

In Panama, institutional coordination related to food systems and climate change involves various government departments and ministries. Additionally, academic institutions and stakeholders collaborate closely in implementing and coordinating activities related to food systems.

Efforts are made to ensure coordination among different government departments and ministries involved in addressing food systems and climate change. The Ministry of Environment leads the

coordination regarding climate change topics, specifically through the Climate Change Department, one of the 10 different Departments of the Ministry. This department plays a key role in actions and coordination for climate change, including[101]:

- Ensure compliance with international agreements and commitments assumed by Panama before the UNFCCC, as the national focal point;
- Generate scientific knowledge on climate change, supporting decision-making in adaptation and mitigation of climate change at the national and international levels;
- Propose, formulate and support the design of public policies, strategies, programs plans and regulations;
- Identify and manage sources of climate finance;
- Promote innovation, transfer and use of green technologies to combat climate change;
- Develop the institutional, operational and technical conditions necessary for work on climate change.

The Ministry of Agricultural Development (MIDA) takes the lead in terms of climate, food, and agriculture. One of the key departments within this ministry for the development of climate-resilient food systems is the Department of Rural Engineering and Irrigation. Its goal is to strengthen agricultural production through the application of appropriate technological levels, production infrastructure, and management and conservation of natural resources[102].

Collaboration with stakeholders, including non-governmental organizations, private sector entities, and civil society organizations, is integral to the success of food systems and climate change resilience initiatives. Mechanisms for engaging stakeholders and ensuring their active participation include various committees and specific instances of participation.

The involvement of academia and research centres is key to the Ministry of Agricultural Development's work. The Agricultural Innovation Institute of Panama (IDIAP) is a government institution whose main function is to research to generate, adapt, validate, and disseminate agricultural knowledge and technologies, framed within the agricultural sector's policies, strategies, and guidelines[103].

While the structure and scope of the institutions are well-framed, several challenges related to institutional arrangements and coordination were identified. These include ensuring effective coordination among departments and ministries to avoid duplication of efforts and promote synergy in food and climate-related actions, as these areas are often treated separately within the institutional framework.

[101] Ministerio de Ambiente, Dirección de Cambio Climático. https://dcc.miambiente.gob.pa/sobre-nosotros/
[102] Ministerio de Desarrollo Agropecuario, Dirección de Ingeniería Rural y Riego. https://mida.gob.pa/direccion-de-ingenieria-rural-y-riego/
[103] Instituto de Innovación Agropecuaria de Panamá (IDIAP)

6. Ongoing projects, programmes and initiatives geared towards climate resilient food systems

Agency	Programme	Dates	Funding (USD)	Description
FAO	Crisis alimentaria y digitalización agricultura: modernización MIDA Panamá	2022-2024	200,000	Panamanian agricultural public institutions adopt and implement digital innovation mechanisms and generate public goods for public and private sector use (transparency and institutional functionality), accelerating the response to the food crisis.
FAO/GCF	Preparation of strategic frameworks and climate finance to reduce deforestation and forest degradation and guide the investment of the GCF in Panama	2020-2023		The main objective of the proposal is the preparation of strategic frameworks and capacity building in climate finance to guide the investment of the GCF in the forestry sector and other land uses in Panama.
FAO/ GEF	Sustainable land management and restoration of productive landscapes in river basins for the implementation of national targets of Land Degradation Neutrality (LDN) in Panama	2022-2025	GEF grant: 1,867,808 Cofinancing: 17,508,517	Expand sustainable land management and restoration of productive landscapes in watersheds for the implementation of national Land Degradation Neutrality (LDN) targets in Panama.

World Bank	Panama Climate Resilience and Green Growth DPL	2023 2024	150.00 million 350.00 million	The development objective is to establish policy foundations to foster low-emission and sustainable economic growth and climate change resilience.
World Bank	Panama Sustainable Rural Development and Biodiversity Conservation	2022-2026	3.51 million	The project's development objective is to strengthen capacity for biodiversity conservation and increase the adoption of biodiversity-friendly and inclusive practices in select rural areas of Panama.
UNDP/ GEF	Realising the potential of native microbes in the agricultural and medical sectors, in accordance with the Nagoya Protocol	2019-2020	GEF grant: 863,242 Cofinancing: 14,535,059	To support the realisation of the potential of native microorganisms to contribute to the agriculture sector while generating global environmental benefits, in accordance with the provisions of the Nagoya Protocol.
IICA/ IDB	Blockchain and Precision: Innovating Together with Rice Chain Producers in Panama.	2022-2025	1,257,700	Increase profitability and reduce greenhouse gas emissions of mechanised rice producers through a pilot scheme with 100 producers to encourage the adoption of a precision production model.

Adaptation Fund	Adapting to climate change through integrated water management in Panama	2018-2020	9,967,559	Establish climate resilience water management to enhance food and energy security at the national level, including an integrated and community-based approach in the Chiriqui Viejo and Santa Maria Watersheds.
IDB	PIASI: Proyecto de Innovación Agropecuaria Sostenible e Incluyente	2021-2026	46,601,560	Improve the food security and incomes of smallholder family farmers by increasing profitability, improving resilience to shocks (climate, pests and diseases, market shocks), and increasing the environmental sustainability of farms.
IDB	Strengthening of the agricultural sector of Panama	2022-2024	5,000,00	Achieving a timely implementation of PIASI; deepening the knowledge of the Panamanian agricultural sector; and conducting feasibility studies to support the modernisation of agricultural health and food safety services.

7. Priority actions in climate and food systems

In its UN Food System Pathway[104], Panama outlined four priority areas. The nexus between food and climate is crucial in the fourth priority, Environmental Sustainability and Climate Change Resilience, which underlines the need for climate action to adapt food systems. The four priorities and their pathways are as follows:

1. Strengthening Family Farming: The priority is to recognize and support family farming as a vital sector for food security and economic development in rural areas. Efforts are needed to address the challenges faced by small-scale farmers and enhance their role in sustainable food systems. The roadmap outlines several actions to achieve this priority, including:

- Establish legislation and institutional frameworks for sustainable rural development.
- Promote productive activities and social development in rural areas.
- Implement market development policies, including public procurement programs.
- Provide direct support to small producers through incentives and differentiated credits.
- Enhance capacities of small producers through training and technical assistance.
- Promote microenterprise development and new productive arrangements.
- Coordinate programs for social inclusion and poverty reduction in rural areas.

2. Innovation and Technological Advancement in Productive Systems: Innovation and technology play crucial roles in improving productivity and competitiveness in agriculture. This priority focuses on enhancing research, education, and technological adoption to modernize Panama's agricultural sector. The roadmap includes the following actions:

- Foster scientific research, innovation, and technological development.
- Prioritize the incorporation of Agrotechnology in agriculture, livestock, fishing, and mariculture.
- Stimulate professional education and establish a national training system.
- Encourage technological innovation in all producer segments through programs and incentives.
- Increase scholarships for training new professionals in technology and innovation.

3. New Relationships with Markets: Panama aims to establish fair and balanced trade relations that benefit domestic producers while ensuring access to affordable food for the population. This priority focuses on reviewing trade agreements, enhancing market access, and strengthening local market infrastructure. The actions outlined in the roadmap include:

- Review bilateral and multilateral treaties to improve Panama's position.
- Create policies to protect domestic producers from excessive imports.
- Establish inclusive marketing mechanisms and networks.
- Build peripheral and community markets to ensure food access.

[104] Ministerio de Desarrollo Agropecuario, 2021. Hoja De Ruta para los Sistemas Alimentarios de Panamá.

- Develop modern and specialized market research mechanisms.

4. Environmental Sustainability and Climate Change Resilience: Environmental degradation, water management, droughts, and other consequences of climate change pose significant challenges to agriculture and food security in Panama. To address these issues, the priority is to emphasize sustainable practices, conservation efforts, and adaptation strategies to mitigate environmental risks. Some of the actions to achieve this priority include:

- Value territorial environment and integrate economic, cultural, and ecological aspects.
- Design and implement environmental development proposals involving community participation.
- Strengthen policies and mechanisms for resource conservation and waste management.
- Promote rural agro industries for waste reduction and employment generation.
- Implement programs for sustainable production systems adapted to climate change.

Additionally, Panama in its updated NDC[105] identified 10 priority sectors and strategic areas, of which three strategic actions are specific to the sustainable agriculture, livestock, and aquaculture sectors:

- By 2025, **the National Climate Change Plan for the Agricultural Sector will have been updated and implemented, and an agroclimatic information system will have been created**: This action aims for a more adapted and resilient agricultural sector, what involves improving the population's food security in the face of climate change factors and climate risk management.

- By 2030, **the Nationally Appropriate Mitigation Action (NAMA) for rice will have begun to be implemented and the livestock NAMA will have been formulated and with implementation underway**: Along with the information system, this action will be accompanied by capacity building and communication strategies for stakeholders, maximizing their productive performance.

- By 2050, **130,000 hectares of degraded lands will have been restored using agroforestry and silvopastoral systems**: This action seeks to contribute to the adaptation and mitigation of climate change in degraded areas of Panama.

8. Needs and Gaps for implementation

While the existing frameworks in Panama concerning climate change and agriculture are robust, there are areas for improvement to progress towards building climate-resilient food systems, some of the needs and gaps for implementation identified through the desk review and interviews with different national and regional stakeholders are:

[105] Ministerio de Ambiente Panamá, 2020. Contribución Determinada A Nivel Nacional (CDN1) Primera actualización.

- **Institutional Coordination Challenges:** Identified challenges in institutional arrangements and coordination reveal the necessity for enhanced collaboration among government departments, ministries, and stakeholders. Effective coordination mechanisms are imperative to prevent duplication of efforts and foster synergy in food and climate-related actions. Often, these areas are treated separately within the institutional framework, highlighting the urgency for integrated approaches and more communication between the different departments.

- **Capacity Building and Producer's Engagement:** A crucial aspect of addressing agricultural challenges involves capacity building for farmers and producers. One of the challenges identified was the need for training and capacity building for farmers, including the use of technologies and monitoring tools, especially for water management.

- **Technology and Funding**: Different interviews and policy documents underscore the need to address irrigation systems and water management challenges, particularly in the face of increasing water scarcity. Additionally, modernizing and strengthening the agricultural sector, such as upgrading rice and maize planting methods and gathering specific data for the country, must overcome financing and resource allocation obstacles.

- **Language and Indigenous Agenda**: Language barriers and the inclusion of indigenous perspectives in climate funds and policy frameworks emerge as critical concerns. While the country recognizes Indigenous Peoples' perspectives, and they own more than 20% of the country's land titles, linguistic barriers in climate project formulation difficult to include Indigenous Peoples' visions into big adaptation and resilience projects and actions.

- **Equitable Water Rights:** An urgent issue highlighted is the inequitable distribution of water rights, which disproportionately favours large-scale agricultural enterprises over smallholders. One of the main challenges regarding this topic is that the legislation dates from the 1960s, and the efforts made to update it haven't been successful.

9. Entry points for the Climate Resilient Food Systems Alliance

Based on the desk review provided, along with interviews conducted with key stakeholders from both Panama and the region, the following entry points are presented, considering the scope of the CRFS Alliance.

Policy support

Support the incorporation of food and climate nexus in the NAP project building from the Readiness project executed by the United Nations Environment Programme (UNEP). The CRFS Alliance can support the inclusion of food and agriculture language and coherence within the NAP text to enhance the food and climate nexus in this key document and build climate resiliency.

The CRFS Alliance can support Panama on their UN Food Systems Pathway, especially on the Environmental Sustainability and Climate Change Resilience priority. The CRFS Alliance, through

its expertise and vast network, could support and review the design and implementation plans of the environmental development proposals involving community participation, as well as review the new or make suggestions to strengthen policies and mechanisms for resource conservation and waste management.

Looking forward to the next NDC update, the CRFS Alliance can provide technical support to Panama for the inclusion of food and climate nexus language and following implementation, especially for the following sectors:

- Integrated Watershed Management
- Marine-Coastal Systems
- Sustainable Agriculture, Livestock, and Aquaculture
- Circular Economy

Enhance Coordination

One of the challenges identified in both the desk review and interviews was the coordination among key governmental actors from various departments of the Ministry of Environment, Ministry of Agricultural Development, academia, and producers. The CRFS Alliance, leveraging its capacities, will seek opportunities to facilitate inter-ministerial dialogues along with producer representatives to ensure clarity of roles and intersections, thereby contributing to filling the gaps in information and coordination that may exist.

Data and Capacity Building

The CRFS Alliance acknowledges the ongoing efforts of various ministries and academia in Panama to generate and continuously update information on water availability for crops, water resource use, and land use. However, limitations in gathering and elaborating more precise data are also recognized, needing to use information from neighboring countries. Therefore, the CRFS Alliance will leverage its network and global reach to highlight the lack of domestic data and seek opportunities to create and find resources to build methodologies for collecting data on water availability for crops in the country through South-South cooperation, existing global or regional projects.

The CRFS Alliance recognizes the importance of empowering farmers with the knowledge and tools needed to make informed decisions regarding water management and crop production. To address this, aligned with the four priorities of the UN Food Systems Pathway, the Alliance aims to support the government in designing and facilitating a series of training sessions and workshops tailored to farmers, focusing on the utilization of available information for optimizing water usage and enhancing crop yields. Additionally, for the design of this training instrument, fostering dialogue between farmers and academia will be prioritized to promote the exchange of insights and best practices related to efficient water resource utilization. Through these initiatives, the Alliance seeks to advance in the achievement of the UNFS Pathways while strengthening the capacity of farmers and enhancing collaboration between key stakeholders to effectively address water management challenges in agriculture.

International Cooperation

The CRFS Alliance also acknowledges the progress and breakthrough actions Panama has been undertaking in international climate processes, as well as its effective international and regional coordination, and the involvement of young people in decision-making. For the CRFS Alliance, it is essential to highlight these examples, as they can offer global visibility and engage with countries and stakeholders from various fields to showcase the country's best practices and share experiences with other CRFS Alliance country members to identify collaboration opportunities.

To conclude, the CRFS Alliance's collaboration with Panama offers a potential pathway to address the critical challenges of climate change and food security. The Alliance seeks to support policy development, particularly in integrating the food and climate nexus into the NDCs, NAP project and the UN Food Systems Pathway, aiming to enhance Panama's climate resilience.

The Alliance is committed to facilitate coordination among key stakeholders and building capacity, aiming to support the country in managing its human and financial resources more effectively. Furthermore, the Alliance recognizes Panama's progress in international climate processes and is engaged in finding spaces to showcase these good practices. The CRFS Alliance appreciates the collaboration with the Ministry of Environment of Panama and its stakeholders to work towards the goal of building climate resilient food systems.