Guyana's National Drainage and Irrigation Strategy 2030

Enhancing Decision Making for a Resilient, Efficient, and Sustainable Drainage and Irrigation System in Guyana

National Drainage & Irrigation Authority
MINISTRY OF AGRICULTURE

GGGI

CDRI
Coalition for Disaster Resilient Infrastructure
IRAF
Infrastructure Resilience Accelerator Fund
IRIS

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Foreword

It is with great pride and a deep sense of responsibility that I present Guyana's National Drainage and Irrigation Strategy 2030. This strategy signifies a crucial step in our country's path toward sustainable agricultural growth, resilient rural communities, and responsible environmental management. It sets out clear targets and goals that align with Guyana's Low Carbon Development Strategy 2030, CARICOM's 25 by 2025 +5 agenda, and Guyana's climate adaptation commitments. As our nation continues to develop, diversify, and modernize, the effective management of water resources through strong and reliable drainage and irrigation systems remains key to our goals for food security, climate resilience, and economic growth.

The National Drainage and Irrigation Strategy 2030 is based on three main pillars: Governance and National Participation, Data and Data Management Systems, and Infrastructure Planning, Maintenance, and Financing. It has a comprehensive roadmap that emphasizes the importance of inclusive and transparent governance, the need for reliable data and innovative technologies, and the significance of modern, sustainable infrastructure to support our agricultural sector and protect our communities. The pillars not only demonstrate our government's commitment to equitable development but also highlight our dedication to empowering all stakeholders, including indigenous populations, farmers, and local authorities, to actively participate in shaping our shared future.

This strategy results from extensive consultation, evidence-based decision-making, and the collective efforts of our technical experts, development partners, and communities. It sets ambitious, yet achievable and forward-looking goals that will enhance our ability to respond to climate change, adopt new technologies, and ensure the long-term sustainability of our drainage and irrigation systems. In doing so, we are laying the groundwork for a resilient, efficient, and sustainable agricultural landscape, one that will support livelihoods, strengthen our economy, and preserve our natural resources for future generations.

I call upon all stakeholders, government agencies, farmers, private-sector partners, and civil society to work together to realize the vision set out in this strategy. Let us embrace innovation, foster collaboration, and remain steadfast in our commitment to safeguarding agricultural production, protecting communities, strengthening national resilience, and supporting Guyana's transformation into a regional food security leader.

Hon. Zulfikar Mustapha

Minister of Agriculture

Message

It is a great honor to help advance the development of Guyana's National Drainage and Irrigation Strategy (NDIS) 2030 as Chair of the National Drainage and Irrigation Authority (NDIA).

As the central coordinating body for drainage and irrigation, the NDIA is committed to playing an integral role in transforming the agriculture sector through the three strategic pillars: Governance and National Participation; Data, Technology, and Knowledge Systems; and Infrastructure, Planning, Maintenance, and Finance. These pillars collectively strengthen our ability to modernize infrastructure, improve decision-making, and build a more climate-resilient and inclusive system.

Guyana continues to face increasing climate-related pressures such as extreme rainfall, droughts, saline intrusion, and rising sea levels, which threaten both rural and urban communities. These challenges demand adaptive, innovative, and sustainable approaches to water management. The NDIS 2030 responds to this reality by integrating climate resilience, nature-based solutions, and data-driven planning into every aspect of our work.

The collaborative development of this strategy would not have been possible without the dedicated participation of a wide range of stakeholders, government agencies, farmers, community leaders, and our development partners, whose insights and commitment were essential in shaping a shared vision for the future of Guyana's drainage and irrigation sector.

Throughout this process, the focus has been on promoting open dialogue and ensuring that all voices are heard, especially those at the grassroots level whose daily experiences shape the practical realities of our work. By facilitating these discussions and providing guidance informed by technical expertise and national priorities, this Strategy was collaboratively developed to balance innovation, resilience, and sustainability while staying grounded in the needs of the country's people and our environment.

I am confident that, together, we will achieve the ambitious goals outlined in this strategy by continuing to build strong partnerships and staying committed to progress. My sincere thanks go to everyone who shared their time, expertise, and passion for this effort. Let us move forward, united in our mission to create a resilient, efficient, modern and sustainable drainage and irrigation system that supports future development for all Guyanese.

Mr. Lionel Wordsworth

Chairman, National Drainage and Irrigation Authority
Co-operative Republic of Guyana

Enhancing Decision Making for a Resilient, Efficient, and Sustainable D&I System in Guyana

Guyana's National D&I Strategy 2030 aims to improve decision-making for a resilient, efficient, and sustainable D&I system. Built on three core pillars, the strategy first encourages Governance and National Participation by promoting fair ownership and the inclusion of all social groups in drainage and irrigation, with special attention to indigenous communities ("Collaborate"). Key priorities include integrated decision-making and budgeting, as well as improved physical planning. The second pillar, Data and Data Management Systems, focuses on increasing access to and the flow of information by creating robust data management tools and governance structures, and by supporting data-driven decisions through new technologies, networks, and research centers ("Inform"). The third pillar, Infrastructure Planning, Maintenance, and Finance, aims to modernize the design, operation, and maintenance of national D&I infrastructure by leveraging technological and human resource innovations, ensuring long-term sustainability and efficiency across Guyana's agricultural sector ("Act"). Together, the three pillars set forward-thinking targets to improve efficiency and sustainable water management for the Agency.

NDIS 2030 - Summary Results Framework

"Resilient, Inclusive and Climate-Smart Drainage & Irrigation Systems"

Climate-resilient, inclusive, and efficiently managed D&I systems supporting food security, economic growth, and sustainable development

PILLAR 1

Governance & Institutional Strengthening

- NDIA strengthened as apex coordinating body
- Inter-ministerial coordination mechanisms
- Joint planning with subnational agencies
- Stakeholder engagement frameworks
- Water Users Associations strengthened
- National financing framework for NDIS

PILLAR 2

Data, Technology & Knowledge Systems

- National D&I data mapping established
- Centralized D&I data repository
- Data sharing standards adopted
- Traditional & local knowledge integrated
- National D&I dashboard deployed
- M&E system for climate monitoring

PILLAR 3

Infrastructure, Planning, Maintenance & Finance

- National O&M system established
- NbS baseline & climate risk methods
- NbS-based infrastructure designs
- NDIA prioritization system
- Community-led maintenance models
- D&I Rangers trained & deployed

Cross-Cutting Themes

- Climate Resilience
- Nature-based Solutions
- Gender & Social Inclusion
- Data-Driven Decision Making
- Community Participation & Local Governance

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ACRONYMS

AIS	Agricultural Information System
AR5	IPCC's Fifth Assessment Report
CANROP	Caribbean Network of Rural Women Producers
CBA	Cost-Benefit Analysis
CDC	Civil Defense Commission
CDC's	Community Development Councils
CHPA	Central Housing and Planning Authority
D&I	Drainage and Irrigation
EPA	Environmental Protection Agency
GESI	Gender Equality & Social Inclusion
GIS	Geographic Information System *(Common expansion)*
GLDA	Guyana Livestock Development Authority
GL&SC	Guyana Lands and Surveys Commission
GuySuCo	Guyana Sugar Corporation
GWI	Guyana Water Incorporated
Hydromet	Hydrometeorological Service
LCDS	Low Carbon Development Strategy
M&E	Monitoring and Evaluation
MEL	Monitoring, Evaluation, and Learning
MHSSS	Ministry of Human Services and Social Security
MMA/ADA	Mahaica-Mahaicony-Abary/Agricultural Development Authority *(Standardized)*
MOA	Ministry of Agriculture
MNR	Ministry of Natural Resources
MoPW	Ministry of Public Works
NAREI	National Agricultural Research and Extension Institute
NbS	Nature-based Solutions
NDC	Neighborhood Democratic Councils
NDIA	National D&I Authority
NDIS	National D&I Strategy
NGESIP	National Gender and Social Inclusion Policy
NGOs	Non-Governmental Organizations
O&M	Operation and Maintenance
PES	Payment for Ecosystem Services
PPPs	Public-Private Partnerships
PTCCB	Pesticides and Toxic Chemicals Control Board
RDC	Regional Democratic Councils
RPA	Rice Producers Association
SDGs	Sustainable Development Goals
SREX	IPCC Special Report on Emissions Scenarios
WUA	Water Users Association

1 Overview

Photo: GGGI

The National Drainage and Irrigation Authority (NDIA) is Guyana's premier organization responsible for all public matters and functions *"as the Nation's apex organization dealing with all public matters about management, improvement, extension, and provision of drainage, irrigation, and flood control infrastructure and services in declared areas of the country. While providing support and assistance to other public institutions dealing with connected activities, it shall also evolve mechanisms for improved water use with financial sustainability, equity, and efficiency as the guiding principles."* Established in 2006 by the D&I Act (No. 10 of 2004)[1], the NDIA has implemented an institutional structure for water resources management strategies and water-use planning, and it sits within the Ministry of Agriculture.

With the rapid expansion of areas being converted to agriculture and the challenges posed by climate change, the improvement and management of both declared and undeclared drainage and irrigation (D&I) areas are increasingly important. In many locations, operational boundaries between drainage systems serving residential areas and those serving agricultural lands are not clearly defined. Consequently, D&I resources are frequently allocated across both types of areas to address shared or overlapping infrastructure. This situation often results in the NDIA assuming "*de facto*" responsibility for the management and maintenance of drainage assets where jurisdictional distinctions are unclear or where local management structures are insufficient. Assuming this de facto responsibility, the NDIA supports providing services along Guyana's low-lying coastal zones, which are vulnerable to flooding, by ensuring that the country's extensive network of canals, pumps, sluices, and embankments is efficient and operational to boost agricultural productivity, manage flood control, and build resilience against climate challenges, prompting the agency to develop a strategy in 2017.

The progression from the NDIA Strategy 2017-2021 to the Capital Works Strategy 2021-2025 in **Table 1** marks a clear shift from strategic planning and foundational work to concrete implementation and outcome delivery. The first period focuses on establishing the systems, data infrastructure, and institutional framework needed for effective decision-making. In contrast, the second period translates those foundations into tangible capital investments with specific, measurable climate resilience targets.

1 D&I Act 2004

Table 1. NDIA D&I Strategies

Strategic Pillar	NDIA Strategy 2017–2021	NDIA Capital Works Strategy 2021–2025
Core Purpose	Establish a strategic framework for improving D&I systems across declared and undeclared lands.	Translate strategy into targeted capital investments to enhance system performance and climate resilience.
Planning & Data Systems	Development of GIS for D&I assets Improved data collection for informed decision-making Risk assessments to identify vulnerable farming areas	Advanced mapping of catchments Determination of drainage coefficients Integration of new technologies for asset management
Hydraulic & Physical Infrastructure	Hydraulic modelling of catchments Increase discharge capacity to manage 3.5 inches/24 hrs	Design for 15-year return period rainfall events Fast-tracking pumped drainage systems Regular maintenance of sluice outfalls
Climate Resilience Outcomes	Improved flood management Target of 50% reduction in water-related crop losses	Enhanced resilience to extreme rainfall 50% reduction in weather-related crop losses through infrastructure upgrades
Community Engagement	Farmer participation in D&I planning Formation of Water Users' Associations (WUAs) Promoting cost recovery for system sustainability	Expansion of WUAs a strengthened community role in operations and maintenance
Capacity Building	Training NDIA staff in D&I planning and execution	Advanced capacity building for system management, climate adaptation, and infrastructure operations
Agricultural Expansion	Development or renewal of 5,000 acres annually	Continued identification and development of 5,000 acres annually to support production growth
Inter-Agency Coordination	Collaboration with GRDB, NAREI, GLDA, Hydromet, GGMC, MMA/ADA for data and planning	Operational coordination to support implementation, risk mitigation, and climate adaptation
Strategic Role	Builds the analytical and institutional foundation	Delivers physical resilience, system reliability, and adaptation outcomes

Acronyms: Guyana Rice Development Board (GRDB), National Agricultural Research and Extension Institute (NAREI), Guyana Livestock Development Authority (GLDA), Guyana Hydrometeorological Service (Hydromet), Guyana Geology and Mines Commission (GGMC), Mahaica Mahaicony Abary Agricultural Development Authority (MMA/ADA)

Both strategy periods uphold consistent principles regarding agricultural expansion and community engagement; however, the 2021-2025 phase markedly elevates ambitions for climate adaptation and infrastructure reliability by shifting from managing 3.5 inches of rainfall in 24 hours to planning for 15-year return-period rainfall events. While this vision has expanded to reflect NDIA's widening mandate, encompassing infrastructure development, climate resilience, and inclusive governance, moving beyond traditional D&I functions, the substantial change underscores the need for a revised strategy and an updated vision to ensure the system remains resilient and responsive to emerging challenges.

1.1 NDIS 2030 Vision

> *"Establish a resilient, inclusive, and climate-adaptive D&I System that reduces flooding, revitalizes agricultural lands, secures water access, and empowers all water and infrastructure users to ensure national food security."*

The NDIS 2030 vision encourages all Guyanese, specifically those working in the agricultural sector, to help build a more resilient and inclusive D&I system and sets out a process through which all water users can benefit from and engage with the NDIA under this strategy. The vision aims to bolster infrastructure, enhance governance, and strengthen institutional and community capacities to deliver integrated D&I services for all Guyanese people. It provides a direction for managing water resources, enhancing agricultural productivity, mitigating flood risks, and strengthening climate resilience. Aligning with national and international best practices, the NDIS emphasizes integrated, data-driven, and inclusive practices across the Governance, Data, and Infrastructure Pillars, with each reinforcing the overall Vision for a resilient, future-oriented D&I Strategy. Through this forward-thinking and adaptable approach, the NDIS 2030 aims to:

- Enable the Government of Guyana to integrate planning, development, and management of water resources through multi-sectoral, multi-disciplinary, and participatory approaches.
- Establish a robust, inclusive, and sustainable water management system that advances food security, economic diversification, and long-term climate resilience.

1.2 Challenges and Opportunities for D&I

The agricultural sector is central to Guyana's economy and food security, but it faces significant climate-related risks, including droughts, increased salinity, and temperature fluctuations. These challenges threaten productivity, livelihoods, and food availability. D&I infrastructure is essential for protecting agriculture, particularly in low-lying coastal plains where much of the fertile land is located. However, many D&I assets, particularly in Region 4 and other regions, require rehabilitation, as collapses in key structures have led to flooding and heightened community exposure to flood risk. There is an urgent need for integrated, sustainable public responses to manage these issues effectively.

The agricultural growth model in Guyana and the wider Caribbean is undergoing significant change, directly impacting D&I requirements. A 2025 IDB report highlights that agricultural productivity growth in Latin America and the Caribbean (LAC) is slowing, and expanding cultivated land is neither environmentally sustainable nor economically feasible. Total Factor Productivity (TFP) accounts for only about 40% growth, with expanded use of land, water, labor, and capital

accounting for the remaining 60%[2]. Agriculture already accounts for 72% of global freshwater withdrawals and over 60% of land degradation, undermining the natural resource base necessary for future production[3]. These trends reflect growing constraints from land degradation, water stress, and climate variability, raising concerns about the sustainability and efficiency of current production pathways.

In 2023, Guyana's agriculture, forestry, and fishing sector accounted for 28% of non-oil Gross Domestic Product (GDP) and employed 13.8% of the population[4]. Despite its macroeconomic significance, agriculture faces mounting challenges, including declining soil health, salinity, climate-induced flooding, rising fertilizer costs, and widespread open burning of rice straw. These pressures reduce farmer livelihoods, degrade environmental quality, and undermine the resilience of national adaptation planning and food security systems. Achieving long-term food security requires sustainable intensification rather than expanding cultivated land.

Guyana's D&I infrastructure supports over 90% of its population and vital agricultural lands. Despite its importance, the system faces challenges from outdated technology, limited drainage capacity, and delayed maintenance. Climate change worsens these issues, with extreme rainfall, droughts, and sea-level rise threatening coastal farming areas through flooding and saline intrusion, especially since Guyana's coast is three meters below sea level. Therefore, preventing floods and hazards across the country is essential.

Flood risk is high throughout Guyana's coastal regions (Regions 1 to 6), as seen in **Figure 1**, mainly due to the presence of major rivers, with notable risk along the Essequibo and Corentyne Rivers in Region 6. Among all regions, Region 5 faces the highest risk of flooding, with over 50% of its area vulnerable and more than a quarter (29%) of its land, including populated and agricultural zones. In contrast, across the coastal regions, Region 1 has the highest level of social vulnerability but the lowest area

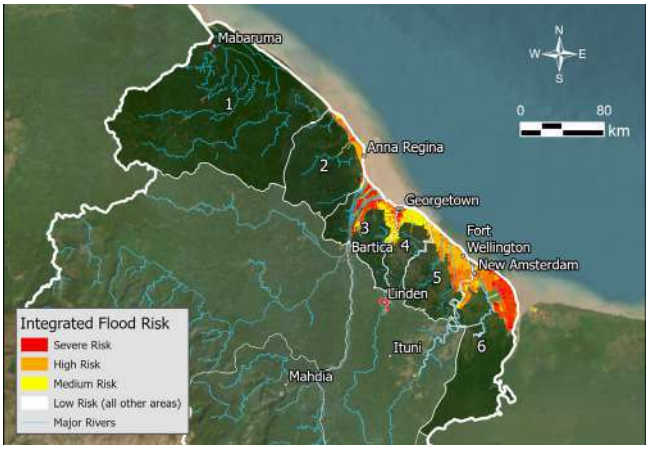


Figure 1: Flood Risk along Guyana's Coast covering Regions 1 to 6

of people and agricultural areas at risk of flood damage[5].

These climate impacts exacerbate inequalities, severely affecting smallholder farmers, women-headed households, and communities in the hinterland. The coastal regions (1–6), home to most of the country's population and economic activity, including agricultural production, are highly exposed to flooding, vulnerable to sea-level rise and saline intrusion, and are compounded by increasing rainfall variability and urban development pressures. In contrast, the hinterland regions (7–10) face droughts, wildfires, and seasonal flooding, driven by savannah and forest ecotones, variable rainfall, and limited water-storage infrastructure, posing a hazard to those communities' water-storage infrastructure, posing a hazard to those communities.

2 Salazar et al., (2025). Agricultural productivity in Latin America and the Caribbean: what we know and where we are heading. Inter-American Development Bank ("IDB").

3 Shagun. (December 2025). Expanding agricultural area no longer viable: Report. *Down To Earth.*

4 Ministry of Agriculture. (2024). *Agriculture Investment Prospectus 2024.*

5 The flood risk assessment was developed to inform the strategy.

Flooding and sea level rise pose a high risk to both rural and urban communities and settlements, as illustrated in **Figure 2**, while coastal overtopping, tidal surges, and saline intrusion particularly jeopardize rice and cash crop production, as evidenced by saltwater intrusion and land loss in areas like East Berbice-Corentyne and Essequibo. Increasing droughts and erratic rainfall reduce crop yields and water availability, causing water scarcity and livestock stress, with urban Region 4 notably affected by drought-driven water service disruptions and heightened saline intrusion. In addition, heatwaves and temperature variability exacerbate crop stress, pest outbreaks, and public health challenges, while wildfires, though less common, further threaten agricultural lands and air quality during dry spells. Collectively, these hazards create a high-risk environment for both rural and urban communities, making flood control and salinity management critical priorities. The hinterland regions of Guyana face distinct climate and water-related hazards driven by their topography and landscape, with droughts and heatwaves posing the most significant threats, especially in the savannahs of Region 9, leading to crop and livestock losses. Wildfires pose a significant threat in forest-savannah ecotones, damaging biodiversity, timber, and public health, while drought-fueled fires in Region 9 lead to habitat loss and respiratory issues. Flash floods and prolonged seasonal inundations in Regions 7, 8, and 10 still damage infrastructure and disrupt communities, and changes in precipitation degrade topsoil, affect farming and river transport, particularly in hilly areas. Because hazards in the hinterland are essentially drought- and wildfire-centered, resilience strategies must prioritize water storage, drought-resistant crops, and fire management.

Guyana's varied regional climate hazards underscore the necessity for adaptation strategies that address local needs. Coastal areas grapple with flooding, salinization, and infrastructure weaknesses, while the hinterland experiences droughts, wildfires, and water shortages. To effectively manage these distinct risks, coordinated and customized approaches are essential, balancing engineered and nature-based solutions for resilient water management, livelihood protection, and improved food and water security nationwide.

Addressing these challenges requires a forward-thinking D&I strategy that integrates data-driven management and nature-based solutions (NbS) and aligns with global best practices. NbS is defined as *"effective and adaptive interventions to protect, conserve, manage, and/or restore*

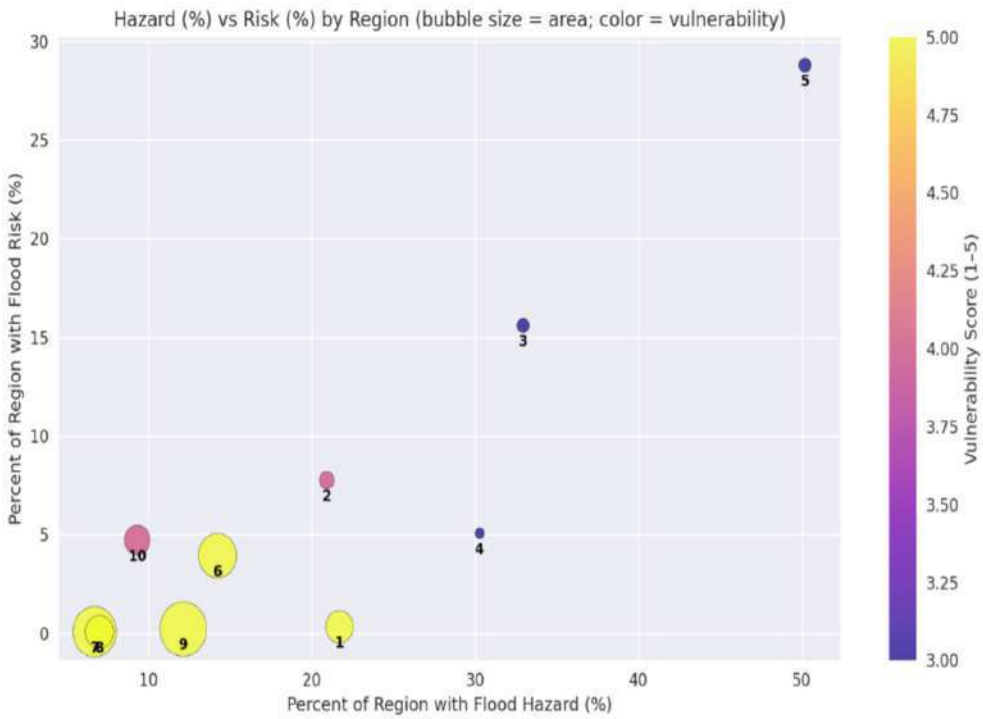


Figure 2: Flood Risk along Guyana's Coast covering Regions 1 to 6

natural or modified systems, including but not limited to coastlines, cities, watersheds, and rivers.[6]" NbS provide flood-mitigation and water-management benefits, while supporting human well-being, ecosystem services, resilience, and biodiversity.

Modernized D&I systems are pivotal to Guyana's climate-resilient development as outlined in the country's Low Carbon development Strategy 2030. They facilitate agricultural intensification without expanding into forests, wetlands, or other landscapes that sustain rural livelihoods and ecosystem services. According to the FAO 2025 report, D&I reduces climate risk by revitalizing croplands, stabilizing soil moisture, supporting multiple cropping, and enabling diversification into higher-value crops, key pathways for income growth and improved food availability[7].

The National D&I Strategy (NDIS) plays a key role in reducing flood risks through advanced water-control infrastructure, improving drought resilience with better water storage and distribution, and ensuring fair access to D&I services. Over the next five years, the NDIS will create a framework for inclusive and innovative development in Guyana's D&I sector, setting integrated, sustainable strategic goals that effectively address flooding issues by targeting both the causes and effects of D&I systems.

Guyana's conservancies and water infrastructure are recognized as vital nature-based solutions throughout the NDIS development, highlighting the importance of these assets and the communities they serve.

Effective D&I networks, crucial for managing Guyana's extensive water resources, enable year-round agriculture and help reduce the risks of droughts and floods. By improving national D&I infrastructure, the NDIS supports food security, enhances quality of life, and promotes economic diversification. As a core part of Guyana's disaster and climate resilience planning, the NDIS aligns with national water resources plans, ensuring D&I systems contribute to both immediate and long-term resilience against climate-related hazards, in accordance with the Act that governs the NDIA mandate. Overall, these measures strengthen the adaptive capacity of the agricultural sector and marginalized communities, fostering equitable and sustainable climate resilience across Guyana through a coordinated and integrated approach to development and climate adaptation.

6 UNEP, Overview of Nature-based solutions - https://www.unep.org/topics/nature-action/nature-based-solutions/overview-nature-based-solutions

7 FAO. 2025. The State of the World's Land and Water Resources for Food and Agriculture 2025 – The potential to produce more and better. Rome.

View of a sluice used for drainage of farmlands in Berbice, Guyana.

2 NDIA 2030 Strategic Framework

Photo: Rice fields in Region 3 (Photo credit: Kezra Boyal)

Guyana's approach to building climate resilience and safeguarding water resources rests on a set of strategic pillars. These pillars provide a structured framework to guide national policy, strengthen governance, and implement targeted interventions to improve D&I services provided by the NDIA in Guyana. By focusing on inclusive management, adaptive infrastructure, and stakeholder participation, the strategy aims to reduce vulnerability, enhance preparedness, and ensure equitable access to D&I services for all Guyanese through three pillars.

The NDIS 2030 adopts a three-pillar structure centered on (1) Governance and national participation in D&I to enhance collaboration; (2) Data and data management systems to improve data access and availability; and (3) Infrastructure planning, maintenance, and finance, which seeks to implement tangible actions, underscored by the formal integration of Nature-based Solutions. This transformative approach, with a targeted set of outcomes, encompasses implementable targets for NDIA and its partners. The three pillars target actionable outcomes for collaboration, information sharing, and action, as illustrated in **Figure 3**, applied to flood management in Guyana's coastal regions. These pillars align with other national development goals outlined in other strategies and consider international best practices.

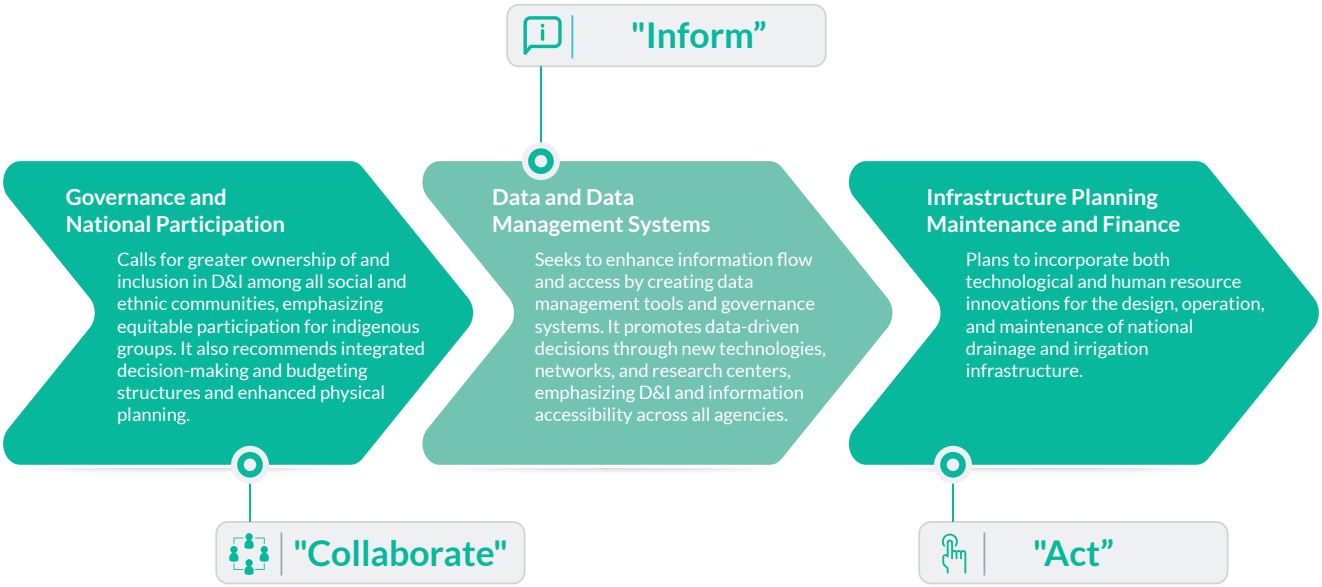
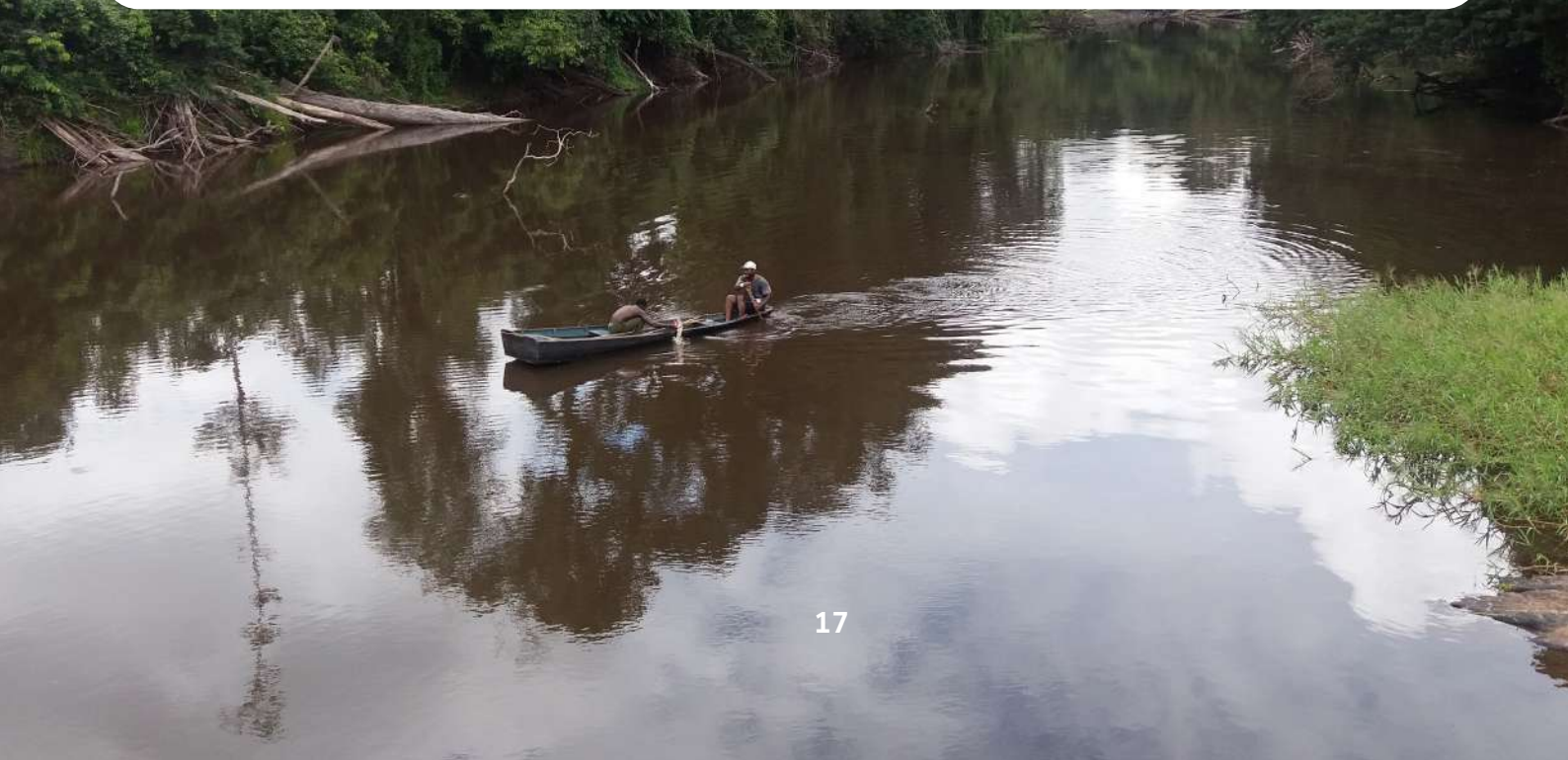


Figure 3: Actionable Outcomes of the NDIA Strategy 2030



2.1 Pillar 1: Governance And National Participation

Guyana's D&I system is increasingly exposed to climate risks, yet management responsibilities are dispersed across more than ten agencies. This includes core organizations such as NDIA, Guyana Water Incorporated (GWI), as well as multiple regulatory authorities, planning institutions, and community groups. The complexity often results in redundant or overlapping mandates, leading to procedural delays and fragmented planning. To address these systemic issues, Pillar 1 is illustrated in **Figure 4** which advances inclusive governance, expands stakeholder engagement, and aligns national decisions and funding across ministries and water-dependent sectors. This approach is designed to strengthen water resource management as a foundation for resilience, equity, and sustainable growth. This pillar sets out 4 objectives with 9 targets to achieve the goal by 2030.

Figure 4: Pillar 1 Governance and National Participation

2.1.1 Goal

Strengthen the governance of D&I systems in Guyana to enable data-driven, inclusive, and coordinated decision-making, ensuring the participation of women and Indigenous peoples while enhancing climate resilience across communities.

2.1.2 Objectives and Targets

Table 2. Pillar 1 Objectives and Targets

OBJECTIVE 1.1

National coordination for D&I management is strengthened under the NDIA's leadership.

Targets	Means of Verification
Target 1.1.1: NDIA's role strengthened as the apex authority for D&I governance and national coordination.	• Government decision / official notification • Ministry planning documents
Target 1.1.2: Joint planning mechanisms between NDIA and subnational agencies are established.	• Planning guidelines and coordination reports • Monitoring reports

OBJECTIVE 1.2

Inclusive governance mechanisms are established to strengthen stakeholder participation in D&I decision-making.

Targets	Means of Verification
Target 1.2.1: Stakeholder engagement mechanisms established for D&I governance.	• Stakeholder mapping report • Official guidelines or policy document
Target 1.2.2: Multi-stakeholder coordination structures established for major water-use domains.	• Coordination body meeting records • Organizational structure and appointment records • Official designation letters
Target 1.2.3: Water Users Associations strengthened and integrated into national D&I governance.	• Assessment report • Policy documents • WUAs registration records and operational reports

OBJECTIVE 1.3

Sustainable and accountable financing mechanisms are established to support the implementation of the NDIS.

Targets	Means of Verification
Target 1.3.1: A dedicated national financing framework for NDIS implementation is established.	• National budget documents • Budget consultation reports • Consultation reports and meeting records

OBJECTIVE 1.4

Integrated planning frameworks support proactive and transparent D&I decision-making

Targets	Means of Verification
Target 1.4.1: D&I are integrated into national water and development planning frameworks, aligned with the principles of Integrated Water Resources Management (IWRM).	• National planning documents
Target 1.4.2: Regional flood mitigation and water management plans developed.	• Regional planning documents • Planning reports
Target 1.4.3: National spatial planning frameworks support coordinated D&I infrastructure investment.	• National Physical Development Plan • Planning databases and reports

2.1.3 The Governance of D&I

The D&I governance framework in Guyana is characterized by a complex institutional landscape, with overlapping responsibilities and varying levels of autonomy across multiple agencies. NDIA has the primary mandate to coordinate water resource delivery and infrastructure maintenance in the agricultural sector, as outlined in its governing Act. However, other entities, including the Guyana Sugar Corporation (GUYSUCO), the Mahaica-Mahaicony-Abary Authority (MMA), and regional conservancies, manage water systems within their respective jurisdictions. This decentralized approach often complicates coordination efforts, especially in emergencies such as flooding.

Regulatory oversight is shared among agencies such as the Central Board of Health, the Sea Defense Board, and Guyana Water Incorporated (GWI), creating ambiguities in accountability and enforcement. Additionally, organizations like the Hydrometeorological Service and the Guyana Lands & Surveys Commission provide vital upstream data and legal authority. However, their contributions are not always effectively or promptly incorporated into infrastructure decision-making. This fragmentation leads to duplicated efforts, unclear accountability lines, and delays in emergency response, ultimately impacting the nation's capacity for long-term climate adaptation planning. **Figure 5** shows that multiple stakeholders are currently involved at all levels in the planning, implementation, and management of water resources and infrastructure. The governance structure is critical to ensuring the sustainability and effectiveness of D&I infrastructure, given its importance to agricultural productivity, flood control, and livelihoods in a country highly susceptible to flooding.

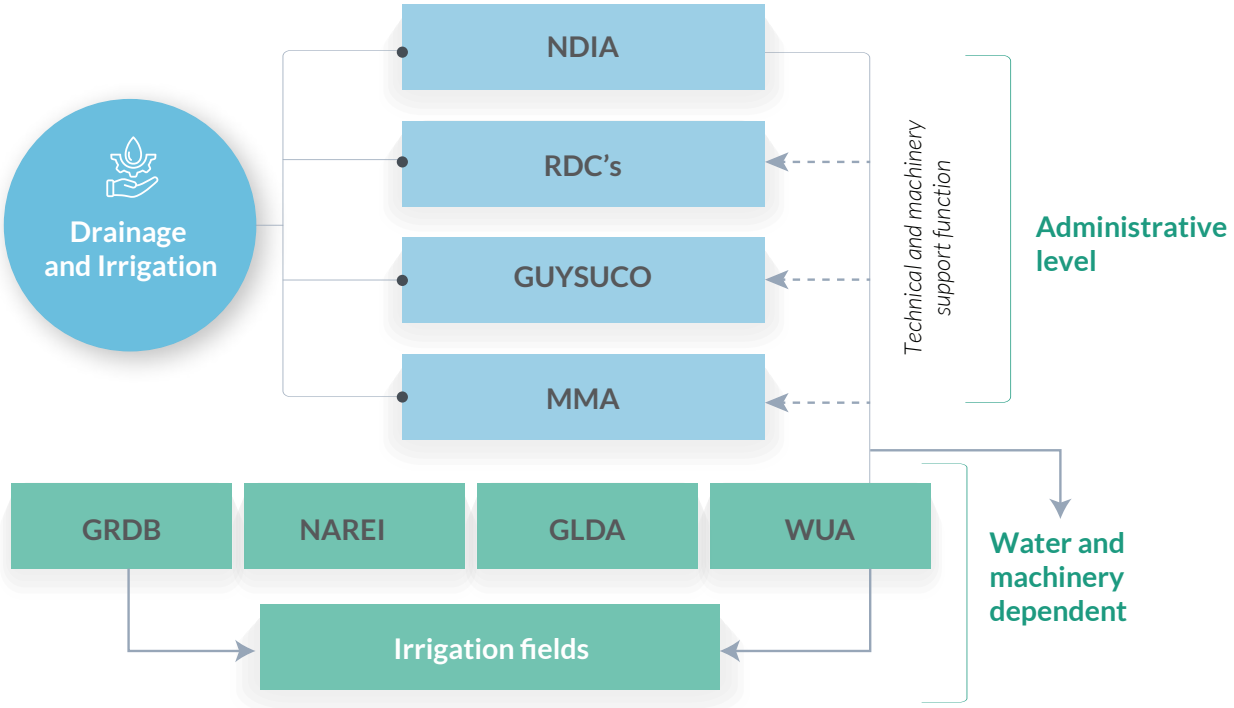


Figure 5. The current governance structure of the D&I sector

Despite these challenges, Guyana's diverse institutional landscape provides growth opportunities. The presence of both national and regional entities enables localized responses to water management needs. Agencies such as GUYSUCO and MMA can use their existing infrastructure and specialized skills to strengthen broader public systems.

By improving coordination, such as implementing shared data platforms, encouraging inter-agency planning, and defining clear mandates, the current framework could develop into a resilient, integrated system that addresses both agricultural and climate resilience goals. Modernization opportunities increase as comprehensive, cross-sectoral planning drives governance in hydropower and urban water management.

This NDIS proposes that the NDIA, working with a wide network of stakeholders across sectors, allows all agencies to operate within their mandates while improving coordination. This institutional setup follows a hub-and-spoke model (see **Figure 6**) where the NDIA provides technical leadership, strategic guidance, and operational oversight of D&I systems at the national level. Importantly, NDIA does not work in isolation but collaborates closely with key agricultural and end users, such as farmers and community organizations.

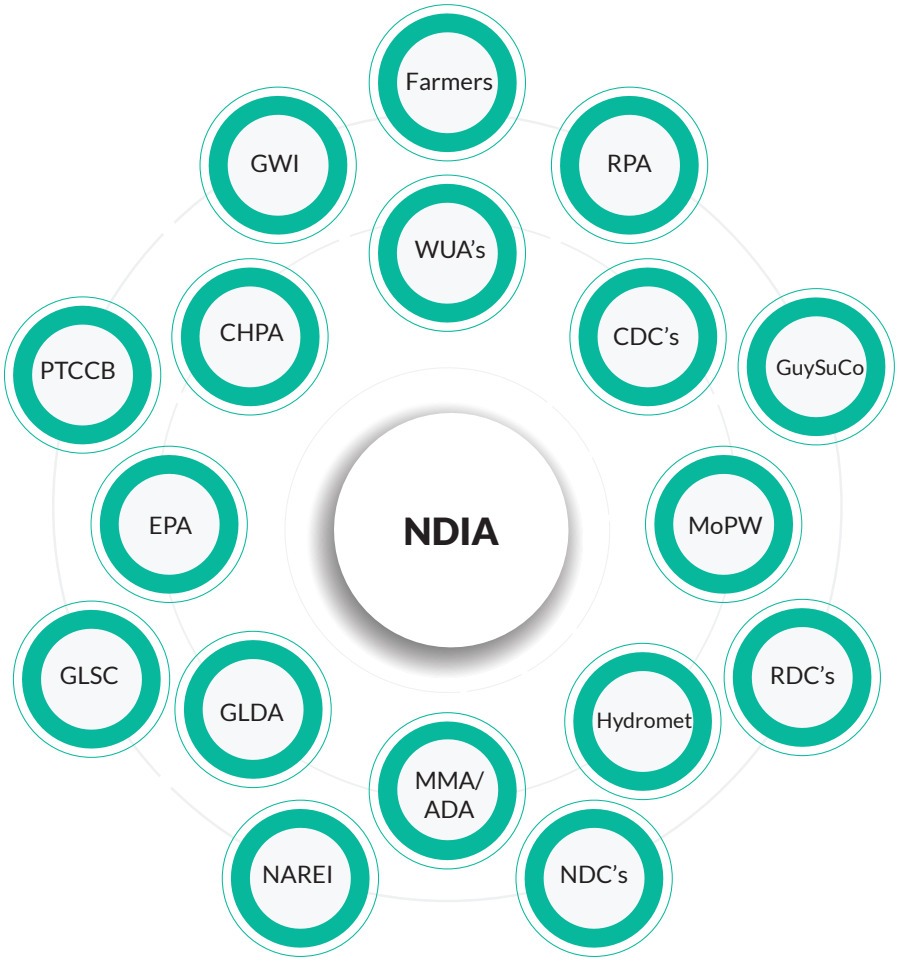


Figure 6. Guyana's Hub-and-Spoke Model Water Resources Management

Acronyms: CDC's – Community Development Councils; CHPA – Central Housing and Planning Authority; EPA – Environmental Protection Agency; GLDA – Guyana Livestock Development Authority; GLSC – Guyana Lands and Surveys Commission; GuySuCo – Guyana Sugar Corporation; GWI – Guyana Water Incorporated; Hydromet – Hydrometeorological Service; MMA/ADA – Mahaica-Mahaicony-Abary / Agricultural Development Authority; MoPW – Ministry of Public Works; NAREI – National Agricultural Research and Extension Institute; NDC's – Neighbourhood Democratic Councils; NDIA – National D&I Authority; PTCCB – Pesticides and Toxic Chemicals Control Board; RDC's – Regional Democratic Councils; RPA – Rice Producers Association; WUA's – Water Users Associations; M&CC – Georgetown Mayor and City Council; DoP – Department of Planning, Ministry of Agriculture.

This model advances integrated planning and promotes cross-sectoral coordination, placing significant operational demands on the NDIA to oversee D&I infrastructure. The NDIA is responsible for planning, maintenance, and rehabilitation tasks, often operating with limited institutional and human resources. To address these challenges, active participation from both national institutions and decentralized entities is essential. This collaborative approach ensures vertical coordination and enhances the system's capacity to respond to regional vulnerabilities and climate risks, laying a foundation for inclusive and adaptive decision-making that helps reduce fragmentation of roles and responsibilities.

Within the hub-and-spoke framework in **Figure 6**, the NDIS serves as a unifying element for agency actions. It supports the implementation of Integrated Water Resources Management (IWRM) principles through a comprehensive, multi-sectoral, and participatory methodology. The national coordinating body, comprising representatives from key stakeholder institutions and a technical advisory group, directs and oversees technical

interventions. These interventions connect with ministries such as Agriculture, Public Works, and Housing, ensuring that diverse expertise and perspectives inform all actions.

The technical entity, in partnership with the Public Utilities Commission, manages all IWRM functions, including water management, quality control, wastewater services, and regulation. Agencies engaged in water-related activities will undergo comprehensive reviews and strengthening to ensure effective implementation of the sector plan. To foster collaboration at the national, regional, and community levels, mechanisms will be put in place to clearly define the roles of policy, regulation, planning, and implementation. These measures, bolstered by the data enhancements outlined in pillar 2, provide a transparent and inclusive framework in which Gender Equality, Disability, and Social Inclusion (GEDSI) perspectives are systematically integrated into policy formulation and sectoral planning.

Water User Associations (WUAs) in Guyana have played an essential role in supporting decentralized management of D&I systems, especially within smaller and tertiary schemes. These farmer-based organizations facilitate timely maintenance, fair water distribution, and local conflict resolution, which are critical functions in areas with limited state oversight. In the Mahaica-Mahaicony-Abary (MMA) area and parts of Region 6, WUAs actively engage farmers and collaborate effectively with NDIA, providing successful examples. However, WUAs capacity varies across the country, with many facing persistent challenges, including limited technical expertise, weak governance, irregular financing, and low member participation. Overlapping responsibilities with regional authorities often leads to confusion and inefficiency. Strengthening WUAs through legal recognition, targeted training, and financial support will enhance local ownership, foster sustainable infrastructure maintenance, and improve D&I system resilience. Integrating Gender Equality, Disability, and Social Inclusion (GEDSI) principles into WUAs operations further ensures that vulnerable groups are represented and empowered in local water governance, reinforcing inclusive and sustainable decision-making.

2.1.4 Integrating GEDSI into Governance and Decision-Making

Smallholders in Guyana, particularly women, face enduring obstacles to accessing irrigation water, which intensify during the dry season. Many women cultivate communal or family plots without formal land titles, which often diminishes their presence in WUAs and other critical water governance platforms, ultimately limiting their influence over water management decisions. Despite their essential contributions to agricultural production, women are disproportionately represented among unpaid family laborers, making up a significant majority of the 51% of the national agrarian workforce identified as unpaid. Their unpaid and informal status further restricts their involvement in essential decision-making processes related to irrigation management, infrastructure investment, and dispute resolution. As a result, compared to national production organizations, smallholders, especially women, are more likely to experience delayed planting, pay informal fees to obtain water, or abandon their plots entirely due to unequal access. However, the Government of Guyana is addressing these issues in its revised strategies and plans, and this NDIS is one such strategy that integrates Gender Equality, Disability, and Social Inclusion (GEDSI).

GEDSI principles play a vital role in D&I systems, as they affect not only lives but also livelihoods. Integrating GEDSI considerations into D&I planning helps ensure that all groups, including women, smallholder farmers, Indigenous communities, and persons with disabilities, benefit equitably from these services and are not disproportionately exposed to risks such as flooding or poor access. Guyana's National Gender Equality and Social Inclusion Policy identifies several groups at a national scale as vulnerable, including women, children and youth, the elderly, persons with disabilities, people living with HIV, and Hinterland communities[8]. Three target areas for vulnerable groups identified in Guyana's National Gender and Social Inclusion Policy include food security, access to credit, and disaster risk management[9].

8 Ministry of Social Protection. National Gender Equality and Social Inclusion Policy. 2019. https://wrd.unwomen.org/sites/default/files/2021-12/GUYANA_NationalGenderEqualitySocialInclusionPolicy.pdf

9 National Gender Equality and Social Inclusion (GESI) Policy for Guyana. Ministry of Social Protection. 2018. https://wrd.unwomen.org/sites/default/files/2021-12/GUYANA_NationalGenderEqualitySocialInclusionPolicy.pdf

Even though Guyana's agricultural policy lacks a clear definition of vulnerable groups within the sector, the policies outline women, youth (children and young adults), and Amerindian populations as vulnerable groups. Other groups mentioned less frequently include people with disabilities and the elderly. The current strategies focus on attracting young people to agriculture through entrepreneurship and technology, supported by training, scholarships, and financial management skills, as well as on facilitating youth, women (and relevant vulnerable groups) in accessing funding to promote value-added, cottage-type industries and agro-processing. One such strategy is the establishment of the Agriculture and Innovation Entrepreneurship Programme (AIEP), which targets current and former agriculture students to produce high-value crops through shade structures built by the government of Guyana. At a high level, integrating GEDSI[10] into water infrastructure and project cycles is possible as illustrated in **Figure 7**.

(i) Collecting disaggregated data and context-specific insights to understand how different groups experience and access D&I services

(ii) Building the capacity of relevant institutions and stakeholders to address barriers and promote inclusive practices

(iii) Ensuring equitable access to water infrastructure, particularly for marginalized groups such as women, youth, and Indigenous farmers

(iv) Improving decision-making processes by involving diverse voices in project planning and governance

(v) Strengthening community resilience by ensuring that all groups have the resources and knowledge needed to adapt to climate and environmental challenges

Figure 7. Principles of GEDSI Integration into water infrastructure and project cycles

10 GESI toolkit for project preparation. 2019. CDRIF: https://cridf.net/RC/publications/gesi-toolkit-for-project-preparation/

2.2 Pillar 2: Data, Management, Technology, and Knowledge

D&I planning in Guyana faces major challenges due to scattered data management, limited data access, and inconsistent information sharing among agencies. Key datasets related to hydrology, infrastructure condition, land use, and climate risk are handled separately by different institutions, leading to little integration or coordinated use of these resources. This lack of unified data hinders the development of effective planning tools and weakens efforts to proactively address the diverse needs of water user groups and vulnerable communities.

To address these challenges, the data management pillar focuses on three main integration areas. First, strengthening internal data systems within the NDIA by standardizing and digitizing data collection and reporting processes will enhance transparency, accountability, and operational planning. Second, improving inter-agency coordination and governance by establishing shared data protocols and interoperable platforms will enable local governance bodies, such as Neighborhood and Regional Democratic Councils, WUAs, and Community Development Councils, to report and access information, thereby reducing duplication and inefficiencies. Third, promoting technological innovation and knowledge sharing with partners like the National Data Management Authority will facilitate the adoption of advanced solutions, including sensor-based monitoring and automated operations, supporting a shift toward proactive management and resilience-building in response to climate variability.

Through these efforts, Pillar 2 which is illustrated in **Figure 8**, seeks to build integrated, standardized data systems that provide all relevant agencies with accurate, timely, and easily accessible information. This foundation will enable more informed decision-making and responsive management across the sector. This Pillar sets out four objectives, with a total of 10 targets.

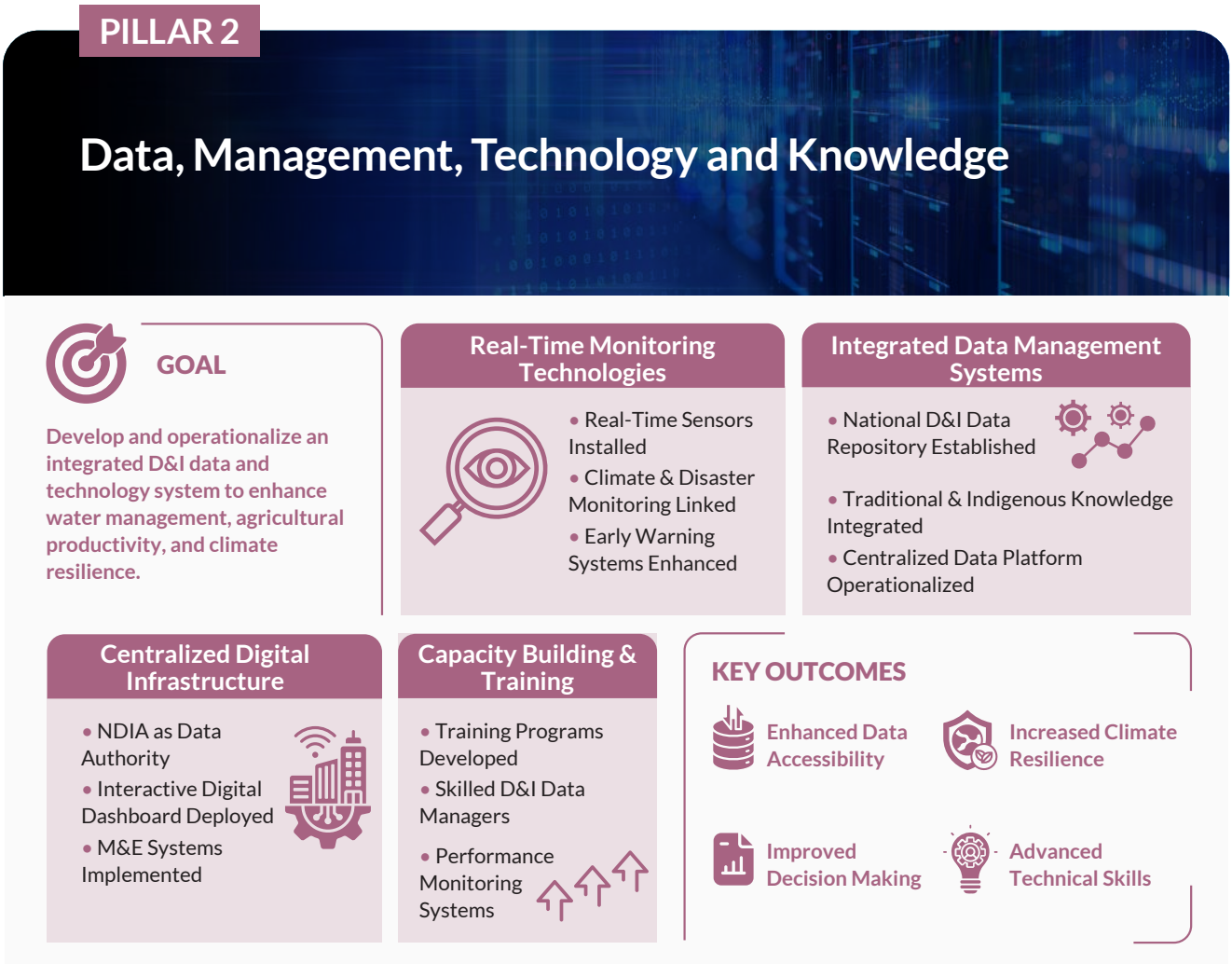


Figure 8. Pillar 2: Data, Management, Technology, and Knowledge

2.1.1 Goal

Develop and operationalize an integrated D&I data and technology system that enables proactive and efficient water management, enhances agricultural productivity, and strengthens the sector's capacity to respond to climate risks affecting diverse water users and vulnerable communities.

2.1.2 Objectives and Targets

Table 3. Pillar 2 Objectives and Targets

OBJECTIVE 2.1

Establish an Integrated Climate and Agronomic Data Repository and Management System to support climate-informed D&I planning and decision-making.

Targets	Means of Verification
Target 2.1.1: Enhance national data management and knowledge through a comprehensive mapping of existing datasets across agencies, establishing a national baseline of D&I data sources, including traditional knowledge systems.	• National mapping exercise of D&I data sources, datasets, and institutional data brokers completed • Assessment report documenting data availability, accessibility, and use across institutions • Data inventory database
Target 2.1.2: Operationalize a centralized or federated D&I data management repository, based on the findings of the national data assessment, supported by interoperability standards and shared data governance procedures.	• Development of a centralized D&I data management system • Official data governance manual for D&I data management and sharing. • Integration of the repository with other agencies
Target 2.1.3: Recognize and integrate non-traditional data sources, including Indigenous knowledge and citizen science, to strengthen data diversity and improve water management insights.	• Knowledge platform documentation • Program reports and participation records • National data portal reports

OBJECTIVE 2.2

Develop centralized institutional and digital infrastructure to support integrated D&I data management across government agencies.

Targets	Means of Verification
Target 2.2.1: Designate NDIA as responsible for national water and D&I data management, ensuring alignment with the governance coordination mechanisms and operational platforms.	• Government decision or official directive • Institutional HR and budget records • Published organogram

Targets	Means of Verification
Target 2.2.2: Develop and deploy an interactive D&I data management dashboard to support coordinated access to key datasets and decision-support tools for agricultural planning and water management.	• Operational dashboard system • System access logs • Training reports
Target 2.2.3: Strengthen institutional capacity to manage digital D&I systems and ensure effective utilization of data management tools.	• Training completion records • Institutional operating procedures
Target 2.2.4: Develop and implement an integrated Monitoring and Evaluation (M&E) system to track the performance of D&I data systems and support monitoring of climate hazards affecting water infrastructure.	• M&E system documentation • Monitoring reports

OBJECTIVE 2.3

Deploy real-time infrastructure and water monitoring technologies to strengthen climate risk-informed decision-making for D&I systems.

Targets	Means of Verification
Target 2.3.1: Establish a real-time data generation and monitoring system for key D&I infrastructure, interoperable with climate monitoring and disaster risk management systems.	• Infrastructure installation reports • Data platform monitoring reports • Procurement and operational records

OBJECTIVE 2.4

Develop centralized institutional and digital infrastructure to support integrated D&I data management across government agencies.

Targets	Means of Verification
Target 2.4.1: Develop and implement training programs to build a national cohort of D&I data managers and technical specialists.	• Training materials and program documentation • Partnership agreements
Target 2.4.2: Strengthen institutional performance monitoring systems to link human resource capacity, infrastructure performance, and data-driven decision-making.	• Institutional performance reports • Training and certification records

2.2.3 D&I Data Management and Integration

At COP 29, the need for robust, high-quality climate and atmospheric data to build awareness of the state of global warming and the necessity of keeping global temperatures below 1.5 degrees Celsius was front and center of discussions[11]. A key challenge for policy documents, such as the NDIS, is integrating climate risk into public decision-making and identifying institutional structures and mechanisms that are proactive and support agile decision-making. Access to and development of integrated data management is crucial to implementing such a strategy.

2.2.4 Challenges of Data and Data Management

Consultations conducted with a diverse range of officials during the development of the NDIS identified several challenges related to knowledge data management and prioritization within the government and the agencies responsible for managing and promoting data management across these organizations. Several related opportunities highlighted that the Ministry of Agriculture is already pursuing this initiative and developing the Agricultural Information System (AIS), which exemplifies more digitized, integrated approaches that NDIA could build upon and expand to stimulate similar advancements across the D&I system.

(i) Climate Monitoring and Seasonal Data: Typical challenges in managing D&I data stem from the multi-scaled nature of the issues and the functions of D&I itself. The primary obstacle concerns monitoring weather and climatic vulnerability and integrating this data into predictive systems for D&I. Although hydrometeorological services are employed, this information is not effectively translated into an operational system that provides data for cultivation timings or anticipates potential challenges arising from changes in temperature or precipitation. Such changes affect the short- and medium-term growing seasons for Guyana's key crops, further exacerbated by unpredictable weather patterns. While this is a basic challenge, existing data management and integration gaps present an opportunity to lay a foundation for informed action.

(ii) Monitoring Data and Baselines: Data is often stored across different systems rather than in a centralized location, with much of it kept on hard paper-based copies or in Excel spreadsheets that must be manually updated by individuals or within agencies. This leads to a fundamental weakness in data management: not only is there no clear baseline for developing programs and improvements, but upgrading such an analogue system also demands considerable time and effort from staff. While some departments maintain centralized databases, they are rarely accessible to other agencies because there are few or no links. However, this challenge presents an opportunity to implement integrated digital platforms that facilitate efficient data sharing and collaboration across departments.

a) Real-Time Interval Data: The manual management of infrastructure and water levels in conservancies is slow and labor-intensive, requiring operators to prevent overtopping and monitor pump stations. The lack of real-time data means responses are reactive, which is a major weakness. This presents an opportunity to modernize with integrated digital systems for proactive, efficient management in the D&I sector.

b) Siloing of Crop-specific and Commercial Data: Certain agencies compile specialized datasets on the commercial export of specific goods. For instance, NAREI collects data on fruit and vegetable quality but not on diseases, vectors, or management practices. Major cash crops have dedicated data repositories maintained by relevant agencies or sectors. Knowing about activities at a location aids planning; for example, if a farmer irrigates, others should avoid certain pesticides to prevent water contamination. While some data could benefit regions or industries, it usually remains restricted within organizations. Creating collaborative platforms for sharing datasets could improve efficiency and decision-making.

c) Lack of Holistic Data on Capacity and Project Management: Staffing capacity and development issues hinder data quality. There's a lack of project management strategies and capacity-building for key roles relying on data. Management requires better methods for evaluating infrastructure and aligning staff skills. Technicians' local land knowledge is underused, except in specific tasks. Reporting and accountability cycles are deficient due to limited monitoring and poor data management from fewer

11 European Centre for Medium-Range Weather Forecasts (ECMWF), *"The Importance of C3S and CAMS Data in a Changing Climate on Stage at COP29," Copernicus Climate Change Service*, November 22, 2024, https://climate.copernicus.eu/importance-c3s-and-cams-data-changing-climate-stage-cop29

digital systems. Addressing these issues through training, data-driven strategies, and leveraging local expertise can improve organizational effectiveness and infrastructure quality.

(iii) Institutional Fragmentation Impacting Data Flow: Fragmentation among agencies with ad hoc coordination structures within Ministries or agencies holding important, related data, such as the Ministry of Health and the Ministry of Agriculture, also presents a challenge. While D&I remain priorities for the Ministry of Agriculture, they are linked closely to many other agencies' and Ministries' functions, which require enhanced data sharing among them. This may reflect the overall national management of data outside of NDIA. Due to the unique and cross-cutting nature of D&I, the NDIA must shift from fragmented approaches to holistic, accountable, and coordinated, technology-driven solutions where stakeholders, including the private and public sectors, contribute to building a resilient economy with clear mandates. The data management system described here supports comprehensive monitoring, predictive planning, and efficient resource allocation—providing a framework for informed decision-making to strengthen resilience within the D&I sector. However, it also depends on human capacity.

2.2.5 Human Capacity Challenges in Data Management

Effective data and performance management in Guyana's D&I sector faces significant hurdles due to limitations in human capacity. The ability to modernize infrastructure and implement advanced technology is tied closely to the skills and expertise available within agencies and institutions. Addressing these challenges is essential for fostering innovation, enhancing operational efficiency, and building resilience throughout the sector. In a fast-paced world where technology advances rapidly, capacity becomes an imperative to ensure efficiency.

(i) Limited Technical Capacity: Guyana's efforts to modernize its agricultural, drainage, and irrigation data and technology are constrained significantly by limited human capacity. A 2020 report by the Ministry of Agriculture[12] indicated that over 60% of technical staff in key agencies such as the NDIA lacked advanced training in modern irrigation design or in water modeling tools. Despite complex climate challenges like rising sea levels and intense rainfall, most drainage systems are operated manually, and many engineers lack exposure to modern hydrological forecasting and remote sensing tools. This skills gap hampers the country's ability to implement climate-resilient solutions in vulnerable areas. Addressing these gaps through training, upskilling, and technology adoption offers Guyana a key opportunity to enhance sector responsiveness and promote sustainable, resilient development.

(ii) Dated D&I Educational and Training Frameworks: The capacity challenge is exacerbated by antiquated frameworks. Although institutions such as the University of Guyana and the Guyana School of Agriculture offer programs in agriculture and natural resource management, these programs frequently lack sufficient resources and practical exposure to emerging technologies such as smart irrigation, geographic information systems (GIS), and precision farming. Extension services, intended to connect farmers with new knowledge and practices, are overstretched. According to a 2019 FAO[13] assessment, the ratio of extension officers to farmers in Guyana was estimated at 1:800, substantially below the recommended 1:250, rendering it nearly impossible for officers to provide effective, individualized support. Consequently, the adoption of innovative techniques among farmers remains sluggish, with many continuing to depend on traditional methods that are ill-suited to the country's evolving environmental conditions.

(iii) Institutional Fragmentation: Institutional challenges further exacerbate the human capacity gap. Agencies working on agriculture and D&I often operate in silos, with minimal cross-sector coordination. This limits the formation of multidisciplinary teams, which are essential for integrated planning. Additionally, the public sector struggles to retain skilled staff due to non-competitive wages, limited upward mobility, and professional development. Without deliberate investment in human capital development, including training, retention strategies, and institutional coordination, even the most promising technological or financial interventions will fall short of their transformative potential.

Despite these challenges in human capacity, institutional fragmentation, and outdated frameworks, they collectively highlight a crucial opportunity for transformation within

12 Ministry of Agriculture (2020) Annual Report

13 FAO (2019) Country Planning Framework for Guyana.

Guyana's D&I sector. When agencies integrate data more effectively and adopt modern digital systems, they streamline operations and gain real-time access to essential information. These technological advances will not only improve resource allocation and support more informed decision-making but also enable current staff to acquire new skills and maximize their contributions. Investing in these solutions ultimately creates a more resilient, efficient, and adaptable infrastructure system capable of better addressing both present and future challenges.

2.2.6 Opportunities for Better Data Integration and Management

Opportunities abound for enhanced data integration in the D&I sector by building upon and expanding existing systems, while leveraging the strong networks of locally embedded officials and officers active across all sectors in Guyana. When managers, operators, and maintenance teams establish consistent data baselines and evaluate performance, they integrate their efforts to effectively assess how actual performance measures up to design standards, make informed decisions about modernization or major maintenance, and quickly adapt to new requirements. Employing performance indicators alongside predictive analytics will further optimize resource allocation and ensure adaptability.

Considering rainfall patterns, the Hydrometeorological Service provides geo-referenced meteorological data on flood hotspots and D&I resource deployment. Building integrated data systems can help reduce flood risks and damage. The goal is to create an integrated flood risk map with hazard and vulnerability layers to minimize losses and enhance response efforts. The current discussion focuses on a management database to record interventions, operations, and maintenance for D&I infrastructure, including channels, pumps, desilting, and rehabilitation, which offers an ideal opportunity to implement the NDIS. This system will include data from emerging actors (**see Figure 9**) such as NDCs, RDCs, MMA, NDIA, M&CC, and CDC to monitor activities.

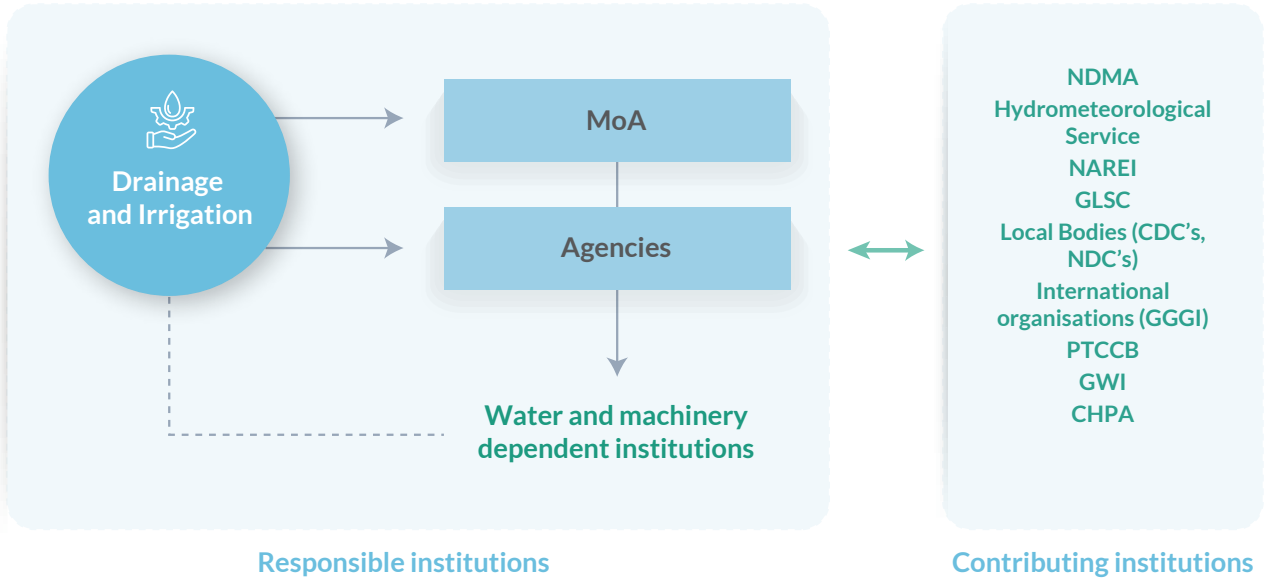


Figure 9. Inclusion of emerging institutions in the D&I interface

Although the NDIA possesses considerable technical capacity and machinery relative to other agencies, it is confronting escalating challenges arising from the impacts of climate change. Coordination and governance issues arising from the distribution of D&I responsibilities among various agencies further exacerbate these challenges.

This is further affected by identified challenges, including machinery downtime, logistical difficulties, and emergency stock management. These issues indicate the need for prioritized measures that account for institutional, capacity-related, and climate-related risks and maintain an active network.

Such networks, while urgent, are catalysts for opportunities in early warning systems. **Figure 10** presents an indicative schematic of a data management system involving National Data Management Authority (NDMA). Operators can extract and analyze pump operating time and fuel consumption data to determine expected fuel requirements, assess proper pump management, and support planning. For instance, this will provide key information for planning for the rainy season to ensure adequate resources are close enough should they be needed. NDIA can develop data management systems that use high-resolution cameras or asset tracking to assess and evaluate the condition of D&I infrastructure, feeding the collected data into a database for analytical processing.

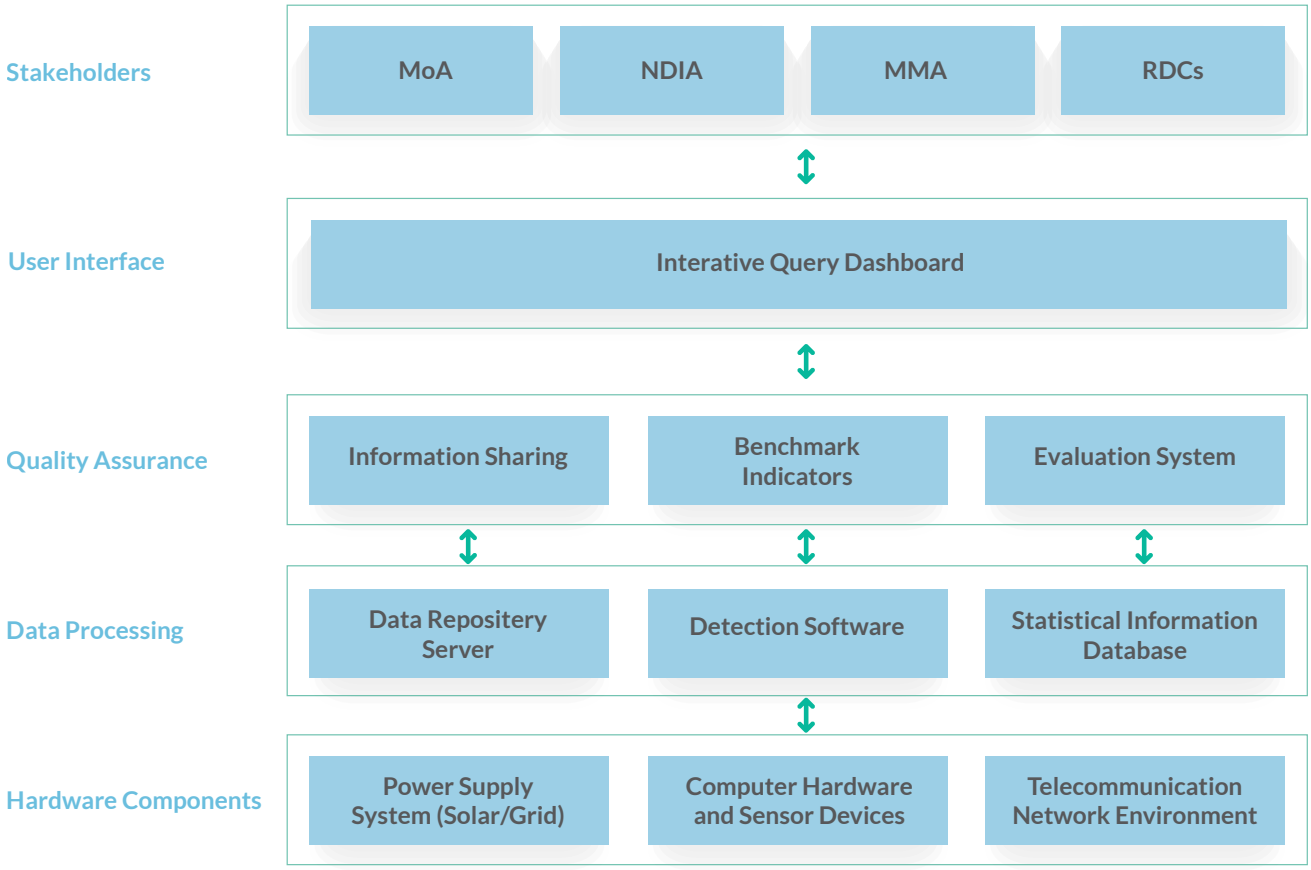


Figure 10. An indicative schematic for a data management system on pump operations

Figure 10 highlights the growing potential to integrate advanced technologies into the management and oversight of D&I pumps across Guyana. Presently, sensor-based devices are attached to the fan motors of pump engines in select locations, providing real-time data on operational status, whether the pumps are active or idle. These pumps draw power from diverse energy sources, including the national grid, independent diesel generators, and, in some cases, solar photovoltaic systems. Compact modem-like devices transmit the sensor data to a centralized server managed by the NDMA. Here, the raw data is processed using predefined criteria to generate actionable insights, including cumulative runtime, operational frequency, and scheduling alignment with tidal cycles. A secure digital interface then makes this information available to the NDIA and other relevant agencies, facilitating improved asset management, tracking, and emergency response by ensuring the deployment of the most effective resources.

Geographic Information Systems (GIS) and remote sensing technologies play a crucial role by providing spatial data for mapping the extensive network of canals, conservancies, and wetlands. These tools enable the identification of priority locations for nature-based solutions, such as riparian buffers and constructed wetlands. In addition, Internet of Things (IoT) sensors installed along canals and drainage channels offer real-time monitoring of water levels, flow rates, and water quality. Multiple agencies can easily share this capability, enabling them to respond promptly to recurrent flooding risks that threaten Guyana's vulnerable coastal regions.

The adoption of advanced automation technologies further optimizes water resource management and flood mitigation in Guyana's predominantly agricultural landscapes. Automated gates and pumps, controlled via centralized platforms, enable precise regulation of water flows based on seasonal rainfall patterns and crop requirements, thereby minimizing the risks of waterlogging and drought. Integration with weather forecasting and early-warning systems enhances the ability to manage extreme rainfall and conserve water during dry spells. Mobile applications linked to cloud-based dashboards empower local water user groups and agencies such as GWI to monitor infrastructure performance, fostering participatory oversight, and greater transparency. Collectively, these integrated technologies, including data analytics, hydrological modeling, and machine learning for predictive maintenance, create a resilient and adaptive D&I system that supports agricultural productivity and climate change adaptation in Guyana.

2.3 Pillar 3: Infrastructure, Planning, Maintenance, and Finance

Pillar 3 illustrated in Figure 11 aims to reinforce the climate resilience of Guyana's D&I infrastructure by advancing modernization, maintenance, and financing for both engineered ("grey") assets and nature-based solutions ("green" NbS). Building upon the governance and coordination achievements of Pillar 1 and the data and technological progress made in Pillar 2, this pillar establishes a foundation for sustainable water management, flood risk reduction, and agricultural productivity. The urgency of infrastructure rehabilitation updated operational and maintenance practices, the integration of NbS, and innovative financing to secure Guyana's D&I systems against climate hazards. By strengthening and modernizing these assets, Guyana can effectively manage its water resources, reduce flood risks, and safeguard agriculture, thereby ensuring long-term resilience.

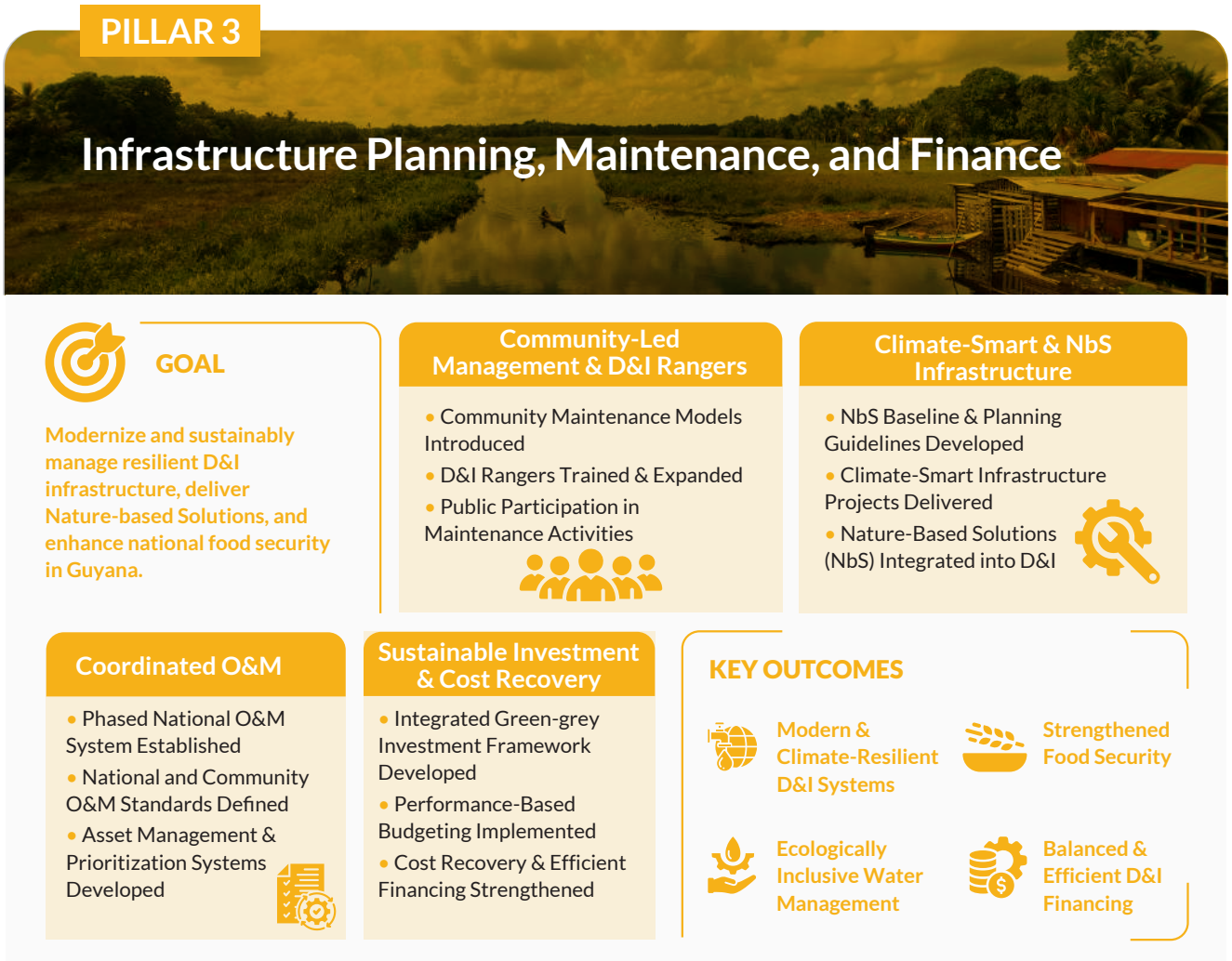


Figure 11. Pillar 3: Infrastructure Planning, Maintenance and Finance

2.3.1 Goal

Ensure Guyana's D&I infrastructure is modernized, resilient, and sustainably managed to address emerging climate risks while strengthening national food security and mainstreaming Nature-based Solutions (NbS) to deliver ecologically inclusive, cost-effective water management.

2.3.2 Objectives and Targets

Table 4. Pillar 3 Objectives and Targets

OBJECTIVE 3.1

Establish a national institutional platform for the coordinated operation and maintenance (O&M) of D&I infrastructure.

Targets	Means of Verification
Target 3.1.1: Establish and operationalize a phased national O&M system for D&I infrastructure, consisting of: a) an institutional coordination platform with staffing, funding, and operational procedures; and b) a technical O&M system supporting maintenance planning, budgeting, capacity-building, and community participation.	• Official establishment documentation; institutional reports. • Assessment reports; infrastructure condition inventory. • O&M system operational records • Sector studies; program reports

OBJECTIVE 3.2

Rehabilitate and expand priority D&I infrastructure in climate-vulnerable and food security regions while integrating NbS into infrastructure planning.

Targets	Means of Verification
Target 3.2.1: Mainstream adaptive, landscape-based infrastructure design approaches across NDIA-led planning processes through the development of a national baseline assessment on the application of NbS alongside grey infrastructure.	• Technical NbS assessment report • Planning guidelines; infrastructure design reports
Target 3.2.2: Design and submit new NbS interventions for D&I infrastructure based on the national NbS baseline and prioritization methodology.	• Project design documentation; national investment reviews

OBJECTIVE 3.3

Establish national standards and planning guidelines to integrate NbS into D&I infrastructure design and project planning.

Targets	Means of Verification
Target 3.3.1: Update and digitize national D&I infrastructure design, maintenance, and financing guidelines, incorporating the application of NbS.	• Official manuals and planning guidelines • Technical guidance documents
Target 3.3.2: Integrate NbS into feasibility studies and environmental assessments of D&I infrastructure projects.	• Project feasibility studies; environmental impact assessments

OBJECTIVE 3.4

Strengthen operation, maintenance, and asset management systems for D&I infrastructure, including integration of green infrastructure components.

Targets	Means of Verification
Target 3.4.1: Operationalize the NDIA Data Prioritization System to support adaptive and risk-informed infrastructure management.	• System documentation; NDIA reports
Target 3.4.2: Introduce community-led maintenance models to strengthen stewardship of drainage infrastructure and associated NbS.	• Program reports; community engagement records
Target 3.4.3: Professionalize and expand the role of D&I Rangers to support monitoring, maintenance, and data collection.	• Training reports; staffing records

OBJECTIVE 3.5

Strengthen investment planning frameworks to support integrated green and grey infrastructure development.

Targets	Means of Verification
Target 3.5.1: Develop an integrated national approach for planning and financing infrastructure investments, recognizing conservancies, green infrastructure, and blue infrastructure as national assets.	• Study reports; sector planning documents. • Policy frameworks; investment planning documents

OBJECTIVE 3.6

Systemize cost recovery and performance-based management for D&I infrastructure.

Targets	Means of Verification
Target 3.6.1: Establish a budget accountability and performance-based management system for water and nature-based infrastructure assets.	• Economic assessment reports • Policy studies; financing reports • Government budget reports; sector performance reviews

2.3.3 Growing Recognition for Adaptive Approaches to Traditional Infrastructure

Strategic investment in Nature-based Solutions (NbS) can greatly enhance traditional grey infrastructure by boosting ecosystem services, reducing flood risks, and supporting sustainable livelihoods through ecological benefits. NbS offers cost-effective alternatives to costly repairs and new installations, especially as climate adaptation becomes more urgent. In the past, development strategies have mainly focused on hard engineering solutions, such as concrete channels and fixed pump stations, which often fail to fully address community and agricultural challenges and can cause business interruptions and infrastructure damage. The increasing use of mobile pumps instead of fixed systems shows a move toward more flexible options. Still, the need for resilient water management highlights the importance of supplementing traditional infrastructure with sustainable, adaptable measures. Projects such as mangrove restoration, watershed reforestation, and the creation of vegetated swales and retention ponds offer effective water management options while also promoting biodiversity and building community resilience. For instance, Guyana's mangrove belt, once stretching over 80 km along the coast, has been reduced by development and pollution. Still, restoration efforts have shown that replanting can decrease wave energy by up to 75%, easing the pressure on sea defenses and flood management systems[14].

Incorporating NbS into the NDIS delivers co-benefits, including enhanced soil health, groundwater recharge, and increased carbon sequestration, aligning closely with Guyana's Low Carbon Development Strategy (LCDS) 2030 objectives. When integrated with traditional engineering solutions, NbS not only extends infrastructure lifespan but also lowers maintenance costs and improves adaptability to climate uncertainties. Achieving these outcomes requires concerted efforts in institutional capacity-building, supportive policy development, and meaningful community engagement to ensure scalability and sustainability. As Guyana modernizes its water infrastructure, embedding NbS into planning and design processes paves the way for a more resilient, inclusive, and ecologically balanced future.

14 Van Wesenbeeck, B. K., Van Zelst, V. T. M., Antolinez, J. a. A., & De Boer, W. P. (2025). *Quantifying uncertainty in wave attenuation by mangroves to inform coastal green belt policies*. Communications Earth & Environment, 6(1), 258.

2.3.4 Augmenting the Value System for Capital Works Decision-making

Decision-making for public infrastructure in Guyana, particularly within the NDIA, relies on a value system framework designed to manage the country's vast D&I assets. However, the values and priorities of the management team often influence how that evidence is interpreted, weighted, and ultimately used[15]. This process is overseen currently by an informal committee consisting of the Chairman, Chief Executive Officer, regional head engineers, and the Monitoring and Evaluation Officer. Together, they review and approve programs and projects seeking D&I funding. The structure's informality enables responsiveness, as regional engineers assess unique vulnerabilities, and the M&E unit evaluates project impacts. Engineers' condition surveys play a fundamental role by assessing community conditions, agricultural activities, and the state of existing infrastructure, thereby supporting the prioritization of interventions, especially in flood-prone or economically vulnerable regions. Nevertheless, the decision-making process is often shaped by the management team's values and priorities, influencing how evidence is interpreted and acted upon. However, considering the number of stakeholders and their interests as illustrated in the stakeholder map, there is an opportunity to include them, assign roles, and share responsibilities.

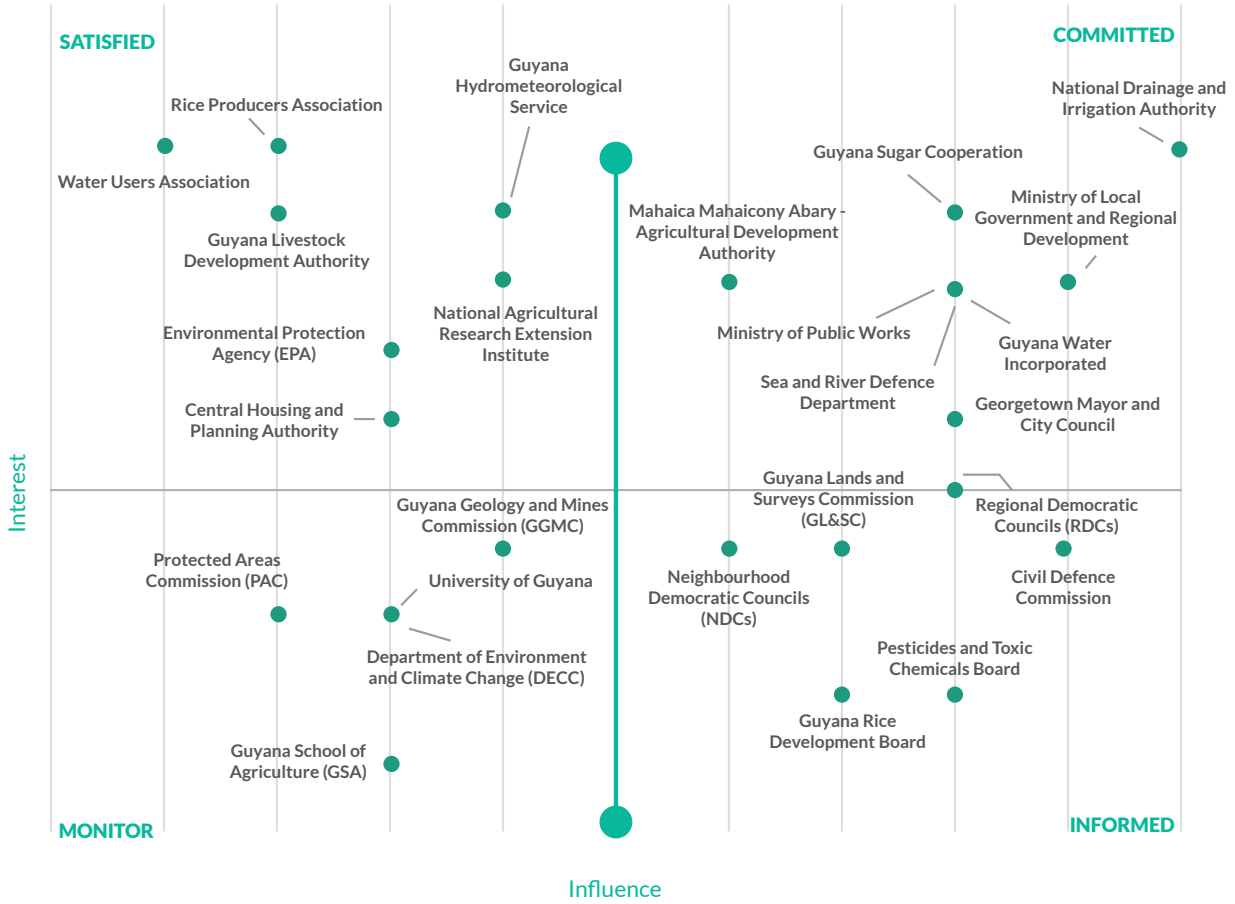


Figure 12. Stakeholder Map in the D&I Sector

15 Baba, V. V., & HakemZadeh, F. (2012). *Toward a theory of evidence-based decision making*. Management Decision, 50(5), 832–867.

However, relying solely on this value-based approach is increasingly insufficient amid evolving climate challenges. The process must move beyond traditional infrastructure perspectives to integrate ecosystem values, environmental considerations, and community inclusiveness. While condition surveys remain important, there is a growing need for more comprehensive baseline analyses that recognize D&I interventions as part of a broader system. This calls for systematic stakeholder engagement and the expansion of data-driven tools, such as the Agricultural Information System (AIS), that incorporate flood-risk and agricultural productivity data to inform the design of innovative solutions. Ultimately, the structure should evolve to address emerging climate risks better and integrate future scenarios, ensuring that capital investments are robust, adaptive, and grounded in holistic evidence.

2.3.5 The Nature-Based Solutions Opportunity for D&I

Nature-based Solutions (NbS) are approaches that utilize natural systems and processes to address societal challenges such as climate change, biodiversity loss, water security, and disaster risk management. These solutions leverage the power of ecosystems such as forests, wetlands, mangroves, and grasslands to deliver a wide range of benefits for both nature and people. By restoring, conserving, and sustainably managing natural resources, NbS offers a holistic approach to tackling environmental problems while simultaneously promoting human well-being and economic development. Examples include afforestation, wetland restoration, and sustainable agricultural practices.

A wide range of NbS types exist, and they are often best designed locally with local ecosystems and built environment contexts in mind. Global and regional databases on NbS are proliferating, such as the NbS Knowledge Database and the NbS Evidence Platform.

Table 5. Examples of Nature-based Solutions for Drainage & Irrigation.[16 17 18 19 20]

NbS Type	Main Function	Drainage Benefits	Irrigation Benefits	Key Co-Benefits
Riparian Buffers	Vegetative zones along water bodies/ canals	Reduces runoff velocity, buffers floods, limits erosion	Stabilizes canal banks, reduces sedimentation	Improves water quality, supports biodiversity
Reforestation / Afforestation	Catchment re-vegetation and flow regulation	Reduces overland flow, sedimentation	Regulates inflows to canals and conservancies	Biodiversity, carbon capture, air and water quality
Check Dams / Vegetative Barriers	Flow-slowing structures in channels	Slows water flow, traps sediments	Promotes infiltration, reduces canal erosion	Groundwater recharge, improved soil stability
Floating Wetlands / Vegetation	Aquatic vegetation for water purification	Reduces nutrients, improves water quality	Stabilizes flow in canals, prevents algal blooms	Enhances aquatic ecosystems, biodiversity

16 Miralles-Wilhelm, F. (2021). *Nature-based solutions in agriculture: Sustainable management and conservation of land, water, and biodiversity.* Food and Agriculture Organization of the United Nations and The Nature Conservancy. https://doi.org/10.4060/cb3140en

17 World Bank. (2017). *Implementing nature-based flood protection: Principles and implementation guidance. World Bank Group.* https://openknowledge.worldbank.org/handle/10986/28807

18 UN Environment-DHI, UN Environment, & IUCN. (2018). *Nature-based solutions for water management: A primer.* https://www.unepdhi.org/wp-content/uploads/sites/2/2020/05/WEB_UNEP-DHI_NBS-PRIMER-2018-2.pdf

19 IUCN. (2020). *Nature-based solutions for agricultural water management and food security.* https://www.iucn.org/resources/publication/nature-based-solutions-agricultural-water-management

20 Miralles-Wilhelm, F. (2021). *Nature-based solutions in agriculture: Sustainable management and conservation of land, water, and biodiversity.* Food and Agriculture Organization of the United Nations and The Nature Conservancy. https://doi.org/10.4060/cb3140en

NbS can also greatly benefit irrigation systems, particularly those in conservancy and surface water-fed networks, such as those found in Guyana. While many of the interventions may appear similar to those used in drainage systems, such as vegetated buffers, constructed wetlands, or check dams, their functionality differs in important ways. In drainage systems, the primary goal is to manage excess water and reduce flood risks through temporary storage, infiltration, and flow regulation. In contrast, NbS in irrigation systems are designed to retain, store, and strategically distribute water to agricultural lands, often during dry periods. For example, while wetlands in drainage systems buffer floodwaters, in irrigation they act as pre-treatment zones and temporary reservoirs, enhancing water quality and availability. Similarly, vegetative buffers along irrigation canals stabilize banks and reduce sedimentation, extending the system's life and improving flow efficiency. The emphasis in irrigation-focused NbS is on prolonging water availability, reducing conveyance losses, and enhancing agricultural resilience, rather than on rapid water removal, which is more typical of drainage-oriented solutions.

Effectively identifying and prioritizing opportunities for NbS requires a structured, interdisciplinary assessment approach that aligns ecological potential with social and economic needs. One leading tool in this space is the World Bank's NbS Opportunity Scan methodology, which provides a replicable, data-driven process to rapidly assess where NbS can have the greatest impact in reducing climate and disaster risk[21]. By combining risk analytics (such as flood hazard maps or storm surge models) with ecological assessments and implementation constraints (e.g. land availability, governance), the scan delivers "hotspot" maps where NbS are not only technically viable but also economically and socially desirable. It supports governments and development partners in moving beyond pilot projects toward portfolio-level planning for NbS investments. This methodology has already been applied in various contexts, including Vietnam, Bangladesh, and parts of Latin America, and offers strong applicability to tropical, flood-prone countries like Guyana.

Other methodologies propose structured frameworks for NbS opportunity assessments. For example, the IUCN Global Standard for NbS outlines a criteria-based approach to determine whether proposed interventions are truly nature-based and aligned with sustainability and equity goals[22]. The standard encourages assessments that include stakeholder engagement, ecosystem service valuation, and adaptive governance structures. Meanwhile, tools such as the Oppla Knowledge Marketplace[23], PANORAMA Solutions[24], and the NetworkNature[25] database enable cross-comparison of existing NbS projects and best practices. These platforms are useful for benchmarking similar interventions in comparable climatic and geographic contexts and can support feasibility and design stages of NbS planning.

An additional layer of assessment comes from integrating ecosystem service modeling tools such as InVEST[26], ARIES[27], and Co$ting Nature[28], which quantify the environmental and economic benefits of NbS interventions. These tools allow practitioners to simulate different scenarios—such as the impact of wetland restoration on flood risk or the value of riparian buffers for nutrient reduction—providing critical input for cost-benefit analyses and funding proposals. Combining tools like these with participatory mapping and local knowledge can ground-truth technical assessments and ensure community alignment. Together, these approaches provide a comprehensive framework for identifying, prioritizing, and operationalizing NbS in a spatially targeted, socially inclusive, and financially sound manner.

21 World Bank. (2023). *Nature-Based Solutions Opportunity Scan*. https://naturebasedsolutions.org/opportunity-scan

22 IUCN. (2020). *Global Standard for Nature-Based Solutions: A user-friendly framework for the verification, design and scaling up of NbS*. https://www.iucn.org/theme/nature-based-solutions/resources/iucn-global-standard

23 Oppla. (n.d.). *Nature-Based Solutions Knowledge Marketplace*. https://oppla.eu

24 PANORAMA. (n.d.). *Solutions for a healthy planet*. IUCN, GIZ, and Partners. https://panorama.solutions/en

25 NetworkNature. (n.d.). *Nature-Based Solutions Knowledge Database*. https://networknature.eu/nbs-knowledge-database

26 Natural Capital Project. (n.d.). *InVEST Tool*. https://naturalcapitalproject.stanford.edu/software/invest

27 ARIES. (n.d.). *Artificial Intelligence for Environment & Sustainability. Integrated Modelling Partnership*. https://aries.integratedmodelling.org

28 PolicySupport. (n.d.). *Co$ting Nature: Natural capital and ecosystem services policy support tool*. King's College London, https://www.policysupport.org/costingnature

3 Sustainable Financing Model for D&I in Guyana

Photo: GGGI Guyana

Guyana's NDIS can be financed through various models, including public funding, Public-Private Partnerships (PPPs), and donor support. Effective and sustainable financing is critical to modernizing D&I systems, particularly amid increasing climate variability and water demand. A growing number of countries have adopted performance-based public financing models in which intergovernmental transfers or sectoral allocations are contingent on results, such as improved irrigation service delivery, reduced flood risk, or timely infrastructure maintenance. These mechanisms enhance accountability across central, regional, and municipal levels, fostering a culture of results-based planning. Examples such as the Philippines' Performance-Based Bonus program and Brazil's Water Producer Program demonstrate how targeted incentives can drive local-level improvements in water management and drainage resilience.

Looking ahead, mechanisms such as climate resilience funds, municipal green bonds, and watershed-based Payment for Ecosystem Services (PES) can offer additional financing pathways. These tools not only mobilize resources for capital investment but also support long-term system sustainability and adaptive capacity. Embedding such innovations within a broader national strategy can enable the D&I sector to shift from reactive infrastructure development to a resilient, performance-driven, and financially viable service delivery model.

Table 6. Various Sources and Financial Model of Funding for D&I

Model	Details	Possible Application
Public Funding	Public funding refers to financial support from national or subnational governments, typically derived from taxes or other public revenues. It is essential for foundational investment, particularly where market incentives are weak. However, overreliance may strain public debt and limit long-term fiscal sustainability.	Public funds can play a catalytic role in upgrading Guyana's D&I infrastructure and de-risking other financing mechanisms. Public investment should focus on core infrastructure and capacity-building while leveraging additional sources.
Public-Private Partnerships (PPP)	PPPs enable governments to deliver infrastructure or services through long-term contracts with private sector partners, leveraging private capital and expertise. Common PPP models include: • Design-Build-Finance-Operate-Maintain (DBFOM) • Build-Operate-Transfer (BOT) • Concession or Private Finance Initiative (PFI). • Effective risk-sharing and strong regulation are key.	Guyana could adopt a tailored PPP approach where the government, water users, or both pay for services. The PPP model should reflect the government's willingness to transfer specific operational or financing responsibilities, particularly in large-scale or urban D&I projects.

Model	Details	Possible Application
Donor Support	Donor support includes financial or technical assistance from bilateral partners, multilateral development banks, or climate finance institutions. This can take the form of grants, concessional loans, or in-kind contributions. Donor engagement often aligns with global development and climate goals.	Guyana's D&I Strategy should actively seek donor funding for climate-resilient infrastructure, capacity development, and nature-based solutions, leveraging partnerships with institutions such as the World Bank, the GCF, and bilateral donors.
Green or Sustainable Financing	Green financing includes instruments such as climate adaptation grants, green/blue bonds, and sustainability-linked loans, which fund projects with environmental or climate resilience benefits. These tools often align with global climate goals and deliver co-benefits such as carbon sequestration and biodiversity conservation.	Guyana can pursue green financing to support mangrove restoration, climate-resilient canal systems, and reforestation of upper watersheds. The country may also access the Green Climate Fund or the Adaptation Fund or pilot a green bond for nature-based drainage solutions.
User Contributions / Water Service Fees	Charges levied on users for irrigation or drainage services, often scaled by volume, user type, or ability to pay. Can be combined with subsidies or community cross-financing.	Guyana could introduce service fees in selected schemes where service quality is high, and reliability is assured. Fees can fund operations and maintenance, with transparent reinvestment mechanisms.
Community-Based Financing	Involves locally managed funds, cooperatives, or community labor for small-scale D&I systems. Often relies on shared ownership and low-cost technologies.	Suitable for rural and indigenous communities managing local canals or drainage systems. Enhances local responsibility and reduces central government burden.
Climate Risk Insurance / Index Insurance	Insurance schemes that protect farmers or infrastructure managers from losses due to floods, droughts, or system failure. Often linked with credit or subsidy programs.	Guyana could pilot index insurance for farmers in flood-prone zones or for infrastructure managers responsible for conservancy systems. It could be integrated with disaster risk management strategies.

3.1 Innovative Financing Mechanisms

Innovative financial instruments, including GSS bonds and Payment for Ecosystem Services (PES), can be used to finance Guyana's NDIS.

3.1.1 Green, Social and Sustainability Bonds

GSS (Green, Social and Sustainability) Bonds are any type of bond instrument where the proceeds will be exclusively applied to eligible environmental and social projects or a combination of both; in specific, sustainability bonds are any type of bond instrument where the proceeds - or an amount equal to the net proceeds - will be exclusively applied to finance or re-finance a combination of Green and Social Projects and which are aligned with the Core Components of the Green Bond Principles (GBP) and Social Bond Principles (SBP)[29]. Given the dual environmental and social benefits of Guyana's D&I Strategy, issuing a sustainability bond would be a more suitable option.

3.1.2 Payment for Ecosystem Services (PES)

Payments for Environmental/Ecosystem Services (PES) is a results-based financing mechanism that promotes environmental conservation and restoration by local communities, farmers, and Indigenous communities, providing cash benefits for acting as custodians of nature on a voluntary basis[30].

PES provides direct financial incentives to individuals or communities for managing local natural resources in ways that maintain or enhance ecosystem services through a bottom-up approach. However, an effective PES scheme also relies on robust Measuring, Reporting and Verification (MRV) systems to track the delivery of environmental services, ensure a fair and just distribution of benefits and responsibilities among all stakeholders, and address related considerations.

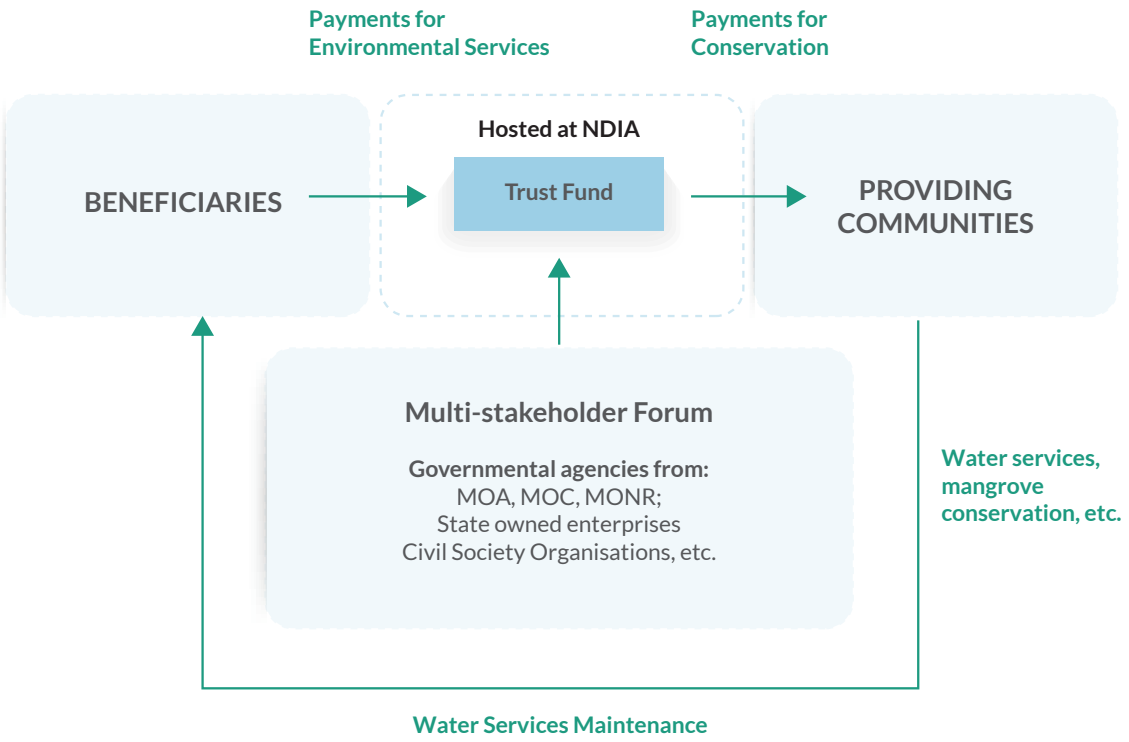


Figure 13. Potential PES Mechanism Design for Guyana's D&I Strategy

29 International Capital Market Association (ICMA), *The Principles Guidance Handbook*, November 2024, 7, https://www.icmagroup.org/assets/documents/Sustainable-finance/2024-updates/The-Principles-Guidance-Handbook-November-2024-171023.pdf.

30 UNDP, *Designing a Digital System to Enable Payment for Ecosystem Services (PES) at Scale – Taking a Digital Public Good (DPG) Approach to Enhance Nature and Climate Action* (New York: United Nations Development Programme, 2024), vi, https://climatepromise.undp.org/sites/default/files/research_report_document/UNDP_Designing%20digital%20systems_PES_July%202024_high%20res%20FINAL3.pdf.

4 NDIS Alignment with Government Priorities

Photo: Georgetown & the Demerara River (Adobe Stock)

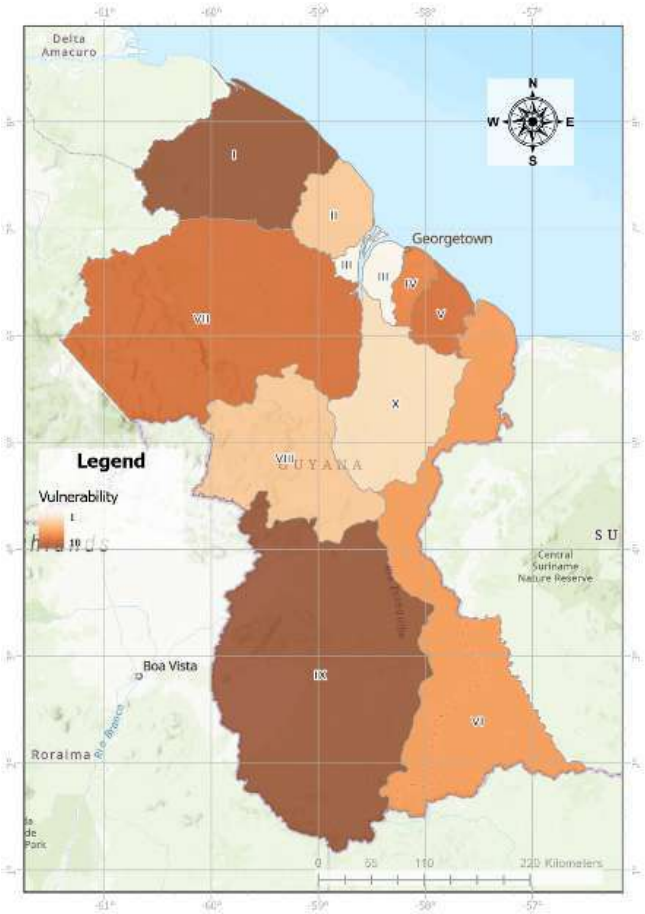
Guyana developed its National Adaptation Plan (NAP) 2025–2050, which identified significant vulnerabilities in the availability and management of its water resources, underpinning the development of the NDIS and providing insight into climate risks, vulnerability conditions, and progress in adaptation policies and actions. Despite widespread public perception in Guyana that water is abundant, significant vulnerabilities in the nation's water resources remain. Extractive industries and agricultural practices further threaten water quality and availability. Policy focus remains primarily on drainage and irrigation, often neglecting potable water and sanitation needs. Access to treated water is limited, especially in the Hinterland and coastal rural areas, and sanitation infrastructure is inadequate; most of the population relies on septic tanks or pit latrines that are vulnerable to flooding.

Guyana continues to develop a strong climate change adaptation policy framework for its water resources sector, highlighted by recent technology assessments and the completion of the NAP and the NDIS. The country has increased its resilience to drought by constructing groundwater wells in the Hinterland regions and is actively working to establish a National Water Council. Agencies such as the NDIA, GWI, and CDC have established collaboration and response measures to address flood and drought risks. Additionally, ongoing large-scale capital investment projects to rehabilitate water conservancies and irrigation networks demonstrate Guyana's commitment to improving water resource management and climate resilience.

The combination of climate hazards and vulnerability exacerbates inequalities, hitting smallholder farmers, women-headed households, and hinterland communities the hardest. A map adopted from Guyana's NAP in **Figure 14**, provides a snapshot of the country's vulnerability by region. The NDIS aims to address these risks by reducing flood exposure through better water control administration and management, enhancing drought resilience via water storage and distribution systems, and prioritizing inclusive access to D&I services.

The NDIS promotes sustainable growth while being adaptable to specific environmental, socio-economic, and climatic conditions, as well as preexisting national policies and international commitments. It captures integrated systems approaches and innovations to address a range of problems and opportunities, including facilitating decision-making, evaluating existing systems, managing water resources, identifying appropriate irrigation methods, adapting to climate change, and increasing overall agricultural output. This will be done with stakeholder involvement, which covers the "soft" institutional architecture needed to ensure that D&I's complex hard "gray" and natural "green" infrastructure functions effectively and efficiently, benefiting Guyana.

The NDIS closely aligns with the NDIA Act by establishing a robust framework for water resource management that promotes governance, data-driven decision-making, and sustainable infrastructure development. First, the Act's emphasis on inclusive participation through water users' associations, local government bodies, and private entities mirrors the strategy's call for collaborative governance and national involvement in D&I, ensuring all communities, including indigenous groups, have a voice in planning and management. Second, by defining the Authority's duties to evaluate, conserve, and utilize water resources, the Act aligns with the pillar focused on creating effective data and management systems, as it necessitates accurate information flow, monitoring, and evidence-based strategies. Lastly, the Act's provisions for



Source: Guyana's NAP 2025

Figure 14. Vulnerability Index of Guyana.

sustainable operation, maintenance, and innovation in D&I systems reinforce the strategy's third pillar, which centers on infrastructure planning, maintenance, and finance, including the adoption of new technologies and nature-based solutions. Together, the NDIA Act and strategy pillars aim to optimize national water management for maximum benefit and sustainability, aligning with broader national strategies.

4.1 NDIS Alignment with National Development Objectives

The NDIS aligns with Guyana's broader objectives for water resource management, agricultural development, climate resilience, and sustainable development targets. These include the LCDS 2030, Guyana's National Adaptation Plan 2025-2050, Guyana Water Incorporated's Strategic Plan 2021-2025, and the National Agriculture Strategy, both currently under revision. **Table 7** lists the alignments.

Table 7. Summary of NDIS's Alignment with Guyana's National Strategy

Low Carbon Development Strategy (LCDS) 2030

The NDIS aligns with the principles and priorities outlined in the LCDS, which promote sustainable water and land use, support low-carbon economic growth, and help preserve forests, biodiversity, and marine resources. By strengthening climate resilience, particularly in flood and drought management, the NDIS incorporates climate risk mitigation and resilience-building within the water sector, reflecting LCDS priorities on adaptation and ecosystem protection.

Guyana's LCDS 2030, based on consultation, sets out four objectives (three carried over from the 2009 LCDS and one newly introduced under the 2030 LCDS) to which the NDIS will contribute to varying extents.

Objective 1: Forest Climate Services and other Ecosystem Services. NDIS supports ecosystem services by improving hydrological management, maintaining water balance across various land uses, and reducing risks of land degradation and ecological damage.

Objective 2: Stimulate future growth through clean energy and sustainable economic activities. NDIS enhances agricultural productivity through efficient, low-carbon irrigation and drainage systems, supporting sustainable livelihoods and green economic growth.

Objective 3: Protect against climate change. The NDIS strengthens climate resilience by reducing flood and drought risks and embedding climate adaptation and risk mitigation within national water management systems.

Objective 4: Align with global climate goals: The NDIS contributes to Guyana's international climate and biodiversity commitments by advancing sustainable water management aligned with SDGs 6, 13, and 15.

National Adaptation Plan (NAP)

Ongoing

The NDIS functions as a sector-specific, actionable framework that directly supports the broader goals outlined in the NAP. Guyana's NAP 2025–2050, prepared in line with the NAP, is built around five core pillars: information systems, governance, skills and awareness, technology solutions, and financial mechanisms. The NDIS advances the NAP's objectives by emphasizing three complementary pillars that improve water resource management and deliver significant cross-sectoral benefits. These include increasing agricultural productivity, strengthening coastal resilience, supporting sustainable development in human settlements, and enhancing disaster management.

The three pillars of the NDIS align with the five pillars in Guyana's ongoing NAP process.

NAP Pillar 1 - Information Systems: Strengthen Guyana's technological and human capacities for weather forecasting, climate change projections, multi-hazard-early, and the continuous monitoring of watersheds and aquifers. – NDIS's Pillar 2 "Data and Data Management Systems" aligns with this NAP Pillar.

NAP Pillar 3 - Skills and Awareness: Develop and implement awareness-raising programmes on the impacts of climate change on water and soil resources, encouraging sustainable practices. NDIS's Pillar 1, "Governance and National Participation in D&I," and Pillar 2, "Data and Data Management Systems", which contain components of training, will contribute to this NAP Pillar.

NAP Pillar 1 - Governance: Strengthen and enforce the policy and regulatory framework centered on a national water council supporting a community-based integrated watershed management approach and a polluters-pay-principle. NDIS's Pillar 1 "Governance and National Participation in D&I" aligns with this NAP Pillar.

NAP Pillar 4 - Technical Solutions: Fortify capital investments in flood protection, drainage, irrigation, and water storage infrastructure, while expanding and improving potable water and sanitation coverage and quality. NDIS's Pillar 2, "Data and Data Management Systems," and Pillar 3, "Infrastructure Planning, Maintenance, and Finance," align with this NAP Pillar.

NAP Pillar 5 - Finance Mechanisms: Introduce financial and fiscal incentives to encourage sustainable watershed management and water efficiency, particularly among the most vulnerable. Increase funding for the regular expansion, maintenance, and repair of the D&I systems, flood protection infrastructure and water treatment and sanitation systems. NDIS's Pillar 3, "Infrastructure Planning, Maintenance, and Finance," aligns with this NAP Pillar.

National Gender and Social Inclusion Policy (NGESIP)

Published in 2018

Guyana's NGESIP framework endeavors to promote Guyana's development by improving the capacities and opportunities for diverse groups of women, men, girls, boys, and vulnerable groups, based on a framework that fosters the dignity of these groups. NDIS, through its three Pillars, provides an opportunity to download the objectives of NGESIP into the D&I sector.

The GEDSI (Gender Equality, Disability, and Social Inclusion) principles have been integrated into the development of NDIS:

NDIS Pillar 1 "Governance and National Participation in D&I" promotes inclusive governance structures and stakeholder engagement mechanisms to ensure that women, indigenous people, youth, and other marginalized groups are meaningfully involved in governance of Guyana's D&I.

NDIS Pillar 2 "Data and Data Management Systems" help identify disparities in water access, climate risk exposure across different vulnerable groups, enabling targeted interventions.

NDIS Pillar 3 "Infrastructure Planning Maintenance and Finance" embeds GEDSI into the planning of D&I infrastructure, ensuring that technical solutions and financial resources respond to the needs of targeted vulnerable groups.

National Agriculture Strategy 2025

Published in 2018

Guyana's National Agriculture Strategy 2025 provides an overarching vision for the long-term development of the agriculture sector by contributing to economic growth and diversification, employment and poverty reduction, food security, and climate-resilient ecosystems and sustainability, inclusive of climate change adaptation.

The pillars of the NDIS closely align with and reinforce the agricultural strategy, serving as key enablers of inclusive governance, data-driven decision-making, and resilient infrastructure development. This can be

NDIS Pillar 1: The NDIS strengthens inclusive governance, equitable participation (including Indigenous communities), and integrated decision-making, directly supporting the agricultural strategy's goals of multi-sector coordination, human resource development, and integrated food and nutrition security.

NDIS Pillar 2: By enhancing data management systems, research, and digital tools, the NDIS reinforces the agricultural strategy's emphasis on resilience, sustainability, modernized support services, and evidence-based

NDIS Pillar 3: The NDIS's focus on drainage, irrigation, performance-based management, and Nature-based Solutions aligns with the agricultural strategy's priorities on infrastructure modernization, climate resilience, market access, and agricultural diversification, helping translate policy into practical results.

4.2 Alignment with Global Best Practice

Global best practices in D&I offer valuable insights for developing effective, inclusive approaches to this strategy. Some practices are superseded by planning documents that facilitate the implementation of the overarching Strategy. For example, Nepal's "Irrigation Master Plan 2019" advocates a comprehensive, demand-driven approach that emphasizes food security and innovation. Other prominent best practices include integrated planning, strategic transformative methodology, the empowerment of Water Users Associations (WUA's), groundwater resource development, and prioritized irrigation financing[31]. On the other hand, the "Drainage Master Plan for the National Capital Territory (NCT) of Delhi" emphasizes the importance of interministerial coordination to foster interdepartmental collaboration. It includes practices such as ensuring data accuracy, conducting detailed drainage assessments, utilizing simulation scenarios for planning, adopting low-impact development solutions, enhancing infrastructure maintenance, and engaging the public[32]. Concurrently, the "African Union's Framework for Irrigation Development and Agricultural Water Management (IDAWM)" concentrates on small-scale, farmer-led irrigation systems. Its recommended practices encompass supporting investments in smallholder irrigation, promoting water harvesting, integrating water management strategies, involving the private sector, and encouraging research and knowledge dissemination[33]. While there is no one-size-fits-all solution, these examples underscore the importance of adopting integrated, participatory, and data-informed strategies that are tailored to both national and local contexts.

31 Government of Nepal, *Irrigation Master Plan 2019* (Kathmandu: Ministry of Energy, Water Resources and Irrigation, 2019).

32 Government of the National Capital Territory of Delhi. *Drainage Master Plan for the National Capital Territory (NCT) of Delhi*. New Delhi: Government of NCT of Delhi, 2018.

33 African Union. *Framework for Irrigation Development and Agricultural Water Management (IDAWM)*. Addis Ababa: African Union, 2020.

5 NDIS Roadmap and Implementation Plan

Photo credit: Narendra Sukhdeo

The NDIS represents a critical step in strengthening Guyana's capacity to sustainably manage its water resources amid rapid agricultural expansion, urban development, and climate change. By aligning national priorities with global best practices, this Strategy advances a unified vision built on inclusive governance, transparent data systems, and resilient infrastructure. Through the interconnected pillars of Collaborate, Inform, and Act, the NDIS provides both a policy foundation and a practical roadmap illustrated in **Figure 15** for achieving climate-smart, socially inclusive, and economically viable D&I development.

This Strategy recognizes that the effectiveness of D&I systems in Guyana depends not only on engineering solutions but also on community engagement, the integration of local and scientific knowledge, and the adoption of nature-based approaches that work with, rather than against, the natural environment. The mainstreaming of gender equity, indigenous participation, and ecosystem-based planning strengthens the adaptive capacity of both rural and coastal populations and helps to future-proof national development.

Moving forward, the successful implementation of the NDIS will require long-term investment, institutional coordination, and accountability at all levels of government. It will also depend on the collective commitment of stakeholders—government, farmers, researchers, private sector actors, and civil society—to co-create a D&I system that reflects the values of resilience, equity, and sustainability. The NDIS offers not just a plan, but a platform for transforming how water is governed, shared, and sustained across Guyana for generations to come.

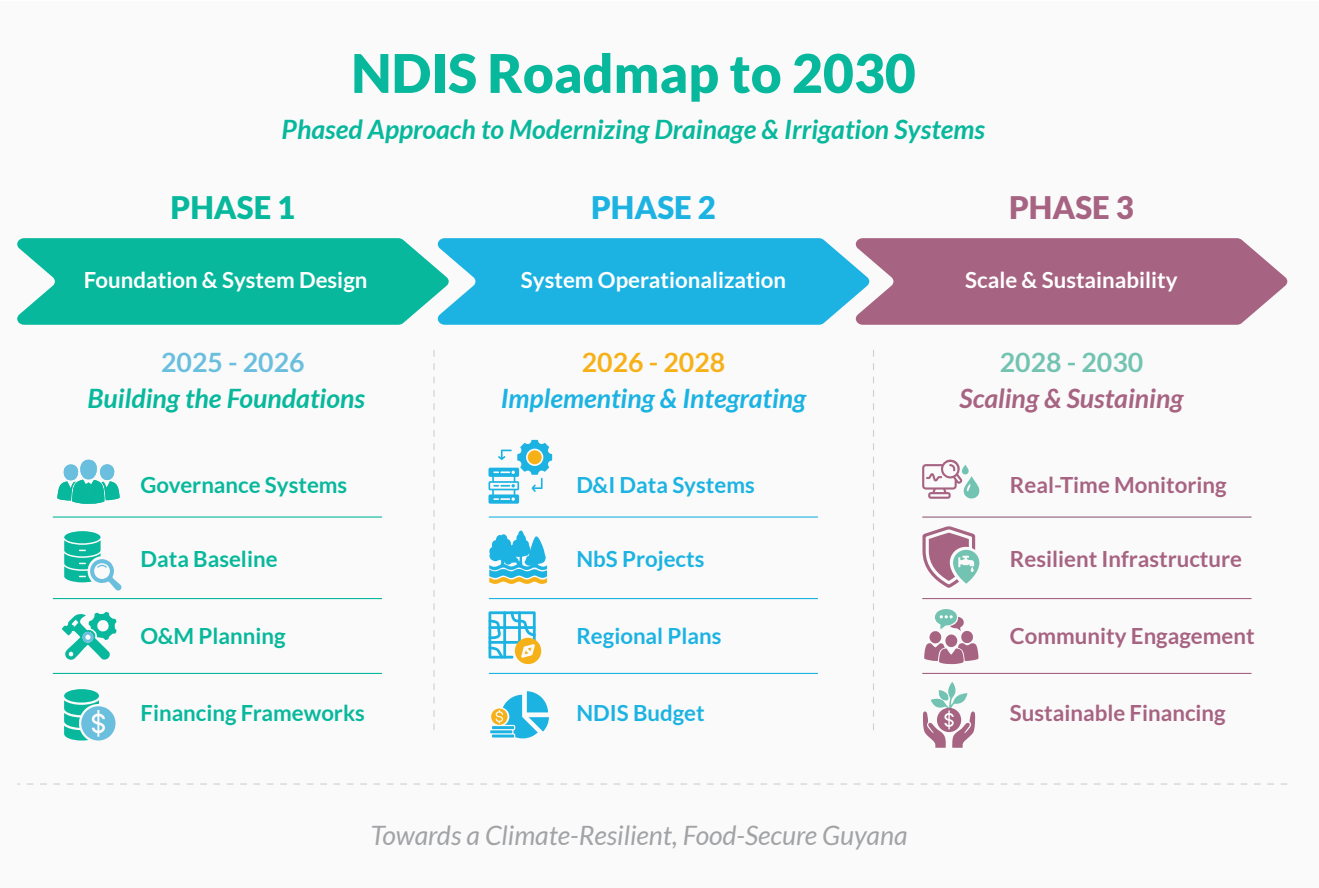


Figure 15. NDIS 2030 Roadmap

5.1 Summary View

Phase 1 (2025–2026)

Building the Foundations

NDIA governance is fully operational, the national data baseline has been completed, and the O&M system has been designed.

Phase 1 (2026–2028)

Implementing and Integrating systems

Data platform and dashboards live, infrastructure investment scaled, and NbS pilots implemented.

Phase 3 (2028–2030)

Scale and Sustainability

Performance-based financing; operational, integrated green-grey infrastructure; mainstreamed and fully optimized national D&I system.

5.2 Phase 1: Foundation and System Design (2025–2026)

"Building the Institutional, Data, and Planning Foundations"

Key results	**Core governance systems, institutional arrangements, and baseline data infrastructure are established to enable coordinated and evidence-based D&I management.**

1. Governance & Institutional Strengthening

- NDIA formally established as apex D&I authority
- Inter-ministerial coordination mechanism operational
- Joint planning framework between national and subnational actors established
- Stakeholder mapping completed and inclusive participation guidelines developed
- Multi-stakeholder coordination body established
- Water Users Associations (WUAs) assessed and formalized within governance framework

2. Data, Technology & Knowledge Systems

- National D&I data mapping and baseline assessment completed
- Lead D&I data management unit designated under NDIA
- Development of data governance standards and interoperability framework
- Initial traditional knowledge and citizen science systems identified

3. Infrastructure, Planning & O&M

- National O&M system design completed
- Assessment of infrastructure condition and maintenance practices completed
- NbS baseline assessment conducted
- Climate-risk-informed planning approaches introduced

4. Financing & Policy Integration

- Initial work toward NDIS financing framework initiated
- Alignment of D&I within national planning and policy frameworks begins

5.3 Phase 2: System Development and Operationalization (2026–2028)

"Operationalizing Systems and Scaling Coordination"

Key results	**Integrated governance, data systems, and planning frameworks are operational, enabling coordinated decision-making and early implementation of climate-resilient interventions.**

1. Governance & Institutional Strengthening

- Cross-agency D&I targets integrated into ministry work plans
- WUAs operational and participating in governance (target: ≥10 by 2028)
- Dedicated D&I coordination capacity established within NDIA
- Inclusive participation (women, Indigenous peoples, youth) institutionalized

2. Data, Technology & Knowledge Systems

- National D&I data repository and dashboard operational
- Integration with Hydromet, agriculture, and disaster risk systems
- M&E system for D&I data and climate hazards operational
- Training programs implemented; at least 10+ staff trained
- Traditional knowledge platform and citizen science programs operational

3. Infrastructure, Planning & O&M

- National O&M system operationalized
- NbS integrated into infrastructure planning and guidelines
- At least 3 NbS-based infrastructure projects designed
- NDIA prioritization system operational

4. Financing & Policy Integration

- Dedicated NDIS budget established (by 2027)
- Participatory budgeting mechanisms implemented
- Regional flood and water management plans completed (all regions)
- National spatial planning frameworks updated to include D&I

5.4 Phase 3: Scale, Integration, and Sustainability (2028–2030)

"Scaling Investments and Institutionalizing Resilience"

Key results	**A fully integrated, climate-resilient, and sustainably financed D&I system supports national food security, economic growth, and community resilience.**

1. Governance & Institutional Strengthening

- Fully institutionalized coordination across ministries and regions
- Sustained inclusive governance with active WUAs and stakeholders
- D&I governance supports data-driven national decision-making

2. Data, Technology & Knowledge Systems

- Real-time monitoring systems deployed across key infrastructure
- Full integration of climate, hydrological, and agricultural data systems
- 10+ agencies actively using D&I data platforms
- Sustained national capacity in D&I data management

3. Infrastructure, Planning & O&M

- Climate-resilient infrastructure investments implemented at scale
- NbS integrated into at least 10 infrastructure/ mitigation plans
- Community-led maintenance systems operational
- D&I Rangers program scaled (≥20 trained personnel)

4. Financing & Policy Integration

- Performance-based budgeting system operational
- Natural capital accounting and water financing mechanisms implemented
- Integrated green, blue, and grey infrastructure investment frameworks operational

5.5 Pillar 1: Governance and Institutional Strengthening

Level	Result Statement	Indicators	Means of Verification	Timeline
Outcome 1.1	National coordination for drainage and irrigation management is strengthened under the NDIA leadership.	Inter-ministerial coordination mechanism operational	Official establishment documents and meeting records	By 2026
		Number of cross-agency D&I targets integrated in ministry work plans	Ministry annual work plans	2026 onward
Output 1.1.1	NDIA strengthened as the apex authority for D&I governance and national coordination.	An inter-ministerial coordination group was established	Government decision / official notification	By 2026
		At least 3 cross-agency D&I targets integrated into the annual work plans of relevant ministries	Ministry planning documents	By 2026
Output 1.1.2	Joint planning mechanisms between NDIA and subnational agencies are established.	National framework for joint target setting developed	Planning guidelines and coordination reports	By 2026
		Share of national water sector targets reflecting integrated infrastructure objectives	Monitoring reports	2027 onward
Outcome 1.2	Inclusive governance mechanisms are established to strengthen stakeholder participation in D&I decision-making.	Stakeholder mapping and officially designated appointments	Stakeholder Map and organizational structure and appointment records	By2026
		Strengthening of Water Users' participation in decision-making.	WUAs registration records and operational reports	2027 onward
Output 1.2.1	Stakeholder engagement mechanisms established for D&I governance.	National stakeholder mapping of D&I actors completed	Stakeholder mapping report	By 2026
		Representation guidelines for women, youth and Indigenous peoples developed	Official guidelines or policy document	By 2026

Output 1.2.2	Multi-stakeholder coordination structures established for major water-use domains.	National multi-stakeholder coordination body operational	Coordination body meeting records	By 2026
		Dedicated D&I coordination capacity established within NDIA	Organizational structure and appointment records	By 2026
		D&I focal points designated across relevant agencies	Official designation letters	By 2026
Output 1.2.3	Water Users Associations strengthened and integrated into national D&I governance.	National assessment of WUA capacities completed	Assessment report	By 2026
		Formal framework recognizing WUAs within NDIA governance adopted	Policy documents	By 2026
		Number of Water Users Associations operational under the new framework	WUA registration records and operational reports	At least [10] WUAs by 2028

Outcome 1.3	Sustainable and accountable financing mechanisms are established to support the implementation of the NDIS	NDIS activities included in the national budget	National budget documents	By 2027
		NDIS budget developed through participatory budgeting processes	Consultation reports and meeting records	By 2027
Output 1.3.1	A dedicated national financing framework for NDIS implementation is established.	Standalone national budget for NDIS approved	National budget documents	By 2027
		Percentage of NDIS budget developed through participatory budgeting processes	Budget consultation reports	By 2027
		Participation of Indigenous groups, women, and smallholder farmers in budgeting processes	Consultation reports and meeting records	By 2027

Outcome 1.4	Integrated planning frameworks support proactive and transparent D&I decision-making	Number of national water-sector planning documents referencing D&I	National Planning Document	At least 2 by 2028
		Integration of Nature-based Solutions (NbS) in regional plans	NbS is integrated into at least 10 mitigation/ infrastructure plans	At least 10 by 2030
Output 1.4.1	D&I are integrated into national water and development planning frameworks, aligned with the principles of Integrated Water Resources Management (IWRM).	Number of national water-sector planning documents referencing D&I	National planning documents	At least 2 by 2028
Output 1.4.2	Regional flood mitigation and water management plans developed.	Regional water management or flood mitigation plans completed	Regional planning documents	All Regions by 2028
		Integration of Nature-based Solutions (NbS) in regional plans	Planning reports	At least 10 by 2030
Output 1.4.3	National spatial planning frameworks support coordinated D&I infrastructure investment.	National physical plan incorporating D&I infrastructure completed	National spatial development plan	By 2028
		Regional spatial plans available in digital and physical formats	Planning databases and reports	By 2029

5.6 Pillar 2: Data, Technology and Knowledge Systems

Level	Result Statement	Indicators	Means of Verification	Timeline
Outcome 2.1	Establish an Integrated Climate and Agronomic Data Repository and Management System to support climate-informed D&I planning and decision-making.	National D&I data management framework operational	Government policy or technical documentation	By 2027
		Number of agencies contributing datasets to the national D&I system	System usage and integration records	2027 onward
Output 2.1.1	Enhance national data management and knowledge through a comprehensive mapping of existing datasets across agencies, establishing a national baseline of D&I data sources, including traditional knowledge systems	Comprehensive mapping of national D&I datasets completed	National mapping exercise of D&I data sources, datasets, and institutional data brokers completed.	By 2026
		Identification of traditional and local knowledge sources related to water management and agriculture.	Data inventory database	By 2027
Output 2.1.2	Operationalize a centralized or federated D&I data management repository, based on the findings of the national data assessment, supported by interoperability standards and shared data governance procedures.	National D&I data repository established	Development of a centralized D&I data management system.	By 2028
		National standards and guidelines for D&I data sharing adopted	Official data governance manual for D&I data management and sharing.	By 2028
		Integration with Hydromet, disaster risk management, and agricultural planning systems	Integration of the repository with other agencies	By 2028

Level	Result Statement	Indicators	Means of Verification	Timeline
Output 2.1.3	Recognize and integrate non-traditional data sources, including Indigenous knowledge and citizen science, to strengthen data diversity and improve water management insights.	Traditional knowledge platform or compendium established	Knowledge platform documentation	By 2027
		Establishment of systems to collect disaggregated data by sex, age, and community characteristics.	Program reports and participation records	2027 onward
		Establishment of systems to collect disaggregated data by sex, age, income, and community characteristics.	National data portal reports	2028 onward
Outcome 2.2	Develop centralized institutional and digital infrastructure to support integrated D&I data management across government agencies.	Operational dashboard for decision-making	Operational dashboard system	By 2027
			Training completion records	2027 onward
Output 2.2.1	Designate NDIA as responsible for national water and D&I data management, ensuring alignment with the governance coordination mechanisms and operational platforms.	Lead agency formally designated	Government decision or official directive	By 2026
		Staffing plan and operational budget approved	Institutional HR and budget records	By 2026
		Institutional organogram showing relationships between data management unit and governance structures	Published organogram	By 2026

Output 2.2.2	Develop and deploy an interactive D&I data management dashboard to support coordinated access to key datasets and decision-support tools for agricultural planning and water management.	National dashboard developed and operational	Operational dashboard system	By 2027
		Number of government agencies accessing the dashboard	System access logs	At least 5 by 2027
		User training programs delivered	Training reports	2027 onward
Output 2.2.3	Strengthen institutional capacity to manage digital D&I systems and ensure effective utilization of data management tools.	Number of staff trained in D&I data management systems	Training completion records	At least 10 by 2027
		Operational protocols for data entry and management adopted.	Institutional operating procedures	By 2027
Output 2.2.4	Develop and implement an integrated Monitoring and Evaluation (M&E) system to track the performance of D&I data systems and support monitoring of climate hazards affecting water infrastructure.	Integrated M&E framework for D&I data management operational	M&E system documentation	By 2027
		Number of climate hazards monitored through D&I data systems	Monitoring reports	2027 onward

Outcome 2.3	Deploy real-time infrastructure and water monitoring technologies to strengthen climate risk-informed decision-making for D&I systems	Number of sensors and monitoring systems installed at critical infrastructure sites	Infrastructure installation reports	
Output 2.3.1	Real-time monitoring infrastructure deployed across key D&I systems.	Number of sensors and monitoring systems installed at critical infrastructure sites	Infrastructure installation reports	By 2029
		Operational real-time data streams integrated into national data systems	Data platform monitoring reports	By 2029
		Deployment of drones and surveillance technologies for D&I monitoring	Procurement and operational records	By 2029

Outcome 2.4	Strengthen human resource capacity and institutional systems to support sustainable data management for drainage and irrigation.	Number of toolkits developed and managers trained	Training materials and report	At least 10 by 2028 and onwards
		Number of partnerships established	Partnership agreements or MoUs	At least 5 by 2030
Output 2.4.1	Develop and implement training programs to build a national cohort of D&I data managers and technical specialists.	Training curriculum or toolkit developed	Training materials and program documentation	By 2027
		Partnership with the University of Guyana and research institutions established	Partnership agreements	By 2030
Output 2.4.2	Institutional performance monitoring systems link data management and operational performance.	Performance management system implemented for D&I data agencies	Institutional performance reports	By 2028
		Number of trained D&I data managers supporting national systems	Training and certification records	At least 10 trained data managers by 2028

5.7 Pillar 3: Infrastructure, Planning, Maintenance, and Finance

Level	Result Statement	Indicators	Means of Verification	Timeline
Outcome 3.1	Establish a national institutional platform for the coordinated operation and maintenance (O&M) of D&I infrastructure.	O&M coordination operational	Official establishment documentation	2026 onwards
		Number of maintenance requests processed	O&M system operational records	2026 onwards
		Number of community-led maintenance models case studies	Sector studies	5 by 2030
Output 3.1.1	Establish and operationalize a phased national O&M system for D&I infrastructure, consisting of: a) an institutional coordination platform with staffing, funding, and operational procedures; and b) a technical O&M system supporting maintenance planning, budgeting, capacity-building, and community participation.	O&M coordination platform established with staffing and operational procedures	Official establishment documentation; institutional reports	2027 onwards
		National assessment of existing O&M practices completed	Assessment reports; infrastructure condition inventory	2026
		Number of maintenance requests processed annually	O&M system operational records	2026 onwards
		Documented case studies of community-led maintenance models	Sector studies; program reports	5 by 2030
Outcome 3.2	Rehabilitate and expand priority D&I infrastructure in climate-vulnerable and food security regions while integrating NbS into infrastructure planning.	Number of NbS baselines assessment completed	Technical Baseline Assessment	2026
		Number of D&I intervention designs developed integrating NbS	Project design documentation	3 by 2030
Output 3.2.1	Mainstream adaptive, landscape-based infrastructure design approaches across NDIA-led planning processes through the development of a national baseline assessment on the application of NbS alongside grey infrastructure.	National NbS baseline assessment completed	Technical assessment reports	2026
		Climate risk methodologies adopted in planning processes	Planning guidelines; infrastructure design reports	2026

Output 3.2.2	Design and submit new NbS interventions for D&I infrastructure based on the national NbS baseline and prioritization methodology.	At least three NbS-based D&I intervention designs developed and submitted	Project design documentation; national investment reviews	2028–2026

Outcome 3.3	Establish national standards and planning guidelines to integrate NbS into D&I infrastructure design and project planning.	Updated engineering manuals to include NbS	Official manuals and planning guidelines	2027
		Number of new projects with NbS considerations	Project feasibility studies	2030
Output 3.3.1	Update and digitize national D&I infrastructure design, maintenance, and financing guidelines, incorporating the application of NbS.	Updated engineering manuals and infrastructure design standards published	Official manuals and planning guidelines	2027 onwards
		NbS methodologies formally documented and shared with implementing agencies	Technical guidance documents	2026
Output 3.3.2	Integrate NbS into feasibility studies and environmental assessments of D&I infrastructure projects.	% of new projects including NbS in feasibility studies	Project feasibility studies; environmental impact assessments	2030

Outcome 3.4	Strengthen operation, maintenance, and asset management systems for D&I infrastructure, including integration of green infrastructure components.	NDIA prioritization system operational	System documentation	2027
		Number of trained rangers	Training reports	At least 20 by 2030
Output 3.4.1	Operationalize the NDIA Data Prioritization System to support adaptive and risk-informed infrastructure management.	NDIA prioritization system operational with planning modules	System documentation; NDIA reports	2027
Output 3.4.2	Introduce community-led maintenance models to strengthen stewardship of drainage infrastructure and associated NbS.	Number of pilot community-led maintenance programs implemented	Program reports; community engagement records	2028 onwards

Output 3.4.3	Professionalize and expand the role of D&I Rangers to support monitoring, maintenance, and data collection.	Number of trained and deployed rangers	Training reports; staffing records	2030

Outcome 3.5	Strengthen investment planning frameworks to support integrated green and grey infrastructure development.	Asset Classification Study completed	Study reports	2027
		Number of policy frameworks	Policy frameworks	2030
Output 3.5.1	Develop an integrated national approach for planning and financing infrastructure investments, recognizing conservancies, green infrastructure, and blue infrastructure as national assets.	National asset classification study completed	Study reports; sector planning documents	2027 onwards
		Framework for integrating green and blue infrastructure into national investment mechanisms	Policy frameworks; investment planning documents	At least 3 by 2030

Outcome 3.6	Systemize cost recovery and performance-based management for D&I infrastructure.	Natural capital accounting study	Study report	2027
		Operational budget system	Government budget reports	2030
Output 3.6.1	Establish a budget accountability and performance-based management system for water and nature-based infrastructure assets.	National natural capital accounting study completed	Economic assessment reports	2027
		National studies on water financing and PES mechanisms completed	Policy studies; financing reports	2027
		Performance-based budgeting system operational	Government budget reports; sector performance reviews	2027 onwards

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