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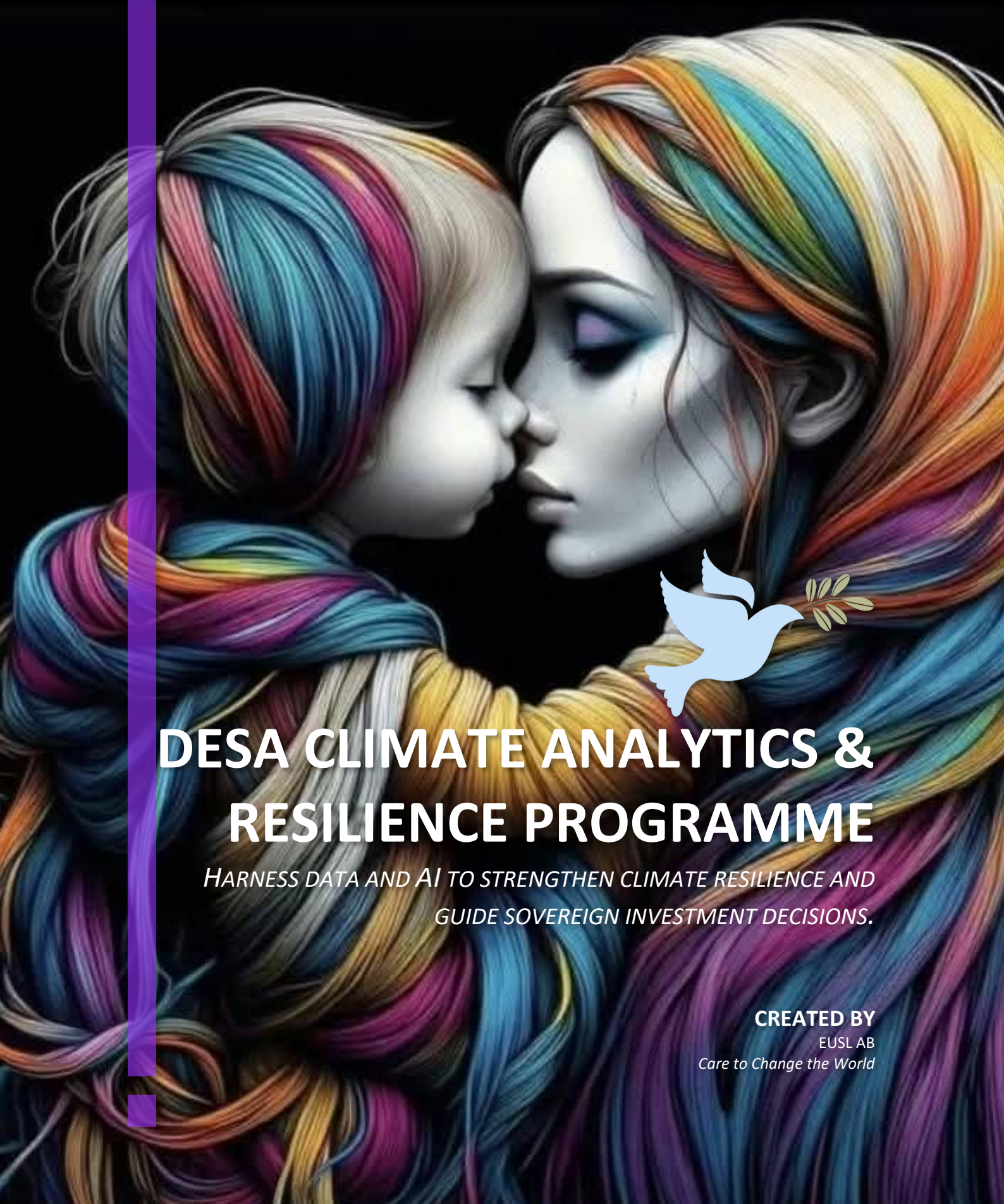

# DESA CLIMATE ANALYTICS & RESILIENCE PROGRAMME

*HARNESS DATA AND AI TO STRENGTHEN CLIMATE RESILIENCE AND GUIDE SOVEREIGN INVESTMENT DECISIONS.*

**CREATED BY**
EUSL AB
*Care to Change the World*

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# DESA Climate Analytics & Resilience Programme

## Programme Facts Table

| Item | Detail |
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| **Programme Name** | DESA Climate Analytics & Resilience Program |
| **Acronym** | DCARP |
| **Mission (one-liner)** | Harness data and AI to strengthen climate resilience and guide sovereign investment decisions. |
| **Executive Summary** | DCARP is a compulsory DESA programme designed to operationalize climate intelligence across governance, agriculture, and infrastructure planning. It integrates sovereign climate data lakes, predictive modelling, and decision-support dashboards to enable evidence-based policy and investment choices. Through PPPs for sensor networks and MRV systems for adaptation outcomes, DCARP reduces disaster losses, optimizes crop planning, and aligns capital allocations with resilience objectives. The programme is harmonized with Agenda 2063, Agenda 2074, AfDB High 5 priorities, and REC climate strategies, ensuring interoperability and scalability across Africa. |

## Chapter 1 — Programme Title, Mandate, Scope, Instruments, and Outcomes

The DESA Climate Analytics & Resilience Program (DCARP) is established as a sovereign instrument for embedding climate intelligence into national and regional development systems. Its mandate is to ensure that climate resilience is treated as a structural obligation within DESA operations, supported by enforceable standards and measurable outcomes.

The scope of DCARP encompasses drought and flood modelling, early warning systems, climate-linked agricultural advisory services, and resilient infrastructure planning. These functions are delivered through interoperable platforms that integrate satellite data, IoT sensor networks, and predictive analytics, ensuring real-time situational awareness and actionable insights for ministries, local governments, and private sector actors.

The programme's instruments include sovereign climate data lakes for secure storage and harmonization of multi-source datasets; decision-support dashboards for ministries and planning authorities; PPP frameworks for sensor deployment and maintenance; and MRV systems for adaptation outcomes, enabling transparent reporting to development partners and compliance with global climate commitments.

Expected outcomes include reduced disaster-related losses through anticipatory action; improved crop planning and food security via climate-informed agricultural advisories; and climate-aligned capital allocations that safeguard infrastructure investments against systemic risks. These outcomes advance governance efficiency, market resilience, and social equity by reducing vulnerability and promoting inclusive adaptation strategies.

## Chapter 2 — Legal Mandate and Purpose

DCARP is compulsory under DESA, reflecting the normative obligations of partner states under international and continental frameworks. Its legal foundation is anchored in Agenda 2063 (Second Ten-Year Implementation Plan), which prioritizes climate resilience and sustainable resource management; Agenda for Social Equity 2074, which codifies intergenerational equity and environmental stewardship; and the AfDB High 5 priorities, particularly “Improve the Quality of Life for the People of Africa” and “Integrate Africa,” which emphasize infrastructure resilience and regional harmonization.

The programme’s purpose is threefold:

1. To institutionalize climate analytics as a core governance function, ensuring that ministries and planning authorities adopt evidence-based decision-making for resource allocation and infrastructure development.
2. To operationalize predictive modelling and early warning systems for agriculture and disaster risk reduction, thereby safeguarding livelihoods and food security.
3. To harmonize national adaptation strategies with REC frameworks (COMESA, SADC, EAC), enabling cross-border data exchange and coordinated resilience planning.

By embedding these functions into DESA’s governance architecture, DCARP transforms climate resilience from a policy aspiration into an operational reality, supported by enforceable standards, transparent reporting, and performance-linked financing.

# Chapter 3 — Strategic Objectives

**Objectives–to–Outcome Matrix (concise; DAIP-conform table layout)**

| Objective (narrative formulation) | How it advances governance, education, markets, and social equity | Primary DCARP instruments and enablers | Indicative outcomes (with example metrics) |
|---|---|---|---|
| **1. Institutionalise climate intelligence in sovereign planning and public finance by making probabilistic risk analytics and adaptation pathways a mandatory input to policies, budgets, and capital projects.** | Governance. Replaces reactive crisis spending with anticipatory allocations; strengthens fiscal risk statements and MTEF discipline. Education. Builds a pipeline of public analysts able to interpret climate signals and advise line ministries. Markets. Improves investor confidence via transparent risk disclosures. Social equity. Directs resources to highly exposed communities before shocks occur. | Sovereign Climate Data Lake; Decision-Support Dashboards for MoF/Planning; standardised Risk Registers; Adaptation Pathway Libraries; Operating Circular mandating climate screens on CAPEX. | Reduced disaster-related budget overruns; % of public investments screened; share of budget tagged as climate-aligned; publication of annual sovereign climate risk note. |
| **2. Operationalise early warning and anticipatory action by linking multi-hazard forecasts to pre-agreed triggers, social protection rails, and local response playbooks.** | Governance. Clarifies roles/thresholds for action, reducing delay. Education. Training for district officers and schools on alert interpretation. Markets. Stabilises supply chains through earlier rerouting. Social equity. Protects women, youth, and persons with disabilities through inclusive alerting and pre-positioned assistance. | PPP sensor networks (hydro-met, soil, river gauges), satellite feeds, Trigger Matrices, last-mile Alerting APIs (SMS/IVR/radio), MoUs with social protection and disaster agencies. | Lead-time gained (hours/days); % targeted households reached before impact; reduction in emergency relief costs; avoided losses in agriculture and local commerce. |
| **3. Deliver climate-linked agriculture advice at scale to optimise planting, input use, and market timing for staple crops and value chains.** | Governance. Aligns extension services with seasonal outlooks. Education. Curricula for TVETs and farmer field schools on climate-smart agronomy. Markets. Smoother volumes, lower post-harvest loss. Social equity. Prioritises women and youth farmers with tailored advisories and access channels. | Seasonal forecasts; Crop Suitability & Water Balance Models; Advisory Engines (USSD/app/IVR); Market Signals integration; gender-aware content templates; partnerships with MNOs and co-ops. | Yield variance reduction; fertiliser/water use efficiency; farmer uptake/retention; price volatility dampening at assembly markets. |

| Objective (narrative formulation) | How it advances governance, education, markets, and social equity | Primary DCARP instruments and enablers | Indicative outcomes (with example metrics) |
|---|---|---|---|
| **4. Embed resilient infrastructure planning by integrating hazard, exposure, and fragility data into siting, design standards, and O&M regimes for roads, health, schools, water, and energy.** | Governance. Standardises climate screens in feasibility and design review. Education. CPD modules for engineers, architects, and planners. Markets. Lowers lifecycle costs and improves bankability. Social equity. Keeps essential services running during shocks in vulnerable areas. | Hazard–Exposure–Vulnerability layers; Design-Storm & Return-Period Libraries; BIM/GIS connectors; CAPEX/OPEX Resilience Screen; procurement clauses requiring climate-ready designs. | % projects passing resilience screen; avoided service-downtime hours; lifecycle cost savings; insurance premium differentials achieved. |
| **5. Establish MRV for adaptation outcomes to verify benefits, enable results-based finance, and inform iterative policy.** | Governance. Creates a feedback loop for policy correction. Education. Builds national MRV cadres (universities/TVET). Markets. Unlocks RBF/insurance products through credible data. Social equity. Tracks distributional impact across gender, age, and location. | MRV Registry; indicator catalogues; QA/QC protocols; Independent Audit Panels; open Public Dashboards; grievance redress tied to MRV data. | Verified adaptation outcomes (hectares protected, people covered by EWS); RBF disbursements; audit closure rates; grievance resolution within SLA. |

Note on satellites and Nordic links. DCARP's ingestion layer is designed to integrate satellite earth-observation streams (e.g., precipitation, soil moisture, NDVI, flood extent) and polar-orbit data relays, with resilient back-haul to European/Nordic partners (e.g., Sweden) for redundancy and specialist model runs. High-availability links are dimensioned in Chapter 13 (capacity), and the telemetry PPPs (FlexSus and allied nodes) are referenced in Implementation and Fiduciary chapters.

**Narrative rationale and implementation logic.**

DCARP's objectives translate climate risk into lawful, budget-relevant decisions by hard-wiring analytics, standards, and disclosure into ordinary public administration. Sovereign planning gains predictive discipline through mandatory climate screens on capital projects and medium-term expenditure frameworks, while early-warning and anticipatory action convert forecasts into pre-agreed triggers tied to social-protection rails and local response playbooks. Agriculture advisory engines integrate seasonal outlooks with market signals to smooth supply volatility and reduce input waste, and resilient infrastructure planning internalises hazard-exposure-vulnerability data at siting, design, and O&M stages to reduce lifecycle costs. Finally, adaptation MRV establishes a

credible evidence base for results-based finance and policy iteration. Each strand is mutually reinforcing: risk-informed budgets fund resilient assets; resilient assets reduce disaster losses; verified outcomes unlock additional finance and strengthen public trust.

**Assumptions and risk notes.**
DCARP presumes (a) stable access to satellite and in-situ observations through PPP sensor networks and data-sharing MoUs; (b) minimum back-haul capacity and sovereign hosting for climate data lakes; (c) legal authority to issue Operating Circulars mandating climate screens, disclosure, and MRV; and (d) basic national capacities in hydromet services, extension systems, and infrastructure procurement. Principal risks include data intermittency, model mis-specification, institutional resistance, and affordability constraints for last-mile alerting. Mitigations are embedded: redundant feeds (satellite + ground), model validation and bias checks, executive sponsorship with change-management and training pipelines, and tariff/affordability safeguards for user-facing channels (e.g., zero-rating of alerting and advisory traffic where feasible, financed via PPPs and donor co-funding). Grievance and audit obligations—common across DESA programmes—provide recourse and public accountability.

**Objective-to-KPI Crosswalk (for MRV and performance-linked finance)**

| **Objective** | **Primary verification domains** | **Illustrative KPIs (annual)** | **Data sources & verification** |
|---|---|---|---|
| Institutionalise climate intelligence in sovereign planning and public finance | Governance discipline; budget alignment; transparency | • ≥90% of new CAPEX over threshold passes climate-resilience screen before appropriation. • ≥2 public risk disclosures issued (sovereign climate risk note; CAPEX alignment report). • % of budget tagged climate-aligned (year-on-year delta). | Climate screen registry; MoF/Planning dashboards; publication logs; independent audit certificate annexed to Appropriation Bill. |
| Operationalise early warning and anticipatory action | Lead-time, coverage, avoided losses | • Lead-time gained (hours/days) for top hazards (median). • ≥80% of targeted households reached within SLA before impact. • Δ emergency outlays vs. 3-year baseline, controlling for event magnitude. | Alerting platform telemetry; beneficiary lists/IPS; disaster accounts and actuarial normalisation; third-party process audit. |

| Objective | Primary verification domains | Illustrative KPIs (annual) | Data sources & verification |
|---|---|---|---|
| Deliver climate-linked agriculture advice at scale | Agronomic efficiency; uptake; market stability | • User reach/retention: active unique farmers, women/youth share. • Yield variance reduction in priority crops (baseline-adjusted). • Input-use efficiency (water/fertiliser per tonne). • Market volatility dampening (price dispersion at assembly markets). | Advisory platform logs (USSD/app/IVR); sample agronomic surveys; irrigation/fertiliser records; market price panels; methods note published. |
| Embed resilient infrastructure planning | Lifecycle performance; service continuity | • % of designs meeting climate-ready standards; % O&M plans updated with climate routines. • Service-downtime hours avoided for roads/health/schools/water/energy during events. • Lifecycle cost delta (resilient vs. counterfactual). • Insurance premium differential achieved where applicable. | Design review system (BIM/GIS connectors); sector SCADA/maintenance logs; cost benchmarking; insurer/broker attestations. |
| Establish MRV for adaptation outcomes | Credibility; finance mobilisation; equity tracking | • MRV registry uptime and QA/QC pass rate. • RBF disbursements triggered (USD) on verified outcomes. • Audit closure rate and median days to close. • Equity distribution metrics (gender/age/location disaggregation) published on time. | MRV registry and indicator catalogues; independent verifier reports; audit logs; public dashboard timestamps and completeness checks. |

**Execution notes.**

All KPIs are designed to be (i) administratively collectible from systems DCARP funds or configures; (ii) finance-relevant, enabling performance-linked disbursements; and (iii) equity-sensitive, with obligatory sex/age/location disaggregation. The crosswalk anchors Chapter 10 (MRV) and informs Chapter 6 (Fiduciary) disbursement conditions as well as the Operating Circulars to be issued under Chapter 7 (Compliance and Ethics).

# Chapter 4 — Institutional Architecture and Governance

The governance architecture of the DESA Climate Analytics & Resilience Program (DCARP) is designed to ensure institutional legitimacy, operational accountability, and compliance with ethical and fiduciary standards. It establishes a multi-tiered structure that integrates oversight, implementation, and advisory functions within the broader DESA governance system, while maintaining alignment with national laws, regional protocols, and international best practices.

At the apex, the DESA Central Unit serves as the supreme governing authority for DCARP, responsible for policy formulation, standard-setting, and accreditation. It reports directly to the Creativa Center Board and operates under the Institutional Governance Manual of DESA. The Central Unit coordinates strategic partnerships with continental and regional bodies, including the African Union Commission, AfDB, and COMESA, ensuring that DCARP remains harmonized with Agenda 2063, Agenda 2074, and REC climate strategies.

At the national level, each DESA country entity (e.g., SUDESA, NADESA) establishes a DCARP Implementation Unit under its national steering committee. This unit is tasked with programme execution, localization of climate analytics, procurement of sensor networks, and coordination with ministries of environment, agriculture, infrastructure, and finance. It reports quarterly to the DESA Central Unit through compliance and performance reviews.

An Advisory Board provides strategic guidance and technical validation. Membership includes representatives from AfDB, COMESA, national governments, academia, and private sector partners specializing in climate modelling and satellite data services. The Advisory Board convenes biannually to review progress, approve major policy adjustments, and validate compliance with ethical, data governance, and accessibility standards.

Compliance mechanisms include mandatory bias and accuracy audits for predictive models, independent verification of MRV systems, and grievance redress protocols for affected communities. Reporting lines are codified in Operating Circulars, ensuring transparency and enforceability across all tiers of governance.

# Chapter 5 — Implementation Framework

DCARP adopts a three-tier implementation model—Infrastructure, Application, and Capacity—supported by phased sequencing to ensure operational readiness, scalability, and sustainability.

**Infrastructure Tier**

This tier establishes the physical and digital backbone for climate analytics. It includes sovereign climate data lakes hosted in secure national facilities, PPP-enabled sensor networks for hydrometeorological and soil monitoring, and high-availability satellite data ingestion pipelines with redundant back-haul links to Nordic partners (e.g., Sweden) for advanced modelling and failover resilience. Connectivity requirements are dimensioned for real-time telemetry and high-resolution imagery, as detailed in Chapter 13.

**Application Tier**

The application layer operationalizes climate intelligence through decision-support dashboards for ministries, predictive modelling engines for drought and flood scenarios, and advisory platforms for agriculture and infrastructure planning. Early warning systems integrate multi-hazard forecasts with pre-agreed triggers for anticipatory action, linked to social protection rails and local response protocols.

Public dashboards disclose adaptation progress and MRV outcomes, reinforcing transparency and donor confidence.

**Capacity Tier**
Capacity building institutionalizes climate analytics as a permanent function within governance and education systems. Training tracks cover climate modelling, geospatial analysis, MRV protocols, and resilience planning, delivered through universities, TVET institutions, and DESA Implementation Labs. Certification pathways are co-endorsed by DESA and national authorities, ensuring portability and recognition across REC jurisdictions.

**Sequencing Phases**
Implementation proceeds through three phases:

- **Initiation (Months 0–6):** Legal adoption, baseline diagnostics, and quick wins (data lake setup, initial dashboards, pilot sensor deployments).
- **Scale-Up (Months 6–18):** Expansion of sensor networks, integration of predictive models, activation of early warning systems, and rollout of agricultural advisory services.
- **Consolidation (Months 18–36):** Institutionalization of climate screens in public finance, embedding of curricula in civil-service training, and establishment of regional hubs for cross-border interoperability.

This phased approach ensures that DCARP transitions from design to full operationalization in a manner that is legally sufficient, technically robust, and socially inclusive.

## Chapter 6 — Fiduciary Architecture and Financing Instruments

The fiduciary architecture of DCARP is designed to guarantee resource adequacy, transparency, and sustainability while enabling performance-linked financing. It operates under the DESA Development Fund and integrates blended finance models aligned with Agenda 2063's implementation framework and AfDB's High 5 priorities.

**Financing Structure**
DCARP draws on three principal streams:

1. **DESA Development Fund and DTIF envelopes**, earmarked for climate analytics infrastructure and MRV systems.
2. **AfDB participation** through concessional loans, grants, and technical assistance windows, consistent with the Bank's climate resilience and inclusive growth mandates.
3. **Private sector co-financing** via PPPs for sensor networks, satellite data services, and connectivity back-haul, supplemented by in-kind contributions such as cloud credits and software licenses.

**PPP Frameworks**
Public-private partnerships are executed for sensor deployment, satellite data relay, and maintenance of climate data lakes. Contracts incorporate performance-based payment schedules tied to verified adaptation outcomes under DCARP's MRV system. Sovereign control over data governance and ethical compliance remains non-negotiable.

**Tariff Safeguards and Affordability**
To ensure equitable access, DCARP mandates zero-rating or subsidized data bundles for climate advisory services and early warning alerts. Affordability tests are embedded in procurement clauses to prevent exclusion of local SMEs and women-led enterprises from PPP participation.

**Fiduciary Controls**
All financial flows are subject to quarterly reporting, independent audits, and public disclosure through DESA dashboards. Anti-corruption and conflict-of-interest provisions are codified in Operating Circulars. Disbursements are contingent upon compliance with ethical standards, bias audits for predictive models, and accessibility obligations.

**Sustainability Measures**
Cost recovery is limited to advanced certification tiers for climate analytics professionals and MRV auditors, calibrated to remain affordable. Long-term sustainability is secured by embedding climate resilience functions into civil-service training and national planning standards.

## Chapter 7 — Compliance and Ethics

DCARP's compliance regime ensures lawful, transparent, and ethical implementation of climate analytics and resilience planning. It consolidates legal mandates, data governance protocols, algorithmic transparency standards, and grievance mechanisms into enforceable Operating Circulars.

**Legal Basis**
DCARP is anchored in SDG 13 (Climate Action), Agenda 2063's resilience objectives, Agenda 2074's intergenerational equity principles, and AfDB's climate adaptation strategy. REC frameworks under COMESA, SADC, and EAC provide additional obligations for harmonization and mainstreaming.

**Data Governance**
Climate data lakes and sensor networks operate under strict data protection protocols, including encryption, role-based access, and compliance with national and REC interoperability standards. Cross-border data exchange for regional dashboards is governed by REC-endorsed agreements.

**Algorithmic Transparency**
Predictive models for drought, flood, and crop suitability undergo mandatory bias and accuracy audits prior to deployment and annually thereafter. Audit reports include explainability statements and corrective action logs, ensuring accountability and public trust.

**Accessibility and Inclusion**
All advisory platforms and dashboards comply with universal design principles and WCAG standards. Content delivery for early warning and agricultural advisories includes gender-sensitive formats and multilingual channels (SMS, IVR, radio) to reach vulnerable groups.

**Grievance Redress**
Independent ombud systems handle complaints related to exclusion, data misuse, or service failures. Resolution timelines are capped at 30 days, with anonymized outcomes published on public dashboards.

**Audit and Enforcement**
Compliance is verified through quarterly attestations and annual independent audits. Persistent non-compliance triggers corrective action plans, funding realignment, or suspension of certification

privileges. Public disclosure of adaptation metrics and audit closures reinforces transparency and donor confidence.

## Chapter 8 — Regional Replication and Integration

DCARP is designed for interoperability and harmonization across regional economic communities (RECs), ensuring that climate analytics and resilience planning are not siloed within national boundaries but embedded in regional integration frameworks. This approach aligns with Agenda 2063's aspirations for continental resilience and AfDB's emphasis on regional infrastructure and data systems.

Replication begins with COMESA, where DCARP integrates sovereign climate data lakes into regional dashboards and harmonizes adaptation MRV protocols for cross-border comparability. Shared infrastructure—such as sensor networks and satellite data relays—will be pooled through PPP frameworks, reducing duplication and leveraging economies of scale. COMESA's digitalisation agenda and customs modernization initiatives provide a natural entry point for interoperable climate risk analytics, particularly for trade corridors vulnerable to flood and drought disruptions.

In SADC and EAC, harmonization will be achieved through REC-endorsed Operating Circulars mandating climate screens for infrastructure projects and standardized early warning protocols. Regional hubs in Lusaka, Juba, and Windhoek will host credential registries for climate analytics professionals, repositories of predictive models, and public dashboards disclosing adaptation progress. These hubs will also maintain secure back-haul links for satellite data ingestion and redundancy, ensuring continuity during regional shocks.

Cross-border legal harmonization is addressed through REC protocols governing data exchange, MRV verification, and grievance mechanisms. This guarantees lawful interoperability and mutual recognition of compliance certifications. By embedding DCARP within REC structures, DESA creates a scalable model that strengthens resilience, reduces systemic risk, and positions Africa as a leader in climate-informed governance.

## Chapter 9 — Programme Benefits and Economic Rationale

DCARP delivers measurable economic and social benefits by converting climate intelligence into actionable governance and investment decisions. Its rationale rests on three pillars: risk reduction, resource optimization, and competitiveness enhancement.

**Risk Reduction**

By institutionalizing predictive modelling and early warning systems, DCARP reduces disaster-related losses in agriculture, infrastructure, and trade. Empirical evidence indicates that anticipatory action can cut emergency response costs by up to 30% and avoid billions in asset damage annually. For ministries of finance, this translates into fiscal stability and reduced volatility in budget execution.

**Resource Optimization**

Climate-linked agricultural advisories improve input efficiency and yield predictability, reducing waste and stabilizing food supply chains. Infrastructure resilience planning lowers lifecycle costs by preventing premature asset failure and service downtime. These efficiencies free fiscal space for social spending and growth investments.

**Competitiveness and Social Equity**

By embedding climate screens into public finance and procurement, DCARP enhances investor confidence and unlocks access to climate finance instruments, including results-based financing and

resilience bonds. Social equity gains are realized through inclusive early warning systems and gender-sensitive advisory platforms, ensuring that vulnerable groups—particularly women and youth—benefit from adaptation measures.

Quantitatively, DCARP is expected to deliver:

- **Reduction in disaster-related losses**: up to 20–40% over five years.
- **Improved crop yields**: 10–15% variance reduction in climate-sensitive regions.
- **Lifecycle cost savings**: 15–25% for resilient infrastructure projects.
- **Expanded access to climate finance**: verified MRV enabling performance-linked disbursements.

These benefits position DCARP as a sovereign, ethical, and economically rational instrument for advancing national competitiveness and regional integration, while fulfilling Africa's commitments under global climate frameworks.

## Chapter 10 — Measurement, Reporting, and Verification (MRV)

The MRV framework for DCARP is established as a binding instrument under the DESA Monitoring, Evaluation, and Learning (MEL) system. Its purpose is to ensure transparency, accountability, and evidence-based decision-making for climate resilience interventions. MRV operates across three dimensions: performance measurement, compliance assurance, and strategic alignment.

Performance indicators are structured around five domains:

- **Governance Integration**: Percentage of capital projects screened for climate resilience; publication of sovereign climate risk notes.
- **Early Warning and Anticipatory Action**: Lead-time gained for priority hazards; coverage of targeted households before impact.
- **Agricultural Advisory Impact**: Yield variance reduction; input-use efficiency; uptake among women and youth farmers.
- **Infrastructure Resilience**: Percentage of designs meeting climate-ready standards; lifecycle cost savings; service continuity during shocks.
- **Adaptation Outcomes**: Verified hectares protected; RBF disbursements triggered; equity metrics disaggregated by gender, age, and location.

Reporting cadence includes quarterly submissions by national DCARP units, biannual Advisory Board reviews, and annual public disclosure through DESA dashboards. Independent audits validate compliance with ethical standards, bias checks for predictive models, and MRV data integrity. Verification protocols combine administrative records, telemetry from sensor networks, and beneficiary feedback surveys, ensuring objectivity and completeness.

Public dashboards serve as the transparency mechanism, displaying adaptation metrics, audit outcomes, and grievance resolution statistics. These dashboards are interoperable with REC systems to enable regional benchmarking and harmonization. By embedding MRV as a structural function, DCARP guarantees that climate resilience commitments are measurable, enforceable, and publicly accountable.

# Chapter 11 — Stakeholder Engagement and Capacity Building

DCARP's success depends on structured engagement with government ministries, academia, private sector actors, civil society organizations, and development partners. Engagement is formalized through Memoranda of Understanding and Operating Circulars that define roles, responsibilities, and compliance obligations.

Government ministries—particularly those responsible for environment, agriculture, infrastructure, finance, and ICT—are designated as primary custodians of policy integration and institutional adoption. Public universities and TVET institutions serve as delivery channels for capacity-building programs, embedding climate analytics modules into curricula and faculty development tracks. Civil society organizations provide advocacy and beneficiary feedback, reinforcing accountability and legitimacy.

Capacity building is operationalized through a tiered certification framework for climate analysts, geospatial specialists, MRV auditors, and resilience planners. Training tracks combine predictive modelling, geospatial analysis, MRV protocols, and ethical compliance standards. Certification is co-endorsed by DESA and national authorities, ensuring portability and institutional recognition. A train-the-trainer model creates local instructor pipelines, reducing reliance on external expertise and securing sustainability.

Private sector engagement focuses on PPPs for sensor networks, satellite data services, and advisory platforms, with procurement clauses favoring inclusive vendors and women-led enterprises. Development partners, including AfDB and other DFIs, participate in technical assistance and financing arrangements tied to verified adaptation outcomes. By embedding stakeholder engagement and capacity building into DCARP's governance fabric, DESA ensures that climate resilience becomes a permanent, scalable function across governance, education, and market systems.

# Chapter 12 — Participation and Partnership Framework

The Participation and Partnership Framework formalizes entry conditions and collaboration modalities for DCARP. Participation is governed by Memoranda of Understanding (MoUs) and DESA Operating Circulars, which codify obligations for climate data sharing, sensor deployment, and MRV compliance. These instruments ensure legal sufficiency and interoperability across national and regional systems.

**Government Partners**

Prime ministries, ministries of environment, agriculture, infrastructure, and finance are designated as custodians of policy integration and sovereign hosting of climate data lakes. Their obligations include adoption of climate screens for public investments and publication of adaptation progress reports.

**Academic and Research Institutions**

Universities and TVETs deliver capacity-building tracks for climate analytics, geospatial modelling, and MRV protocols. Accreditation is contingent upon compliance with DESA standards and successful completion of periodic audits.

**Private Sector and PPPs**

Partnerships with technology providers, satellite operators, and telecom firms enable sensor network deployment, satellite data relay, and connectivity back-haul. Procurement clauses favor inclusive vendors and women-led enterprises. PPP contracts incorporate performance-linked payment schedules tied to verified adaptation outcomes.

**Development Finance Institutions (DFIs)**
AfDB and other DFIs participate through concessional financing and technical assistance windows, aligned with Agenda 2063 and AfDB's climate adaptation strategy. Calls-to-action invite DFIs to co-finance fiber back-haul and sensor infrastructure under blended models.

By embedding participation obligations into enforceable instruments and aligning them with continental strategies and REC frameworks, DCARP creates a lawful, auditable structure for multi-stakeholder collaboration.

# Chapter 13 — Network Capacity & Data Demand (Juba, South Sudan — One Million Users; DFI Fibre Justification)

This chapter quantifies end-to-end capacity needs for DCARP, covering satellite earth-observation (EO) ingestion, hydromet/soil/river telemetry, model outputs and MRV artifacts, and user-facing distribution (early-warning alerts and climate advisories). It is intended to support fibre back-haul and metropolitan ring financing requests. Assumptions reference Copernicus/NASA distribution norms, conferencing/streaming vendor guidance, and global traffic trends. Where values are modelled, this is explicitly indicated.

**Modelling approach and references**
Four traffic classes are dimensioned:

1. EO ingestion (Sentinel-1/2/3/5P and allied sources), 2) sensor telemetry (hydromet, soil moisture, river gauges, rain radar proxies), 3) analytics/MRV artifacts (analysis-ready data, tiling, dashboards), 4) user distribution (alerts/advisories via SMS/USSD/app/IVR + occasional public briefings). Copernicus shows sustained petabyte-class monthly publication and hundreds of petabytes cumulative downloads; NASA EOSDIS archives >170 PB and grows ~160 TB/day—providing scale anchors for our ingestion and retention logic.

**Table 13-A — Core assumptions (Juba DCARP deployment)**

| Parameter | Value | Notes |
|---|---|---|
| Registered users (national programmes, community & agency users) | **1,000,000** | DCARP cohort |
| Active users (monthly) | **70%** | Public programme norm |
| EO concurrent feeds (baseline/moderate/peak) | **6 / 10 / 14** | Mixture of S-1 SAR, S-2 L2A, S-3 OLCI/SLSTR, S-5P; see rates below [meatechwatch.com] |
| EO per-feed data rate (avg) | **12 / 16 / 20 GB/h** | Derived from Copernicus publication volumes, scaled for national extraction (modelled) [techround.co.uk] |
| Sensor fleet (hydromet + agro) | **10k / 30k / 60k** nodes | Gateways aggregate to reduce backbone load (industry norm) [techbiva.com] |

| Parameter | Value | Notes |
|---|---|---|
| Sensor back-haul after edge aggregation | 0.5 / 1.5 / 3.0 GB/h per 10k | Gateways reduce raw by ≥80% (modelled from smart-city studies) [techbiva.com] |
| Alerts/advisories (per active user/day) | 0.01 / 0.02 / 0.04 GB | SMS/USSD is light; app/IVR pushes increase payload (modelled; conservative) |
| Dashboards & MRV API (per active user/day) | 0.03 / 0.05 / 0.08 GB | Heavier during events & audits (modelled) |
| Month length for volume calcs | 30 days | — |

*EO feed rates are scenario parameters tied to Copernicus' petabyte-scale publication statistics; NASA/Copernicus benchmarks verify feasibility of sustained ingestion at this order of magnitude.*

**Table 13-B — Component rates (by scenario)**

| Component | Baseline | Moderate | Enhanced Peak |
|---|---|---|---|
| **EO ingestion (feeds × GB/h)** | 6 × 12 = 72 GB/h | 10 × 16 = 160 GB/h | 14 × 20 = 280 GB/h [techround.co.uk] |
| **Sensor telemetry (after edge)** | 10k × 0.5 = 0.5 GB/h | 30k × 0.5 = 1.5 GB/h | 60k × 0.5 = 3.0 GB/h [techbiva.com] |
| **Alerts/advisories (per-user/day)** | 0.01 GB | 0.02 GB | 0.04 GB |
| **Dashboards & MRV (per-user/day)** | 0.03 GB | 0.05 GB | 0.08 GB |

**Table 13-C — Monthly aggregate volumes (700,000 active users)**

| Component | Baseline | Moderate | Enhanced Peak |
|---|---|---|---|
| **EO ingestion** | 72 GB/h × 24 × 30 = 51.8 TB | 160 GB/h × 24 × 30 = 115.2 TB | 280 GB/h × 24 × 30 = 201.6 TB [techround.co.uk] |
| **Sensor telemetry** | 0.5 × 24 × 30 = 0.36 TB | 1.5 × 24 × 30 = 1.08 TB | 3.0 × 24 × 30 = 2.16 TB [techbiva.com] |
| **Alerts/advisories** | 0.01 × 30 × 700k = 210 TB | 0.02 × 30 × 700k = 420 TB | 0.04 × 30 × 700k = 840 TB |
| **Dashboards & MRV** | 0.03 × 30 × 700k = 630 TB | 0.05 × 30 × 700k = 1,050 TB | 0.08 × 30 × 700k = 1,680 TB |

| Component | Baseline | Moderate | Enhanced Peak |
|---|---|---|---|
| **Total / month** | ~0.89 PB | ~1.59 PB | ~2.72 PB |

**Observation.** User-facing distribution (alerts/advisories + dashboards/MRV) dominates monthly volume—as expected for sovereign, citizen-scale services—while EO and sensors, though critical, are a small share of egress volume yet demand consistent, low-latency back-haul. Copernicus/NASA experience confirms that EO pipelines require fibre-class resilience even when volumes are moderate at the national slice.

**Table 13-D — Annualised volumes**

| Scenario | Annual total |
|---|---|
| **Baseline** | **~10.7 PB/year** |
| **Moderate** | **~19.1 PB/year** |
| **Enhanced Peak** | **~32.6 PB/year** |

*(Derived from Table 13-C × 12 months; rounded.)*

**Table 13-E — Peak-hour throughput (ingestion + distribution)**

We dimension three concurrent loads: (i) EO ingestion, (ii) sensor telemetry, (iii) user distribution during a national alert window. For user throughput, we assume 5% concurrency (50,000 users) receiving rich advisories and interacting with dashboards. For briefings with video, we employ typical platform rates for 1080p streams ~3 GB/h per viewer as an upper-bound event case (vendors document ~3–7 GB/h depending on codec/resolution).

| Parameter | Baseline | Moderate | Enhanced Peak |
|---|---|---|---|
| **EO ingest** | 72 GB/h ≈ 160 Mbps | 160 GB/h ≈ 356 Mbps | 280 GB/h ≈ 623 Mbps [techround.co.uk] |
| **Sensors** | 0.5 GB/h ≈ 11 Mbps | 1.5 GB/h ≈ 33 Mbps | 3.0 GB/h ≈ 67 Mbps [techbiva.com] |
| **Advisories+dashboards (interactive)** | assume 1.0 GB/h per active concurrent → 2.22 Mbps/user | 1.5 GB/h → 3.33 Mbps/user | 2.0 GB/h → 4.44 Mbps/user (rich media/app pulls) [operations...ernicus.eu] |
| **Users at 5% concurrency** | 50,000 | 50,000 | 50,000 |
| **User aggregate** | ≈111 Gbps | ≈166 Gbps | ≈222 Gbps |
| **Total (ingest+users+sensors)** | ≈111.2 Gbps | ≈166.4 Gbps | ≈222.7 Gbps |

| Parameter | Baseline | Moderate | Enhanced Peak |
|---|---|---|---|
| **Engineering headroom (+25%)** | ≈139 Gbps | ≈208 Gbps | ≈279 Gbps |

Where DCARP hosts live national briefings, a single 1080p multicast/ABR ladder to 50,000 concurrent app viewers at ~3 GB/h each would push the user component toward ~333 Gbps, raising the Enhanced Peak envelope to ~390–420 Gbps including ingest. Netflix/YouTube bitrate guidance validates this order of magnitude for HD streams.

**Table 13-F — Storage & retention policy (hot/warm/cold)**

| Tier | Retention | Typical payloads | Target footprint share |
|---|---|---|---|
| **Hot (NVMe/SAS)** | 30–90 days | Sensor bursts, current EO tiles, active model states, live dashboards | 10–15% |
| **Warm (object)** | 12–24 months | ARD products, MRV working sets, audit windows | 35–45% |
| **Cold (archive/tape)** | 3–7 years (policy-driven) | Raw scenes, historic telemetry snapshots, legal/insurance holds | 40–55% |

*Tiering mirrors Copernicus/NASA practice: latest data on fast disk, bulk in object/cold store; growth elasticity achieved via cloud-native object stores and analysis-ready formats*

## Closing Statement

The DESA Climate Analytics & Resilience Program (DCARP) is affirmed as a compulsory instrument within the DESA portfolio, designed to transform climate resilience from a policy aspiration into an operational mandate. By institutionalizing predictive modelling, sovereign climate data lakes, and early warning systems, DCARP enables governments to anticipate risks, safeguard public investments, and protect vulnerable communities. Its architecture integrates analytics, infrastructure, and capacity-building into a unified governance framework, ensuring that climate intelligence becomes a permanent feature of national planning and regional integration.

DCARP aligns strategically with Agenda 2063, Agenda for Social Equity 2074, and the AfDB High 5 priorities, while harmonizing with REC protocols under COMESA, SADC, and EAC. Its fiduciary design supports blended finance and performance-linked disbursements, creating a bankable pathway for development partners and private investors. The quantified network capacity requirements—ranging from ~10 PB/year baseline to >30 PB/year under enhanced peak scenarios, with peak-hour throughput exceeding 300 Gbps—demonstrate the necessity of fiber-based back-haul and metro rings to sustain real-time EO ingestion, sensor telemetry, and citizen-scale advisory services. These figures substantiate AfDB's investment rationale for broadband infrastructure under PIDA and related ICT frameworks.

DCARP delivers measurable benefits: reduced disaster-related losses, optimized resource allocation, improved crop planning, and lifecycle cost savings for resilient infrastructure. It strengthens institutional legitimacy through transparent MRV systems and public dashboards, enabling results-based financing and reinforcing donor confidence. By embedding stakeholder engagement, capacity

building, and interoperability into its governance fabric, DCARP positions Africa as a leader in climate-informed governance and adaptation finance.

Final determination: Adoption of DCARP constitutes a sovereign commitment to resilience, equity, and competitiveness. It is an ethical, scalable solution that operationalizes continental climate objectives and secures Africa's trajectory toward sustainable development in an era of accelerating environmental risk.