Global Implementation Initiative on Sand and Dust Storms

Combating Sand and Dust Storms Through Source Mitigation
A Flagship Initiative for Wind Erosion Control
The Challenge Demands Urgent Action

Sand and Dust Storms (SDS) impose an unprecedented economic and environmental burden that has been systematically underestimated. Wind erosion and resulting dust cost the United States alone $154 billion annually, with a similar annual cost for the Middle East and North Africa region —quadruple previous estimates and exceeding most weather and climate disasters.

Globally, 151 countries and over 2 billion people are directly affected by SDS events. It is estimated that about 28% of the global land area experiencing land degradation suffers from this wind-driven soil erosion process, with drylands having double the erosion rate of other lands (JRC), with 500 million hectares highly vulnerable to wind erosion. It should be noted that 25% of SDS sources are attributed to human land uses; the majority of which are emerging hydrological sources created by unsustainable water use and management.

Sand and dust storms do not respect political borders. The degraded landscapes, shared river basins, and transboundary water systems that generate and amplify SDS events are, in many cases, shared resources among neighboring states, including states with complex or fragile diplomatic relationships. This creates a unique opportunity: collaborative management of shared natural habitats and dryland ecosystems can serve as a platform for confidence-building, joint scientific exchange, and sustained diplomatic engagement. Where SDS source areas straddle national boundaries, multi-country restoration programs offer a concrete, politically neutral entry point for cooperation that yields tangible benefits for all parties.
Shared river basins and transboundary water systems are particularly critical.

Hydrological SDS sources — dried lakebeds, exposed riverbeds, irrigated lands with depleted soils — account for a significant share of dust emissions in arid regions. Coordinated water governance across shared watersheds, including joint management of groundwater depletion, irrigation efficiency, and floodplain restoration, directly reduces dust generation while building institutional frameworks for broader bilateral or multilateral cooperation. The Central Asia river systems and Aral Sea basin, the Lake Chad basin, and similar transboundary water systems illustrate both the scale of the challenge and the potential of collaborative action to reverse degradation.

The full economic cost of sand and dust storms has been consistently underestimated in policy discourse. Direct quantifiable costs [agricultural losses, infrastructure damage, increased healthcare expenditure, transportation disruption, and energy system impacts] already exceed $150 billion annually at the global level. Indirect costs, including lost labor productivity, suppressed

investment in affected regions, and long-term soil capital depletion, would substantially expand this figure.

Source mitigation investments offer among the most favorable cost-benefit ratios of any land restoration intervention, addressing climate security concerns. Every dollar invested in wind erosion source control can generate an estimated $10 or more in avoided costs across agriculture, health, infrastructure, and energy sectors. This provides a compelling case for mobilizing both public development finance and private capital at scale. The private sector has strong financial incentives to engage in SDS source mitigation. Industries directly exposed to SDS economic risk represent a natural constituency for restoration investment, and their participation can substantially expand the resource base beyond official development assistance and public budgets.

Yet current policy responses remain fragmented and reactive, focused primarily on detecting and forecasting atmospheric dust rather than addressing the fundamental land degradation processes that generate dust at its source.

- **The Root Problem:** A critical disconnect has emerged between dust modeling/forecasting and the information needed for effective source mitigation. Climate, infrastructure and health impacts dominate dust science, while the importance of land—the actual source of emissions—has diminished. This has left land managers and policymakers without the tools and evidence base needed for actionable decision-making on wind erosion control.
- **Our Integrated Response:** This initiative refocuses global SDS efforts on land and source management—on identifying hotspots of dust generation, especially those resulted from unsustainable land use and management, stabilizing degraded soils, restoring vegetation structure, and implementing sustainable land management that addresses soil health, in particular its susceptibility to wind erosion that generates new or expands existing SDS sources (rather than merely detecting, tracking, and predicting dust emissions in the atmosphere). Source mitigation leads to multiple benefits. In addition to reducing SDS it supports achieving LDN, enhances resilience to climate change and biodiversity loss and can boost food security.
- **Vision for 2035:** Reduce wind erosion and SDS impacts by 50% through anthropogenic source-focused mitigation on 200 million hectares, preventing $75+ billion in annual economic losses, protecting 1 billion people from health hazards, and transforming degraded drylands into resilient, productive landscapes.

Four Pillars of Source-Focused Action

Pillar 1: Land-Focused Monitoring and Assessment

Transform monitoring from atmospheric dust detection to land-based wind erosion assessment through standardized in-situ measurements, vegetation structural indicators, land use, climatic

conditions (wind, moisture, etc), soil surface condition monitoring, and integration of land health data with remote sensing and dust emission modeling.

2035 Targets:

- Establish standardized wind erosion monitoring in priority source regions
- Deploy coordinated monitoring networks using standard methods at local, national, and regional levels
- Integrate land degradation monitoring frameworks with SDS risk assessment
- Develop land potential and ecological state-based benchmarks for wind erosion thresholds
- Develop global remote sensing-based vegetation fractional cover and structure products needed to improve monitoring and the fidelity of dust models
- Create dust emission flux datasets to improve model parameterization of source areas
- Enhance capacity at national/regional level

Pillar 2: Source Area Stabilization and Restoration

Stabilize dust-generating lands through evidence-based sustainable land management (SLM) and water use practices that addresses first-order controls on wind erosion—soil, vegetation structure, and surface roughness—rather than complex predictive modeling.

2035 Targets:

- Stabilize X million hectares of high-priority wind erosion source areas (hotspots)
- Increase vegetation cover and structural complexity in critical source zones
- Restore soil organic matter and aggregate stability to reduce erodibility
- Implement landscape-scale practices using land potential and sustainable land use systems (SLUS) concepts and integrated land use planning (ILUP) approaches
- Reduce sediment transport and dust emission rates by 50% in priority hotspots

Pillar 3: Science-Policy Integration for Source Mitigation

Bridge the disconnect between dust science and land management by refocusing modeling efforts, improving collaboration between dust and wind erosion communities, and developing frameworks that support management decisions.

2035 Targets:

- Refocus dust models to better resolve source areas and emission processes, not just atmospheric dust loads
- Establish research priorities that elevate land as central to SDS mitigation
- Develop parsimonious wind erosion models appropriate for diverse land use systems
- Create policy frameworks that recognize SDS as both a land health and air quality issue
- Align SDS assessment with Land Degradation Neutrality (LDN) and climate frameworks

Pillar 4: Coordinated Response and Capacity Building – at regional level

Build capacity for source-focused SDS mitigation through (sub)regional and cross-border cooperation and financing, early warning systems linked to land management, and integration of monitoring data to inform adaptive management.

2035 Targets:

- Establish (sub)regional cooperation agreements and joint action plans for 30 shared dust source regions
- Link early warning systems with land condition monitoring and management responses
- Reduce health impacts by 40% through integrated source mitigation, operational alert systems and protection measures
- Build technical capacity for wind erosion assessment in 50+ affected countries
- Reduce economic losses from wind erosion and SDS by $75 billion annually – effectively engage the private sector in the response.

Approach

Implementation partners agree to work in the context of 4 key deliverables:

1. **Knowledge** – research agenda prioritizing land-focused wind erosion science and mitigation measures, dust source mapping using land indicators, improved model parameterization of source areas, and standardized emission monitoring to complement atmospheric observations
2. **Engagement** – especially of land managers, dryland communities, and practitioners who need guidance on identifying and prioritizing source areas, selecting appropriate mitigation measures, and evaluating outcomes using land-based benchmarks
3. **Advocacy** – to elevate dust as a land degradation issue alongside its atmospheric and health dimensions, promote policy frameworks supporting source mitigation investment – especially positive impact on food security and resource availability, and ensure integration across LDN, climate adaptation, and biodiversity conservation programs
4. **Resource Mobilization** – development of an investment pipeline recognizing that source mitigation investments yield large economic returns (with previous estimates suggesting $13.5 billion annually needed to combat wind erosion generating over $150 billion in avoided costs)

Implementation Pathway

Phase 1: Foundation (Years 1-2)

- Complete global dust source mapping using land indicators (soil, vegetation, surface conditions, climatic conditions?) – update and enhance the SDS source base map tool
- Establish standardized monitoring protocols and pilot networks in priority source regions
- Establish data sharing platforms to support remote sensing based product development

- Develop guidance on source identification, prioritization, and mitigation practice selection
- Build partnerships between dust modeling, wind erosion, and land management communities
- Secure initial funding recognizing economic case for source mitigation – blended finance with infrastructure, healthcare and insurance as target private sector investors.

Phase 2: Acceleration (Years 3-5)

- Scale source-focused monitoring and mitigation to X countries and X million hectares
- Integrate land health indicators with atmospheric dust observations in operational systems
- Demonstrate measurable reductions in wind erosion, dust emission, and economic impacts
- Develop remote sensing based vegetation products that include fractional cover and structure indicators
- Refine dust models to better represent land surface processes and support source mitigation
- Establish regional centers of excellence for wind erosion assessment and management
- Showcase the multiple benefits of combating wind erosion and SDS on land degradation, climate resilience, biodiversity, and food security to attract the investment in phase 3.

Phase 3: Transformation (Years 6-10)

- Achieve implementation in XX+ countries with xxx million hectares under source mitigation
- Establish permanent financing mechanisms justified by economic returns on investment
- Reach 1 billion protected beneficiaries through reduced wind erosion and dust exposure
- Integrate SDS monitoring and mitigation fully with LDN reporting and climate frameworks
- Meet 2035 transformation targets for wind erosion reduction and economic impact prevention

Expected Outcomes

- **Environmental Restoration:** Stabilized dust source areas with enhanced soil health, restored vegetation structure, improved land function, and demonstrable reductions in wind erosion and dust emission rather than just atmospheric dust concentrations
- **Economic Benefits:** Prevention of $75+ billion in annual losses from agriculture, health, transportation, energy, household impacts, and infrastructure damage, with returns on mitigation investment exceeding 10:1 based on comprehensive economic analysis
- **Health and Safety:** Significant reduction in premature mortality, respiratory diseases including Valley fever, traffic fatalities, and other health burdens from dust exposure through source-focused prevention
- **Scientific Advancement:** Resolution of the disconnect between dust modeling and source mitigation through improved monitoring networks, better model representation of land processes, and frameworks that support evidence-based management decisions using land potential and ecological state concepts

Call to Action

Wind erosion and SDS cannot be solved by predicting dust in the atmosphere. The solution lies in addressing degraded land—the source of dust. This requires refocusing scientific efforts, monitoring systems, and investments on the land surface processes that generate wind erosion and dust emission. Three decades of increasing emphasis on atmospheric dust modeling and climate impacts have created a critical gap: land managers lack the tools and information needed to combat wind erosion effectively.

This global implementation flagship initiative requires unprecedented coordination to bridge the disconnect between dust science and land management and source mitigation. We welcome all stakeholders committed to addressing SDS through source-focused approaches that recognize land and soil degradation as the root cause requiring integrated solutions across science, policy, and practice.

Next Steps: Secure initial funding emphasizing economic returns on source mitigation investment, complete global dust source characterization using land indicators, convene dust modeling and wind erosion communities to address scientific gaps, identify champion countries, and prepare for launch at COP 17 aligned with UN Decade on Combating Sand and Dust Storms (2025-2034).