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Guideline on the Integration of Sand and Dust Storm Management into Key Policy Areas

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Executive Summary

The Guideline is voluntary and can be used by regional, national, and sub-national authorities and actors responsible for formulating and implementing sand and dust storms (SDS) initiatives in key policy areas. It aims to raise awareness on development challenges related to SDS risk, vulnerability, and exposure that are often not fully appreciated or considered by policymakers. The Guideline outlines the principles and enabling environment to prevent and reduce SDS sources and their social, economic, and environmental impacts while improving productivity and resilience.

Agriculture: SDS policies, programmes, and investments related to food production should be guided by the integrated management of land, soil, crops, livestock, and water. Nature-based solutions, mainly in the agriculture, forestry, mining, and livestock sectors, are recognised as cost-effective ways to prevent and reduce anthropogenic SDS sources. Specific attention should be given to incentives for more efficient water resource use and, ideally, planning at landscape scales to ensure optimal outcomes among a mosaic of land uses, including the protection and restoration of natural ecosystems.

Human Health: Epidemiological studies can be used to better understand the impact of different types of SDS events on chronic and acute health risks and the populations most affected. Enhanced coordination among the health sector and institutions monitoring air quality would enhance the ability of early warning systems to forecast and broadcast the likelihood of SDS events so that businesses and communities can take timely precautions. Contingency planning, based on the likelihood of specific SDS events, can minimise their risk and exposure to individuals participating in paid and non-paid labour, education, and recreation.

Built Infrastructure: SDS policies, programmes, and investments should consider the adverse impacts on built infrastructure, its operational efficiency, and user demand for transport, energy, and manufacturing. One aspect of SDS that is of growing concern to policymakers and investors is their impact on renewable energy sources, particularly wind and solar farms. As the share of renewable energy increases in SDS-impacted regions, investments and operations should include contingency planning and proactive measures to avoid major disruptions.

Early Warning: While there have been significant advances in early warning systems, current air quality monitoring typically does not register or report on SDS events. Early warning systems linked to anticipatory actions must benefit all strata of society by reducing the impacts of a forecasted SDS event before it occurs or its most acute impacts are felt. Introducing the capacity to predict and monitor SDS events into the forecasting work of meteorological agencies could help protect lives, livestock, and livelihoods.

Finance: SDS sources are often in marginal rural areas or far from major population centres, making it difficult for policymakers to justify, allocate, and sustain finance for prevention and reduction activities. Greater attention and support from the public sector will be required to close the financing gap and foster a balanced approach to SDS source reduction, impact mitigation, and enhanced adaptive capacity. The recognition that effective SDS management not only benefits local land users, but also other sectors and countries, is slowly shifting policy and funding priorities as in the case of the Middle East, Northeast Asia, and Central Asia.

The Guideline can be adapted to specific contexts and applied in key policy areas consistent with sustainable land and water management approaches and existing obligations under national and international law. It encourages the integration of SDS management measures into national strategies and action plans mandated through global and regional agreements (e.g., commitments related to the Rio conventions, food security, human health, air pollution, drought resilience, and disaster risk reduction) to promote a more holistic approach to SDS source and impact mitigation.

1. Introduction

The **Guideline on the Integration of Sand and Dust Storm Management into Key Policy Areas** ("the Guideline") is a high-level primer to raise awareness and promote the more effective management of sand and dust storms (SDS), their sources and impacts. It is not a technical or exhaustive treatment of SDS issues but an accessible introduction for policymakers and other stakeholders, with links to key references for further information.

The Guideline is a response to a decision adopted by the Conference of the Parties (COP) to the **United Nations Convention to Combat Desertification** (UNCCD) at its 15th session which:

> Reiterated that the global frequency, intensity, and duration of SDS have increased in the last decade and that SDS have natural and human causes that can be exacerbated by desertification, land degradation, drought, biodiversity loss, and climate change.

> Requested the secretariat and the Global Mechanism, within the scope and mandate of the Convention and in collaboration with partners, to develop a voluntary policy guideline, in consultation with countries affected by sand and dust storms, to assist in the integration of sand and dust storms management into key policy areas.[1]

The Guideline is voluntary and can be used by regional, national, and sub-national authorities and actors responsible for formulating and implementing SDS-related initiatives in key policy areas (e.g., agriculture, human health, infrastructure). It builds upon the **UNCCD Policy Advocacy Framework for Sand and Dust Storms** which outlines the principles and enabling environment to prevent and reduce SDS sources and their socioeconomic impacts while improving productivity and resilience.[2]

The Guideline aims to raise awareness on development challenges related to SDS risk, vulnerability, and exposure that are often not fully appreciated or considered by policymakers. In addition to greater political attention, it underscores the need for assessments and actionable data to address SDS hazards more effectively. The Guideline is informed by scientific, technical, and evidence-based knowledge resources, many of which have been produced by the UNCCD, the Food and Agriculture Organization of the United Nations (FAO), and members of the **United Nations Coalition on Combatting Sand and Dust Storms** as well as other partners and experts from around the world.

The Guideline advocates for the integration of SDS policy and implementation frameworks into national strategies and action plans under the **Sustainable Development Goals** (SDGs), **Land Degradation Neutrality** (LDN), the **Paris Agreement**, **Global Biodiversity Framework** (GBF), and **Sendai Framework for Disaster Risk Reduction**, among others. Incorporating SDS management measures into these strategies and action plans would help leverage inherent synergies in implementation to deliver co-benefits and expand the pool of resources to combat increasingly frequent and intense SDS events.

2. Background and Context

SDS have become a serious global concern due to their adverse impacts on key sectors of the economy – agriculture, environmental and human health, and built infrastructure.

While only 25 per cent of SDS phenomena can be attributed to human activities, for the purposes of the Guideline, SDS management concerns both:

(i) **natural sources,** in terms of risk mitigation, adaptation, response, and recovery for affected communities and sectors; and

(ii) **anthropogenic sources** where prevention and reduction are key strategic priorities.

It is important to note that SDS have been a critical part of the Earth's bio-geochemical cycles, influencing weather patterns, nutrient cycling, and biomass productivity. However, human activities have become a major contributor to the growth of existing and new SDS source areas, increasing their socioeconomic and transboundary impacts as well as the risk of becoming permanent sources.

SDS events are often triggered by the same direct drivers of desertification, land degradation, and drought, including:

(i) unsustainable land, water, and livestock management practices;

(ii) land use and climate change; and

(iii) biodiversity loss.

The indirect drivers of SDS include poverty and structural inequalities, weak land governance, and natural resource conflicts which can create additional barriers for local land users (e.g., farmer and herder communities) to adopt SDS management measures.

SDS events are recognised as a transboundary challenge of growing concern with serious implications for food and water security, human health, and sustainable development. While SDS sources are most prevalent in the drylands (i.e., arid, semi-arid, and dry sub-humid areas), major wind erosion events can transport fine particulate matter over great distances. SDS impacts can be felt in areas where they originate and in communities thousands of kilometres from the source.

Over the past few decades, land degradation has contributed significantly to the increased number and size of anthropogenic SDS sources.[3] Current trends in deforestation, agricultural expansion, and more frequent and severe droughts make countries more susceptible to SDS hazards and threaten the achievement of 11 of the 17 SDGs.[4]

2.1. Characteristics

Understanding the type, frequency, and intensity of SDS is an important first step in planning and designing source mitigation and impact management measures.

SDS are considered a hazard that occurs when surface conditions and wind speed are sufficient to cause mineral soil, sand, and dust particles to move along the ground (saltation) or into the air (entrainment). SDS particles range in size, from silt to sand, are commonly measured within a band of 2.5-10 microns of particulate matter. In general, the smaller the particle, the longer it can remain in the air and the further it can travel from its source.

While SDS phenomena have many names, they can be characterised as:

- **global-scale events** involving the long-range transport of fine dust and mineral nutrients at continental or transoceanic scales often via seasonal weather patterns and trade winds;
- **meso-scale events** involving the medium- and short-range transport often caused by frontal weather activity which creates walls of sand and dust that are propelled by gusts of cold air;
- **micro-scale events** involving the local or short-range transport of sand and dust into areas adjacent to or not far from their sources, such as sand blasting across agricultural fields and roads, and the movement of sand dunes into settlements and urban areas.

SDS are common hazards in arid and semi-arid regions where winds disturb the layer of topsoil and transport clouds of particles across the landscape, while sand storms are typically limited to hyper-arid regions and tend to be more contained as sand is heavier and cannot be sustained airborne over long distances. Local soil conditions, ground temperature, vegetation cover, and geomorphic characteristics influence the frequency and intensity of SDS events.

It is important to note that SDS particulate matter can carry and increase exposure to biological or chemical substances, including bacteria and fungi (e.g., pathogens), chemical compounds (e.g., fertilisers, pesticides, toxins), and radioactive substances (e.g., uranium) that pose serious risks to human, animal, and plant health.

Climate forecasts and environmental feedback loops are important considerations when planning and implementing SDS management measures. Climate change can alter seasonal weather patterns associated with SDS: where change leads to wetter conditions, the likelihood of SDS events may decrease, while under drier or drought conditions, their incidence and severity may increase. SDS can impact glaciers and snowpack, altering their physical attributes by reducing albedo, accelerating melting, and disrupting the hydrology of water basins.[5]

2.2. Source Areas

The management of SDS source areas can be enhanced with a better understanding of the geological controls and climate states – past, present, and future.

SDS source areas are characterised by bare or disturbed land surfaces that are exposed to wind erosion, typically soils and sand with low moisture and organic content. The world's major SDS source areas occur in the northern hemisphere, stretching from northern Africa to Europe and the Middle East to Central and East Asia. Source areas of concern also exist in North America and in the southern hemisphere, and to lesser spatial extents in Australia, South America, and Southern Africa.

Natural SDS source areas are considered permanent and predominantly occur in deserts and drylands but can manifest in other regions when and where soil conditions are conducive to wind erosion. **Anthropogenic SDS source areas** tend to be temporary and dynamic, primarily a result of poor land, water, and livestock management activities (e.g., overgrazing, deforestation, wetland conversion, industrial agriculture) and exacerbated by human-induced climate change. **Emerging SDS source areas** have been associated with the warming of the Arctic and high latitude regions, the seasonal or permanent drying of inland waters and river deltas, or following large-scale deforestation and wildfires, volcanic eruptions, or even the ploughing of a single field. The loss of snow cover, retreat of glaciers, and increase in drought intensity due to climate change can lead to surface conditions that increase the likelihood of the creation and expansion of SDS source areas.[6]

Another important feature of many SDS is that source and impact areas either overlap or are adjacent to one another. The short-range transport of particles can take place as creep or saltation close to the surface – rolling or sliding with the wind – as is the case with the formation of sand dunes. The distance between SDS source and deposition areas is primarily determined by:

(i) the size and weight of particulate matter;

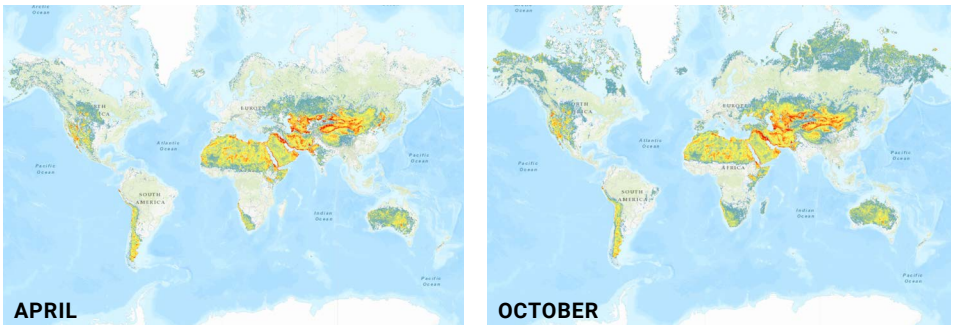
(ii) atmospheric circulation, including wind speed, turbulence, and vortices;

(iii) surface roughness, vegetation cover, and topography; and

(iv) gravitational pull.

The **Global SDS Source Base Map** can be used to identify SDS sources of concern at national and sub-national scales. The map is based on an identification of soil types which are susceptible to becoming sources under certain environmental and meteorological conditions. The geo-referenced map provides information on the distribution and annual variability of SDS source areas, surface vulnerability to sand and dust emissions, and projected intensity of future SDS events. The map can inform policies and programmes as well as risk and vulnerability assessments to help guide investments in SDS management activities at various scales.[7]

FIGURE 1 **Global SDS Source Base Map: Potential Sources**



The Global SDS Source Base Map presented in Figure 1 was derived from the publicly available global data sets from 2014 to 2018, some the warmest years ever recorded in the past 139 years.[8] Areas susceptible to wind erosion, representing 22-43 per cent of the Earth's land surface are classified as permanent (active throughout the whole year) or temporary (active in some seasons or under extreme weather conditions) which is evident when comparing potential sources from April to October. The largest areas with high or permanent SDS source potential are in the Northern Hemisphere, mainly in a broad Dust Belt that extends from the west coast of North Africa including the Horn of Africa, across the Middle East to South, Central, and Northeast Asia. Drylands in the Southern Hemisphere are less active SDS sources, despite the major concentrations of SDS activity in Central Australia, Southern Africa, and the Atacama in South America.[9]

3. Socioeconomic Impacts of Sand and Dust Storms

SDS present significant threats to our societies and economies – from declines in food production to infrastructure damage, energy and transport disruptions, and human health risks.

SDS are a unique form of hazard in that the source and impact areas can be the same or separated by great distances. Even far from their source, sand and dust emissions can impose substantial costs to various social and economic sectors, including food and water, environmental and human health, transportation, renewable energy, and industry.

The risks associated with SDS hazards are often underappreciated, pointing to serious gaps between current knowledge and the policy actions needed to prevent and reduce harm to affected communities and businesses.[10] Data on the costs and magnitude of the threat posed by SDS to food security, livelihoods, human health, and economic development is not well developed. Nevertheless, losses from a single SDS event have been estimated to be in the hundreds of millions of dollars.

- The economic impact of dust events in the **Asia-Pacific region** is estimated to be USD 5.6 billion annually.[11]
- In 2021, a major SDS event in **Northeast Asia** killed 200,000 livestock, destroyed 121 animal shelters in Mongolia, and prompted health advisories in the Republic of Korea.[12]
- In the **Middle East and North Africa**, the economic costs of SDS are estimated at more than USD 150 billion annually, equivalent to more than 2.5 per cent of GDP for most countries in the region.[13]
- In **Iraq**, exposure to SDS reduces crop yields by 0.7 to 2.8 per cent for each additional SDS day, with the greatest impacts on vegetables and dates.[14]
- In **Uzbekistan**, SDS from the Aralkum are causing Karakalpakstan to lose USD 44.2 million per year – equivalent to 2.1 per cent of its GDP.[15]
- On the island of **Crete**, during the most intense day of the African dust episode (22 March 2018), total losses were estimated in the order of EUR 3.4 to 3.8 million in the aviation, health, solar energy, and emergency services sectors.[16]

Unlike other disasters, there are no systematic mechanisms for tracking and recording loss and damage associated with SDS events, including non-economic losses and irreversible damages. In 2015, the UN General Assembly recognised the need to address the adverse impacts of SDS on communities and economies through enhanced data collection and analyses concerning loss and damage to better inform decision making and coordination at regional and national levels.[17] With this aim, the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) developed a complementary Guideline on Monitoring and Reporting the Impact of Sand and Dust Storms through the Sendai Framework Monitoring.[18]

3.1. Agriculture

Declines in agricultural production due to SDS often disproportionately affect the poorest and most vulnerable communities – those without food security or social safety nets. Like desertification, land degradation, and drought, SDS can affect women and men in different ways and to different extents given their specific roles and activities in the agricultural sector.[19]

The impacts of SDS on crops and livestock of most concern are associated with reduced yields and productivity due to:[20]

- wind erosion resulting in the loss of soil health in crop and grazing lands;
- sand blasting and dust deposition that damage crops and reduce forage;
- increased livestock mortality and reduced animal health and productivity;
- increased siltation and sedimentation in water sources and irrigation canals;
- pathogen transmission and the spread of plant and animal diseases;
- prolongation of drought conditions and declines in pollinator communities; and
- damage to farm equipment and built infrastructure.

3.2. Human Health

SDS negatively affect human health in both source and impact areas, primarily through exposure to air pollution from increased particulate matter. Epidemiological research has established a correlation between SDS events and the increased risk for respiratory morbidity and cardiovascular mortality.[21] The World Health Organization (WHO) has included good practice statements in its Air Quality Guidelines 2021 which reflects a concern that SDS may be a significant risk factor for inflammatory and allergic lung diseases, such as child and adult asthma, and may contribute to the transmission of infectious diseases, such as Valley Fever and meningitis.[22]

The impacts of SDS on water quality and availability, and sanitation can be significant due to the siltation and contamination of reservoirs, dams, catchments, underground canals, and flood control installations. This can lead to disruptions in already scarce water supplies, the need for additional water treatment, and increased demand in operations to remove sand and dust – all of which can result in greater operating costs (e.g., more frequent water sluicing) and capital outlays (e.g., additional labour, equipment) for governments, communities, and businesses.

Sand and dust emissions are a multi-faceted threat to human health. Globally, air pollution from increased concentrations of particulate matter is responsible for 7 million deaths each year. A 2016 study estimated the annual global welfare losses from air pollution – to which SDS contribute – at USD 3.6 trillion.[23] Additional indirect costs to society and the economy can be attributed to SDS events that debilitate individuals, especially those with compromised respiratory and cardiovascular systems or other underlying health conditions. The elderly, disabled, and pregnant and lactating women are particularly vulnerable to sand and dust emissions.

3.3. Infrastructure

SDS impacts on transportation are linked to unsafe travel conditions and those that compromise built infrastructure. While the interruption of air transport and safety risks from SDS events have been substantially reduced by modern navigation technologies, disruptions in road and rail travel remain a significant challenge. High impact consequences can occur when blowing sand and dust contributes to low visibility and results in fatal or costly accidents. SDS can disrupt waterway transport, although this appears to be more correlated to strong or unpredictable winds which can be worsened by airborne sand and dust.

In areas where land cover is absent or severely disturbed, wind-blown sand and dust can impede or stop the functions of energy and other critical built infrastructure. Sand and dust cover solar panels, infiltrate wind turbines, and disrupt power stations/grids which reduce energy generation and transmission. This can lead to their abandonment or additional costs to ensure that these systems continue to operate efficiently and profitably. Poor air quality and limitations on mobility during and after SDS events can affect daily social and economic activities that rely on built infrastructure, such as those related to work, education, and recreation.

3.4. Sectoral Linkages

While sector-specific interventions can respond to certain impacts, SDS events often have cross-sector implications which require planning and policy coherence for their holistic management. SDS impacts on built infrastructure can affect multiple economic sectors (e.g., transport, manufacturing, water, energy), while reduced agricultural productivity contributes to food insecurity and poor health and livelihood outcomes.

These linkages highlight the need for multi-sector planning and multi-hazard approaches to improve SDS management and reduce their socioeconomic impacts. Policy and regulatory mechanisms that encourage institutional coordination within and across sectors and levels of governance (local to national) are considered essential. At global and regional scales, knowledge sharing, technical cooperation, and transboundary partnerships are indispensable.

3.5. Gender, Youth, and Equity

Disasters can exacerbate many prevailing generational and gender inequalities. In general, women and youth are more vulnerable to disaster impacts, often due to discriminatory social norms and other cultural barriers. The impacts of SDS on women and girls, men and boys can be expected to differ across sectors as risk, vulnerability, and exposure varies according to their differentiated roles and responsibilities. Exposure to SDS impacts may be significant for men and boys working in the fields while the burden of clean-up may be greater for women and girls, or vice versa. Gender-based differences and intergenerational equity can be addressed in SDS policies, strategies, and action plans through meaningful youth engagement and gender-responsive measures.

Not everyone is affected in the same way by SDS events or have the same means to manage sources or cope with their impacts. Issues related to land governance and other social and economic inequalities should be considered when identifying SDS management options and their potential benefits. Some inequalities can be addressed directly through source and risk mapping as well as vulnerability and impact assessments. Early warning systems linked to anticipatory actions must benefit all strata of society by reducing the impacts of a forecasted SDS event before it occurs or its most acute impacts are felt.

4. Knowledge Resources to Manage Sand and Dust Storms

A wealth of knowledge resources on the management of SDS are available to support and facilitate policy and actions – from stand-alone projects to integrated programmes.

There is a significant body of scientific and empirical evidence which can be used to evaluate the risks posed by and the options to avoid, reduce, and manage SDS sources and impacts.[24] This chapter presents the primary references and repositories of evidence-based information, tools, technologies, and knowledge products upon which policymakers and decision makers can draw upon for the successful application of the Guideline.

UN Coalition on Combating Sand and Dust Storms[25]

In response to various UN General Assembly resolutions and specifically resolution 72/225, the UN Coalition on Combating Sand and Dust Storms was officially established at the UNCCD COP14 in 2019.[26] The UN System is committed to a proactive approach that enhances cooperation and coordination for the management of SDS at global, regional, and national levels. The mandate of the UN Coalition is to promote and coordinate a collaborative response that facilitates:

- the exchange of knowledge, data, and good practices;
- dialogue and collaboration among affected countries and the UN system; and
- capacity building and awareness raising to support preparedness and response measures in critical regions.

There are five working groups, each led by individual members and with a mandate to contribute to the overall strategy of the SDS Coalition:

- adaptation and mitigation (UNDP and FAO) fosters a better understanding of SDS sources, dynamics, and impacts, as well as raising awareness on good management practices and the assessment of loss and damage on different sectors;
- forecasting and early warning (WMO) shares SDS forecasting and early warning information on a dedicated platform;
- health and safety (WHO) documents and shares knowledge on SDS impacts on human health and potential response options;
- policy and governance (UNCCD) focuses on the implementation of SDS source and impact mitigation practices and, together with other working groups, develops policy relevant recommendations; and
- mediation and regional collaboration (ESCAP and ESCWA) works to improve regional collaboration on SDS management and raise awareness at regional and country levels.

4.1. Global

The **Global Assessment of Sand and Dust Storms** was produced in 2016 by the United Nations Environment Programme (UNEP), World Meteorological Organization (WMO), and the UNCCD. The report presents the science of SDS processes and forms the foundation for technical and policy options for reducing and managing SDS sources and impacts. It includes an overview of SDS trends, including global and regional characteristics and sources as well as the socioeconomic and environmental impacts of SDS. The assessment also describes existing policy and monitoring initiatives, including case studies at regional and national levels.[27]

The **Sand and Dust Storms Compendium: Information and Guidance on Assessing and Addressing the Risks,** launched at the UNCCD COP15 in 2022, includes approaches and methodological frameworks for data collection, source and impact assessments, monitoring and early warning systems, and preparedness and impact mitigation needed to develop and implement SDS policies at sub-national, national, regional, and global levels. It is the single most comprehensive resource to date on SDS management.[28]

The **SDS Toolbox** was inaugurated on 12 July 2023 during the first observance of the **International Day to Combat Sand and Dust Storms**. It provides practical tools, guidance, and training modules which can be used to identify SDS sources, and to develop and implement policies, strategies, and action plans to better manage their risks, vulnerabilities, and impacts. The SDS Toolbox provides decision support tools to observe, monitor, and forecast SDS events as well as technical guidance to develop and implement projects and programmes that mitigate sources and manage impacts.[29]

The WMO established the **Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)** in 2007. The SDS-WAS enhances the ability of countries to deliver timely, quality SDS forecasts, observations, information, and knowledge. The WMO SDS-WAS operates as an international hub of researchers, operational centres, and end-users that provides services through its regional activity nodes. At present, there are four regional nodes: (i) North Africa, Middle East and Europe; (ii) Asia; (iii) the Americas; and (iv) the Gulf Cooperation Council countries. Emerging initiatives, such as Iran and Türkiye cooperation, are also building regional alliances in West and Central Asia.[30]

4.2. Regional

The **Sand and Dust Storms in Asia and the Pacific: Opportunities for Regional Cooperation and Action** analyses the potential drivers, points to the risk of problem areas, and identifies gaps in information, cooperation, and policy action to enhance the science-based understanding of SDS phenomena among policymakers. It supports the development of mitigation and adaptation policies related to SDS at regional and national levels.[31]

The **Sand and Dust Storms Risk Assessment in Asia and the Pacific** examines the potential impact of SDS on human health, agriculture, energy, transportation, environment, and urban areas, taking into account the distinct mechanisms through which these events affect each sector.[32] The insights derived from this assessment played a pivotal role in shaping the **Regional Plan of Action on Sand and Dust Storms in Asia and the Pacific** endorsed by UNESCAP in 2022.[33]

Sand and Dust Storms in the Middle East and North Africa Region: Sources, Costs, and Solutions offers a state-of-the-art assessment of SDS trends and sources as well as solutions to inform policymakers and stakeholders in the region.[34]

The Value of Landscape Restoration in Uzbekistan to Reduce Sand and Dust Storms from the Aral Seabed estimates the economic benefits of landscape restoration to enable national and local authorities to allocate limited resources for SDS measures focused on soil stabilisation and related ecosystem services.[35]

The **Guideline on Monitoring and Reporting the Impact of Sand and Dust Storms through the Sendai Framework Monitoring** provides countries from the Asia-Pacific region with a practical step-by-step guide to support their efforts to monitor and report the impacts of SDS through the Sendai Framework monitoring.[36]

4.3. Sectoral

The United States Department of Agriculture's **Dust Mitigation Handbook: One Stop Guide to Dust Mitigation**, published in 2019, provides some of the most extensive descriptions of SDS source management methods based on field experiences and practitioners' research.[37]

The FAO **Sand and dust storms: a guide to mitigation, adaptation, policy and risk management measures in agriculture,** published in 2023, provides an overview of SDS and the impacts on agriculture and food systems. It examines how agriculture can create SDS sources and highlights the impacts of SDS on agricultural production in both source and deposition areas. It includes a searchable database of more than 150 high-impact, location- and context-specific practices to reduce SDS sources and impacts on agriculture at the local level, comprising technical and non-technical interventions. Moreover, it assesses how SDS risk is addressed at the policy level and discusses options for integrating SDS at national and regional levels into multi-hazard disaster risk reduction and management strategies or sectoral development programmes.[38]

The WHO **Global Air Quality Guidelines** provide recommendations focused on the likely consequences of SDS and mitigation options, including:

(i) strengthening and/or establishing air quality management programmes;

(ii) measuring particulate matter components for the purpose of source apportionment;

(iii) conducting research on health impacts and epidemiological studies.[39]

5. Guiding Principles for Sand and Dust Storms Management

- **The Guideline can be adapted to specific contexts and applied in key policy areas consistent with sustainable land and water management approaches** and existing obligations under national and international law. It is fully compatible with the response hierarchy and level of ambition set out in national LDN targets under the UNCCD and closely aligned with the principles and practices contained in the Sendai Framework for Disaster Risk Reduction 2015–2030.
- **The Guideline encourages the integration of SDS management into national strategies and action plans mandated through global and regional agreements** (e.g., commitments related to the Rio conventions, food security, human health, air pollution, drought resilience, and disaster risk reduction) to promote a more holistic approach to SDS source and impact mitigation.
- **The Guideline recognises the need for greater awareness, capacity development and technical assistance, and knowledge and information sharing.** The provision of sustained finance is essential to operate SDS early warning systems and implement source management measures, which can be employed as part of nature-based solutions that include regenerative agriculture, ecosystem restoration, and disaster risk reduction.
- **The Guideline provides recommendations that are grounded in proven, science-based, gender-responsive, and internationally recognised principles and practices** for creating the appropriate enabling environment for the integration of SDS management into key policy areas.

5.1. Enabling Environment

A combination of awareness and knowledge, stakeholder engagement, capacity building, access to finance, tools and technologies, and policy and regulatory mechanisms are essential to create an appropriate enabling environment for efficient and effective SDS management.

SDS management approaches and measures can often be aligned with national commitments to scale up land- and nature-based solutions under various multilateral processes, such as the Rio conventions (i.e., UNFCCC, CBD, and UNCCD) and the Bonn Challenge and its regional initiatives. A concerted effort to enhance governance and administrative coherence at the appropriate scales (local to regional) would allow countries to harness synergies among relevant processes for more cost-effective implementation and to realise the full suite of benefits from integrated landscape management approaches and actions.

A response hierarchy (e.g., avoiding, reducing, and reversing land degradation) can help frame planning and policy efforts to combat SDS and deliver co-benefits to vulnerable or marginalised population groups. Essential to the success of these efforts are provisions for responsible land governance (e.g., tenure security), integrated land use planning (e.g., green/blue infrastructure), and incentives for sustainable land and water management (e.g., payments for ecosystem services). As a result, countries and regions may find themselves in a better position to reduce SDS risks, vulnerabilities, and exposure while at the same time contributing to greater food security and livelihood opportunities, climate change mitigation and adaptation, biodiversity conservation, disaster risk reduction, and intergenerational and gender equality.

5.2. Integrated Risk Management Approaches

A multi-hazard, multi-sectoral, multi-actor risk management approach is an effective way to address the feedback loops between SDS and other global environmental challenges, such as climate change, biodiversity loss, and water scarcity.

Countries developing or revising their SDS policies, strategies, and action plans can identify the ways and means to promote synergies among key sectors and policy areas, such as through integrated spatial planning, improved tenure security, and land and ecosystem restoration projects and programmes.[40] [41] When selecting a particular SDS source management intervention, full consideration should be given to how it will interact with, or pose risks to, other social, economic, and environmental functions. One objective may be to improve access to finance and equitable benefit sharing (e.g., gender, youth) related to SDS management by promoting employment and investment opportunities that extend beyond short-term technical interventions (e.g., soil stabilisation, erosion control).

The adoption and upscaling of good practices for SDS management at local, landscape, and regional scales can be accelerated with the support of well-coordinated risk monitoring and early warning systems. These systems should strive to be operational and trigger anticipatory actions that minimise the impacts of SDS events. Robust monitoring, analytical, and forecasting tools that include agrometeorological, environmental, and human health data can provide timely information to alert populations at risk. Once identified and mapped, SDS hazards can be included in existing policy and implementation frameworks centred on early warning and crisis prevention, preparedness, mitigation, response, and recovery.

Regional Strategy for Sand and Dust Storms Management in Central Asia[42]

More than 80 per cent of the 400 million hectares of the territory in Central Asia is covered by deserts and steppes which, coupled with climate change and persistent drought, represent a natural source of SDS. However, unsustainable practices of irrigated farming and livestock grazing, mining, and other activities create favourable conditions for the formation of anthropogenic SDS sources. The drying of the Aral Sea led to the creation of 5.5 million hectares of salty desert and the source of 100 million tonnes of dust and poisonous salt. In 2020, the UNCCD secretariat initiated a pilot project on Regional Approaches for Combating SDS and Drought in Central Asia to develop a regional strategy as part of the Regional Environmental Programme for Sustainable Development in Central Asia 2021–2030. The key priorities are to:

- raise awareness of potential harms, risks and related mitigation measures to help inform integrated and synergistic interventions and stimulate knowledge and technology transfers;
- eliminate the environmental and socioeconomic causes of desertification, land degradation, and drought; and
- ensure regional cooperation and coordinated action.

Likewise, the **Regional Plan of Action on Sand and Dust Storms in Asia and the Pacific** provides a strategic framework and reference for countries in the region to act at national and regional levels, in the context of multi-hazard disaster risk reduction, to reduce the negative impact of SDS and identify measures that could contribute to or mitigate their formation and intensity.[43]

5.3. Source and Impact Assessments

Any project or programme focused on SDS source and impact mitigation should first conduct assessments to identify the drivers, risks, and vulnerabilities.

For **SDS source management**, baseline assessments should be based on the latest information and science (e.g., climate/topographical data, geospatial analysis) to best understand the character of SDS sources – their land use and degradation status, location in the wider landscape, and the character and degree of human influence. Distinguishing between permanent and temporary SDS sources is another element that can help to inform policy priorities and management measures.

Many SDS sources are highly specific landscape units (e.g., individual fields, ephemeral lakes, large-scale depressions) which should be differentiated from other source areas to formulate effective responses. Understanding historical source areas, their natural and anthropogenic drivers, and climate change projections is critical to multi-sector, multi-disciplinary approaches that prioritise and implement SDS source management measures. The SDS Source Base Map is one tool, coupled with other knowledge resources and guidance documents (*Guideline Chapter 4*), that can be used to identify and evaluate potential intervention sites located in or near SDS source areas.

FIGURE 2 Global Variability of SDS Emission Potential

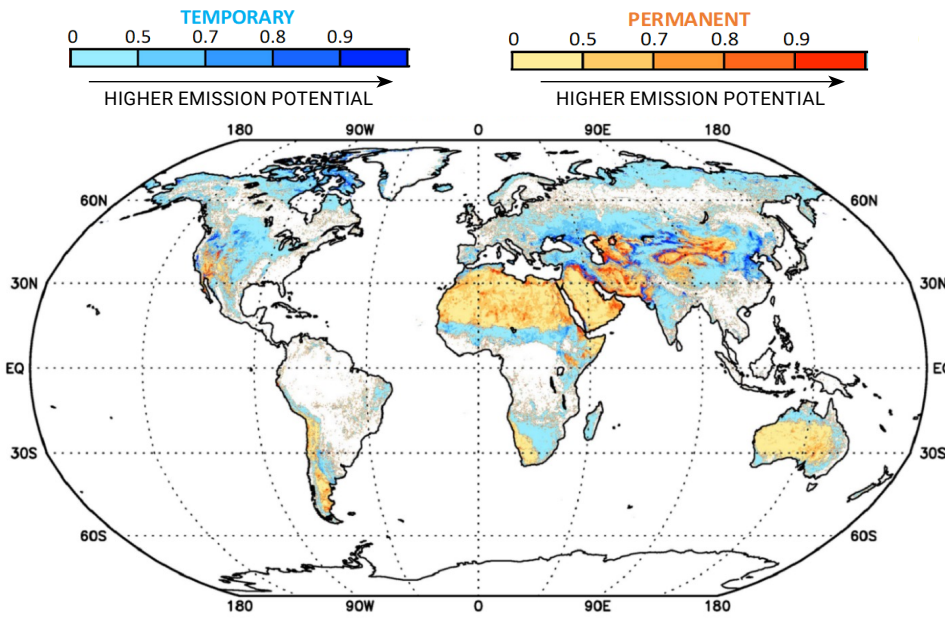


Figure 2 illustrates the global distribution of permanent sources (with source intensity values marked in yellow for surfaces with lower emission potential and orange to red for surfaces with higher to extremely high emission potential) and temporary sources (with source intensity values marked in light blue for surfaces with lower emission potential and medium to dark blue for surfaces with higher to extremely high emission potential. The map is derived from the G-SDS-SBM data: permanent sources represent the areas constantly exposed to wind erosion; temporary sources include areas which are exposed to wind erosion in certain seasons and/or during extreme weather events, like drought and heat waves.[44]

For **SDS impact mitigation**, baseline assessments should include stakeholder consultations to ensure that policies, projects, and programmes: (i) address potential SDS impacts identified by local communities and businesses; and (ii) respond to considerations that may have been neglected during the planning and design stages. There are numerous guidelines and good practices for conducting social, economic, and environmental impact assessments (*SDS Compendium Chapter 13*).

For both SDS source and impact mitigation, expert and community level impact assessments can be effective methods for collecting data and information (*SDS Compendium Chapters 4 and 5*) while economic impact assessments are a critical source of information for policymakers and decision makers (*SDS Compendium Chapter 6*). The use of geographic information systems can provide a better understanding of how SDS events impact lives and livelihoods (*SDS Compendium Chapter 7*) while scientific research and technical reports are potential sources of information to better assess SDS sources and impacts at regional and national levels.

5.4. Early Warning Systems and Technical Interventions

Early warning systems can reduce the socioeconomic and environmental costs of SDS events and inform the design and application of technical interventions to prevent and mitigate them.

Considerable progress has been made in early warning systems and forecasting through the SDS-WAS and its regional nodes as well as national and local meteorological authorities and, in some cases, private weather forecasting companies. Current air quality monitoring and early warning systems typically do not register or report on SDS events as they are not equipped to monitor the relevant particulate matter. Introducing the capacity to predict and monitor SDS into the forecasting work of meteorological agencies could increase the efficacy of anticipatory actions that help protect lives, livestock, and livelihoods (*SDS Compendium Chapter 10*).[45]

Nature-based solutions can often be employed as part of SDS management approaches that protect, conserve, restore, sustainably use, and manage ecosystems while simultaneously providing human wellbeing, ecosystem services, resilience and biodiversity benefits.[46]

Selecting the most suitable, technical intervention to address a particular SDS source will depend on site conditions as well as the estimated costs/benefits of each intervention. In addition to mapping, the site selection process should identify the potential negative impacts of a chosen measure on relevant stakeholders and ecosystem functions, both on- and off-site. Context-specific and cost-effective interventions proven to reduce SDS sources and impacts in the agricultural sector include:

(i) conservation agriculture in dryland systems;

(ii) drought-tolerant forage species;

(iii) traditional and mechanised water harvesting and storage;

(iv) aerial seeding of saxaul trees.[47]

5.5. Awareness Raising, Stakeholder Engagement, and Capacity Building

The efficacy of SDS management approaches increases with the meaningful participation of affected populations – from the initial planning and design stages to implementation and monitoring.

Awareness raising campaigns are a powerful tool for engaging stakeholders and sharing knowledge on SDS sources, risks, and impacts, as well as promoting the role of individual and community actions in mitigating these hazards. Multistakeholder platforms and capacity building initiatives (e.g., technical assistance, formal training, peer-to-peer learning) can further the exchange of knowledge and skills among relevant stakeholders to enhance SDS prevention, preparedness, response, and recovery.

Stakeholders can be identified and engaged through a variety of methods, including baseline surveys, risk mapping exercises, and participatory appraisals (*SDS Compendium Chapter 5*). It is important to involve all relevant stakeholders and assess their respective levels of knowledge and engagement as part of a socially inclusive and gender-responsive approach to SDS management. Firsthand knowledge of the landscape often provides an understanding of past land use dynamics which may no longer be obvious but continue to influence the current situation. Attention to the local biophysical and socioeconomic aspects can help facilitate adaptive learning, continuous monitoring, and gender-balanced engagement.

Building institutional, technical, and administrative capacities is often a prerequisite to ensure coordinated SDS policy development and implementation at the regional, national, and sub-national levels. This coherence, supported by multi-level governance systems, can significantly enhance:

(i) **absorptive capacity** or the ability to tolerate hazards and minimise exposure;

(ii) **adaptive capacity** or the ability to adjust to changing conditions;

(iii) **transformative capacity** or the ability to positively affect livelihoods.

Building capacity to assess and cost SDS impacts in key sectors (e.g., estimates of loss and damage) could facilitate synergies with domestic and international finance earmarked for programmatic activities related to climate, biodiversity, development, and disaster risk reduction.

5.6. Regional Cooperation

Regional cooperation is essential to address the transboundary nature of SDS events.

Regional SDS management frameworks and strategies can enhance prevention, preparedness, mitigation, response, and recovery by improving transboundary risk governance and promoting technical cooperation and coordinated interventions at different scales. Regional platforms bring together governments and stakeholders to identify common challenges and implement political commitments to address them at the appropriate level. Multi-country SDS networks can support the monitoring and assessment of implementation, strengthen technical partnerships, mobilise and sustain finance, and provide space to share knowledge and good practices.

Regional Plan of Action on Sand and Dust Storms in Asia and the Pacific[48]

The Asia-Pacific region ranks second globally in terms of mineral dust emissions with four primary SDS corridors: (i) East and Northeast Asia; (ii) South and Southwest Asia; (iii) Central Asia; and (iv) the Pacific.

Considering the frequent transboundary effects of these storms, the findings of the risk assessment advocate for the development and implementation of well-coordinated initiatives at the national and regional level to properly address the socioeconomic consequences of SDS. The Regional Plan of Action proposes a set of specific actions under three operational objectives:

- improve the understanding of SDS impacts to accurately inform policies and investments;
- expand monitoring and improve early warning systems to include an impact-based focus, provide timely forecasts, and enable targeted measures to manage SDS;
- establish coordinated regional actions in the most at-risk geographical areas to mitigate risk and exposure.

Regional Master Plan for the Prevention and Control of SDS in Northeast Asia[49]

Northeast Asia is the world's second largest SDS source, contributing to about 40 per cent of the global dust loading, with most emissions transported from Mongolia to China, Korea, Japan, the Pacific Ocean, and as far as the west coast of the United States. The Regional Master Plan was developed by government officials and national experts, in collaboration with regional and international organisations, with the aim to establish an effective vehicle for regional cooperation in combatting SDS. Achievements to date, include a regional monitoring and early warning network as part of the WMO SDS-WAS Asia Node hosted by the China Meteorological Administration. In general, the implementation of SDS source prevention and mitigation measures has not yet progressed beyond the pilot stage. Greater knowledge and capacity are still needed for national staff to design and implement source mitigation measures, including a more robust understanding of source area dynamics, criteria, and indicators used for monitoring and evaluation, and linkages with other development challenges, such as desertification, land degradation, and drought.

6. Integrating Sand and Dust Storms Management into Key Policy Areas

Effective SDS management requires policy actions that target those sectors generating SDS sources as well as those affected by the transport and deposition of airborne sand and dust.

6.1. Agriculture

SDS policies, programmes, and investments related to food production should be guided by the integrated management of land, soil, crops, livestock, and water – ideally at landscape scales to ensure optimal outcomes among a mosaic of land uses, including the protection and restoration of natural ecosystems.

Sustainable land and water management practices, mainly in the agriculture, forestry, mining, and livestock sectors, are recognised as practical and cost-effective ways to prevent and reduce anthropogenic SDS source areas. Some of the most well-known cropping and grazing practices which can be tailored to local conditions are:

(i) conservation, climate-smart, and regenerative agriculture;

(ii) agroforestry and silvopastoralism;

(iii) rotational livestock grazing.

More specifically, multi-storey and alley cropping, hedgerows and windbreaks, traditional water harvesting, and soil moisture retention practices can help reduce the susceptibility of agricultural land to becoming a temporary or permanent source of SDS (*Guideline Chapter 4*).

The use and management of water resources, primarily surface and groundwater for irrigation or mining activities, is an important consideration when creating incentives for more efficient water resource use to reduce SDS sources and impacts. In areas where SDS sources are considered natural, a combination of risk mitigation measures (e.g., ecosystem restoration, afforestation, soil/sand stabilisation), along with planning for adaptation, response, and recovery, can help mitigate SDS impacts on surrounding crop and grazing lands. Inclusive and responsible land governance frameworks that improve tenure security for farmers and herders can be a powerful incentive to catalyse and sustain technical and non-technical interventions at the farm or community level.

6.2. Human Health

The health sector can use epidemiological studies to better understand the impact of different types of SDS events (and related weather patterns) on chronic and acute health risks and the populations most affected. These studies can also help identify the causal links between sand and dust emissions and ambient temperature which result in specific health outcomes, such as respiratory and cardiovascular disease. This information can then be used to guide SDS planning and policies to avoid overburdening the health care system. Ideally, coordination among the health sector and institutions monitoring air quality would enhance the ability of early warning systems to forecast and broadcast the likelihood of SDS events so that individuals, businesses, and communities can take timely precautions.

Response planning for health and sanitation interventions in SDS impacted areas should account for potential sand and dust loads that affect social and economic functions and require clean-up and recovery efforts. Contingency planning, based on the likelihood of specific SDS events, can minimise exposure and disruption to individuals participating in paid and non-paid labour, education, recreation, and outdoor activities. Consideration should be given to collecting, moving, and processing large quantities of sand and dust without overloading or damaging sanitation systems. Sand washed off roads may be prone to fill drainage and sewage pipes, while sand and dust cleared from energy and built infrastructure may increase water scarcity or overburden water treatment facilities. The level of risk posed by sand and dust deposition to water and sanitation systems can vary widely and should be accounted for in SDS impact assessments and management plans (*SDS Compendium Chapters 10 and 13*).

6.3. Infrastructure

SDS policies, programmes, and investments should consider the adverse impacts on built infrastructure, its operational efficiency, and user demand for transport, energy, and manufacturing. The transportation sector should give attention to the direct impacts on the safety and efficiency of transport modes (e.g., airplanes, trains, boats) and mechanisms (e.g., rail, roads, waterways). Targeted response measures should be based on impact and operational assessments to reduce risks to specific transport modes and mechanisms in SDS prone areas. Likewise, industry and manufacturing should consider potential SDS impacts on:

(i) product quality;

(ii) equipment, facilities, and distribution networks;

(iii) recurrent maintenance and clean-up costs.

One aspect of SDS that is of growing concern to policymakers and investors is their impact on renewable energy sources, particularly wind and solar farms. Not only does SDS deposition reduce the efficiency of wind turbines and solar panels, but sand and dust particles in the atmosphere can reduce electricity output by deflecting incoming solar radiation. Power grids and transmission lines in impacted areas often require additional maintenance to avoid short circuits and power outages. As the share of renewable energy grows in those regions impacted by SDS, policies and investments should include contingency planning and proactive measures to avoid major disruptions.

6.4. Sectoral Linkages

As part of multi-hazard risk reduction and management strategies, countries and regions can operationally link SDS management to LDN targets, the Paris Agreement, GBF, and Sendai Framework for Disaster Risk Reduction, as well as other human health and sustainable development priorities and commitments. Measures to combat SDS that are integrated into policies, programmes, and investments across multiple sectors can contribute to enhanced climate action, biodiversity conservation, and rural development.

The large-scale application of SDS source and impact mitigation practices not only requires supportive legislation and regulation but institutional and administrative capacities and the provision of adequate and sustained finance. A pilot exercise for developing a national SDS strategy in Nigeria proposes a whole-of-government, multi-sector approach to reducing SDS sources and achieving LDN.

Proposal for a National Strategy on SDS Mitigation[50]

The northern part of Nigeria has witnessed the impacts of SDS phenomena (harmattan) for centuries. The resulting depositional effect, primarily the creation of sand dunes, has now become a driver of secondary SDS sources in Nigeria. The goal of the proposed national strategy on SDS mitigation in Nigeria is to reduce SDS impacts and help achieve LDN targets by:

- harnessing the appropriate SDS data;
- promoting the essential linkages between the three dimensions of sustainable development;
- raising awareness of early warning systems and encouraging the communities to participate in SDS mitigation processes;
- building partnerships among all stakeholders; and
- adopting good practices for SDS mitigation.

A multi-sector approach, involving the ministries of environment, agriculture, health, water, disaster management, and the National Aerospace Research and Development Agency, is envisioned to support the implementation of the national SDS strategy, which is expected to include:

- legislation that encourages the development of a national SDS programme;
- an institutional framework and funding mechanism to operationalise the programme;
- enhanced international and regional cooperation; and
- the creation of a SDS Monitoring and Evaluation Unit.

6.5. Finance

Given the complexity and range of activities involved, public and private sector investment in SDS management remains a significant challenge in many developing countries. SDS sources are often in marginal rural areas or far from major population centres, making it difficult for policymakers to justify, allocate, and sustain public sector finance for prevention and reduction activities. However, the growing realisation that effective SDS management not only benefits local land users, but also other sectors and countries, is slowly shifting policy and funding priorities, as in the case of the Middle East, Northeast Asia,[51] and Central Asia.[52]

Improved Resilience against Transboundary Sand and Dust Storms in Kuwait and Southern Iraq

This four-year (2023-2027), USD 13 million project follows a three-pronged approach to achieve interrelated objectives. First, it improves the knowledge base to provide a better understanding of the conditions that generate SDS, their impact on human health, and the most appropriate prevention and mitigation measures. Second, it makes a substantial effort to restore critical ecosystem functions in SDS source areas. Third and most important, it helps enhance the resilience and capacity of local authorities, and the most vulnerable communities in southern Iraq, to adapt to the impacts of desertification and mitigate the root causes of SDS.[53]

An initial consideration for relevant authorities is whether to pursue stand-alone funding for SDS management or to repurpose budget allocations within existing sectoral, climate, development, and disaster risk reduction programmes. The latter can help attract new and additional finance from the developed to developing countries in the form of grants and concessional loans, without increasing their debt burden and in compliance with internationally agreed commitments. Where appropriate, countries can prioritise SDS management measures within domestic resource allocations for climate adaptation, disaster risk reduction, or protected areas. This can serve to attract bilateral funding which often fills a gap in development finance by directly addressing the causes of natural disasters.

Regenerative land management projects and programmes in the agriculture, forestry, and mining sectors can be avenues for financing SDS-targeted interventions that improve food production, water availability, carbon storage, and rural livelihoods. Many SDS source mitigation practices can be adopted and scaled with innovative or blended finance mechanisms, such as payments for ecosystem services, nature-based solutions, public-private partnerships, conservation set-asides, and ecotourism.

While private sector finance is also needed, these limited investments in SDS source mitigation tend to be focused on short-term economic benefits from increased land productivity rather than long-term objectives of sustainability and resilience. In some cases, SDS-related legislation and regulation can encourage and facilitate private sector investments in building green and blue infrastructure, reducing energy and water use, improving climate resilience, and restoring natural capital and ecosystems. In the near term, greater attention and support from the public sector will be required to close the financing gap and foster a balanced approach to SDS source reduction, impact mitigation, and enhanced adaptive capacity.

7. Conclusion

The Guideline aims to raise awareness, mobilise political will, activate collaboration, and attract the financial resources needed to support informed and concerted actions to better manage SDS sources and impacts. For some countries, aligning SDS management measures with their climate, biodiversity, and development priorities enables them to harness inherent synergies with nature-based solutions, such as green and blue infrastructure, regenerative agriculture, ecosystem restoration, and disaster risk reduction.

The Guideline points to the wealth of knowledge resources available to foster the enabling conditions for implementing SDS policies, strategies, and action plans. As SDS impacts on communities and key sectors continue to grow, political attention and funding for SDS management should increase proportionally. There is a need for greater coherence among national policies and initiatives with those at regional scales to help mobilise the necessary resources and accelerate action to reduce SDS sources and their transboundary impacts.

The UNCCD, FAO, members of the UN Coalition on Combatting Sand and Dust Storms, and other partners will continue their efforts, according to their respective mandates and capacities, to assist countries and regions in developing or revising their SDS policy, implementation, and monitoring frameworks for improved management outcomes, including the establishment of early warning systems linked to anticipatory actions that protect lives, livestock, and livelihoods.

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Guideline on the Integration of Sand and Dust Storm Management into Key Policy Areas

The Guideline is voluntary and can be used by regional, national, and sub-national authorities and actors responsible for designing and implementing SDS-related initiatives in key policy areas (e.g., agriculture, human health, infrastructure). It builds upon the UNCCD Policy Advocacy Framework for Sand and Dust Storms which outlines the principles and enabling environment to prevent and reduce SDS sources and their socioeconomic impacts while improving productivity and resilience.

The Guideline aims to raise awareness on development challenges related to SDS risk, vulnerability, and exposure that are often not fully appreciated or considered by policymakers. In addition to greater political attention, it underscores the need for assessments and actionable data to address SDS hazards more effectively. The Guideline is informed by scientific, technical, and evidence-based knowledge resources that have been produced by the UNCCD, the Food and Agriculture Organization of the United Nations (FAO), and members of the United Nations Coalition on Combatting Sand and Dust Storms as well as other partners and experts from around the world.

Members of the United Nations Coalition on Combating Sand and Dust Storms

Convention on Biological Diversity (CBD)
International Civil Aviation Organization (ICAO)
International Telecommunication Union (ITU)
International Union for Conservation of Nature (IUCN)
UN Convention to Combat Desertification (UNCCD)
UN Department of Economic and Social Affairs (DESA)
UN Development Programme (UNDP)
UN Economic and Social Commission for Asia and the Pacific (ESCAP)
UN Economic and Social Commission for West Asia (ESCWA)
UN Economic Commission for Europe (ECE)
UN Educational, Scientific and Cultural Organization (UNESCO)
UN Environment Programme (UNEP)
UN Food and Agriculture Organization (FAO)
UN Framework Convention on Climate Change (UNFCCC)
UN Institute for Training and Research (UNITAR)
UN-Habitat
UN Office for Disaster Risk Reduction (UNDRR)
UN University Institute for Water, Environment and Health (UNU-INWEH)
World Bank
World Health Organization (WHO)
World Meteorological Organization (WMO)

United Nations
Convention to Combat Desertification

United Nations Convention to Combat Desertification (UNCCD)

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