United Nations ICCD/COP(14)/17

Convention to Combat Desertification

Distr.: General
24 June 2019

Original: English

Conference of the Parties
Fourteenth session
New Delhi, India, 2–13 September 2019
Item 3 (c) (ii) of the provisional agenda
Effective implementation of the Convention at national, subregional and regional level
Follow-up on policy frameworks and thematic issues
Sand and dust storms

Follow-up on policy frameworks and thematic issues: Sand and dust storms

Note by the secretariat

Summary

Decision 31/COP.13, entitled "Policy Advocacy Framework to combat Sand and Dust Storms", requested the secretariat and appropriate United Nations Convention to Combat Desertification (UNCCD) institutions and bodies to collaborate with other relevant United Nations entities and specialized organizations in the process of assisting Parties in implementing the Policy Advocacy Framework, in particular anthropogenic sand and dust storms source mitigation and strengthening resilience.

By its decision 31/COP.13, the Conference of the Parties requested the secretariat to prepare a report on the implementation of decision 31/COP.13 and follow up on sand and dust storms at its fourteenth session.

This report provides a summary of the activities undertaken by the secretariat for the period from 2017 to 2019. It presents recommendations on approaches and priorities for future action to strengthen capacity and ongoing efforts in addressing the negative impacts of sand and dust storms.

GE.19-10488(E)
1910488

Please recycle

Contents

I. Background

1. Decision 8/COP.9 requested the secretariat to generate advocacy policy frameworks on thematic issues in order to address the adverse impacts of desertification/land degradation and drought (DLDD), keeping in mind gender-sensitive approaches, and to regularly inform affected countries and other key stakeholders on such proceedings that may be useful in the implementation of action programmes.

2. Decision 9/COP.10 requested the secretariat to (a) develop a standard approach and process to ensure consistency of advocacy policy frameworks, (b) advise on any other emerging issues and strategic approaches that require an advocacy policy framework, and (c) collaborate closely with other relevant institutions when preparing draft advocacy policy frameworks.

3. Parties, by decision 9/COP.12, requested the secretariat to participate, within the mandate and scope of the Convention, in partnerships fostering capacity development to respond to sand and dust storms (SDS) and floods.

4. Decision 31/COP.13, entitled "Policy Advocacy Framework to combat Sand and Dust Storms" requested the secretariat and appropriate United Nations Convention to Combat Desertification (UNCCD) institutions and bodies to collaborate with other relevant United Nations entities and specialized organizations in the process of assisting Parties in implementing the Policy Advocacy Framework, in particular anthropogenic SDS source mitigation and strengthening resilience.

5. Decision 31/COP.13 invited the secretariat to participate in United Nations system-wide coordination, where appropriate, to address SDS. The same decision requested the secretariat to prepare a report on the implementation of decision 31/COP.13 and follow up on SDS at its fourteenth session.

6. Building on these actions, this report contains the activities undertaken by the secretariat with the support of the Government of the People's Republic of China and the Government of the Republic of Korea in collaboration with other relevant United Nations entities, institutions and country Parties. It also proposes elements for further action to support the implementation of the Policy Advocacy Framework, in light of strengthening the mitigation of SDS sources in the context of land degradation neutrality (LDN) and enhancing resilience and preparedness, informed by the UNCCD Gender Action Plan to support gender mainstreaming.

II. Implementation progress

A. United Nations Coalition on Combating Sand and Dust Storms

7. By the mandate given by decision 31/COP.13, the secretariat participated in the United Nations Coalition on Combating Sand and Dust Storms. In September 2018, the 24th Senior Officials Meeting (SOM 24) of the United Nations Environment Management Group agreed to form the Coalition to Combat Sand and Dust Storms in response to the United Nations General Assembly (UNGA) resolution 72/225.[1] United Nations agencies, including the secretariat of the Convention, nominated their focal points to the Coalition following an invitation by the Executive Director of the United Nations Environment Programme (UNEP).

8. The Coalition has been developing the Terms of Reference and a plan of work of the Coalition in consultation with participating organizations. The key objectives of the Coalition include:

(a) Preparing a global response to SDS, including a strategy and action plan, which could result in the development of a United Nations system-wide approach to addressing SDS;

[1] <http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/72/225>.

(b) Identifying entry points to support countries and regions affected by SDS in the implementation of cross-sectoral and transboundary risk reduction and response measures for SDS;

(c) Preparing a platform for engaging with partners and enhancing dialogue and collaboration among affected countries and the United Nations system agencies at global, regional and subregional levels;

(d) Providing a common platform for the exchange of knowledge, information and technical expertise and resources for strengthening preparedness measures and strategies for risk reduction, consolidated policy, innovative solutions, advocacy and capacity-building efforts, and fund-raising initiatives; and

(e) Identifying, mobilizing and facilitating access to financial resources for joint responses to SDS, including through new and innovative resources and mechanisms.

B. Partnership, advocacy and capacity-building

1. Partnership, advocacy and collaboration

9. The secretariat participated in the UNGA High-level Interactive Dialogue on sand and dust storms, held at the United Nations Headquarters in New York on 16 July 2018, to discuss action-oriented recommendations and address the challenges faced by the affected countries, including ways to improve policy coordination at the global level to tackle those challenges in the context of the Sustainable Development Goals (SDGs). During the dialogue, the ongoing need to confront the multiple challenges presented by SDS was highlighted.

10. The secretariat helped prepare the report of the Secretary-General entitled, "Combating sand and dust storms", submitted to the 73rd session of the UNGA (A/73/306).[2] The report presented details on developments within the United Nations system since the first General Assembly resolution on SDS (A/RES/70/195)[3] and covered the period from 2016 to mid-2018. The report highlighted activities and initiatives undertaken by United Nations entities, including the secretariat of the Convention, Member States and a range of stakeholders. It underscored achievements, including cross-cutting activities, made during the reporting period in the following three principal areas, as set out in the Policy Advocacy Framework: (a) monitoring, prediction and early warning; (b) impact mitigation, vulnerability and resilience; and (c) source mitigation.

11. The secretariat collaborated with the Desertification, Land Degradation and Drought Northeast Asia Network (DLDD-NEAN). Established in 2011, the DLDD-NEAN is a subregional reporting entity to the UNCCD. It is a cooperation platform to support the implementation of the Convention in the region with emphasis on impact mitigation of SDS, including capacity development and source management. Active members of the DLDD-NEAN include the People's Republic of China, Mongolia and the Republic of Korea. Members agreed on a subregional plan of action built upon the Regional Master Plan for the Prevention and Control of Dust and Sandstorms in Northeast Asia,[4] developed in partnership with the Asian Development Bank, UNEP, the United Nations Economic and Social Commission for Asia and the Pacific and the UNCCD in 2005. The secretariat has been assisting with the implementation of a cooperative SDS source management project in the China–Mongolia border area.

12. The secretariat has also collaborated with United Nations entities including UNEP and the World Meteorological Organization (WMO), specialized agencies, institutions and country Parties in organizing meetings, training sessions and workshops, including the following:

(a) The 5th International Workshop on Sand and Dust Storms: Dust sources and their impacts in the Middle East (23–25 October 2017, Turkey);

[2] <https://undocs.org/A/73/306>.
[3] <http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/195>.
[4] <https://www.preventionweb.net/files/1821_1821VL102237.pdf>.

(b) The Regional Training Workshop on Sand and Dust Storms in the Arab Region (10–12 February 2018, Egypt);

(c) The 9th International Workshop on Sand/Dust Storms and Associated Dustfall (22–24 May 2018, Spain);

(d) Steering Committee Meeting of the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) (25–26 May 2018, Spain);

(e) The 24th Senior Officials Meeting of the United Nations Environment Management Group (24 September 2018, United Nations Headquarters);

(f) Sand and Dust Storms Technical Workshops (1–4 October 2018, Switzerland);

(g) The 6th International Workshop on Sand and Dust Storms (12–15 November 2018, Turkey);

(h) The 7th Steering Committee Meeting of the DLDD-NEAN (12–13 December 2018, the Republic of Korea);

(i) Global Sand and Dust Storms Source Base-Map Pilot Project Technical Workshop (18–22 February 2019, Mongolia); and

(j) Sand and Dust Storms Technical Scoping Meeting (15–16 April 2019, Switzerland).

2. Capacity-building

13. In January 2019, the UNCCD organized its first global Capacity Building Training Fair in Georgetown, Guyana immediately prior to the seventeenth session of the Committee for the Review of the Implementation of the Convention. Topics concerning SDS and drought formed one of the modules covered during this training event. The module on SDS and drought was prepared and presented in collaboration with UNEP and WMO with assistance of the Caribbean Institute for Meteorology and Hydrology, a regional centre of the WMO Sand and Dust Storms Warning Advisory and Assessment System.

14. Building on the draft of the Sand and Dust Storms Compendium referred to in section C.2. below, the secretariat, in collaboration with UNEP and the WMO, has been developing training modules and e-learning materials on SDS risk management. Further information is available in document ICCD/CRIC(18)/8.

C. National and regional policy development and implementation

15. By decision 31/COP.13, Parties were invited to use, as appropriate, the Policy Advocacy Framework to combat Sand and Dust Storms, on a voluntary basis, in policy development and implementation for SDS. In the same decision, Parties were also invited to explore anthropogenic source mitigation in national voluntary LDN target-setting and options to integrate source mitigation measures into national voluntary LDN target-setting, as appropriate.

16. The secretariat has been assisting in the development of national and regional policy and frameworks in accordance with the Policy Advocacy Framework, in collaboration with partners. The following section summarizes the secretariat's activity in this work stream.

17. The Policy Advocacy Framework proposes principles and priority action areas to enhance resilience to SDS, set out in three interrelated principal action areas and cross-cutting and integrated actions, including: (a) monitoring, prediction, early warning and preparedness; (b) impact mitigation, vulnerability and resilience; and (c) source mitigation.

1. Monitoring, prediction, early warning and preparedness: Global sand and dust storms source base-map

18. In supporting the country Parties' approach to integrating SDS source mitigation measures into the LDN target-setting process, one fundamental necessity is baseline information and a source area map, including hotspots. Therefore, the secretariat has been

developing, in collaboration with UNEP and the WMO, a global SDS base-map to meet this need and provide an initial data set at global level, with the support of selected experts from the Science-Policy Interface (SPI).

19. The global SDS source base-map is designed as a set of geo-referenced numerical maps at 1km resolution and built upon the publicly available and open-access global data sets and information, including remote sensing imagery. The global SDS source base-map specifically focuses on soil surface status, including parameters on soil texture, structure, moisture and temperature in combination with vegetation coverage to better detect active and dormant sand and dust storms sources, taking into account the seasonality of sources and extreme weather conditions such as drought.

20. The global SDS source base-map can help define sand and dust storms source patterns, including small-scale and point sources. This information is needed to plan mitigation action related to sand and dust storms sources, as well as source monitoring, early warning, and risk, impact and vulnerability assessments.

21. In the development of the global SDS source base-map, national and regional pilot projects have been initiated to test and improve resolution and accuracy at national level and provide input to the calibration and interpolation of parameters in the data processing of the global SDS source base-map. As part of the global SDS source base-map development process, a prototype of a web-based user interface is under development.

2. Impact mitigation, vulnerability and resilience: a compendium for sand and dust storms

22. While assisting in the development of sand and dust storm-related policy by country Parties, there was a strong need for guidance material to provide information and methodologies to define the scope of sand and dust storm impacts and develop plans to address these impacts. Given the broad range of sand and dust storm impacts, cross-sectoral approaches and multi-disciplinary collaboration among various players and stakeholders is an essential element of maximizing the efficiency and effectiveness of policy development and implementation, as highlighted in the Policy Advocacy Framework.

23. In response, and as requested by some country Parties, and also taking into account decision 31/COP.13, the secretariat has been developing a science-based communication with the suggested title of, “Sand and Dust Storms Compendium: Information and Guidance on Assessing and Addressing the Risks Posed by Sand and Dust Storms” in collaboration and partnership with the SPI, selected experts, country Parties and relevant United Nations entities, including UNEP, WMO, the World Health Organization, the United Nations Office for Disaster Risk Reduction, the United Nations Development Programme, the Food and Agriculture Organization, the United Nations Office for Outer Space Affairs and the United Nations Entity for Gender Equality and the Empowerment of Women.

24. The aim of the Compendium is to provide information and guidance on how to assess and address the risks posed by SDS, and plan actions to combat SDS, underscoring gender sensitiveness and gender equity issues. The Compendium draws together information and guidance from a wide range of sources to provide the user with sufficient information. It includes approaches and methodology frameworks for gender aggregated data collection, assessment, monitoring, forecasting, early warning, impact mitigation and preparedness, source mapping and anthropogenic source. This information is required in the development and implementation of gender informed policies related to SDS at subnational, national, regional and global levels, taking into account the principles set out in the Policy Advocacy Framework, and the cross-sectoral and multidisciplinary nature of the potential negative impact of SDS on socioeconomics and the environment.

25. The principle topics of the Compendium include:

(a) The nature of sand and dust storms;

(b) Understanding sand and dust storms as a disaster risk;

(c) Sand and dust storms risk assessment framework;

(d) A geographic information system-based sand and dust storms vulnerability assessment and mapping;

(e) Sand and dust storms economic impact assessment framework;

(f) Sand and dust storms and health;

(g) Sand and dust storms source mapping and monitoring;

(h) Sand and dust storms observation, monitoring, and modelling;

(i) Sand and dust storms forecasting;

(j) Sand and dust storms early warning;

(k) Sand and dust storms source management; and

(l) Sand and dust storms impact mitigation.

26. Further information on the Compendium and topics is presented in the annex to this document.

3. Source mitigation: national and regional planning and implementation

27. Pilot projects have been initiated to assist in the development of national and regional plans, policy and frameworks in Nigeria, Mongolia, Kazakhstan, Turkmenistan, Uzbekistan, China, and Kuwait, with focus on impact mitigation, including anthropogenic source management. Methodology frameworks for the assessment of risk, vulnerability and economic impact were developed with the assistance of selected experts and tested respectively, where appropriate, in the implementation process of the pilot projects.

28. The Global Mechanism (GM), in collaboration with the secretariat, assisted countries in setting national voluntary LDN targets and mapping land degradation transformative projects, taking into account sand and dust storm source mitigation in countries such as Pakistan, Mongolia and Iraq.

III. Conclusions and recommendations

29. During the 2017–2018 biennium, the Policy Advocacy Framework to combat Sand and Dust Storms provided useful guidance and context for the activity of the secretariat on sand and dust storm-related issues. It is currently being used to assist five countries to develop and pilot a policy and implementation framework related to SDS. The Policy Advocacy Framework served as template for the Secretary-General's report on combating SDS, submitted to the 73rd session of the UNGA (A/73/306).[5]

30. This document highlights the niche role the UNCCD can play in advancing international cooperation and support to combat SDS, specifically anthropogenic source mitigation. The global community has recognized that unsustainable land management practices can cause or exacerbate these phenomena and pose a serious challenge to the sustainable development of affected countries and regions in arid, semi-arid and dry sub-humid areas, especially in Africa and Asia. LDN can provide an effective and pragmatic entry point in this context, taking into account gender responsive approach advocated by the UNCCD Gender Action Plan.

31. Cooperation and collaboration are fundamentally important for addressing transboundary issues related to SDS. Fostering collaboration and partnership is an integral element of combating SDS at regional and global levels across sectors, stakeholder groups, expertise and disciplines. Enhanced cooperation is needed to promote institutional and technical capacity development, the sharing of information and best practices, and the implementation of regional and subregional projects to scale up gender-responsive sustainable land management (SLM) practices that can partially prevent and control some SDS.

[5] <https://undocs.org/A/73/306>.

32. Moving forward and benefiting from the establishment of the United Nations Coalition on Combating Sand and Dust Storms, the Convention would benefit from a strategic approach to proactively integrate, mainstream and enhance the anthropogenic source management of SDS into its implementation process. Options for regional and subregional cooperation mechanisms would help accelerate the integrated implementation of LDN targets and SDS measures.

33. Addressing SDS can bring about multiple benefits for the environment and human society while achieving the SDGs. Mitigation of SDS sources would contribute to achieving strategic objectives (SO) within the UNCCD 2018–2030 Strategic Framework.

34. Accordingly, the COP may wish to consider the following at its fourteenth session:

(a) The establishment of a mechanism, such as a thematic programme network on SDS, to mainstream and reinforce efforts of like-minded Parties to boost cooperation and enhance source management;

(b) Use of the Sand and Dust Storms Compendium in developing and implementing relevant gender-informed policy on SDS risk reduction at national, regional and global levels, including anthropogenic source management, gender-sensitive early warning systems and preparedness and emergency planning;

(c) Refinement of the global SDS source base-map at global, regional and national levels, including a web-based interface. Development of a web-based SDS toolbox with decision-making support tools to promote the implementation of SLM practices in source areas, sharing of information and knowledge and capacity-building; and

(d) Continued collaboration by the secretariat with other United Nations entities, specialized agencies and partners, particularly the United Nations Coalition on Combating SDS, in assisting affected countries.

Annex

Sand and Dust Storms Compendium: Information and guidance on assessing and addressing the risks posed by sand and dust storms

1. Sand and dust storms (SDS) are natural phenomena[6] affecting all sectors of society and the environment. An estimated 2,000 million tons of dust enters the atmosphere annually. The majority of sand and dust is emitted due to natural conditions, but human activities contribute significantly to SDS through unsustainable land management and water use.

2. SDS impact local and global weather, climate, nutrient cycles and biomass productivity. SDS can affect air and water quality, hygiene and sanitation, human and animal health, transport, education, farming and business and industry, with some of impacts understood to be positive. SDS have significant economic impacts. SDS cost the oil sector in Kuwait an estimated USD 190 million yearly. A single SDS in 2009 resulted in an estimated USD 229 to USD 243 million in damages in Australia.

3. SDS can be life-threatening for individuals with compromised health. SDS are not gender-neutral: impacting men, women, boys and girls in different ways based on roles and vulnerabilities in the productive, family and social spheres.

4. Effectively addressing the negative impacts of SDS faces four challenges:

(a) A need to address a wide range of SDS impacts, including those caused by human action;

(b) The multi-faceted, cross-sectoral and often trans-national impacts of SDS, requiring corresponding cross-sectoral and trans-national approaches and cooperation between stakeholders at all levels;

(c) The diverse scales of intervention required, and the range of stakeholders at each scale, with effective sharing of information about SDS critical to successful SDS management; and

(d) The general low profile of SDS as a hazard, where weak data sets on impacts means SDS has received limited attention in mainstream disaster risk management efforts.

5. The Compendium compiles information and guidance from a wide range of sources to allow a user to (a) define the scope of SDS impacts, and (b) develop plans to address these impacts. Using the Compendium will increase awareness among decision-makers and other stakeholders on policies and approaches to mitigate the impact of SDS. Expected users include local, subnational and national government, emergency management, healthcare, natural resource management, agriculture, livestock, forestry and transport officials including aviation, and community and civil society stakeholders.

6. The Compendium is based on the SDS risk reduction cycle to support the implementation of the Policy Advocacy Framework to combat Sand and Dust Storms. The goal of the Policy Advocacy Framework is to reduce vulnerability to SDS by focusing on (a) pre-impact governance to strengthen resilience, reduce vulnerability and minimize impacts (mitigation), (b) preparedness plans and policies, including monitoring, forecasting and early warning, and (c) post-impact crisis management (emergency response procedures).

7. Addressing SDS using the Compendium contributes to the achieving nine Sustainable Development Goals (SDGs), including 1, 2, 3, 5, 6, 11, 13, 15 and 17. The Compendium supports the Sendai Framework for Disaster Risk Reduction by (a) improving the

[6] There are many sources of atmospheric particulate matter, but SDS in the Policy Advocacy Framework to combat Sand and Dust Storms refers to mineral sand (particle size 63 microns to 2 mm) and dust (particle size range < 1–63 microns) that originates from land surfaces, including wind erosion. This concept of SDS would also be applicable for the use of the Compendium. <https://www.unccd.int/sites/default/files/sessions/documents/2017-08/ICCD_COP%2813%29_19-1711042E.pdf>.

understanding of SDS risk (Priority 1), (b) strengthening SDS risk governance (Priority 2), and (c) enhancing disaster preparedness for effective response by strengthening SDS forecasting, early warning, preparedness and response capacities (Priority 4).

I. The nature of sand and dust storms

8. SDS are composed of mineral dust lifted into the atmosphere through a mechanical process involving wind. In most cases, mineral dust is considered natural when produced in arid and semi-arid regions characterized by sparse vegetation and anthropogenic when human activities directly lead to dust emission.

9. The major global sources of mineral dust are in the Northern Hemisphere, across an area including North Africa, the Middle East, East Asia and North America. In the Southern Hemisphere, dust sources have a smaller spatial extension and are mainly located in Australia, South America and South Africa. Globally, the main large dust source regions are shallow and dry lakes but local sources can be found in anywhere soils can be lifted into the air by wind including glacial outwash plains, volcanic ash zones, recently ploughed agricultural fields, mining activities, etc.

10. The potential for sand or dust to move into the atmosphere is affected by soil moisture, soil texture, surface crust, roughness elements, vegetation, wind speed, turbulence and thermal convection. Conditions conducive to dust emission in one location can change from one point in a year to the next and can vary significantly between years.

11. There are six types of weather conditions with the potential to trigger SDS including: (a) large-scale flows (e.g. the Harmattan); (b) synoptic-scale weather systems such as cyclones, anticyclones and their cold frontal passage, leading to episodic, large, intense dust events; (c) moist convection leading to convective mesoscale dust storms, often referred to as Haboobs; (d) microscale dry convection in the daytime planetary boundary layer over deserts, creating turbulent circulation leading to dust devils and dust plumes; (e) topographic effects, such as elevations of dust surfaces and gaps in mountain ranges, which can channel wind and lead to local SDS; and (f) diurnal cycles which can mobilize dust through the development and subsequent breakdown of nocturnal low-level jets.

12. Fine dust particles are lifted by turbulent diffusion and convection to higher tropospheric levels (up to a few kilometres in height) where winds can transport particles over long distances. The lifetime of dust particles in the troposphere is dependent on the particle size. Smaller particles take longer to deposit back on the surface than larger particles.

II. Understanding sand and dust storms as a disaster risk

13. As a natural hazard, SDS occurs due to a combination of weather conditions, the geophysical presence of mineral dust and sand and specific land forms. Understanding how the right wind speeds and right-sized sand and dust particles come together on the right land forms – often with other factors – to make SDS is essential to defining and addressing the risk posed by SDS

14. Recognition of SDS as a disaster risk appears to be high in North-East Asia and North America but less prominent elsewhere. The low recognition of SDS as a disaster risk is likely due to the lack of significant direct immediate human fatalities or injuries from individual SDS events in many cases, and limited consolidated documentation of long-term impacts on health, the economy, etc.

15. Managing the risk of disaster posed by SDS involves (a) defining the physical nature of the hazard and how physical factors can vary over time and space, (b) assessing social vulnerability and risk levels associated with the hazard, and (c) designing and implementing gender informed measures to prepare for, respond to, recover from and reduce the risk of SDS. This is a cross-sectoral process engaging multiple stakeholders. This involves both short- and long-term interventions and increased attention from at-risk populations to SDS as a hazard and disaster risk.

16. Understanding the risk posed by SDS is a principal step in managing the disaster potential from SDS. SDS risk assessment results, based on a systematic and gender-informed analysis, shape SDS prevention and risk reduction, preparation and warning, response and recovery.

III. Sand and dust storms risk assessment framework

17. A variety of approaches can be used to assess risk. Risk assessments are a trade-off between accuracy, cost and timely results. The Compendium presents two approaches to risk assessment, one based on a survey of at-risk populations and the other based on structured expert evaluation of factors defining SDS risk. A survey-based assessment may require weeks to more than a month depending on the sample size and number of survey teams. A survey-based assessment does not need to be completed by SDS experts, although the involvement of experts is useful to understanding the results and defining risk management measures.

18. The expert-based assessment process involves using experts in SDS and related fields (e.g. meteorologists, geographers, sociologists, agriculturalists, community development experts, gender, age and disability experts, health officials – doctors as well as public health specialists, engineers responsible for infrastructure at risk from SDS, etc.) to develop a structured understanding of SDS risk.

19. The two approaches allow for the fact that detailed data on the nature of the SDS hazard and vulnerability may not be available where risk assessments are needed to evaluate risk and define risk reduction measures. The Compendium includes a draft questionnaire and other guidance.

20. Both methods provide results which identify risk salience and can guide risk management interventions including for: (a) SDS Risk Management Policy, framing SDS risk reduction policy using an evidence-based identification of risk; (b) SDS Warning, identifying which triggers are most relevant to at risk-populations; (c) SDS Response, identifying and raising the profile of SDS response options by identifying where specific responses can be more effective in reducing SDS impact as well as defining coping and adaptation strategies used by at-risk populations; and (d) risk reduction, identifying where risk reduction efforts can be targeted and providing evidence justifying the cost and nature of these interventions. SDS risk assessment results can also feed into larger assessments and strategies related to other hazards such flooding or drought.

IV. A geographic information system-based sand and dust storms vulnerability assessment and mapping

21. Maps of social vulnerability can provide a fine-grained understanding of (a) who is vulnerable to SDS (including gender, age and disability analysis), (b) the degree of vulnerability, and (c) the reasons for this vulnerability. This vulnerability mapping informs decision- and policy-makers on the severity and extent of the SDS risks, and who is most vulnerable, and provides information to local government, emergency, health and social welfare officials, civil society and other stakeholders on where to direct SDS risk management efforts.

22. Social vulnerability exhibits large spatial-temporal variability which an interactive geographic information system-based platform can help address efficiently. Vulnerability is not an intrinsic property of a system to be directly observed or measured but is deduced through a set of variables (indicators) estimating exposure, sensitivity and adaptive capacity.

23. A common practice to estimate vulnerability is to use surrogate measures of vulnerability components and then aggregate them to yield the overall vulnerability score. Indicators related to human health, socioeconomics, gender equality, the environment and the agroecosystem are seen to be core to the vulnerability assessment process.

24. Selecting specific indicators requires the consideration of three questions:

(a) Question 1: How the given indicators (data layer) contribute to vulnerability to SDS?

(b) Question 2: Which vulnerability component(s), i.e. exposure, sensitivity and adaptive capacity, does the given indicator belong to?

(c) Question 3: Which level of analysis (i.e. local, sectoral, national or international) does the given indicator belong to?

25. In the assessment and mapping process, a number of technical issues need to be considered. This includes data conformity in the same geometric data model and structure; conversion of non-geometric data sources into spatial representation; unification of various indicator measurement scales, including scaling and standardization, and the data weighting process.

V. Sand and dust storms economic impact assessment framework

26. Measuring the economic impact of SDS is critical as it determines if the costs of SDS can be moderated through the investment in mitigation projects. It is important to recognize that most benefits of mitigation will be experienced by individuals but most costs are incurred by governments or government agencies. Thus, while there may be a net benefit, the funding agency may not have sufficient funds to finance the mitigation programme.

27. Dust mitigation projects may be undertaken in source regions outside the national boundaries of a country as airborne dust particles have been shown to travel long distances. Hence there can be a significant distance between the source region and the impact region. As a result, the benefits and costs of a mitigation programme may fall on countries different from where some of the major impacts occur. However, the major decision criterion is that the net benefits of the programme (the sum of benefits in both the impact and source regions) exceed the costs.

28. A range of costs need to be considered in assessing economic impact across sectors, areas, gender and age groups. These include: (a) direct costs, i.e. those associated with the immediate impact of a disaster; and (b) indirect costs, i.e. those imposed on an economy due to business disruptions or other similar impacts due to a disaster. For the purposes of assessing the SDS economic impact, costs to be considered include on-site costs associated with the loss of soil, organic matter and nutrients, damage to infrastructure, loss of livestock and forage for livestock, sand-blasting of crops, and road cleaning. Off-site costs depend on many factors, mainly the level of economic activity in the affected region. Specific areas of off-site costs include transport, health, household cleaning, commerce and manufacturing, agriculture, including crop and animal loss, and quality deterioration.

29. Other costs of SDS in the affected region include: (a) a reduction in construction and mining activity due to health and safety issues at the construction or mine site; (b) increased emergency service activity due to road or traffic accidents or ambulance traffic to transport patients to hospitals due to dust-related health problems; and (c) damage to utility infrastructure, such as electricity transmission lines or pylons. SDS can also impact cultural, leisure, and sporting activities and the cost to the economy will depend on the type of event affected.

30. Typically, there are few immediate benefits from SDS events and these are usually relatively small when compared to off-site costs. The benefits of SDS arise from two main sources: (a) nutrient deposition on land, and (b) mineral and nutrient deposition on water, more particularly ocean bodies. SDS dust content may contain soil nutrients, such as nitrogen, phosphorus, and potassium, as well as organic carbon. When deposited, these nutrients can supply crops or pasture downwind of the source area.

31. There are numerous approaches to measuring the economic impact of SDS and the costs and benefits of mitigation programs. However, given the wide variety of resources to collect and analyse SDS economic impact data across countries, the recommendation is that a relatively simple approach be taken. The preferred method is a combination of cost

accounting and surveys, where surveys are used to identify costs that may not be readily available, such as household cleaning costs. This method will allow cross-country comparisons as all countries or regions will be using the same framework.

32. A major challenge in cost-benefit analysis is estimating costs and/or benefits for attributes that may be impacted by SDS but have no identifiable market value or valuation method using market-based techniques, such as environmental benefits, ecosystem services, or benefits from improving health outcomes, gender equality and women's empowerment outcomes. There are two categories of non-market valuation techniques: revealed preferences and stated preferences. Several methods are available for revealed preferences, including Hedonic Pricing, Travel Cost Method, Contingent Valuation Method, Choice Modelling and Experimental Analysis.

VI. Sand and dust storms and health

33. The health implications of SDS have been increasingly investigated since the end of last century. In particular, changes in air pollution in areas affected by SDS have been studied to understand their health implications.

34. The first issue that must be considered for one to comprehend the health impacts of SDS is the characterization of exposure of individuals and populations, which can be done in various ways. Secondly, the availability of health data is a challenge in many areas affected by SDS. Most of the studies have been conducted in East Asia, Europe and the Middle East; with a lack of studies in West Africa.

35. Many health outcomes, for both mortality and morbidity, have been examined in epidemiological studies, mainly focused on the short-term effects of SDS. The results of systematic reviews indicate various conclusions. In terms of increased risk, effects have been seen for cardiovascular mortality and morbidity due to respiratory causes, including childhood asthma. Specific estimates of the impact and burden of SDS are still to be fully developed taking into consideration a gender perspective because of women and children's vulnerability to SDS.

VII. Sand and dust storms source mapping and monitoring

36. The source of SDS can be defined as a relatively dry, unprotected topsoil surface, free of vegetation, snow/ice or water and unfrozen, with soil particles available for emission under windy conditions. Source erodibility or dynamics is affected by climate, weather conditions (e.g. wind speed or drought), soil surface conditions and characteristics and human activity.

37. The dynamics of SDS sources relate to seasonal changes in the vegetation cover, snow cover, the existence of changes to the extent of water bodies, and whether or not the soil is frozen. These variations cause notable changes in SDS-source geographic distribution. A soil surface is more susceptible to wind erosion when it contains smaller soil particles, in general clay, and silt size particles up to about 50-60μm in diameter. Dust emission is increased if the soil structure is disturbed and loose.

38. Knowledge of SDS sources is required for SDS risk and impact assessment, SDS mitigation planning, SDS forecasting and the establishment of SDS early warning systems. Mapping of spatial and temporal distribution of SDS sources requires an understanding of the causes, formation and activation of SDS sources.

39. SDS source mapping can be divided into two approaches. One uses data from past SDS occurrences, with better maps produced the longer the time frame covered by the data sets in question. This approach provides a good overview of major and frequently active SDS sources, including global and regional sources which dominate SDS generation. The weaknesses of this approach include: (a) spatial and temporal discontinuity of observations; (b) relatively lower mapping resolution than when using soil-related parameters; and (c) local and short-term SDS event and sources can be neglected or underestimated.

40. The other option is mapping based on surface condition data, with a focus on assessing the potential of winds causing soil surface erosion. The important soil-related parameters required for SDS source mapping include soil characteristics such as soil texture, soil structure, soil particle size distribution, soil moisture, soil temperature, soil texture, land cover and frozen soil.

41. Advantages of this approach include: (a) incorporating information on soil surface status such as soil characteristics and land use; (b) detecting and delineating localized sources; and (c) identifying dormant or non-significant seasonal sources. However, this option requires a complex combination of information from different data sources and must contend with the lack of information on soil characteristics and soil analysis.

VIII. Sand and dust storms observation, monitoring, and modelling

42. Dust measurements can be divided into two groups: remotely sensed and in-situ. Operational meteorologists typically use multi-spectral products generated from measurements performed by instruments on board geostationary satellites for dust monitoring and nowcasting. The latest generation of geostationary satellites provide a vital tool for atmospheric monitoring as they combine the advantages of geosynchronous orbits (frequent image capture over wide areas) with the capabilities of high-resolution radiometers with availability in Near-Real-Time (NRT). However, satellite products used to monitor dust events encounter challenges including: (a) ascertaining the elevation of dust particles; (b) the low aerosol detectability over bright surfaces, such as deserts; and (c) insufficient information on dust layers under clouds.

43. In-situ information collection for SDS is also required for effective monitoring and forecasting. This includes ground measurement stations, air quality networks, weather records, and visibility observation. These measures have pros and cons depending on locations and measurement methodology. For instance, visibility observations recorded in weather records can be used to identify past dust events. Weather station reporting based on the World Meteorological Organization (WMO) synoptic code of present weather can be used to identify airborne sand and dust.

44. Numerical Weather Prediction (NWP) and dust transport models have been developed to predict concentrations of atmospheric constituents such as mineral dust and address the limitations of in-situ observation. These numerical models are closely linked to the forecast of SDS. On global and regional scales, the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) has been operating since 2007.

45. The WMO SDS-WAS enhances countries' capacity to deliver timely and quality SDS forecasts, observations, information and knowledge to users through an international partnership of research and operational communities. The WMO SDS-WAS works as an international hub of research, operational centres and end-users, organized through regional nodes. The WMO SDS-WAS nodes currently in operation are: (a) the Regional Node for Northern Africa, the Middle East and Europe (NAMEE) with its centre based in Barcelona, Spain, and hosted by the State Meteorological Agency of Spain (AEMET) and the Barcelona Supercomputing Centre; (b) the Regional Node for Asia, with its centre based in Beijing, China, and hosted by the China Meteorological Administration; and (c) the Regional Node for Pan-America, with its centre based in Bridgetown, Barbados, and hosted by the Caribbean Institute for Meteorology and Hydrology.

IX. Sand and dust storms forecasting

46. People-centric and impact-based forecasting is the process of incorporating information on the impact of the forecasted weather on those who may experience it into information provided to the public. The distinction is between a forecast stating that there will be a dust storm in the next few days and a forecast stating the time at which the dust

storm will begin and the potential impact of the dust on individuals, e.g. that those with breathing problems should take steps to protect against the forecasted SDS.

47. Leading practice impact-based forecasts are based on (a) a very good, NRT understanding of evolving weather conditions, and dust concentration forecasting using NWP and dust transport models and accurate and timely weather data from ground and remote sensing sources, (b) clear standards or categories of weather conditions which correspond to different levels of impact, and (c) a risk assessment with which to identify impacts on specific locations or groups in these locations (e.g. children).

48. Forecast information is usually generated through numerical weather and dust transport prediction models. A number of models are available at national, regional and global level. Ensemble prediction is one of the methods developed to improve the forecast results. It describes the future state of the atmosphere from a probabilistic point of view. Multiple simulations are run to account for the uncertainty of the initial state and the inaccuracy of models and the mathematical methods used in the simulation process.

49. National Meteorological and Hydrometeorological Services (NMHS) are responsible for formulating SDS forecast information at national level. Depending on the size of a country and MNHS capacities, forecasts may be developed at subnational (province, state) level. These forecasts and associated warning information must be linked to subnational (provincial, state) disaster management authorities, as well as other organizations and actors involved in dealing with SDS.

50. The capacity of NMHS to manage the SDS data analysis and forecasting process can vary considerably. Where NMHS modelling and forecasting capacities may be limited, WMO SDS-WAS products can be provided directly to NMHSs to support local forecasting directly from the WMO SAS-WAS Centres and via the WMO website.[7] These outputs, together with any modelling done by NMHSs, can be used in daily and near-term (three-day) forecasting for SDS.

51. To ensure harmonious SDS forecasts and timely, accurate, gender sensitive and coordinated SDS forecasts and warnings, NMHSs can collaborate with commercial forecasters to develop a coordinated forecast and warning dissemination plan. This plan may also need to include forecasting from outside a country when warnings are commonly provided from these sources, e.g. through global media.

X. Sand and dust storms early warning

52. The effectiveness of SDS warning systems and plans is judged by how well those affected by an SDS take action to avoid or reduce the impact of the SDS, rather than the sophistication of the SDS forecast and modelling. A critical part of successful warning is ensuring that those receiving a warning understand the information provided as well as the corresponding actions to reduce impacts.

53. The people-centric, impact-focused approach turns forecasts into warnings which lead to practical action to reduce the impact of SDS on individuals, and society as a whole. The people-centric focus recognizes that it is the actions of at-risk individuals that turn warnings into action. The impact focus of the warning system identifies how an SDS can affect someone threatened by the event and what actions can be taken to reduce this threat.

54. An effective people-centric and impact-based warning system has four components: (a) risk knowledge; (b) detection, monitoring, analysis and forecasting; (c) warning dissemination and communication; and (d) preparedness and response capacities. An effective SDS warning systems uses a *whole of community* approach, where all stakeholders, including the at-risk populations and applying a gender-responsive approach, are incorporated into a single approach to ensure that warnings are provided in a timely manner, and that appropriate actions are taken to reduce or avoid impact.

[7] <https://public.wmo.int/en/our-mandate/focus-areas/environment/SDS/warnings, http://www.wmo.int/sdswas>.

55. An SDS warning system is based on an overall warning plan which includes sources of information and analysis, dissemination methods and standard operating procedures to ensure warnings are received in a timely manner. This overall plan is complemented by sub-plans for specific sectors (e.g. health), specific groups of people who are in vulnerable situations (e.g. women, children, elderly, disabled) and specific facilities (e.g. clinics) or specific purposes (e.g. road travel warnings, aviation, etc.). The planning and overall coordination of warning processes is usually led by the national disaster management authority.

56. As the SDS warning process can vary considerably between countries, the following need to be clear to all stakeholders involved:

(a) Who has the legal authority to issue warnings?

(b) Who ensures that a warning is acted upon? (The party responsible for issuing a warning, e.g. the local weather office, may be different from the party responsible for ensuring warnings are followed, e.g. the head of local government, disaster office staff, police, etc.);

(c) For whom and how do the NMHS or sub-national offices provide forecast and warning information to ensure warnings are issued in a timely manner?

57. How forecast or warning information is provided can vary between countries. In some cases, written-text watches and warnings are the norm. Elsewhere, colours or numbers may be used to indicate the importance of warnings. Common mechanisms for warning dissemination include print media, radio, TV and the Internet, including email, social media and warning web sites, and mobile phone messaging. Time, method and place to provide warning is also critical, in particular for women who are in many instances engaged in household work or child care and are not present to receive information aired on radio or TV. Language needs to be considered too as many women are illiterate due to existing gender inequalities.

58. SDS forecasts and warnings contribute to improving SDS preparedness in three ways:

(a) Understanding the nature of SDS creates an awareness of SDS as a hazard for which preparedness is needed;

(b) Forecasts can trigger warnings which in turn trigger other actions needed to reduce the impact of an SDS; and

(c) Educating those at risk from SDS makes warnings more effective and improves response capacities once a warning has been received, and the level of individual and social preparedness for SDS.

XI. Sand and dust storms source management

59. Measures for mitigating the impacts of SDS fall into two groups to reduce (a) emissions from the sources of dust and sand (preventive measures), and (b) the impacts of mobilized sand and dust in deposition areas (protective measures).

60. Preventive control measures are divided into three groups operating in (a) natural ecosystems and rangelands, (b) crop lands, and (c) industrial settings, including mining. Protective measures cover the physical protection of valuable assets, such as towns, infrastructure, and irrigation schemes; forecasting and early warning systems; and preparedness and emergency response procedures.

61. Control measures in natural areas, rangelands and crop lands focus on reducing wind speed and the erodibility of the soil. The control of windblown sand and moving sand dunes is also considered, even though sand movement can occur at wind speeds below those required to generate SDS.

62. Sustainable land management (SLM) and integrated landscape management (ILM) are important concepts for the integrated application of these control measures. The greatest attention must be paid to ILM in potential source areas, combining the sustainable

management of all landscape elements, including a water use strategy and the reduction of dust from industrial sites, e.g. tailings dams or open storage areas.

63. Policies for SLM and ILM can be deployed in the context of the land degradation neutrality (LDN) process to address SDS sources in affected areas at national level. The LDN target-setting process provides an opportunity to collectively consider options to mitigate particularly anthropogenic SDS sources, including assessment and trends of land degradation, and identification of drivers for land degradation, with the participation of relevant land and water resources stakeholders, including affected women and men. An integrated and holistic approach of SLM and ILM can form an integral part of and maximize synergies among various actions for the long-term reduction of anthropogenic dust emissions at larger scales.

64. Regional cooperation is imperative for the management of anthropogenic dust emissions at landscape levels, including through sustainable water use. Regional mechanisms based on strong political commitment are needed for policy coordination between source and deposit areas.

XIIs. Sand and dust storms impact mitigation

65. Preparedness and emergency response play critical roles in disaster risk reduction by helping to mitigate disaster risk and ameliorate the impacts. Preparedness for, and emergency response to, SDS events can take place at individual, community and organizational levels. Preparedness strategies and the identification of impact mitigation measures are developed through identification and mapping of the hazard in question, vulnerability analysis and risk assessment, taking into account gender considerations. Knowledge gained in these ways can then be used to develop protective actions. The effectiveness and cost-to-benefit justification of each of these measures needs to be assessed based on local conditions.

66. Effective preparedness reduces vulnerability, increases mitigation levels, enables timely and effective response to a disaster event and hence shortens the recovery period from a disaster, while at the same time increasing community resilience. An SDS disaster management plan for a specific location or activity (e.g., city, school, factory) should follow the outline of other disaster risk management plans for the same location or activity. As appropriate, annexes to the plan can include specific procedures for source and impact mitigation and the identification of who takes primary and supporting responsibilities for implementing these procedures. An effective SDS disaster risk management plan should (a) include sufficient information to allow necessary actions to be taken, but (b) should not include excessive details which may hinder the use of the plan.