



Sand and Dust Storms Risk Assessment in Asia and the Pacific



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Front cover photo:

Dust storm in Mildura, Victoria, Australia, photo taken by Robert Klarich on 7 May 2019. Photo Submitted to APDIM Call for Photography 2021: Living with Sand and Dust Storms



Back cover design:

The letter D shuttered cubes are part of the APDIM logo and are meant to evoke the destruction brought about by disasters and the impact on development. The back cover picks up the graphic theme of APDIM's logo and amplifies it in the context of dust storms, indicating the sectors covered by the assessment of this report. The back cover was designed by Armin Farahani.

Foreword



The achievement of the 2030 Agenda for Sustainable Development, including reaching the targets of the Sendai Framework for Disaster Risk Reduction 2015-2030, are significantly under threat by the risk posed by sand and dust storms as a transboundary meteorological hazard. In the past

few years, sand and dust storms have taken a high toll in terms of socio-economic damage and loss in the areas exposed to this hazard, underscoring the need to take prompt action to address the challenges associated with them. The Asian and Pacific Centre for the Development of Disaster Information Management (APDIM), a regional institution of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), as a member of the United Nations Coalition on Combatting Sand and Dust Storms works with other Coalition partners and member States to promote North-South, South-South and triangular cooperation to combat the negative socio-economic impact of sand and dust storms as mandated through General Assembly and the ESCAP Commission resolutions.

Following repeated requests made by member States to gain a better understanding of the negative impact of sand and dust storms, APDIM undertook to understand the severe multidimensional impact of sand and dust storms, including the deterioration of human health, well-being and urban health, and the potentially adverse impact on clean energy production, transport, agriculture and environment sectors, the result is this report: Sand and Dust Storms Risk Assessment in Asia and the Pacific.

The report's analysis - first of its kind for geographic and sectoral scope - shows that the health of millions of people in South and South-West Asia is affected by sand and dust storms as are thousands of hectares

of agricultural lands in Central Asia and thousands of hectares of glaciers in Himalaya and Tibetan mountains. The report also illustrates how food security, energy production, agriculture, water stress and flood regimes are all directly and indirectly impacted by sand and dust storms. It is critical that, based on the evidence produced in this report, we mobilize regional coordinated action for combating the transboundary impact of this hazard.

The *Sand and Dust Storms Risk Assessment in Asia and the Pacific* report specifically makes the case that there is an urgent need for countries in the region to consider joint action towards a deeper understanding of the socio-economic impact of sand and dust storms; a coordinated monitoring and early warning system, with an impact-based focus, to timely forecast sand and dust storms and enable targeted measures to minimize exposure and reduce risks and coordinated actions in most at-risk and exposed geographical areas to mitigate the risks.

This assessment by APDIM would have not been possible without the collaboration of member States and partners who actively contributed to the research and the analysis. I hope their contribution will be brought even more to fruition as this report becomes the evidence base to guide the development of concerted action at regional level to combat the negative impact of this hazard.



Armida Salsiah Alisjahbana

Under-Secretary-General of the United Nations and
Executive Secretary of United Nations Economic and
Social Commission for Asia and the Pacific

Executive Summary

Sand and dust storms occur frequently in deserts and semi-deserts when strong winds detach small particles from dry soils with little or no vegetation cover. The Asia-Pacific region is the world's second largest in terms of mineral dust emissions, with four main sand and dust storm corridors: (i) East and North-East Asia; (ii) South and South-West Asia; (iii) Central Asia; and (iv) the Pacific subregions. These corridors contain numerous sand and dust storm hotspots.

Sand and dust storms are important for the functioning of ecosystems, but they also pose risks to society and the environment, directly threatening the achievement of 11 of the 17 Sustainable Development Goals. The impacts occur not only where these atmospheric events originate but also in places downwind far from the source areas, frequently across international boundaries.

This report assesses the risk of sand and dust storms separately for each sector analysed – agriculture, energy, environment, aviation, human health, and cities – using a quantitative method with a transboundary approach at a regional scale. Risk is measured as a function of the hazard posed by sand and dust storms, vulnerability (exposure and sensitivity), and resilience. For all sectors, the dust hazard is assessed on an annual basis using data from the Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2), a reanalysis dataset that combines observational and modelled climatological conditions. Exposure, sensitivity, and resilience are each characterised using appropriate datasets, where data are available separately for each sector.

The findings of this risk assessment indicate that more than 500m people in India are exposed to medium and high levels of poor air quality due to sand and dust storms, along with 173m people in Pakistan, 62m in the Islamic Republic of Iran and 40m in China. In proportional terms, more than 80 per cent of the entire populations of Turkmenistan, Pakistan, Uzbekistan, Tajikistan and the Islamic Republic of Iran are exposed

to medium and high levels of poor air quality due to sand and dust storms.

In the energy sector, sand and dust storms have a considerable impact on the generation of electricity by solar power plants which, measured in economic terms, is greater than USD107m a year in India, and exceeds USD46m and USD37m a year in China and Pakistan. The risk to electricity generation posed by sand and dust storms is likely to become greater as governments strive to ensure access to affordable, reliable, sustainable and modern energy for all (SDG 7).

In the aviation sector, the exposure of aircraft engines to dust particles is a considerable risk on flight paths traversing southwestern and central parts of Asia. Flights to and from airports on the Arabian Peninsula, Pakistan, India, and China are most affected. The risk of a flight delay, diversion and cancellation due to low visibility caused by sand and dust in the atmosphere at ground level is greatest at airports in Central Asia, southern parts of the Islamic Republic of Iran, the border area between Pakistan and India, and northern parts of China.

Large areas of farmland are affected by dust deposition in Turkmenistan (71% of the cropland area), Pakistan (49%) and Uzbekistan (44%). Much of this dust is characterised by a high salt content, which typically makes the dust toxic to plants. This reduces yields, representing a significant threat to the production of irrigated cotton and other crops.

Very high dust deposition occurs in the Himalaya-Hindu Kush Mountain range and the Tibetan Plateau, the so-called Third Pole which provides fresh water to more than 1.3 billion people in Asia. The deposition of dust on glaciers induces a warming effect, increasing the melting of ice, with direct and indirect impacts on society through numerous issues, including food security, energy production, agriculture, water stress and flood regimes.

Cities in southwestern parts of Asia have the highest

exposure to sand and dust storms, which make a significant contribution to poor air quality in Karachi, Lahore, and Delhi, where nearly 60 million people experienced more than 170 dusty days a year in 2019. The situation is much worse for 6 million residents of eight cities across the region (three in China, two in the Islamic Republic of Iran, two in Pakistan, and one in Uzbekistan) who breathed air with unhealthy concentrations of particulate matter every day for at least ten months in 2019.

The risk of impacts from sand and dust storms is projected to increase in the 2030s due to more extreme drought conditions in parts of Western Australia, south-eastern Turkey, the Islamic Republic of Iran and Afghanistan, while sources in Kazakhstan, northern China, Mongolia and the Ganges basin in India face a lower risk of drought and hence probably less risk from sand and dust storms. The risk in south-eastern Turkey, the Islamic Republic of Iran and Afghanistan is even more likely to materialise given that this area is also projected to experience extremely high levels of water stress in 2030. Managing the risks associated with sand and dust storms may also become necessary in places not previously recognised as source areas for such phenomena due to more extreme droughts projected in parts of northern and southern Thailand, south-eastern China, northern Malaysia and southeasternmost Australia.

This risk assessment report demonstrates that the cumulative effects of sand and dust storms on society are significant, not least because sand and dust storms are more frequent than most other types of natural hazards. Their impacts are complex, they are very widespread, and they represent an important emerging issue for policymakers. However, our understanding of how sand and dust storms interact with society and the environment is still undermined by considerable uncertainties.

A lack of data presented one of the most prominent challenges throughout the process of conducting this risk assessment. Several types of sand and dust storm hazard are poorly accounted for, and in-depth risk assessments for sand and dust storm events across

multiple sectors at national and local levels are needed. At the international level, coordinated multi-country transboundary studies of individual dust storm events are required to fully understand their multiple impacts. The lack of data is particularly acute in the case of economic analysis. This situation has prompted ESCAP-APDIM to advocate for sand and dust storm issues to be mainstreamed into disaster risk reduction strategies and become fully integrated into multi-hazard management plans for disaster risk reduction at all levels and across all sectors.

Given the frequent transboundary impact of sand and dust storms, there is a strong case for the design and implementation of well-coordinated actions at national, regional and interregional levels. The analysis in this report highlights critical areas for countries in the region to consider joint action towards:

- A deeper understanding of the socio-economic impacts of sand and dust storms;
- A coordinated monitoring and early warning system, with an impact-based focus, to timely forecast sand and dust storms and enable targeted measures to minimize exposure and reduce risks;
- Coordinated actions in most at-risk and exposed geographical areas with a view to mitigating the risks.

This report is the first attempt to assess and analyse the risks posed to society and the environment by sand and dust storms in such a large-scale geographical area. It is the product of collaboration, active support and contributions from other UN entities and subsidiary bodies of ESCAP, national agencies, research institutions and universities all over the world.

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The Report and the Analysis:

The risk assessment was conducted, and this report was prepared under the direction of Letizia Rossano, Director of APDIM. The coordinator of the assessment and production of the report was Amin Shamseddini, Programme Officer, APDIM.

The core team of authors were Amin Shamseddini, Programme Officer and Ava Bahrami, Public Information Officer, APDIM and Nicholas Middleton, Oxford University, UK.

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The Methodology

The methodology for this assessment was initially discussed during an expert meeting co-convened by the Asian and Pacific Centre for the Development of Disaster Information Management (APDIM) and World Meteorological Organization (WMO) in Geneva on 30-31 October 2019. The workshop discussed various methodologies for sand and dust storms risk assessment including probabilistic and deterministic methods. Participants of the workshop were Sara Basart, Barcelona Supercomputing Centre; Sahar Safaei Director and Principal Consultant at Sage on Earth Consulting Ltd; Alexander Baklanov and Jose Camacho, World Meteorological Organization; Utchang Kang, United Nations Convention to Combat Desertification; and Hossein Fadaei, United Nations Environment Management Group; Yoshiya Touge, Tohoku University, Japan; Gabriel Bernal, Risk Nexus Initiative; Nicholas Middleton, Oxford University, Letizia Rossano, Director of APDIM, Amin Shamseddini, Programme Officer, APDIM. The methodology was subsequently discussed and further refined at the Steering Committee meeting of the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) and its Regional Nodes (Pan American, North Africa, Europe and Middle East (NAMEE) and Asian Nodes) organized by the China Meteorological Agency in November 2019 in Hangzhou, China.

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