Global Overview of Land Use related Sand and Dust Storm impacts

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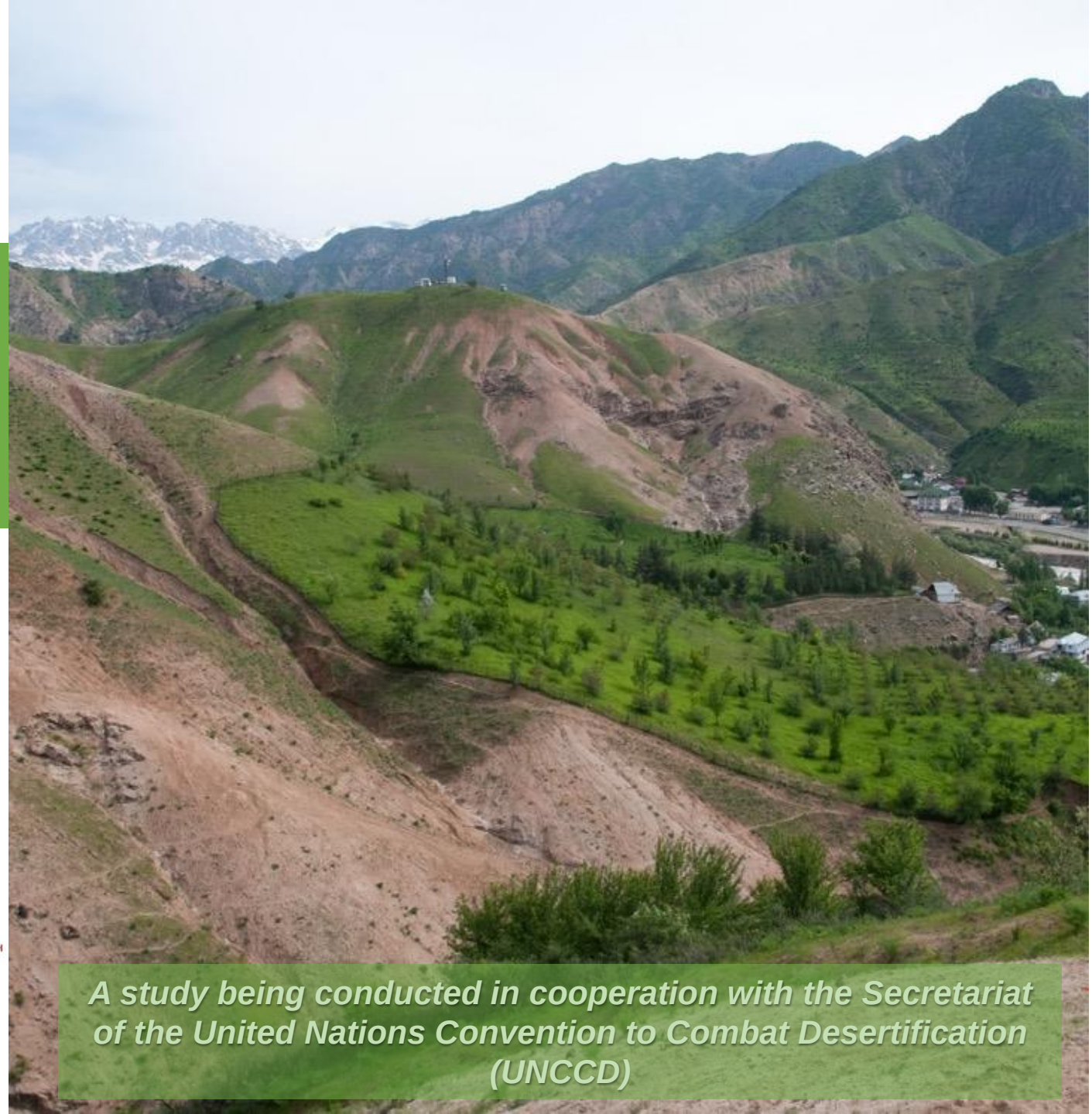


A study being conducted in cooperation with the Secretariat of the United Nations Convention to Combat Desertification (UNCCD)

Context

Understanding the linkages between **drivers and impacts**, notably the role of unsustainable land use and **land degradation** as anthropogenic causes of SDS in source areas, will be of great importance towards the definition of the source mitigation targets that affected countries should set based on the Policy Advocacy Framework of SDS

Sahel Landscape. Credit: Daniel Tiveau/CIFOR. Flickr.com

Herder with his cattle in Niger. Credit: Friederike Mikulcak

Aral Sea. Credit: AFP

Context

Source mitigation may be the only way to reduce SDS generation, and dust emission.

Sustainable Land Management (**SLM**) has a high potential to control on-site soil erosion and provide co-benefits including improving yield/productivity and water availability.

WOCAT, the World Overview of Conservation Approaches and Technologies, can provide state of art solutions.

Appropriate SLM techniques adapted to the varying contexts need to be identified and scaled up.

Dune stabilisation by using palisades (left), bird's eye view of a stabilised sand dune (right). Credits: Guéro Maman, Andreas Buerkert

Sand Dune Stabilization in Niger as SDS Mitigation

Purpose of this study

1. **Analyse the available knowledge** evidence on the global impacts of SDS and draft a preliminary global overview on **impacts** and on how they are **related to land use and land degradation**.

2. Document a few **case studies** illustrating the **causes** of SDS and **impacts** of land use and land management and the **induced SDS**.

3. Draft preliminary **proposals** on **approaches** on how to include **SDS aspects into LDN targets**, for further discussion and exploration.

Method and sources of information

Scientific sources

Main source of **scientific evidence**: peer-reviewed articles available online.
Preliminary analysis based on around **250 articles** with a relatively **balanced geographical and thematic coverage**

Priority to recent articles (mostly after 2000) to capture:

- *most updated findings in terms of research methods and data availability,*
- *recent and historical trends of natural and anthropogenic dynamics that show important decadal changes.*

Focus on **land areas** (terrestrial ecosystems) and mid-latitudes.

SDS-related processes, like airborne sand and dust generation by wind erosion, short and long -scale transport and deposition, and SDS impacts on ecosystems and on human life are subject of a **huge number of scientific articles** belonging to very **diverse and not connected fields**: environmental pollution; human health; earth and planetary sciences; atmosphere and CC; ecology; technological and military applications…

Method and sources of information

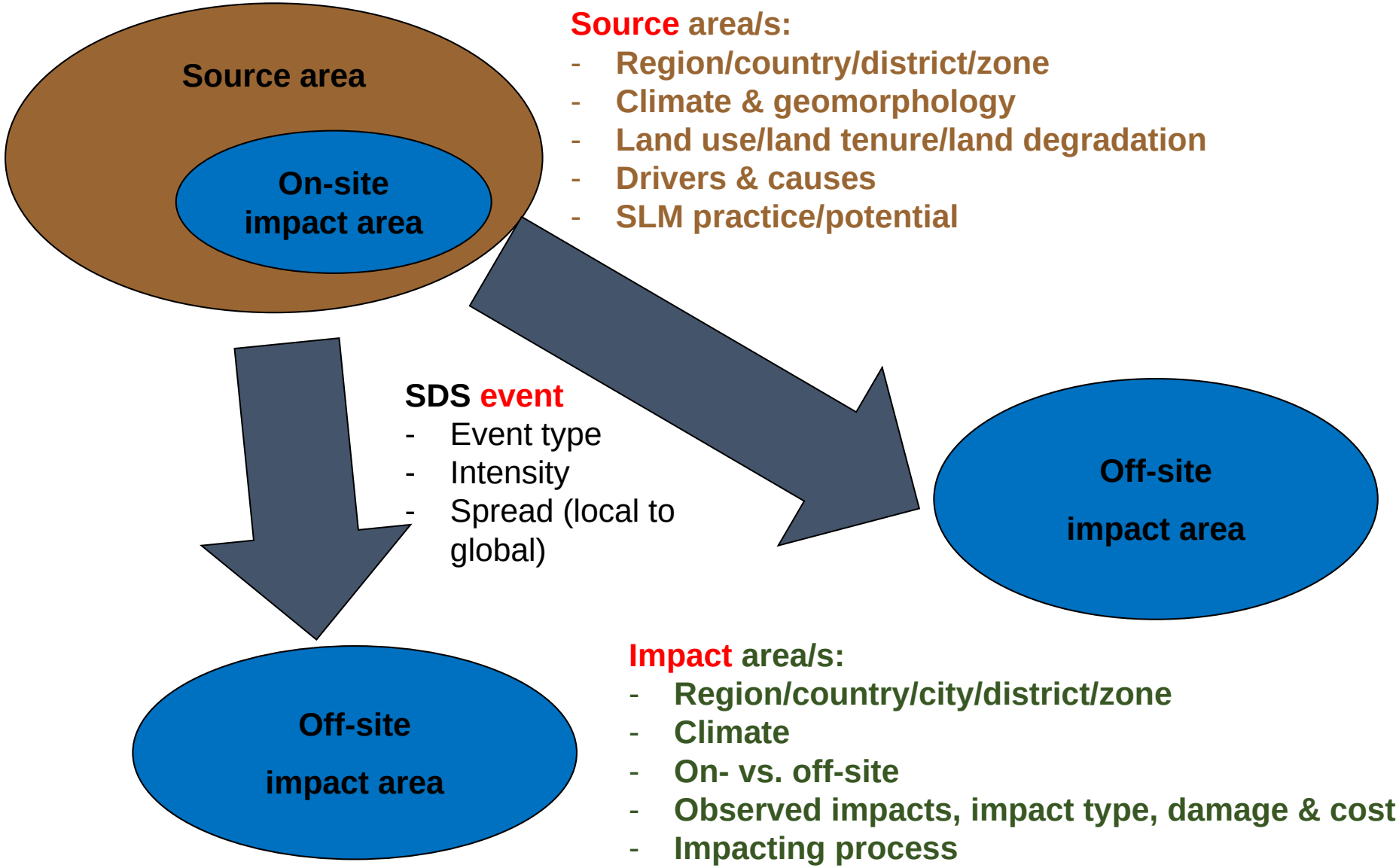
Approach to obtain a **balanced coverage** and to link **impact to LM/LD in source areas**

How to check if SDS **impacts exist**, and what is their **extent**, in **regions** and **contexts** for which such impacts are **not investigated** by scientists, addressed by journal articles?

- Refer to available **global source area maps** to identify impacted (potentially/actually) regions.
  - Identify **target world regions** to drive a balanced literature search.
- Organize the information provided by journal articles systematically by using a **data base** purposely designed, to capture information as **explicitly** stated by the authors.

Method and sources of information

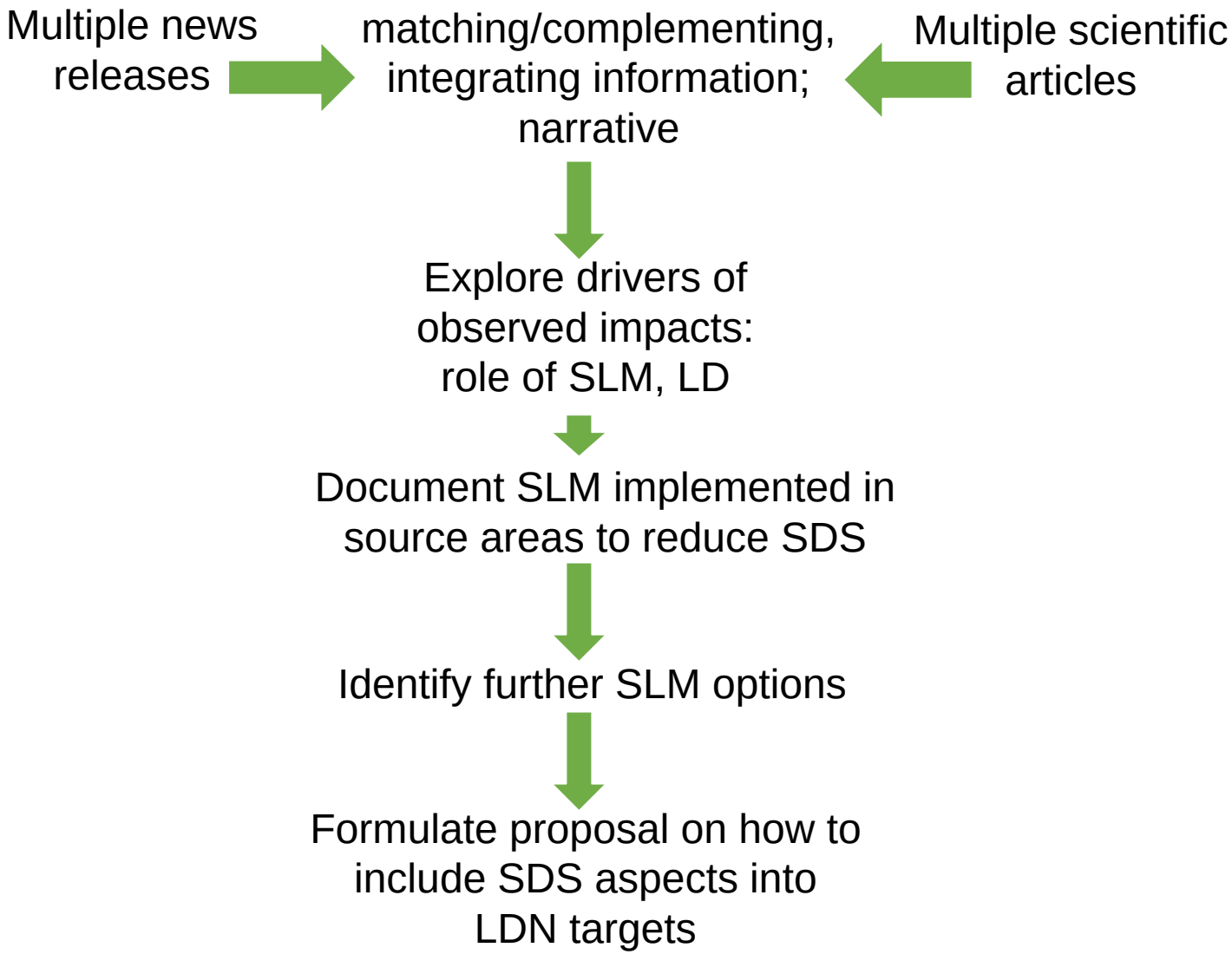
Data base fields:



Method and sources of information

- Search/analyse online **news** releases about major SDS events worldwide.
  - We found that SDS are among the **most frequent catastrophic hazard** in the news, and that some **categories** of damages (like road accidents, flight disruptions, etc.) are **extensively reported only in the news**. Sometimes news include the point of view of the affected people.
- Develop **case studies**, complementing science with news, and integrating information from **multiple sources** (e.g., several articles addressing the diverse impacts of SDS in one city or region).

SDS case study approach and ambition



Scientific knowledge review: preliminary findings (Asia, SSA)

Major knowledge **gaps**:

Strong disconnection between "**impact narrative**" and "**source**" and "**causes**" narratives.

What happens in **source areas** is principally the focus of "wind erosion" research which **rarely discusses what happens downwind**

On the other hand, articles focusing on impacts e.g. human health often **do not discuss sources and causes** of SDS events

The **complexity** of SDS related processes, their **transboundary nature and climate dependency** play a role here, along with sometimes **poor inter-disciplinarity** of the research

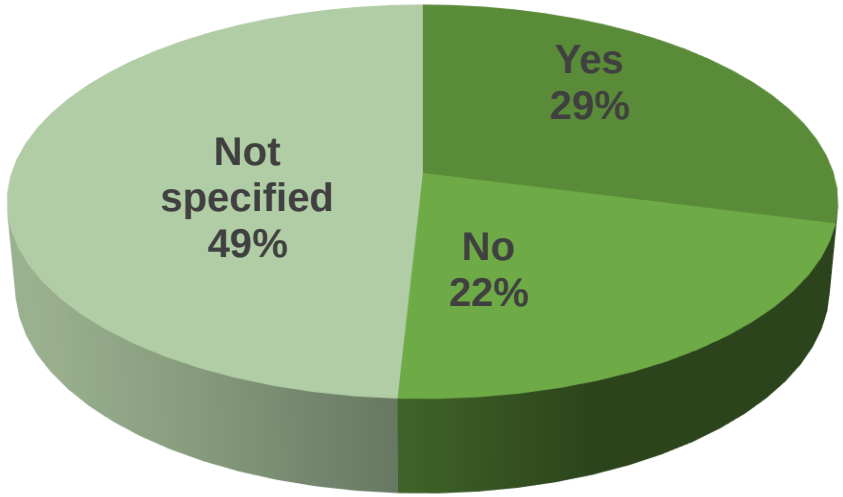
Therefore, the link between **SDS and mismanagement of land, and LD, is poorly explored**

Tengger desert in Inner Mongolia. Credit: Josh Haner/The New York Times

Dust storm in Tehran on 2 June 2014.. Karami et al., 2017.

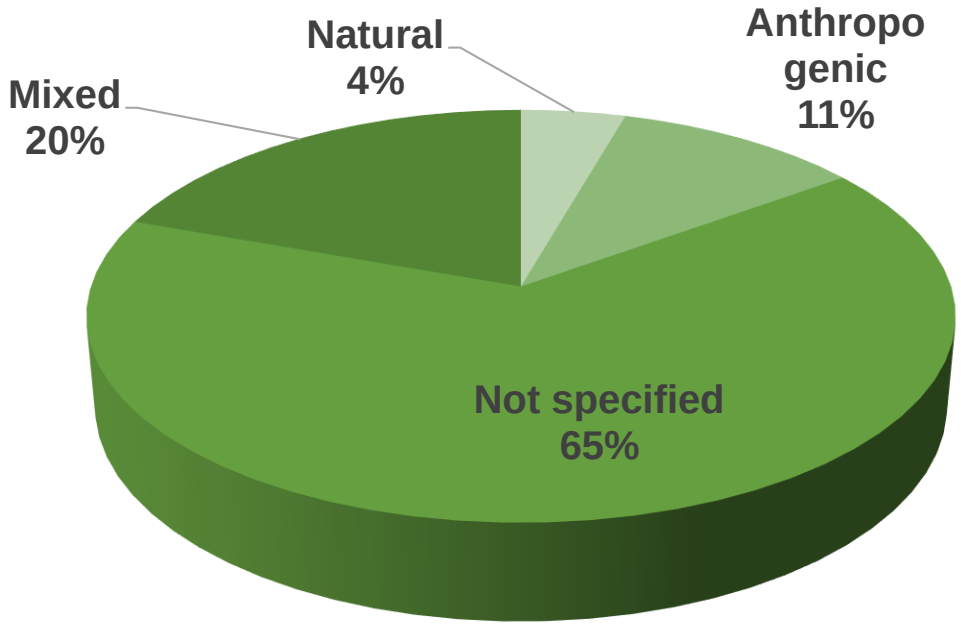
Transboundary provenance of SDS that generated the observed impact

(as stated by the articles addressing SDS impacts)



N = 179

Driver type in Source Areas



Scientific knowledge review: preliminary findings (Asia, SSA)

Strong thematic unbalance in terms of **type of impacts covered**

For example, while impacts on human health are abundantly covered, very few articles **quantify** impacts related to, e.g., **road accidents, economic activities, and economic costs for households**, although the latter are recognized as the most important economic cost of SDS in cities.

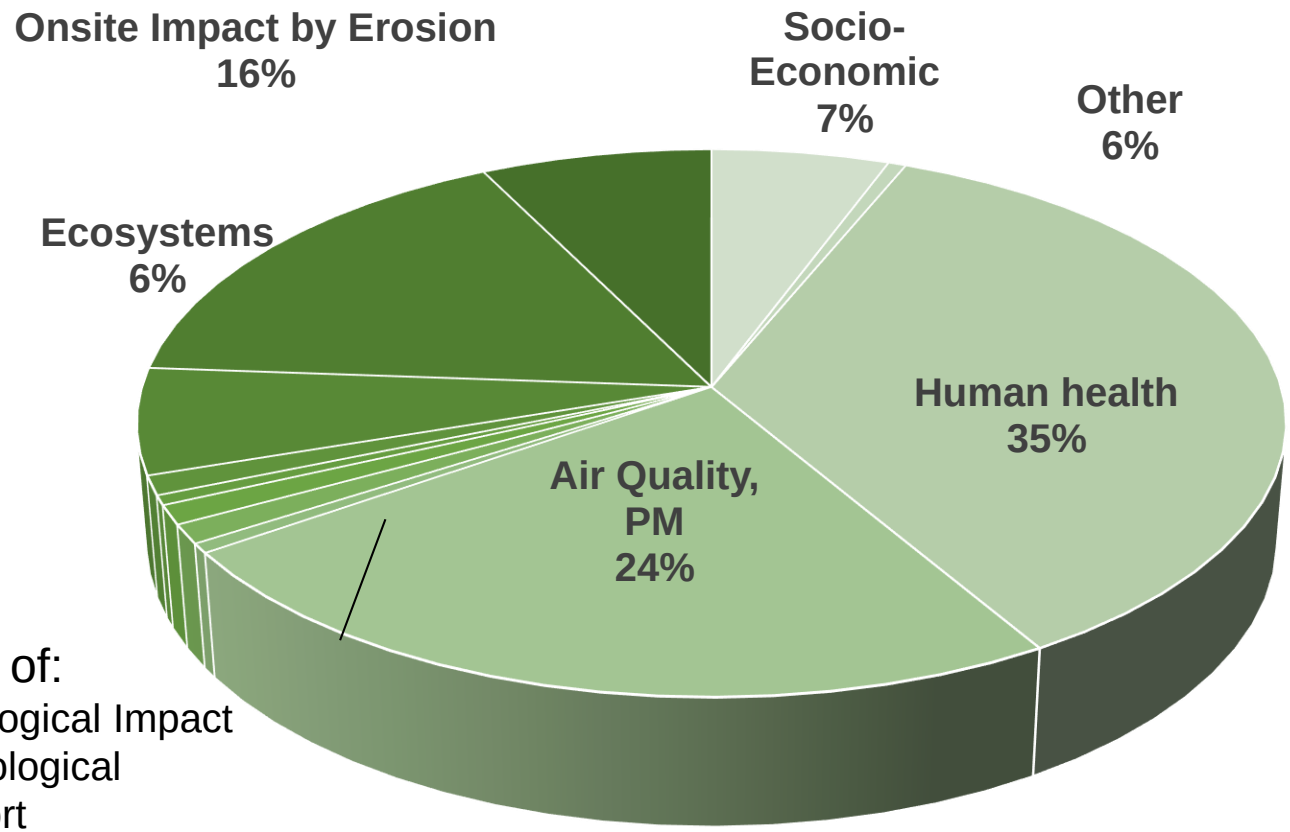
So some impacts are poorly covered by science and therefore underrepresented.

People wearing protective masks. Credit: Reuters

Dust storm in Tehran on 2 June 2014.. Karami et al., 2017.

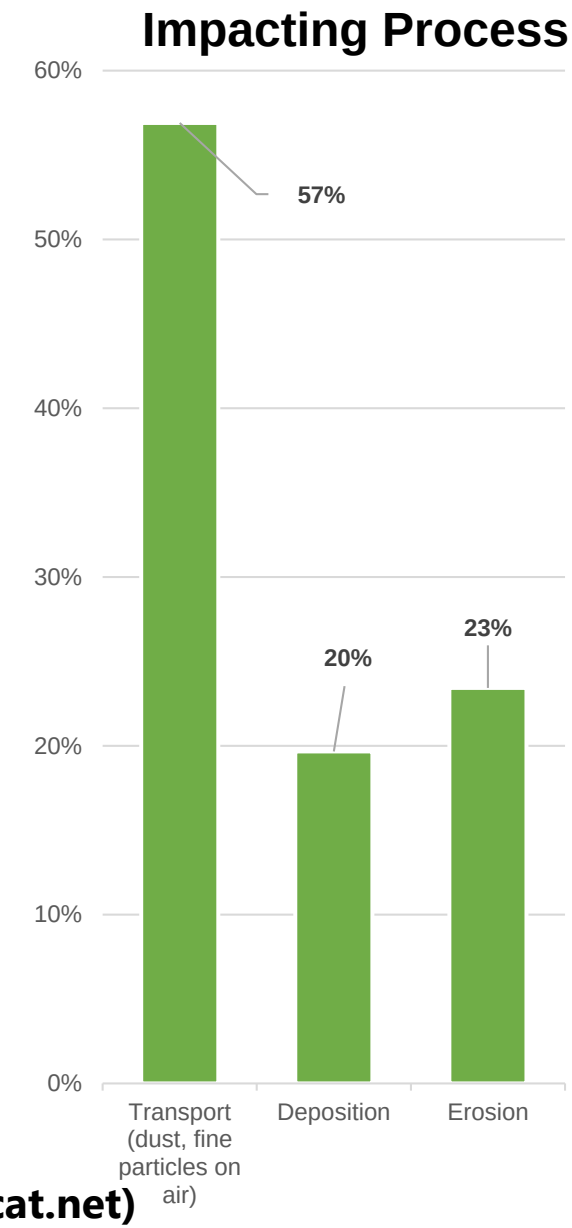
Type of Impact

(178 total articles addressing Asia and SSA)



1%; each of:

- Psychological Impact
- Microbiological
- Transport
- Soil Health
- Animal Health
- Solar Energy Systems



WOCAT: World Overview of Conservation Approaches and Technologies (www.wocat.net)

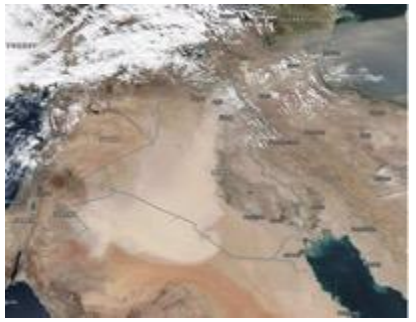
Unbalanced representation of SDS impacts across geographic areas.

The scientific picture is multifaceted and relatively exhaustive in rich regions where source and impacted areas coexist, like USA, Australia, and China (several papers describing all different aspects).

In developed regions that are only impacted, like the EU and parts of Eastern Asia, scientific communities are more concerned with “distal” impacts on human health, air quality in cities, or with SDS role in earth and planetary processes and CC.

The representation is variable in developing countries; e.g., SDS impact is addressed by many articles, in the Middle East and in some South Asia countries, but poorly investigated in South America and Sub-Saharan Africa.

Dust storm headed towards Phoenix, AZ, in 2011. Credit: Alan Stark. Flickr.com

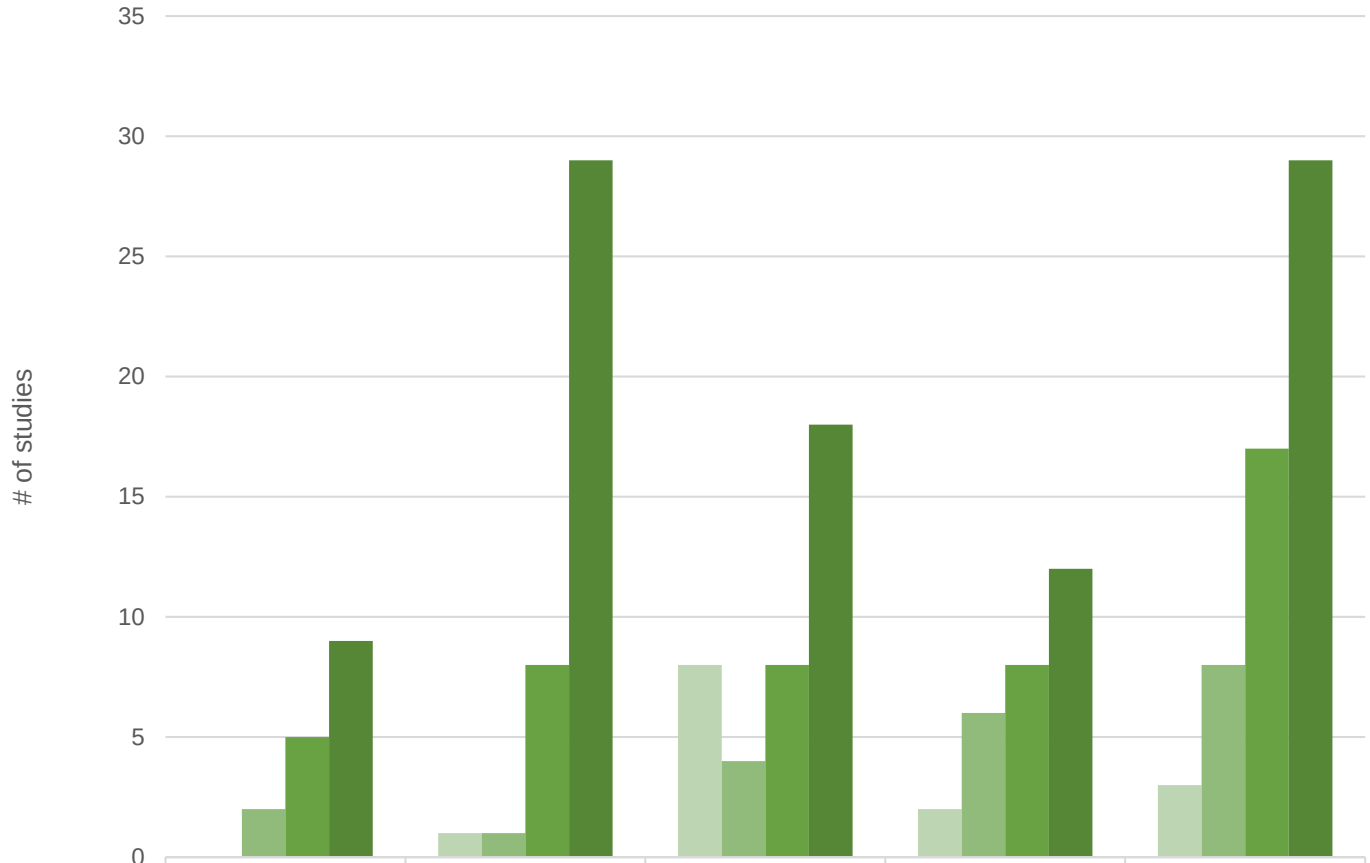


Massive SDS hits Middle East in 2017. Credit: NASA/NOAA Suomi NPP / VIIRS

Sand storm in Mali, 2001. Credit: Remi Benali/Corbis

N 181 of studies reviewed by Region by Year

(1999-2019; Asia and SSA)



	Sub-Saharan: Sahel and WA	West Asia (Middle East)	Central Asia	South Asia	East Asia
1999-2003	0	1	8	2	3
2004-2008	2	1	4	6	8
2009-2013	5	8	8	8	17
2014-2019	9	29	18	12	29

Impact and Source

(by number of articles - 181, addressing impacts in Asia and SSA)

SDS Impact

Top 10 Impact	Top 10 Source
China	China
Mongolia	Mongolia
Iran	Iran
India	India
Uzbekistan	Uzbekistan
Kazakhstan	Kazakhstan
Pakistan	Pakistan
Turkmenistan	Iraq
Korea	Saudi Arabia
Mali	Syria

SDS Source

- ⟨ 3
- 3 - 5
- 6 – 13
- 14- 19
- ⟩ 20

Some highlights from the science review (work in progress)

Health
-**Link** between **onset of SDS season** and **meningitis epidemics** in western Sahel.
-**Link** between **SDS** and (serious) **respiratory and cardiovascular deseases** in sensitive population (e.g., asthmatic; children) **observed** wherever investigated, both **near sources and far away** (Europe, Japan, SE China, Taiwan…)
-Critical synergies with **anthropogenic air pollution**

Ecology, climate
-Regional climatic impacts, e.g., weakening monsoon in south Asia
-**Threat to wetlands**, oases systems in central Asia (e.g., western China)
-**Affect snow cover** melting and hydrological cycles in central and southern Asia mountains (e.g., Tien Shan, Himalaya)

Economy
-**Economic costs estimated in few impacted countries** (total costs: China, Korea, Iran; sectoral costs: Kuwait) are high. E.g., 1B$/y in Iran (Meibodi et al. 2015), around 0.8 of Korean GDP (Yeong et al. 2008)
-**Few studies** on **photovoltaic performance** in India and Burkina Faso show consistent effects on productivity.

Preliminary findings about SDS impacts in the news (work in progress)

Geographic areas frequently mentioned in the news as being impacted by SDS are Middle East, South Asia, East Asia, USA and Australia.

Frequently reported SDS impacts range from **casualities, injured people, road accidents to flight, power and school disruptions**.

Media increasingly focuses on human **health risk** aspect of SDS as dust can mix with pollutants, fertilizers, bacteria, and thereby aggravate the human health risk of SDS.

…often news **do not mention the conditions that cause a storm** and rarely mention the **source of dust or sand**.

…when in combination with thunderstorms, hail or heavy rains as e.g. often the case in India, news often **do not specify damages and costs** resulting from SDS only.

Reduced visibility in Beijing. Credit: Reuters

Damaged electric pole in Rajasthan, India. Credit: Reuters

Damage to unplanted cotton field in Oklahoma. Credit: Robb Kendrick, National Geographic Creative

SDS Case studies

Work in progress:

Mongolian deserts and rangelands as SDS source areas impacting Mongolian rural communities (ONSITE), as well as air quality in NE China, Korea, Japan...(OFFSITE)

Thar Desert and surrounding dry lands as SDS source impacting local communities (ONSITE) and downwind cities (e.g., Indian Ganges river plain) and ecosystems (e.g., Himalaya snow fields and glaciers) (OFFSITE)

Sahelian agropastoral areas that are SDS source impacting local farmers yield and health (ONSITE), as well as air quality and health of citizens living in main Sahelian cities ...(OFFSITE)

Future potential case studies:

Middle East, **Tigris/Euphrates plain** (Syria, Iraq), triggered by human-driven land degradation in vast areas, as SDS sources impacting local communities (ONSITE) and all the region (OFFSITE)

Lakes drying-up like Aral sea, Great Salt Lake (Utah), Ebinur Lake (China), Lake Eyre Basin (Australia), Hamoun lake (Iran), Hawr-al-Azim Wetland (Iraq/Iran), etc., as SDS source for costal areas (ONSITE) and for downwind regions (OFFSITE)

Understanding impact-source linkages

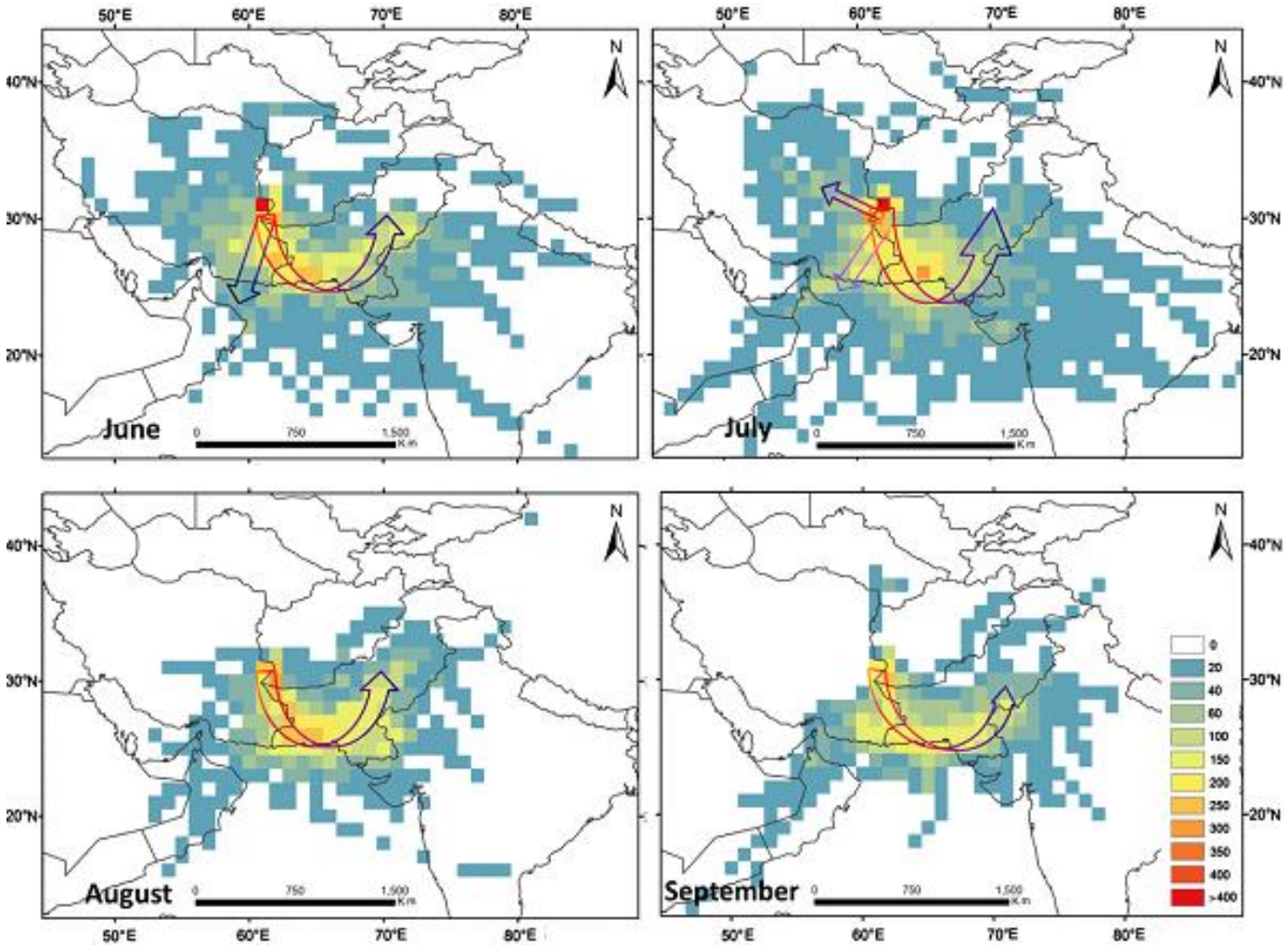
- **Many to many relationship**. One impact region can receive dust from different sources, one source area can contribute dust to different impact regions, depending on regional atmosphere circulation at the time of SDS event.

- **Flyover, entrainment**. SDS are large-scale phenomena that can activate several source areas; various sources can contribute dust, or pollutants along the trajectory
  e.g. most Middle East SDS reach cities of Indo-Gangetic plain flying over Thar desert; SDS reaching Korea, Taiwan, bring anthropogenic dust from Chinese industrial areas.

- **Natural versus anthropogenic SDS sources**. Most SDS trajectory modelling is done at regional scale. Land use data are not used. “Deserts” often are considered as natural sources by definition. Anthropogenic contribution likely not captured
  e.g. most of Indian Thar desert region is under heavy human pressure, with expansion of desert and dried up lake areas

- **SLM not in the picture**. Poor SLM mapping. Poor capacity to quantify/predict benefits of SLM investment
  e.g. not univocal assessments of impacts of Chinese afforestation efforts, and Green Great Wall, on SDS

Need to **focus research on hotspot SDS sources** triggered by either human pressure or climate change **to analyse the specific impacts** generated locally and far away, by modelling the forward trajectories of SDS like in the example below, and **assessing/simulating the benefits of SLM practices**.



Average regional forward trajectories of SDS generated by Hamoon Lake drying-up in Eastern Iran, mainly impacting Pakistan (Rashki et al., 2015)

Well documented "source case study": Hamoon Lake drying-up in Eastern Iran; Rashki et al., 2015).

Project proposal designed by the WOCAT Consortium

A pilot project to be implemented in target regions/countries that significantly contribute to SDS and their on- and off-site impacts, in synergy with ongoing projects implemented by UNCCD with the countries, to deliver:

1. **Classification criteria for SDS source** areas according to dominant combinations of natural/anthropogenic drivers.

2. **Inventory of SDS-mitigating SLM practices** suited to the specific target contexts.

3. **Tools to support SLM planning at local scale**, best **spatial allocation** of SLM to landscape, **SLM upscaling to hotspot areas at larger scal**e (sub-national to regional), and **on- and off-site benefit assessment**.

4. **Concrete sets of practices** with proven on- and off-site benefits **selected for implementation and scaling in specific target sites**.

5. Documentation and training material.

Conclusions and way forward

- The link between SDS **sources and impacts is very complex** and needs to be better explored.
  The potential of **SLM in mitigating SDS sources is not in picture** yet and should be identified.
  There is a need to focus research on **hotspot sources**, **analyse the specific impacts generated**, and understand/simulate **benefits of locally-feasible SLM practices**.

- Until 31 October 2019, **complete the activities under the ongoing project**. In particular, **further explore the SDS source-impact linkages** and how they are linked to land use and land degradation, **identify the potential of SLM in SDS source mitigation**, and propose approaches on **how to include SDS aspects into LDN targets -** through the case study approach.

- **Discuss with UNCCD and interested institutions and donors** and further develop the project proposal.

Thank you

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