Hexi Corridor—Taklamakan Desert Edge Blocking Campaign: Aeolian Sand Conditions and Prevention and Control Tasks (Postprint)

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Abstract

To implement the important spirit of General Secretary Xi Jinping's speech at the symposium on strengthening comprehensive desertification prevention and control and advancing key ecological projects such as the "Three-North" program, this article takes winning the defensive campaign at the edge of the Hexi Corridor–Taklamakan Desert as its primary objective, and conducts in-depth research on the wind-sand regime and prevention tasks in this region. Based on the characteristics of desertified land and wind-sand activity patterns at the edge of the Hexi Corridor–Taklamakan Desert, with the goal of "preventing shifting sand from spreading further and effectively controlling dust sources," and taking "wind prevention, sand blocking, and dust control" as the core research topics, the strategic approach for the defensive campaign at the edge of the Hexi Corridor–Taklamakan Desert is established. By systematically identifying the source areas and transport pathways of "wind, sand, and dust," targeting critical zones for sand prevention and control at the desert margin and prioritizing prominent sand hazard mitigation, the key task areas and key tasks for sand prevention and control at the edge of the Hexi Corridor–Taklamakan Desert are proposed, aiming to provide scientific and technological support for winning this defensive campaign.

Full Text

Preamble

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Title

The Battle on the Edge of Hexi Corridor–Taklimakan Desert: Wind-Blown Sand Situation and Prevention Tasks

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Abstract

To implement the spirit of General Secretary Xi Jinping's important speech at the symposium on strengthening comprehensive desertification prevention and control and advancing key ecological projects such as the "Three-North" Shelterbelt Program, this study aims to win the battle against desertification on the edge of the Hexi Corridor–Taklimakan Desert region. We conducted in-depth research on the wind-blown sand situation and prevention tasks in this critical area. Based on the characteristics of desertified land and wind-sand activity patterns, we established the strategic framework with the goal of "preventing drifting sand from spreading further and effectively controlling dust sources," focusing on the core tasks of "wind prevention, sand blocking, and dust control." By systematically analyzing the source areas and transport pathways of wind, sand, and dust, and targeting key zones along the desert edge where sand control is most critical, we identified key task areas and specific missions for desertification combating. This work provides scientific and technological support for successfully winning this decisive battle.

Keywords: Hexi Corridor, Taklimakan Desert, desertification combating, strategic battle, strategic area, desertified land, wind-blown sand situation

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1. Desertification Status of the Hexi Corridor–Taklimakan Desert Edge Strategic Area

1.1 Overview of the Strategic Area

The Hexi Corridor–Taklimakan Desert edge strategic area (hereinafter "strategic area") is located in the core region of China's arid northwest, serving as the throat of both the ancient "Silk Road" and the modern "Eurasian Continental Bridge." This region features dry and windy conditions, low vegetation coverage, well-developed aeolian landforms, and dominant desert, gobi, and yardang formations. With extensive and contiguous distribution of desertified land, concentrated mobile dunes, and severely desertified areas, it represents China's most intense wind-sand activity zone, the most severe wind-sand disaster area, the main battlefield for three iconic desertification control campaigns, and a critical zone for building the northern ecological security barrier.

The strategic area primarily includes the Hexi Corridor region (Jiayuguan, Jiuquan, Zhangye, Wuwei, Jinchang, and western Baiyin in Gansu Province) and five prefectures in southern Xinjiang (Aksu, Kashgar, Hotan, Bayingolin Mongol Autonomous Prefecture, and Kizilsu Kirghiz Autonomous Prefecture) [Figure 1: see original paper]. The total area is approximately 827,800 km^2, with a population of about 15.77 million, average annual precipitation of approximately 97 mm, and total oasis area of about 107,100 km^2.

The Hexi Corridor lies in western Gansu, stretching from Gulang Gorge in the east to the Gansu-Xinjiang border in the west, bordered by the Qilian Mountains to the south and Inner Mongolia to the north. Spanning approximately 1,000 km east-west and up to 200 km north-south, it covers 276,000 km^2 of territory with a population of 3.5 million. The northern part contains the Badain Jaran and Tengger Deserts, while the southern part features the Qilian Mountains with significant topographic relief. The climate is extremely arid with scarce precipitation, with many areas receiving less than 200 mm annually, creating a landscape pattern of coexisting deserts, dunes, and oases. Oasis expansion began accelerating during 1990–2000 and has continued significantly since 2010.

The Taklimakan Desert edge region features flat terrain surrounded by high mountains—the Tianshan to the north and the Karakoram, Kunlun, and Altun Mountains to the south, connecting with the Qinghai-Tibet Plateau. It contains the world's second-largest shifting desert, the Taklimakan, which spans approximately 1,000 km east-west and 400 km north-south, covering 337,600 km^2. Average annual precipitation is about 50 mm, with minimums of only a few millimeters, while evaporation reaches 2,500–3,400 mm. These extremely arid conditions and intense wind-sand activities severely impact the regional ecological environment.

1.2 Land Desertification Analysis

Using MODIS (Moderate Resolution Imaging Spectroradiometer) satellite remote sensing data from 2000–2022, we analyzed desertification conditions in the strategic area. The land desertification distance index served as the evaluation metric, calculated based on a two-dimensional feature space constructed from the Modified Soil-Adjusted Vegetation Index (MSAVI) and albedo (ALBEDO). Using the point (1,0) with highest MSAVI and lowest ALBEDO as the base point, we calculated distances of all sample points to characterize desertification degree. MSAVI was derived from MODIS MOD09A1 band values, while ALBEDO data came from MODIS MCD43A3 products.

In 2022, total desertified land area in the strategic area was approximately 794,200 km^2, mainly distributed in the five southern Xinjiang prefectures, with relatively less in the Hexi Corridor. From 2000–2022, desertification remained stable across most areas, with changes occurring only in limited regions [Figure 2: see original paper]. Desertification intensified in approximately 18,694 km^2, while improving in about 92,379 km^2. Significant improvement occurred in southwestern Korla, southern Kashgar, and western/northwestern Alar (totaling 38,409 km^2). Moderate improvement appeared in southeastern Kashgar, Hotan, Dunhuang, Jiayuguan, Zhangye, and southeastern Wuwei (53,970 km^2). However, significant deterioration occurred in scattered areas of northern southern Xinjiang prefectures, Bayingolin Prefecture, and Wuwei (13,034 km^2).

2. Wind-Sand Activity Patterns in the Strategic Area

2.1 Strong Wind Intensity and Primary Wind Gap Areas

The strategic area lies deep inland with a unique topography of alternating high mountains and depressions/basins. Influenced by westerly circulation below 400 hPa, winter monsoons, local circulation, and this distinctive terrain, the region contains numerous wind-prone areas such as canyons, river valleys, and passes, making it one of China's major windy regions. It experiences frequent strong winds with long durations and high intensity, posing significant hazards to agriculture, transportation, and property.

The resultant drift potential (RDP) effectively characterizes regional wind-sand environments and represents wind energy conditions. Based on RDP spatial distribution [Figure 3: see original paper] and field data, major wind gaps include the Shule River Valley-Mazong Mountain gap, the downwind area of western Pamir Plateau airflow (western Kashgar and northern Kizilsu Kirghiz Autonomous Prefecture mountains), and the eastern inflow gap of the Taklimakan Desert. High wind-energy zones are located in northwestern Hexi Corridor and the eastern edge of the Taklimakan Desert. The narrow-gorge effect from special terrain significantly contributes to frequent strong winds in the Hexi Corridor.

The Shule River Valley area, bordered by the Qilian Mountains to the south and Mazong Mountain to the north, serves as an entrance for northwest airflow and cold air. Due to topographic channeling, it experiences the most frequent strong winds, highest maximum wind speeds, and longest durations outside high mountain areas, with annual average strong wind days of 41.4 and maximum wind speeds of 27 m/s. This makes northwestern Hexi Corridor a famous wind gap and "wind reservoir." Mazong Mountain and surrounding areas also show high wind values, influenced by the strong wind area of Shisanjianfang in Hami, Xinjiang, which experiences up to 209 strong wind days annually with average wind speeds of 8.6 m/s. Along the Lop Nur-Kuruk Tagh Desert to Ruoqiang-Kashgar, maximum annual wind speeds exceed 20 m/s, maintaining a medium-high wind-energy environment.

Wind intensity correlates closely with topography, generally showing: more strong winds in high mountains than mid-low mountains; more at basin/depression edges than centers; and maximum wind speeds in canyons, valleys, and mountain gaps. The region has distinct seasons with spring showing the strongest winds, followed by summer, and autumn/winter the weakest. Winter monsoons bring cold, dry airflow that dominates wind direction as northwesterly in Hexi Corridor and easterly in the Taklimakan Desert.

2.2 Dune Activity and Protection Gaps at Desert Margins

The strategic area contains numerous small deserts and scattered dunes interspersed with oases, such as the Kumtag and Kuruk Tagh Deserts. Approximately 70% of the area is covered by native deserts and gobi with mobile dunes, making it a major dust source in northwestern China. RDP values are generally below 200 VU (vector units) across most areas, indicating a low wind-energy environment, except in wind gap regions. Dunhuang's northern area and the eastern Taklimakan Desert near Lop Nur and Ruoqiang experience persistently high wind-energy conditions where desert margin dunes are extremely active. For example, barchan dunes near the Kuruk Tagh Desert adjacent to the eastern inflow gap move an average of 30 m annually.

2.2.1 Wind-Sand Channels Between Desert Margin Oases Wind-sand channels between desert margin oases are active zones where sand invasion and dune activation readily occur. There are at least 16 wind-sand protection gaps in the Hexi Corridor–Taklimakan Desert region, including 5 in the Hexi Corridor and 11 around the Taklimakan Desert. In the Hexi Corridor, oases are scattered, creating extensive wind-sand channels, notably: Dunhuang's Yangguan Town-Erduan Village channel; Yangguan Town-Qili Town channel; Mogao Town-Guazhou Town channel; Yumen City-Chijin Town channel; and Yumen Xiaoheqing Town-Qingshui Town-Minghua Township channel.

Around the Taklimakan Desert, wind-sand channels primarily distribute along the southwestern margin (Yecheng-Pishan section), southern margin (Kunyu City-Ruoqiang County section), and eastern margin (Xinjiang Production and Construction Corps 34th Regiment area south of the desert and the Taitema

Lake section), spanning approximately 1,400 km of sand-control lines. Major channels include: the Yecheng-Pishan gobi-covered area; Pi County's Acha Kash Ranch-Piyalema Township gobi area; and the Cele County western mobile dune and gobi area. These regions, dominated by fixed/semi-fixed dunes or gobi, face high risks of soil and vegetation degradation due to climate change and human activities.

2.2.2 Dune Activation at Desert Margins Dune activation and sand invasion at desert margins constitute significant hazards, largely induced by unreasonable land development. Across the Hexi Corridor, risks of sand invasion, vegetation degradation, and activation of fixed/semi-fixed dunes exist from Minqin and Jinchang in the east to Guazhou in the west, particularly in Gaotai County (Luocheng, Heiquan, Xuanhua, and Luotuo towns) and northeastern Yumen. The oasis shelterbelt networks urgently require quality improvement. Unreasonable development of desert-oasis transition zones has created protection gaps, facilitating sand invasion and dune activation, with Minqin County, northern Gaotai towns, and northern Linze being most severely affected.

Around the Taklimakan Desert, large areas of degraded desert-oasis transition zones and scattered deserts remain. The Kashgar oasis delta region, including the alluvial fan transition zone west of Kashgar City, the two scattered desert-oasis transition zones between Jiashi and Makit Counties, and the desert-oasis transition zone north of Tumushuke City-Bachu County, are all located downwind of the western basin wind gap and face high degradation risks. In Aksu and parts of Bayingolin Prefecture, such as the Tumushuke-Awati desert section, Alar desert front, and Kuqa-Luntai-Tiemenguan southern desert section, the oasis protection forest systems are severely aged and desert-oasis transition vegetation is seriously degraded.

2.2.3 Oasis Expansion Issues Southern Xinjiang also faces oasis expansion problems, primarily through reclamation of desert-oasis transition zones, notably in new Xinjiang Production and Construction Corps farms such as the 14th Division's Kunyu City, 37th and 38th Regiments of the 2nd Division, and northern farms of the 1st Division's Alar City. Additionally, numerous wind-sand protection gaps exist between oases along the western, southern, and eastern margins of the Taklimakan Desert.

2.3 Dust Source Areas and Transport Pathways

The Hexi Corridor–Taklimakan Desert region shows distinct geographic dust storm patterns, with significantly higher frequencies along the Taklimakan Desert margin. From 1970–2007, Minfeng and Kalpin Counties near the Taklimakan Desert had the highest dust storm frequencies at 36.92 and 28.16 days annually, followed by Minqin County in Gansu at 26.21 days. Dust storms mainly occur April–August around the Taklimakan Desert and March–May in the Hexi Corridor. The longest durations reach 10–26 hours along the southern Taklimakan margin and 6–12 hours in the Hexi Corridor.

While northern China dust storm frequency has significantly declined over the past 50 years, it has increased since 2020, with spring 2023 experiencing the highest frequency in a decade. The average annual dust emission rate from 2000–2020 was 0–3,275 g/m^2 [Figure 4: see original paper], with the highest rates in the eastern and southeastern Taklimakan margins and around Lop Nur, followed by lower reaches of the Shiyang, Heihe, and Shule Rivers in the Hexi Corridor (Subei, Guazhou, Jinta, and Minqin). The strategic area's total annual dust emission is 1.14×10^{8} tons, accounting for over 60% of East Asia's total. The Taklimakan Desert alone emits approximately 0.63×10^{8} tons annually (55% of the strategic area's total). Quantitative analysis of spring 2023 dust events revealed the Taklimakan Desert contributed about 26% on average.

Three main spring dust transport pathways exist from the Taklimakan Desert: (1) cold air from the western Tianshan and Pamir Plateau entering the basin from the west; (2) northern cold air crossing the Tianshan Mountains; and (3) strong eastern cold air entering the basin's northeastern opening. Strong eastern inflow carries substantial dust, driving weaker western and northern dust bands southwestward. Blocked by the Qinghai-Tibet Plateau, dust lifts along its northern slope and migrates toward the Hexi Corridor. Dust from the Taklimakan and Kumtag Deserts combines with dust from Guazhou, Yumen gobi, and the Badain Jaran and Tengger Deserts in the Hexi Corridor, then continues eastward under the corridor's channeling effect, impacting the Loess Plateau and North China Plain. Severe dust storms can even affect Wuhan, Changsha, Hangzhou, and Shanghai in the Yangtze River Basin.

3. Wind-Sand Disaster Risk in the Strategic Area

Wind-sand disasters are meteorological hazards caused by wind-sand activities that affect human living environments and socio-economic development, manifesting as soil erosion, sand burial, dune encroachment, and air pollution. The Hexi Corridor–Taklimakan Desert edge experiences intense wind-sand activity, with widespread sand invasion hazards that severely threaten oasis farmland, towns, industrial bases, and ecological environments.

From 2000–2020, overall wind-sand disaster risk in the strategic area declined, with extremely high-risk areas decreasing from 12.7% to 8.0% of the total area. By 2020, risk distribution showed significantly higher levels in desert-margin oasis areas than in desert interiors [Figure 5: see original paper]. In these environmentally fragile, densely populated zones, disaster-causing factors easily damage vulnerable assets, creating extremely high risks. High and extremely high-risk zones are widely distributed around the Taklimakan Desert margin and along the Hotan and Keriya Rivers penetrating the desert interior. In the Hexi Corridor, such zones mainly occur at the southwestern margins of the

Badain Jaran and Tengger Deserts. Economic activities and high population density further increase the risk of major economic losses, exposing all major cities in the strategic area to high or extremely high wind-sand disaster risks.

4. Key Tasks for the Hexi Corridor–Taklimakan Desert Edge Battle

4.1 Strategic Framework

Winning the battle on the Hexi Corridor–Taklimakan Desert edge is a systematic project requiring coordination across resources, environment, society, and economy. It must implement overall desertification control requirements for the new era while highlighting the eco-geographical characteristics of arid regions. The strategy involves: (1) applying systematic thinking to identify source areas and pathways of wind, sand, and dust; (2) prioritizing key zones by focusing on critical desert-margin areas; and (3) employing scientific sand control through integrated planning of wind prevention, sand blocking, and dust control.

Based on the spatiotemporal patterns of wind, sand, and dust, combined with desertified land distribution and wind-sand disaster risk assessment, we established the strategic framework with the goal of "preventing drifting sand from spreading and effectively controlling dust sources," focusing on the core tasks of wind prevention, sand blocking, and dust control [Figure 6: see original paper]. By identifying regional wind gaps, wind intensity, channels, sand invasion patterns, and protection gaps, we prioritized key management zones, particularly the wind-sand protection gaps between desert-margin oases around the Taklimakan, Tengger, and Badain Jaran Deserts. Through dust source delineation and transport pathway tracking, we emphasized controlling wind erosion in major source areas. This approach identified four key task areas and 15 major tasks [Figure 7: see original paper].

Given abundant sand sources and strong winds, frequent wind-sand activities severely threaten infrastructure safety. Due to complex and spatially variable wind-sand environments, setting appropriate engineering measures requires understanding regional contradictions and implementing specific measures under the principle of "prevention based on hazard characteristics." Each key task area requires two types of projects: (1) oasis protection system quality improvement and (2) major infrastructure and industrial area protection.

4.2 Key Task Areas

4.2.1 Hexi Corridor Oasis Sand Blocking and Fixing Task Area The Hexi Corridor oasis sand blocking and fixing belt consists of oases, surrounding shelterbelts, and outer protection zones, distributed along three inland rivers (Shiyang, Heihe, and Shule) with a total area of approximately 30,000 km^2 (including 21,400 km^2 of oasis and 9,000 km^2 of desert-oasis transition zone). This belt plays a critical role in blocking sand invasion, maintaining oasis ecosystem stability, and ensuring food security, forming an important component of the northern sand prevention belt in China's "Two Screens and Three Belts" ecological security framework.

However, rapid oasis expansion has intensified water resource conflicts, lowered groundwater tables, reduced ecosystem stability, and increased desertification risks. This expansion primarily occurs through reclamation of the desert-oasis transition zone (sand blocking belt), destroying its stability and increasing sand invasion risks. Key tasks include: (1) enhancing oasis stability; (2) optimizing sand blocking functions at oasis edges; and (3) protecting "rain-fed vegetation" in peripheral desert areas.

4.2.2 Kumtag Desert–Lop Nur Wind Erosion Dust Source Control Task Area This task area is bounded by the Altun Mountains to the south, Beishan to the north, Kuruk Desert to the west, and Lop Nur to the east, covering approximately 360 km east-west. Land types are primarily desert, gobi, and saline-alkali soils. The area belongs mainly to Ruoqiang County, with eastern parts in Dunhuang City and southeastern portions in Aksai Kazak Autonomous County.

Wind-sand hazards here primarily manifest as gobi wind-sand flow, such as at the Dunhuang Mogao Grottoes. Recent discovery of mineral resources (potassium salts, coal) and associated infrastructure development have exacerbated road wind-sand problems. Threats include water shortages, intensified wind erosion, and dust diffusion. Key tasks involve: (1) protecting gobi wind erosion dust sources and desert ecosystems; and (2) constructing wind prevention systems for major infrastructure and industrial areas.

4.2.3 Southern Taklimakan Desert Edge Wind Prevention and Sand Blocking Task Area Extending 1,200 km from Ruoqiang in the east to Pishan in the west, this area involves 7 counties and 1 city in Bayingolin Prefecture and Hotan region. Land types include desert, gobi, grassland, artificial oases, and saline-alkali soils. The southern Tarim Basin margin is a strong wind-sand activity zone and major dust source, known as Xinjiang's "thousand-mile wind-sand line," with oases distributed like prayer beads along this line.

Despite expanding artificial oases and improving protection systems, reclamation of desert-oasis transition zones has increased wind-sand hazards, particularly through protection gaps between oases that serve as main channels for sand invasion. Sandified land is highly mobile and severe, with extremely high disaster risks. Key tasks include: (1) vegetation restoration and reconstruction in desert-oasis transition zones; (2) wind prevention and sand blocking in inter-oasis protection gaps; (3) optimizing and upgrading oasis peripheral protection systems; and (4) sealing protection for sandified land unsuitable for treatment.

4.2.4 Tarim River Desert Riparian Vegetation Conservation Task Area This area extends from the downwind zone of western Pamir Plateau airflow, including middle-lower reaches of the Yeerqiang, Kashgar, and Gez Rivers, through Xiaoqiaoke/Aral, Xinquman, Yingbaza, middle-stream Wusiman and Aqike, to downstream Qiala, Yingsu, Alagan, and Taitema Lake. The Kashgar-Shache-Tumushuke delta lies downwind of the Pamir Plateau, affected by strong winds, salinization, and human disturbance. The Tarim River main stream's wind erosion dust sources are distributed across the Tarim River plain.

The Tarim River's middle-upper reaches are wandering channels with wide historical floodplains. Reduced water flow from upstream reservoirs and consumption has weakened flooding, decreased channel migration, caused Populus euphratica forest decline, and created dry, exposed riverbeds that become important dust sources. Although emergency ecological water delivery over the past 20 years has restored downstream corridor functions, groundwater recovery remains slow and the ecological corridor remains fragile. Under eastern inflow winds, this area experiences the basin's strongest wind-sand activity. Key tasks include: (1) controlling wind erosion in dry riverbeds and lakeshore areas; (2) establishing sealed protection zones for contiguous sandified land; (3) constructing integrated river-lake-road protection systems; and (4) improving saline farmland and conducting comprehensive saline-alkali land management.

References

1. Zhao W Z, Ren H, Du J, et al. Thoughts and suggestions on oasis ecological construction and agricultural development in Hexi Corridor. *Bulletin of Chinese Academy of Sciences*, 2023, 38(3): 424-434. (in Chinese)
2. Sun Q K, Zhou L, Tang X L, et al. Spatial influence and prediction of oasis urban expansion on cultivated land in arid areas: A case study of the Hexi Corridor. *Journal of Natural Resources*, 2021, 36(4): 1008-1020. (in Chinese)
3. Zhu Z D, Chen Z P, Wu Z, et al. *Aeolian Landforms in the Taklimakan Desert*. Beijing: Science Press, 1981. (in Chinese)
4. Chinese Academy of Sciences Xinjiang Comprehensive Expedition Team. *Xinjiang Landforms*. Beijing: Science Press, 1978. (in Chinese)
5. Li J F. *Weather and Climate in the Taklamakan Desert and Surrounding Mountains*. Beijing: Science Press, 2003. (in Chinese)
6. Fryberger S G, Dean G. Dune forms and wind regime. In: McKee E D, ed. *A Study of Global Sand Seas*. Washington DC: Geological Survey and United States National Aeronautics and Space Administration, 1979: 137-170.
7. Dong A X, Hu W C, Zhang Y, et al. Study of the relationship between gale and the peculiar terrain in the Hexi Corridor. *Journal of Glaciology and Geocryology*, 2014, 36(2): 347-351. (in Chinese)
8. [Reference text incomplete in original]
9. Qian W H, Quan L S, Shi S Y. Variations of the dust storm in China and its climatic control. *Journal of Climate*, 2002, 15(10): 1216-1229.

10. Wang S G, Dong G R, Chen H Z, et al. Advances in studying sand-dust storms of China. *Journal of Desert Research*, 2000, 20(4): 349-356. (in Chinese)
11. Chen S Y, Zhao D, Huang J P, et al. Mongolia contributed more than 42% of the dust concentrations in Northern China in March and April 2023. *Advances in Atmospheric Sciences*, 2023, doi: 10.1007/s00376-023-3062-1.
12. Du H Q, Wang T, Xue X, et al. Modelling of sand/dust emission in Northern China from 2001 to 2014. *Geoderma*, 2018, 330: 162-176.
13. Song H Q, Zhang K S, Piao S L, et al. Soil organic carbon and nutrient losses resulted from spring dust emissions in Northern China. *Atmospheric Environment*, 2019, 213: 233-242.
14. Guan Q Y, Luo H P, Pan N H, et al. Contribution of dust in Northern China to PM10 concentrations over the Hexi Corridor. *Science of the Total Environment*, 2019, 660: 141-150.
15. Gao S Y, Shi P J, Ha S, et al. Causes of rapid expansion of blown-sand disaster and long-term trend of desertification in Northern China. *Journal of Natural Disasters*, 2000, 9(3): 31-37. (in Chinese)

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Note: Figure translations are in progress. See original paper for figures.