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**Items resulting from the work programme of the Science-Policy Interface for the triennium 2022–2024**
**Evidence on historical global and regional aridity trends and future projections that may contribute to expanding drylands and affected populations and the adaptation approaches**

## Policy-oriented recommendations resulting from evidence on historical global and regional aridity trends and future projections, under objective 2 of the Science-Policy Interface work programme for the triennium 2022–2024

### Report by the Executive Secretary

*Summary*

By its decision 18/COP.15, the Conference of the Parties (COP) requested the Science-Policy Interface (SPI), as objective 2 of its work programme for the triennium 2022–2024, to provide science-based evidence on the historical regional and global aridity trends and future projections that may contribute to expanding drylands and affected populations and the adaptation approaches that reduce risks to environmental, social and economic systems.

Following an extensive scientific review and assessment of existing synthesis reports and the primary literature, the SPI produced a technical report on historical global and regional aridity trends and future projections that may contribute to expanding drylands and affected populations.

This document presents the activities undertaken by the SPI on objective 2, the underlying evidence and rationale results from the assessment and a summary of the key findings emerging from the technical report.

# Contents

# I. Background

1. By its decision 18/COP.15, the Conference of the Parties (COP) adopted the Science-Policy Interface (SPI) work programme for the triennium 2022–2024. Under objective 2 of this work programme, the SPI is requested to provide science-based evidence on historical regional and global aridity trends and future projections that may contribute to expanding drylands and affected populations and the adaptation approaches that reduce risks to environmental, social and economic systems, based on a review of existing synthesis reports and the primary literature.

2. In response to this request, and following its mandate, as defined in decisions 23/COP.11 and 19/COP.12, the SPI conducted a thematic assessment in collaboration with commissioned experts[1] working under the supervision of the SPI. Based on this assessment, the SPI prepared a technical report entitled "Provision of science-based evidence on the historical regional and global aridity trends and future projections".

3. The technical report was prepared in accordance with the rules and procedures established by the COP, by which any scientific output prepared under the supervision of the SPI should undergo both an international, independent review as well as an internal SPI review.[2]

4. The final draft of the technical report and an associated science-policy brief are in press at the time of this publication and will be made available to the public online in December 2024. The main scientific findings and consensus emerging from this technical report are summarized in this document.

# II. Evidence base and rationale

5. Based on established scientific evidence, the SPI reported in its assessment that understanding the intricate nature of aridity and its far-reaching consequences on ecosystems and societies is of paramount importance in today's rapidly changing climate.

## A. Aridity, drought and water scarcity

6. Aridity refers to a state of long-term climatic feature characterized by low average precipitation or available water in a region.[3] A defining characteristic of aridity is the imbalance between precipitation and atmospheric evaporative demand (AED). High aridity regions experience a persistent deficit where AED exceeds precipitation, leading to significant water scarcity. This deficit highlights the limitation in available water for evaporation, exacerbated by the limited water reservoirs in the soil. Elevated AED intensifies aridity through increased evaporation and transpiration, and by inducing plant water stress.

[1] With support from the secretariat to the United Nations Convention to Combat Desertification, the Science-Policy Interface (SPI) drafted concept notes, terms of reference and evaluation criteria for the selection of these subject matter experts. Following a public competitive tender, three experts were commissioned for the task of drafting these domain-specific background reports under the guidance of the SPI.

[2] Drafts of the technical report were initially reviewed and refined by the Science-Policy Interface (SPI)-dedicated working group. The next draft of the technical report was peer-reviewed by all SPI members, including all members of the Bureau of the Committee on Science and Technology and representatives from SPI observer organizations (143 review comments received). After addressing these comments, the next draft of the technical report underwent an independent scientific review, which included domain experts selected by the Co–Chairs of the SPI from each region (293 review comments received). These comments were considered in shaping the final draft of the report, which was then reviewed by the Bureau of the COP. The co-lead authors of the technical report ensured that all peer review comments received appropriate consideration.

[3] The definition for aridity employed by the Science-Policy Interface was intergovernmentally agreed under the proceedings of the Intergovernmental Panel on Climate Change in 2021. See Annex VII Glossary of the Sixth Assessment Report: https://doi.org/10.1017/9781009157896.022.

Aridity is thus a climate condition characterized by a severe lack of available moisture to support most forms of life.

7. To establish a clear understanding of aridity as a distinct concept with essential biophysical and hydroclimatic significance, it is imperative to delineate the differences with two other related concepts: drought and water scarcity, each of which offer a unique perspective on water limitations.

8. Due to its multifaceted nature, aridity is a complex concept characterized by a range of indicators. The most widely used global aridity indicator, the Aridity Index (AI), formulated by the United Nations Environment Programme in 1992, remains prevalent due to its simplicity and effectiveness in encompassing these core variables. The SPI report, while acknowledging uncertainties, underscores the importance of adopting a widely accepted climatic approach based on the AI which is effective for evaluating climate change impacts in arid regions.

9. Drought is defined as an anomalous period of water shortage for existing ecosystems and the human population, together with its economic sectors, triggered by several different factors including: (i) lower than usual precipitation; (ii) deficits in soil moisture and/or usable water sources like streamflow and groundwater; and (iii) higher temperatures. Drought is part of the natural climate variability, capable of occurring in virtually any climatic regime, encompassing both high and low precipitation-regime areas. However human activities, such as land use and land management, contribute to shaping and often exacerbating drought events. It is crucial to highlight the temporary nature of drought in contrast to the permanent characteristics of climate features associated with aridity. Aridity refers to long-term mean conditions with potential changes occurring over lengthy time scales (e.g. decades).

10. Water scarcity is predominantly centred around the availability and use of water resources. The Integrated Drought Management Programme characterizes water scarcity as the gap between the available supply of and expressed demand for freshwater in a specified domain, under prevailing institutional arrangements (including resource pricing and retail charging arrangements) and infrastructural conditions, always involving a human dimension in the reduction in natural water supply.[4] The primary driver of water scarcity is typically a human-induced increase in water demand, and its severity is influenced by management strategies and practices.

## B. Aridity trends

11. The SPI assessed the global and regional evolution of drylands in terms of changes in the AI from the mid-20th century to 2020.[5] The global aridity map produced by the SPI for 1991–2020 reveals that drylands constitute 40.6 per cent of the world's land area (excluding Antarctica) (see figure 1).[6] Hyper-arid regions cover 9.1 per cent of this area, encompassing

[4] https://www.droughtmanagement.info/literature/1284_IDMP_Water_Scarcity_Report.pdf

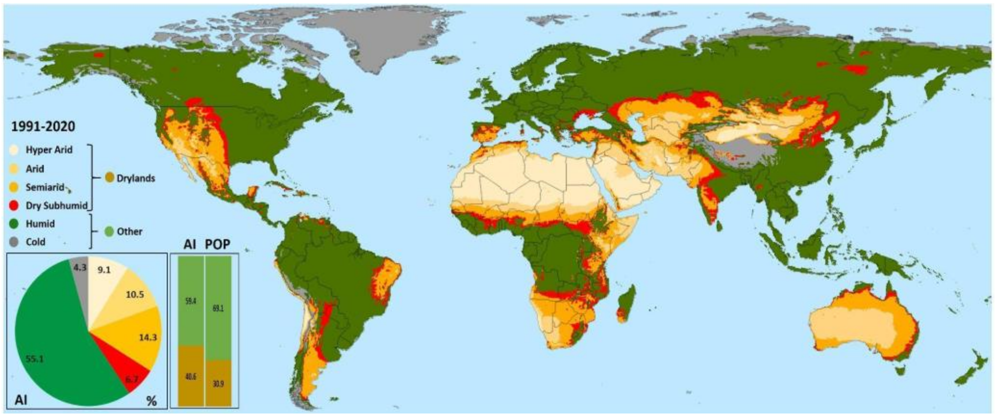
[5] The underlying data and information products generated for the development of the Science-Policy Interface technical report have been made available on the Aridity Visual Information Tool, which can be accessed through the UNCCD Website under Knowledge–Sharing Systems. This includes the global spatial distribution of the average aridity index and various aridity categories across two periods (1961–1990 and 1991–2020). Additionally, it includes aridity projections for 2100 based on two different emission scenarios and highlights the uncertainties in these projections. This information is necessary for assessing aridity trends at local to global scales, exploring scenarios to develop future projections, and for assessing socioeconomic and environmental aridity impacts, future risks, and the influence of mitigation and adaptation efforts.

[6] The methodology employed by the Science-Policy Interface (SPI) to quantify aridity is documented in the SPI technical report. It builds on the methods used in the World Atlas of Desertification, 3rd Edition https://publications.jrc.ec.europa.eu/repository/handle/JRC111155. https://wad.jrc.ec.europa.eu/patternsaridity with similar results. Most global assessments have found that drylands (excluding Antarctica) occupy between 37 and 42 per cent of the Earth's land surface. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate Change and Land (https://www.ipcc.ch/srccl/) reported a larger global extent of drylands (around 46 per cent), however this finding was derived from only two published papers, therefore the IPCC labelled this finding as "low confidence".

the Atacama, Sahara and Namib deserts, the Arabian Peninsula, and deserts in China and Mongolia. Arid, semi-arid and dry sub-humid zones are found across various continents, including in Brazil, Mexico, the southeastern United States of America, the Mediterranean, and much of Africa and Asia. Oceania has the largest proportion of drylands at 88 per cent, while Africa and Asia have the most extensive dryland areas, spanning over 21 million km² and 16 million km², respectively. More than half of the land falls in the humid class of the AI (55.1 per cent, and 49.5 per cent according to region, including Antarctica, in the global total) and the remaining 4.3 per cent (14.0 per cent including Antarctica) in the cold class, including the whole of Greenland, the Himalayan Plateau, and areas at very high latitudes in the Northern Hemisphere.

Figure 1

**Global Aridity Index map for 1991–2020**




*In the boxes:* percentage of lands (and population) within each Aridity Index class and within drylands or non–drylands (other) macro–classes. Antarctica falls entirely within the cold class but is not included on this map and is also excluded from the global percentages. *Abbreviations*: AI = Aridity Index; POP = Population

12. From 1961–1990 to 1991–2020, drylands expanded from 37.5 per cent to 40.6 per cent of global land area (excluding Antarctica), an increase of around 4.3 million km². Notable increases have been seen in western United States of America, northeastern Brazil, the Mediterranean, the Sahel, and central Asia. Countries like South Sudan and Tanzania experienced significant shifts in dryland conditions, with China having the largest increase in dryland area. Conversely, areas such as central United States of America, coastal Angola, and parts of southeast Asia show a wetting tendency. Overall, 77.6 per cent of global lands exhibit a drying trend, while 22.4 per cent show a wetting trend, with significant regional variations.

13. Historical simulations (which include all known climate change forcings, both natural and anthropogenic) indicate a 1.2 per cent larger dryland area from 1981–2010, compared to historical-natural simulations (which include only natural forcings, excluding any anthropogenic influences), suggesting human influence on arid area growth. Historical simulations reveal more drying in Latin and Central America, sub-Saharan Africa and East Asia in comparison to historical-natural simulations. Historical simulations estimate about 1.5 million km² more drylands globally than historical-natural simulations.

## C. Aridity impacts

14. Aridity impacts can be amplified or moderated by existing conditions and factors inherent to societies, the environment, and territories. Understanding these factors is crucial for designing effective mitigation and adaptation strategies to minimize the impacts of aridification in the coming decades. In 2020, drylands were home to 30.9 per cent of the global population, approximately 2.3 billion people. Asia and Africa host the majority, with 1.35 billion and 0.62 billion inhabitants in drylands, respectively. Densely populated dryland

areas include California, Egypt, Pakistan, India, and northeastern China, with China, India, and Pakistan combined accounting for around 50 per cent of the global dryland population.

15. Aridity profoundly affects both natural ecosystems and human societies by limiting water availability which affects the food system, security and livelihoods. Arid regions face challenges such as sparse vegetation, biodiversity loss and soil degradation, necessitating adaptive strategies for sustainable land management (SLM) and conservation. Long-term changes in climatic aridity are a major cause of land degradation, leading to desertification in drylands. Increasing aridity can cause abrupt changes in ecosystems, reducing soil fertility, productivity, and vegetation cover, which exacerbates land degradation. Furthermore, the response of ecosystems to aridity is non-linear, with small increases in aridity potentially causing drastic ecosystem changes, including reduced plant cover and an increased albedo effect.

16. Wildfires are strongly influenced by aridity, with increased atmospheric aridity leading to more frequent, severe and extensive fires, particularly in semi-arid regions like California, Chile, southern Europe and south Australia. These fires exacerbate land degradation and have significant feedback mechanisms with climate change.

17. Increased aridity affects economic wealth by degrading land and reducing water availability, which lowers crop yields and pasture quality, thus reducing income and profits for farmers and pastoralists. The relationship between aridity and poverty is complex and varies by region. For instance, a decrease in AI (i.e., an increase in aridity) is linked to declining GDP per capita in Africa and Asia.

18. Water scarcity is a critical issue affecting up to two billion people, predominantly in drylands. Conditions such as aridity, as well as anthropogenic factors such as population growth and unsustainable water use, exacerbate water scarcity by reducing water availability and increasing demand, affecting agriculture, livelihoods and socioeconomic stability.

19. The productivity of agricultural systems is highly dependent on water availability, making crops in arid lands particularly vulnerable to climate fluctuations.

20. In the absence of viable crop production due to arid conditions, pastoralism becomes critical for rural livelihoods in arid regions. Intense grazing exacerbates vegetation and rangeland degradation which can lead to changes in the composition of livestock species and a reduction in overall food production, aggravated by increased aridification.

21. Aridification affects health through water scarcity, land degradation and insufficient food production. Malnutrition, particularly in children, is linked to declining food production and essential nutrients in soils. Water scarcity forces reliance on poor-quality water, leading to diseases such as diarrhoea and cholera. Carrying water over long distances causes musculoskeletal disorders and increases the risk of violence, particularly for women and children. Additionally, dust storms, exacerbated by aridification, cause respiratory and cardiovascular diseases, increasing mortality rates. Wildfires, intensified by arid conditions, pose significant health risks through direct fatalities and pollution-related morbidity. Smoke from wildfires is strongly associated with respiratory problems, cardiovascular issues and increased mortality. Exposure to wildfire smoke exacerbates asthma, chronic obstructive pulmonary disease and other respiratory infections. The health impacts of wildfires highlight the need for better management and mitigation strategies in arid regions prone to such events.

22. Poverty significantly increases vulnerability to climate change and climatic shocks, including in regions that will experience increased aridity. Factors contributing to this vulnerability include limited resources to recover from climate shocks, livelihoods dependent on climate-sensitive sectors, low-income jobs with little protection against climate disruptions, higher exposure to climate extremes, limited access to adaptation knowledge, and fewer alternative livelihood options. The relationship between land degradation and poverty is complex and often conceptualized as a "self-reinforcing downward spiral". In fact, poorer households may adopt more sustainable land management practices due to greater dependence on land for livelihoods.

23. Population growth and overpopulation increase vulnerability to climate hazards, including those exacerbated by increasing aridity, by exposing more people to risks and increasing pressure on land and resources. Structural population characteristics such as the

rural population percentage, refugees, literacy rate, and life expectancy are used as proxy variables for designing vulnerability indexes to drought. Gender inequity and age further exacerbate vulnerability, with women and children particularly at risk due to health conditions, gender-based violence, and greater responsibilities in agriculture and household work. Limited access to education and healthcare also increases children's vulnerability to climate impacts, including aridification.

24. Aridification drives mobility and migration as people seek better living conditions due to economic hardship and lack of resources. Environmental changes, particularly in drylands, force people to migrate. This migration is influenced by socio-economic, political, and cultural factors. Political instability and armed conflicts, often exacerbated by environmental stress, further drive migration in arid regions.

25. The degradation of ecosystems and desertification driven by aridity occur in a non-linear fashion, following stages of increasing damage and vulnerability. Once an aridity threshold is crossed, small increases in aridity can lead to drastic changes in ecosystem structure. Previous degradation states of ecosystems, driven by both climate and non-climate factors such as rapid population growth and unsustainable farming practices, play a significant role in land vulnerability.

## D. Aridity projections and future risks

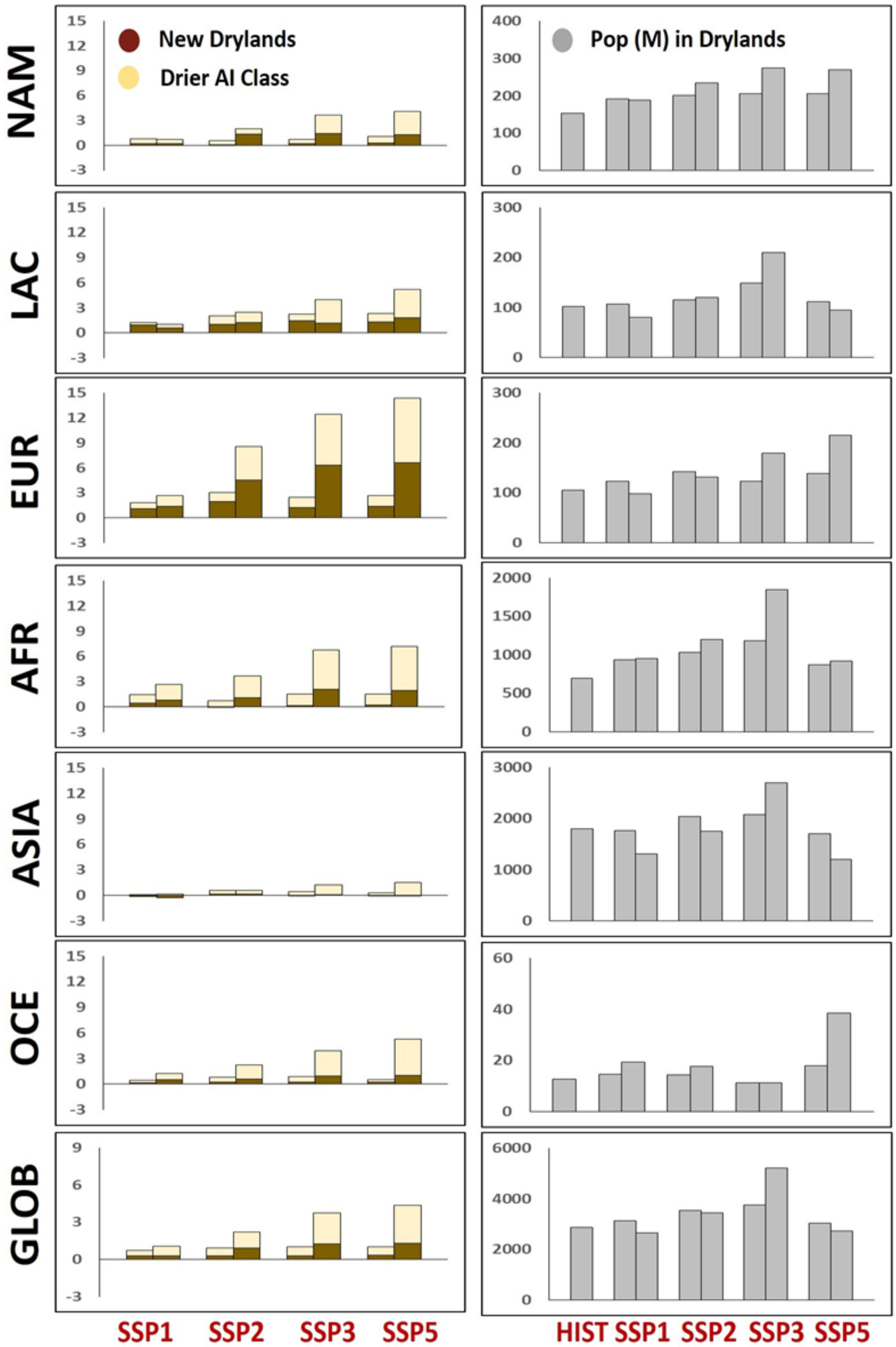
26. Climate change is expected to increase aridity, with significant regional differences. For example, global dryland areas could expand by 23 per cent and 11 per cent according to the Representative Concentration Pathways (RCP) 8.5 and 4.5 scenarios, respectively, by 2100. Areas like Europe, western Asia, and northern China show higher aridification, while regions like the Qinghai–Tibet Plateau and India may see decreased aridity. Notably, projections for Central Asia and China show contrasting trends, with potential decreases in desert land area due to increased rainfall and ecological protection measures.

27. The SPI future aridity projections depict heterogeneous changes in the global AI (see figure 2). Significant changes in AI classes are observed towards the end of the century, particularly under the Shared Socioeconomic Pathway (SSP)[7] SSP3 and SSP5, indicating a shift from non-drylands to drylands in various regions. No regions are projected to shift from historical drylands to future humid lands. This indicates a general trend towards increased aridification in several key regions. Drying and wetting patterns are more pronounced under SSP3 and SSP5 scenarios representing less sustainable development.

[7] Shared Socioeconomic Pathways (SSPs) are climate change scenarios of projected socioeconomic global changes up to 2100, as defined in the Intergovernmental Panel on Climate Change Sixth Assessment Report on Climate Change in 2021: https://www.ipcc.ch/report/ar6/wg1/.
The SSPs have different features, but can be generalized as follows:
SSP1: Gradual but pervasive shift to mitigation and adaptation
SSP2: Intermediate challenges to mitigation and adaptation
SSP3: High challenges to mitigation and adaptation
SSP4: Adaptation challenges dominate
SSP5: Mitigation challenges dominate

Figure 2

**Future aridity and populations based on the projected percentage of regional and global changes from the recent past (1981–2010) to 2050 and 2100, according to four SSPs**




*Left panels:* new drylands and shift to drier AI classes (%). *Right panels:* total population in drylands (in millions of people), including values for the recent past. *Abbreviations:* NAM = North America; LAC = Latin American and the Caribbean; AFR = Africa; ASIA = Asia; OCE = Oceana; GLOB = global; AI = Aridity Index; Pop = Population; SSP = Shared Socioeconomic Pathway; HIST = Historic trend (1981–2010); M = Millions; SSP - Shared Socioeconomic Pathway

28. Increased aridity will likely lead to more frequent and severe sand and dust storms (SDS). In the southwestern United States of America, high emission scenarios predict a 57 per cent rise in atmospheric dust by the end of the century, causing significant health and economic impacts. However, some models suggest reductions in SDS in regions such as western Asia due to higher soil moisture and lower wind speeds. The complexity of these multi-causal events underscores the need for more research to improve robustness and reduce uncertainties.

29. Future aridity will significantly affect ecosystems and biodiversity. Over 20 per cent of the terrestrial surface may cross aridity thresholds by 2100, causing non-linear ecological changes. Increased atmospheric CO2 concentration levels may mitigate some impacts by enhancing plant water use efficiency, however severe habitat loss for terrestrial vertebrates is expected under high emission scenarios, with arid regions such as West Africa and the Iberian Peninsula most affected. Aquatic ecosystems and forested areas will also face severe stress, potentially leading to shifts towards more drought-resistant shrub species.

30. Climate change is projected to worsen drought and water scarcity, particularly in dry subtropical regions. Global terrestrial water storage may decrease across two-thirds of land by the end of the century, driven by changes in precipitation and evaporation patterns. Regions like the Mediterranean, Central Asia, and the Middle East and North Africa are highlighted as hotspots of reduced water availability. Projections for river flow reductions and increased water demand in agriculture underscore the urgent need for sustainable water management strategies.

31. Agriculture and food production are already suffering due to climate change with future warming expected to further threaten food safety and security. Increased aridity will reduce yields of major crops like maize, rice, and wheat, especially in regions such as Sub-Saharan Africa and South Asia. While some studies consider the potential benefits of higher atmospheric CO2 concentration levels on crop yields, the overall trend indicates significant risks to food production and livestock due to heightened heat stress, reduced water availability and degraded quality.

32. The impact on populations within drylands varies by scenario. SSP3 is the worst-case scenario, projecting over five billion people in drylands by 2100, while SSP1 and SSP5 project around 2.5 billion. Regionally, North America, Europe and Africa are likely to see an increase in populations in drylands across all SSPs. Conversely, Asia and Oceania show more complex patterns, with significant population increases under SSP3. SSP1 is considered the optimal scenario for minimizing aridification risk and population growth in drylands, indicating that a sustainability-focused pathway may mitigate some of the worst impacts of aridification.

## E. Aridity adaptation and future approaches

33. Adaptation measures are essential to reduce the vulnerability of ecosystems and populations to increasing aridity, from broad, large-scale measures to regional or local approaches focused on vulnerable communities in the most affected arid countries. The effectiveness of any adaptation strategy is clearly linked to global mitigation actions and efforts to limit global warming. The SPI assessed the determining factors for the level of vulnerability of ecosystems and societies to aridity, as essential knowledge to design mitigation and adaptation strategies that help minimize the impacts of aridification in future decades.

34. Arid regions historically developed livelihood means adapted to limited water resources, such as rainfed agriculture and pastoralism. While these adaptations help cope with harsh conditions, dependence on these activities increases vulnerability to aridity and climate extremes like floods and droughts.

35. Key priorities for adaptation to aridity include assessing the effectiveness of adaptation responses, understanding adaptation limits, enabling individual and societal adaptation, and improving methods for synthesizing evidence. The assessment of factors contributing to the vulnerability of societies and environments to increased aridity is critical.

There is a need for more scientific research on the socioeconomic impacts and vulnerabilities associated with prolonged aridification, which is currently underexplored.

36. Sectoral approaches tailored to specific regions and communities are crucial to mitigate the impacts of aridity, especially on food systems. Agricultural adaptation measures include developing highly productive, heat-resistant and water-efficient crop varieties. Sustainable practices such as polyculture and agroecology are recommended to enhance biodiversity and resilience. Additionally, crop diversification, such as growing sorghum instead of maize, and implementing agroecological principles, can improve food production, nutrition, and soil fertility under dry conditions. Climate services allowing for a dynamic approach to cultivars have recently been proven to produce major benefits, especially when coupled with economic stabilizing mechanisms.

37. Sustainable irrigation methods, such as drip irrigation, are key to diversifying crop production in arid regions while conserving water. While large-scale conventional irrigation can lead to severe environmental degradation, localized sustainable practices have demonstrated significant benefits, such as increased crop yields and reduced water usage. However, efficient irrigation systems can sometimes lead to unintended consequences like increased overall water consumption and soil salinization. Thus, careful planning and capacity-building are necessary to ensure these methods contribute positively to water resource management and agricultural sustainability.

38. Adapting livestock and pastoral practices to increasing aridity involves using species better suited to hot and dry conditions. Examples include switching from cows to goats for dairy production and adopting camel management in regions where camels are more resilient to drought. Supporting traditional practices through appropriate policies can help communities better withstand the impacts of climate variability and aridification.

39. Effective water management is essential for sustaining agriculture and ensuring water security in arid regions. Practices like rainwater harvesting and soil moisture conservation have proven effective in increasing agricultural productivity. Technological solutions like desalination and managed aquifer recharge have been implemented in wealthier countries, however they require significant investment and infrastructure, often making them less feasible in low-income regions. The reuse of greywater is gaining traction as a cost-effective method of addressing water scarcity, though it requires careful management to ensure safety and effectiveness.

40. Transformational adaptation to aridity involves large-scale, fundamental changes to affected systems, as opposed to incremental adaptations that progressively increase the intensity of existing actions. Large-scale adaptation examples include progressive re–greening of degraded landscapes and targeted forest restoration to mitigate drought risk.

41. Early warning systems play a crucial role in minimizing the effects of aridification, particularly for sudden events like sand and dust storms. These systems provide critical information on drought conditions and other climate-related phenomena, enabling timely risk management while optimally contributing to adaptation measures. Effective early warning systems have been shown to reduce the negative impacts of aridification by improving preparedness and response, supporting better understanding of aridification processes, and enhancing decision-making capabilities in vulnerable regions.

42. Capacity-building, knowledge integration and education are critical for comprehending and addressing aridification challenges. This includes training on new technologies, the promotion of sustainable practices, and the establishment of early warning systems and climate services. Education and awareness programmes are vital for informing local communities about drought impacts and fostering effective adaptation strategies. Indigenous local knowledge has proven successful in adapting to changing climatic conditions, emphasizing the importance of involving local communities in the design and implementation of adaptation plans. Investing in education and capacity-building programmes prepares societies for future aridification impacts and promotes sustainable adaptation practices. Universal access to education is a critical measure for reducing vulnerability to environmental and climate shocks as educated populations are better equipped to respond to and recover from disasters. Education, particularly for women and children, can mitigate the adverse effects of climate change, such as child stunting.

Investments in primary and secondary education are considered highly effective in enhancing societal resilience. Additionally, awareness and climate information services are vital for helping farmers and communities adapt to changing environmental conditions by providing accurate weather forecasts and climate trends, facilitating informed decision–making.

43. Effective adaptation to aridity and climate change requires policies informed by comprehensive knowledge and guided by robust governance, practices, and information dissemination. Developing conceptual frameworks for effective policies and measures is crucial to combat the large-scale impacts of aridity. Incremental approaches like sustainable land management have guided land degradation practices for decades, however, the urgency of actions needed to mitigate climate change effects has led to the adoption of the land degradation neutrality (LDN) concept. LDN aims to stabilize or increase land resources to support ecosystem functions and food security. Robust governance structures are essential to coordinate climate change and aridification adaptation initiatives effectively. Good governance involves creating and implementing policies that address climate impacts, fostering collaboration among public and private institutions. Multi–stakeholder partnerships have proven effective by leveraging diverse sector strengths and addressing participatory gaps. Involving local and regional entities in decision-making processes ensures that adaptation efforts are context-specific and responsive to unique geographical challenges, promoting a more inclusive and holistic approach.

44. Robust monitoring and reporting mechanisms ensure accountability and track progress in adaptation plans and measures, however they do not currently account for aridity trends and future risks. Regular assessments provide insights into the effectiveness of implemented strategies, identifying successes, challenges and areas needing attention. Adaptation reporting elevates climate risks to the corporate level, facilitating integration into existing risk management and governance structures. For policymakers, reporting enhances understanding of climate risks from a bottom-up perspective, aiding national-level adaptation planning. Transparent reporting can foster a culture of learning and continuous improvement which is essential to adapt to climate change and aridification.

45. At present, aridity trends and projections are typically not incorporated into existing monitoring frameworks used to support climate change adaptation planning and drought resilience monitoring. Moreover, alternative approaches to assessing aridity trends and impacts may yield different results. The uniqueness of each region makes it challenging to develop standardized assessments that universally capture the diverse factors at play. This variability emphasizes the importance of adopting a widely accepted climatic approach based on the AI when assessing the projections of aridity under future climate scenarios and when developing standards for aridity impact assessments. Such an approach can account for the full range of uncertainties in the estimated changes in a consistent way, offering a more standardized foundation for evaluating the potential impacts of climate change on aridity conditions. At the same time, it is essential to account for the full range of uncertainties in the estimated changes.

46. Adequate financial resources are crucial for implementing effective adaptation strategies to combat aridification, ensuring communities and institutions have the necessary means to address the challenges posed by increasing aridity. Private sector participation is vital, though engaging private funding is challenging due to the lack of direct incentives for adaptation measures compared to mitigation activities. International funding plays a significant role in supporting vulnerable regions. Investments in adaptation strategies should be cross-sectoral to maximize benefits, addressing poverty alleviation, food security and ecosystem conservation.

# III. Conclusions and recommendations

**47. The SPI technical report identifies and provides science-based evidence on historical global and regional aridity trends and future projections that may contribute to expanding drylands and affected populations and the adaptation approaches. The SPI drew five conclusions supporting the vision of the 2018–2030 Strategic Framework of the UNCCD: "A future that avoids, minimizes, and reverses desertification/land**

**degradation and mitigates the effects of drought in affected areas at all levels and strive to achieve a land degradation neutral world consistent with the 2030 Agenda for Sustainable Development, within the scope of the Convention."[8]**

## A. Conclusion 1 on strengthening aridity monitoring

**48. Access to aridity information is essential for improving the capacity of governments and institutions to address the impacts associated with changes in aridity and to develop better adaptation tools. The assessment of desertification vulnerability and risk, which are influenced by aridity trends, can be enhanced through the application of indicator-based systems for monitoring at national, regional and global scales.**

**49. Aridity monitoring systems should be integrated into existing drought monitoring frameworks to identify critical ecological and socioeconomic thresholds. More comprehensive aridity monitoring and reporting approaches would also enhance early warning capabilities for water-related sectors, particularly if the system leveraged existing drought observatories and the United Nations Early Warning for All initiative for improved global cooperation.**

## B. Conclusion 2 on an aridity impact assessment standard

**50. The development of a global standard for assessing the socioeconomic and environmental impacts of aridity would facilitate consistent and cross-regional analysis, enabling (with appropriate support) effective adaptation strategies and promoting resilience among vulnerable communities, particularly in shared river basins and watersheds. Guidelines would emphasize temporal and spatial monitoring to adapt methodologies in response to climatic, environmental and socioeconomic changes. This global-to-local hierarchical approach would facilitate unified understanding, enable evidence-based tailored strategies, promote inclusivity in addressing aridity impacts and integrate, where possible, Indigenous knowledge and community-led monitoring efforts to ensure the framework's cultural sensitivity and ground it in local realities.**

## C. Conclusion 3 on integrating aridity adaptation and drought planning into National Adaptation Plans

**51. Aridity adaptation and drought planning should be consolidated into a unified strategy both internationally and under National Climate Adaptation Plans in order to reduce the compound effects of climate change. In addition to mainstreaming sectoral plans into national adaptation strategies, emphasizing community involvement and capacity-building to foster sustainable water and land management practices is also a priority focus area. A robust monitoring framework for aridity-specific indicators will ensure the efficiency and sustainability of adaptation measures, aligning with overarching national and regional climate adaptation strategies. Proven adaptive management practices from diverse ecological zones, such as the use of water-saving technologies and practices in agriculture, should be leveraged while advocating for flexible funding mechanisms to support these strategies using robust evidence and scalability.**

## D. Conclusion 4 on integrative resilience strategies

**52. Emphasis should be placed on existing and emerging land-use planning and sustainable land-use practices to combat land degradation exacerbated by drought and aridity. Incentives should be offered for the adoption of conservation agriculture and**

[8] Decision 7/COP.13, Annex, paragraph 4: https://www.unccd.int/official–documentscop–13–ordos–china–2017/7cop13.

**forestry to maintain ecosystem services, underpinned by policy incentives, market incentives and emerging technologies for predictive analysis and strategy optimization. Comprehensive land-use planning (with environmental, social and economic criteria) should be promoted, alongside soil conservation through sustainable practices such as agroforestry, organic farming, agroecology and/or climate-smart agriculture. Measures such as terracing and reforestation should be implemented to enhance soil and forest health. These actions should be supported with financial incentives tied to environmental performance (within both the public and private sectors), encouraging broader adoption of sustainable practices.**

**53. The development and use of both emerging technologies (artificial intelligence and digital twins) and traditional knowledge systems should be advocated to support precise land management. The compilation of a global repository of case studies on successful land restoration efforts should be advocated, providing a blueprint for addressing land degradation and fostering resilience. This implies strengthening networks of field meteorological stations, which are particularly scarce in arid regions, integrating soil and hydrogeological survey data into 3D models to evaluate flood risks and hydrological disruptions, and regulating the exploitation of deep aquifers that contain non-renewable and fossil groundwater resources.**

## E. Conclusion 5 on promoting cross-sectoral aridity governance

**54. Adaptation to aridity, as well as to climate change extremes, requires cross sectoral action guided by policy and informed by knowledge. LDN is a resilience framework that, by avoiding, reducing and reversing land degradation, contributes to biodiversity conservation, climate change mitigation and adaptation, food and water security and poverty reduction through integrated and inclusive land use planning and sustainable land and water management. Responsible and inclusive multi-level land governance is central to the efforts of Parties to achieving LDN by 2030 and pursuing a nature-positive trajectory thereafter.**

**55. The UNCCD LDN multi-level governance framework should be enhanced to integrate aridity adaptation and risk reduction while addressing land degradation and drought impacts, drawing on the principles of the Sendai Framework for Disaster Risk Reduction, the Convention on Biological Diversity, and the United Nations Framework Convention on Climate Change. This cross-sectoral collaboration should continue to promote initiatives that harness and maximize synergies among existing multilateral agreements, goals and targets, including the Sustainable Development Goals (SDG), particularly SDG Target 15.3 on LDN, the Sendai Framework, the Kunming-Montreal Global Biodiversity Framework, and the Global Goal on Adaptation, showing quantitative alignment, where possible. Robust public-private partnerships should be encouraged to mobilize resources for innovative and integrative sustainable land and water management projects, aligning with the objectives of the LDN targets under the UNCCD. Such cooperation is vital for the development and implementation of technologies and conservation practices that support risk reduction and adapt to aridity. International cooperation and local capacity enhancement are pivotal in this endeavour, as are sustainable financing mechanisms, communication and outreach to the public. By connecting global decision-makers, civil society and practitioners, the integrative LDN governance framework helps advance the adoption of best land practices and active participation in global initiatives. This approach should continue to leverage financial partners such as the Global Environment Facility and the Green Climate Fund, ensuring that efforts to combat aridity and land degradation are well-supported and aligned with broader environmental and climate goals. It should also begin to explore substantive global financing mechanisms to assist with adaptation efforts in areas already being affected by increased aridity.**

**56. Parties may wish to consider these conclusions when engaging in consultations on a draft decision to be considered by the COP based on the draft text for negotiations that can be found in document ICCD/COP(16)/CST/10, which, following decision**

**33/COP.15, contains all draft decisions prepared for Parties for consideration at the 16th session of the Committee on Science and Technology.**