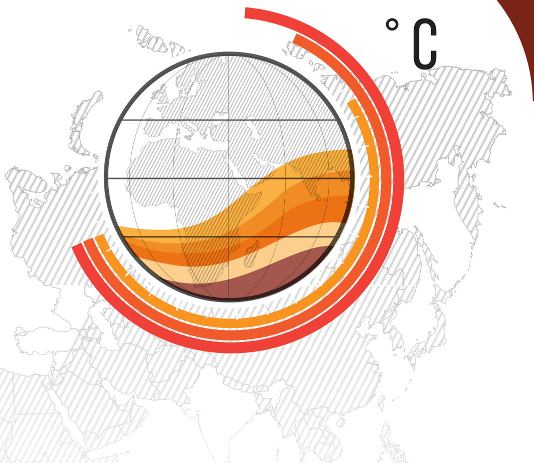
WHAT GLOBAL WARMING OF 1.5°C AND HIGHER MEANS FOR NAMIBIA



The Paris Agreement has a goal of limiting global warming well below 2°C, ideally 1.5°C. Understanding the local-level impacts of these global temperature targets is crucial for informing climate change adaptation needs and actions. To date, mitigation pledges by nations fall far short of what is needed, with the world on track to warm by 3.2°C by the end of the century[1].

For Namibia, local warming and drying will be greater than the global average. So, even a 1.5°C increase in global temperature will have severe local impacts, negatively affecting water supply, agriculture, health, and other vulnerable sectors. The 1.5°C threshold could be breached within the next decade, and the 2°C threshold the decade after[2]. This means there is an urgent need to accelerate Namibia's adaptation responses.

LOCAL IMPACTS IN NAMIBIA

GLOBAL WARMING ABOVE PRE-INDUSTRIAL LEVELS

			1.5°C	vs 2°C	vs 2.5°C	vs 3°C
Projected climate changes[3]	CLIMATE	Mean temperature (°C)	▲ 2	▲ 2.7	▲ 3.3	▲ 4
		Heat waves (days)	▲ 50	▲ 78	▲ 114	▲ 148
		Annual rainfall	▼ 4%	▼ 7%	▼ 11%	▼ 14%
		Heavy rainfall (days)	▼ 1	▼ 1	▼ 2	▼ 2
		Dry days	▲ 12	▲ 17	▲ 22	▲ 27
Estimated impacts[4]	WATER	Evapotranspiration rates[5]	▲ 10%	▲ 14%[6]	▲ 17%[6]	▲ 20%[6]
		Surface runoff[7]	▼ 19%[6]	▼ 30%[6]	▼ 40%[6]	▼ 50%[6]
		Groundwater recharge rates[8]	▼ 33%[6]	▼ 49%[6]	▼ 66%[6]	▼ 82%[6]
	AGRICULTURE	Cereal crops[5] (productivity)	▼ 5%[6]	▼ 10%	▼ 15%[6]	▼ 20%
		Livestock[5] (productivity)	▼ 5%	▼ 20%	▼ 35%	▼ 50%
	HEALTH	Malaria[9] (months of risk)	▼ 23%[6]	▼ 34%[6]	▼ 44%	▼ 56%[6]
		Heat stress[10] (number of days of exposure)	▲ 21	▲ 41	▲ 41	▲ 188
	BIODIVERSITY	Desert encroachment[5]	▲ 11%[6]	▲ 18%[6]	▲ 18%	▲ 43%
		Species loss[11]	▲ 30%[6]	▲ 40%	▲ 50%	▲ 60%

[1] Climate Action Tracker. https://climateactiontracker.org/global/cat-thermometer.
[2] Nkemelang, T. et al. 2018. Determining what global warming of 1.5°C and higher means for the semi-arid regions of Botswana, Namibia, Ghana, Mali, Kenya and Ethiopia: A description of ASSAR's methods of analysis. https://bit.ly/2yHbWPf.
[3] Based on climate modelling by T. Nkemelang. University of Cape Town, South Africa.
[4] Based on data analysis by R. Bouwer. University of Cape Town, South Africa.
[5] Reid, H., Sahlén, L., Stage, J. and MacGregor, J. 2008. Climate change impacts on Namibia's natural resources and economy. *Climate Policy*. https://doi.org/10.3763/cpol.2008.0521.
[6] Extrapolated assuming a linear progression with no threshold being reached.
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[11] Midgley, G., Hughes, G., Thuiller, W., Drew, G. & Foden, W. 2005. Assessment of potential climate change impacts on Namibia's floristic diversity, ecosystem structure and function.Climate Change Research Group: South African National Biodiversity Institute. Cape Town.

ASSAR
Adaptation at Scale in Semi-Arid Regions

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IMPACTS OF GLOBAL WARMING THRESHOLDS ON NAMIBIA'S CLIMATIC ZONES

	HYPER ARID				ARID SOUTH			
	1.5°C	2°C	2.5°C	3°C	1.5°C	2°C	2.5°C	3°C
Annual rainfall (%)	-6	-9	-12	-16	-7	-9	-16	-18
Duration of dry spells (days)	+ 10	+ 17	+ 18	+ 25	+ 12	+ 18	+ 22	+ 28
Duration of wet spells (days)	0	0	-1	-1	0	-1	-1	-1
Heavy rainfall days (>10mm/day)	0	0	0	0	0	-1	-1	-1
Extreme heavy rainfall days (>20mm/day)	0	0	0	0	0	0	0	0
Amount of rain in heavy rainfall events (%)	0	-2	-5	-7	+1	+2	-4	-7
Amount of rain in extremely heavy rainfall events (%)	+15	+12	+8	+3	+11	+11	+3	-4
Amount of rain in highest rainfall day (%)	0	-2	-3	-2	0	0	-2	-4
Amount of rain in highest five consecutive rainfall days (%)	0	-5	-5	-4	+1	-2	-3	-5
Temperature change (°C)	+1.6	+2.2	+2.7	+3.2	+1.9	+2.6	+3.2	+3.8
Number of hot days (>90th percentile)	+73	+105	+139	+171	+73	+103	+134	+159
Number of hot nights (>90th percentile)	+77	+111	+147	+183	+63	+91	+124	+150
Number of cold days (<10th percentile)	-40	-45	-49	-51	-31	-37	-40	-43
Number of cold nights (<10th percentile)	-49	-54	-57	-59	-40	-45	-49	-52
Duration of heat waves (days)	+38	+65	+95	+126	+34	+61	+89	+117

	ARID NORTH				SEMI-ARID SOUTH			
	1.5°C	2°C	2.5°C	3°C	1.5°C	2°C	2.5°C	3°C
Annual rainfall (%)	-4	-6	-9	-13	-3	-8	-8	-12
Duration of dry spells (days)	+ 13	+ 17	+ 21	+ 28	+ 12	+ 17	+ 22	+ 30
Duration of wet spells (days)	0	-1	-1	-1	-1	-1	-2	-1
Heavy rainfall days (>10mm/day)	0	-1	-1	-2	-1	-2	-2	-2
Extreme heavy rainfall days (>20mm/day)	0	0	0	0	0	0	0	0
Amount of rain in heavy rainfall events (%)	+5	+5	+5	+1	+2	+3	+1	0
Amount of rain in extremely heavy rainfall events (%)	+19	+21	+22	+12	+13	+19	+17	+12
Amount of rain in highest rainfall day (%)	+2	+4	+3	+4	+4	+4	+5	+4
Amount of rain in highest five consecutive rainfall days (%)	+2	+2	+4	+3	+2	+1	+2	+2
Temperature change (°C)	+2.0	+2.7	+3.4	+4.0	+2.1	+2.9	+3.5	+4.2
Number of hot days (>90th percentile)	+85	+124	+157	+189	+86	+125	+164	+201
Number of hot nights (>90th percentile)	+78	+111	+150	+183	+86	+125	+165	+198
Number of cold days (<10th percentile)	-30	-36	-39	-42	-30	-35	-39	-41
Number of cold nights (<10th percentile)	-41	-45	-48	-50	-42	-46	-49	-50
Duration of heat waves (days)	+53	+84	+123	+160	+59	+92	+134	+174

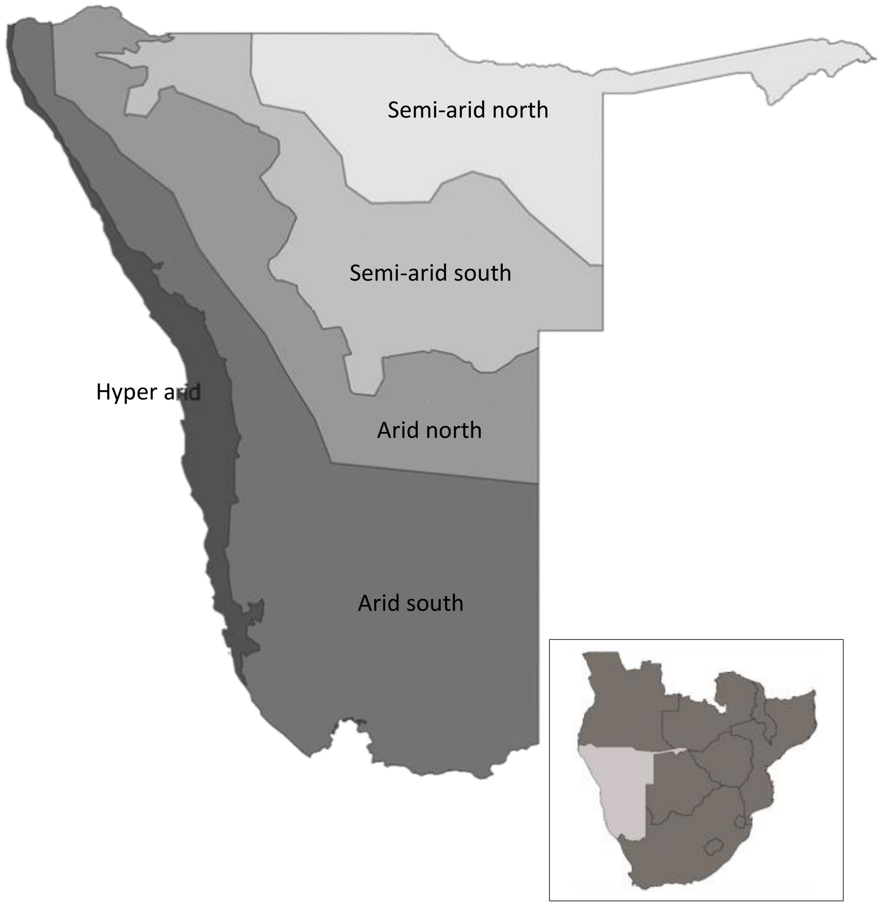
	SEMI-ARID NORTH				NAMIBIA OVERALL			
	1.5°C	2°C	2.5°C	3°C	1.5°C	2°C	2.5°C	3°C
Annual rainfall (%)	-4	-6	-9	-12	-4	-7	-11	-14
Duration of dry spells (days)	+ 13	+ 17	+ 21	+ 28	+ 12	+ 17	+ 22	+ 27
Duration of wet spells (days)	-1	-1	-2	-2	-1	-1	-1	-1
Heavy rainfall days (>10mm/day)	-1	-2	-3	-4	-1	-1	-2	-2
Extreme heavy rainfall days (>20mm/day)	0	0	0	0	0	0	0	0
Amount of rain in heavy rainfall events (%)	+5	+1	+3	+8	+6	+5	+1	+1
Amount of rain in extremely heavy rainfall events (%)	+14	+14	+25	+26	+15	+13	+18	+21
Amount of rain in highest rainfall day (%)	+5	+5	+5	+6	+3	+3	+3	+2
Amount of rain in highest five consecutive rainfall days (%)	+2	+2	+2	+4	+3	+1	+2	+1
Temperature change (°C)	+2.1	+2.8	+3.5	+4.1	+2.0	+2.7	+3.3	+4.0
Number of hot days (>90th percentile)	+89	+128	+168	+205	+81	+118	+153	+184
Number of hot nights (>90th percentile)	+95	+136	+179	+216	+75	+111	+150	+183
Number of cold days (<10th percentile)	-30	-35	-39	-41	-33	-37	-41	-43
Number of cold nights (<10th percentile)	-42	-46	-49	-51	-41	-46	-49	-51
Duration of heat waves (days)	+59	+96	+146	+180	+50	+78	+114	+148

Anticipating a 1.5°C+ world

The Paris Agreement has a goal of limiting global warming to below 2°C (and ideally below 1.5°C) above pre-industrial levels. Current emissions reduction promises by nations fall short of what is needed to meet this target. Instead, global average temperatures could exceed the 1.5°C warming mark by as early as the next decade and the 2°C threshold the decade after (Nkemelang *et al*. 2018). The world is on track for a warming of 3.2°C by 2100 (Climate Action Tracker).

For vulnerable countries like Namibia, these seemingly small increments in global temperature can lead to distinct local climate conditions, which can interact with, and worsen, existing vulnerabilities. Many communities in Namibia have little capacity to adapt to the impacts of the changes projected at 1.5°C and above, and government-led adaptation often tends to focus on immediate development needs. There is thus an urgent need for Namibia to adopt extensive adaptive and transformative response in order to deal with the increasing risks associated with global temperature rise of 1.5°C and above (Spear *et al.*, 2018).

As this brief highlights, Namibia needs to anticipate and plan for rapid changes in local weather and climate. To adapt to a 1.5°C+ world, Namibia will need to accelerate the implementation of its National Policy on Climate Change through identified adaptation options outlined in the Climate Change Strategy and Action Plan. With these instruments in place, and aware of the near-term risks of 1.5°C warming and above, Namibia will be in a far better position to respond to the impacts associated with 1.5°C and above.



Namibia

Namibia is an arid country. Its climate ranges from semi-arid in the north-east to hyper arid in the south and west. For our analysis we assess the impacts of exceeding different global warming targets across five geoclimatic zones: hyper arid, arid south, arid north, semi-arid south and semi-arid north zones.

With its dry and hot climate, Namibia is already vulnerable to climate variability, and without adaptation, climate change will heighten this vulnerability. As global temperature increases by 1.5°C and more, climate models project that Namibia will experience increasing frequency and intensity of climate extremes.

Anticipated changes in Namibia's climate and its extremes

Increasingly warm temperatures

Temperatures in Namibia are set to rise much more rapidly than the global average. For each 0.5°C increment in global temperature, mean temperature for Namibia will increase by 0.5-1°C more. At 1.5°C global warming, for example, temperature increases across the country will be between 1.6-2.1°C (Table 2). The semi-arid south is expected to have the biggest temperature increases while the hyper-arid zone will experience the lowest increase.

As global and local mean temperature rises, temperature extremes will change as well. Hot days and nights will increase sharply, while cold snaps will decrease along with distinct decreases in cold days and nights. Warm spells and heat waves will also be much more frequent and last for longer. At 1.5°C, the duration of heat waves will increase by up to 59 days, with the biggest increase in the semi-arid zones. Heat waves are expected to increase in duration by up to 96 and 180 days respectively at 2°C and 3°C. The largest increase will occur in the semi-arid north. Increasing temperatures will increase heat stress in Namibia's vulnerable sectors, and will also increase the severity of droughts in the country.

Birgit Ottermann

Table 2: Local changes to Namibia's temperature, heat waves and rainfall

	Local temperature increases	Duration of heat waves	Local rainfall decreases
1.5°C	+ 1.6-2.1°C	+ 34-59 days	- 3-7%
2°C	+ 2.2-2.9°C	+ 61-96 days	- 6-9%
2.5°C	+ 2.7-3.5°C	+ 89-146 days	- 9-16%
3°C	+ 3.2-4.2°C	+ 117-180 days	- 12-18%

Decreasing annual rainfall

At increasing levels of global warming, total annual rainfall is projected to decrease across the country (Table 2). The largest relative decrease in rainfall will be experienced in the hyper-arid and arid-south zones, which will experience decreases of 6% and 7% respectively at 1.5°C. At 3°C, these regions will experience decreases of 16% and 18% respectively. The impact of decreased rainfall may result in the increasing expansion of the hyper-arid zone into the arid south, and the loss of land suitable for rain-fed agriculture and livestock grazing. Decrease in rainfall will correlate with the increasing duration of dry spells and a slight decrease in the duration of wet spells (see Table 1 for details for each zone).

Decreasing frequency but increasing intensity of heavy rainfall events

As temperature increases and rainfall decreases in Namibia, the amount of days with heavy rainfall are expected to decrease across the arid and semi-arid zones. The hyper-arid zone is not expected to change in this regard. While the number of days with heavy rainfall will decrease, the amount of rain falling within heavy rainfall events, and particularly extremely heavy rainfall events, will increase. At 1.5°C and 2°C, the arid north will experience the largest increase with increases of 5% and 19% at 1.5°C for heavy and extremely heavy events respectively and a 5% and 21% increase for heavy and extremely heavy rainfall events at 2°C. The amount of rain falling within the largest rainfall event and five consecutive day event will increase by up to 5% and 2% respectively at 1.5°C.

While most zones will have increasing strong rainfall events, the hyper-arid zone will either have the smallest increase or experience decreases. In terms of the amount of rain falling within extremely heavy events, the zones will experience an increase of 15% but this will be reduced to increases of 3% by 3°C (see Table 1 for details for each zone).

Marine and coastal changes

Namibia's coastal zone is important for the economy, playing a vital role in trade, fisheries and tourism. Global temperature increases of 1.5°C and above are expected to have significant impacts on the country's marine and coastal areas. Sea surface temperatures along the coast of Namibia have been observed to have cooled by 0.2 - 0.4°C between 1950 -2011 (Potts *et al*., 2015). Changing wind speeds and directions are also expected to increase upwelling along the coast. Changes in the Benguela current will have uncertain impacts on marine ecosystems. Some predictions suggest increased reproduction of fish species, and possible migration of new species into Namibian waters (Potts *et al*., 2015).

Coastal towns such as Walvis Bay, Luderitz, Swakopmund and Henties Bay are important for tourism, fisheries and trade. Walvis Bay's deep water port is a vital trade centre for the country and its neighbours. For each increment in global temperature, these coastal areas will experience increasing sea level rise. Walvis Bay will be particularly vulnerable due to the low height above sea level and erodible coastline. Between 1.5°C and 2°C, sea level rise in Walvis Bay will be between 14-26cm (Climate Analytics, 2018). It should be noted that sea level rise lags behind temperature increases, and the impacts related to each increment of temperature will only be experienced in later years. The Namibian government estimates that 30cm of sea level rise will result in flooding of significant areas of Walvis Bay (Republic of Namibia, 2002). This means that warming of 1.5-2°C will have significant impacts for coastal areas in Walvis Bay. While sea level rise in Luderitz will be slightly higher than in Walvis Bay (Table 2), the steep and rocky shoreline makes the town less vulnerable to the impacts of 1.5°C and above.

Trey Ratcliffe

1.5°C+: Impacts on Namibia's vulnerable sectors

Increasing climate extremes will have numerous impacts on Namibia's vulnerable sectors, making the need to adapt critical. The country is already prone to droughts and flooding. Approximately 1.2 and 1.1 million people in Namibia were affected by drought and flooding, respectively, between 1996 and 2016 (AfDB, 2018). As global temperature rises by 1.5°C and higher, the threat of droughts and flooding will worsen for Namibia, along with other climate-related challenges.

WATER: Increasing pressure on an already-challenged system

Namibia is exposed to large variability in rainfall between seasons and years, making the country prone to water scarcity, drought and flooding (Republic of Namibia, 2015).

At a 1.5°C and above increase in global temperature, the step changes in local temperature and rainfall will drive further water scarcity.

Table 3: Changes to Namibia's water system

	Evaporation	Surface runoff	Streamflow	Groundwater recharge
1.5°C	+ 10%	- 19%	- 10%	- 33%
2°C	+ 14%	- 30%	- 20%	- 49%
2.5°C	+ 17%	- 40%	- 30%	- 66%
3°C	+ 20%	- 50%	- 40%	- 82%

Irene Kunamwene

Increased evapotranspiration: Temperature increases will lead to an increase in evapotranspiration in Namibia placing considerable strain on water by reducing soil water, groundwater and surface water availability. Global temperature increases of 1.5°C and 2°C will result in 10-14% more evaporation in the country, with further increases of up to 20% by 3°C.

Surface runoff: Increased temperatures and evaporation, as well as decreased rainfall, will have significant impacts on surface water sources. Surface runoff will decrease by approximately 19% and 30% at 1.5 and 2°C respectively (Arnell and Gosling, 2013). Runoff will decrease by approximately 50% at 3°C.

Streamflows: The local impacts of 1.5°C and above are likely to result in further water scarcity, as water resources decline. Stream flows across Namibia are expected to decrease by 10% and 20% respectively at 1.5°C and 2°C (Döll *et al.*, 2018).

Groundwater recharge: Groundwater recharge is extremely variable in Namibia. Less rainfall, more evaporation, and more intense droughts are expected to significantly affect groundwater recharge in the country. At 1.5°C and 2°C, recharge is projected to decrease by approximately 33% and 49% respectively (Döll and Flörke, 2005). This decrease could be as much as 82% with a 3°C increase in global temperature.

AGRICULTURE: Decreases in crop and livestock productivity

Namibia's agricultural sector is extremely vulnerable to the impacts of 1.5°C warming and higher. For example, prolonged drought conditions in 2018 led to the death of 300 cattle and relocation of 17,000 animals in the Omaheke zone in the arid north (Reliefweb, 2018). The largely arid climate does not allow for extensive agricultural activities, with livestock rearing making up the majority of the sector. Continued warming and drying will most likely lead to increasing losses in crop and livestock activities.

Table 4: Changes to Namibia's agriculture

	Agricultural land	Commercial crop productivity	Subsistence crop productivity	Livestock productivity
1.5°C	- 15%	- 5%	- 20%	- 5%
2°C		- 10%	- 40%	- 20%
2.5°C		- 15%	- 60%	- 35%
3°C		- 20%	- 80%	- 50%

Decreasing area of agricultural land: Increased drying will result in Namibia's already marginal agricultural lands shrinking. Desert encroachment will result in the loss of grasslands and rangelands vital for pastoralism. It is expected that land in the arid south will lose as much as 15% of its carrying capacity for livestock at 1.5°C (Reid *et al*., 2011)**.**

Crop productivity: Increases of 1.5°C and above will have severe impacts on crops. Crop productivity is expected to drop by 5-10% at 1.5°C and 2°C, with a decrease of 20% at 3°C. This loss will be even larger for subsistence farmers with expected decreases of 20-80% between 1.5°C and 3°C (Reid *et al.*, 2008).

Livestock productivity: Increasing temperatures negatively impact livestock productivity because of lower feed intake, milk production, fertility and longevity (Thornton *et al*., 2009). Livestock productivity is expected to drop by 5-20% at 1.5°C and 2°C, with further decreases of 50% at 3°C (Reid *et al.*, 2008).

Dian Spear

HUMAN HEALTH: Added risks

The increasing temperatures and changing rainfall patterns projected to occur at warming of 1.5°C and above are set to alter the prevalence of disease. Health risks (with climate components) such as malnutrition, malaria, respiratory infections, and diarrhoea, which affect children and adults are major concerns for Namibia. Global temperature increases of 1.5°C and above will result in increasing water scarcity and malnutrition resulting in an increased burden of disease in the country (von Oertzen).

Table 5: Changes to Namibia's heat risks

	Exposure to heat stress (days)	Malaria exposure (months of risk)
1.5°C	+ 11-30	-23%
2°C	+ 31-50	-34%
2.5°C	+ 31-50	-44%
3°C	+ 80-296	-56%

Heat stress: High temperatures will exposure the population to dangerously high temperatures which will make people vulnerable to heat stroke and heat exhaustion. People living with pre-existing conditions and rural populations without access to health services will be adversely affected (von Oertzen).

- At 1.5°C most of the country will experience an increase of 11-30 days of 'caution' exposure to heat stress, with part of the arid zones increasing by 31-50 days. At 3°C these days will increase by 80-296 (Garland *et al.*, 2015).
- At 3°C there will also be significant increases in 'extreme caution' and 'danger' exposure days (particularly in the semi arid zones) of 82-138 and 104-164 days respectively (Garland *et al.*, 2015).

Table 6: Heat Index (National Weather Service Weather Forecast Office).

Apparent temperature range	Classification	Effect on body
27°C – 32°C	Caution	Fatigue possible with prolonged exposure and/or physical activity
32°C – 39°C	Extreme caution	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
39°C – 51°C	Danger	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
51°C	Extreme danger	Heat stroke highly likely

Malaria exposure: Global temperature rise of 1.5°C and above will likely result in faster breeding of mosquitoes. The development of the malaria parasite and vector, however, is slow and requires wet conditions. In hot climates a rainfall season of three months is sufficient to support a malaria season while in milder climates at least five months of rainfall are needed (Craig *et al.*, 1999). Increasing temperatures may increase the prevalence of mosquitoes in Namibia and result in outbreaks in new areas. However, decreasing rainfall and intense rainfall may disrupt mosquito breeding resulting in overall declines in malaria in the country. At 1.5°C and 2°C global temperature increase the persons exposed to malaria per month is expected to decrease by 23% and 34% respectively. At 3°C this decline will be a further 56% drop in exposure (Tanser *et al.*, 2003).

BIODIVERSITY: Increased loss of endemic vegetation and animals

Namibia is home to a diversity of endemic vegetation and wildlife. Global temperature rise of 1.5°C and above is expected to negatively affect the distribution of biodiversity within the country. The endemic vegetation in the Karoo Biome (arid south zone) is particularly vulnerable to the effects of reduced rainfall (Midgley *et al.*, 2005). The impacts on biodiversity will affect livestock production (due to reduce grazing), malnutrition, and the tourism industry (Reid *et al.*, 2008).


Dian Spear

Table 7: Changes to Namibia's biodiversity

	Desert encroachment	Species loss	Endemic species extinction	Endemic species endangered
1.5°C	+11%	+30%	+6%	+4%
2°C	+18%	+40%	+9%	+6%
2.5°C	+18%	+50%	+12%	+7%
3°C	+43%	+60%	+15%	+9%

Desert and bush encroachment: Global warming of 1.5°C and above will have significant impacts on Namibia's landscape, with the savannah grasslands losing their dominance to desert and shrublands. The arid south is particularly vulnerable to desert encroachment, with significant decreases in rainfall. It is expected that desert encroachment will increase by 11 and 18% respectively at 1.5°C and 2°C. This increase could be as much as 43% by 3°C (Midgley *et al.*, 2005).


Charles J Sharp

Endangered and extinct species: A 1.5°C increase in global temperature will result in a decline in Namibia's rich biodiversity as areas become unsuitable for certain species. Overall, species loss is expected to increase by 30% and 40% respectively at 1.5°C and 2°C. At 3°C this loss will increase to 60% (Midgley *et al.*, 2005). Endemic species will be slightly more adapted to the environment but will still suffer losses, with 6-9% of endemic species expected to go extinct and 4-6% of endemic species being classified as critically endangered at 1.5°C and 2°C respectively. At 3°C the amount of endemic species classified as extinct or critically endangered will increase to 15% and 9% respectively (Midgley *et al.*, 2005).

1.5°C+: Implications for Namibia's policies and development agenda

Namibia's 5th National Development Plan (NDP) is built on the pillars of economic progress, social transformation, environmental sustainability, and good governance. While climate change does not feature in the NDP, the impacts of global warming of 1.5℃ and above on local climate will pose significant challenges for Namibia's vulnerable sectors, and compromise the country's ability to meet its development goals. The National Policy on Climate Change, introduced in 2011, outlines Namibia's ambitions to improve coping capacities and reduce vulnerabilities across communities and sectors. The likelihood of global temperatures reaching and exceeding 1.5℃ within the next few decades makes it necessary for the Namibian government to take urgent adaptation action to ensure its vulnerable sectors are able to withstand and adapt to these projected changes.

Higher temperatures and decreasing rainfall will exacerbate water scarcity and lead to regular and severe droughts and heat stress. Increasing intensity of rainfall events will have significant impacts on the environment and will increase the risk of floods, and associated negative impacts. To enable climate -smart development and decision-making requires government to make dedicated efforts to develop and disseminate information about projected climate changes and their impacts across all levels and sectors of government.

Namibia's agricultural sector is not only important for the economy, but for the identity of many local communities too. The livelihoods of subsistence and small-scale farmers are already supported by remittances and pensions, and many young people are migrating to urban areas in search of alternative opportunities. Global warming of 1.5℃ and higher, and the associated agricultural losses expected, will add further challenges to food security and the sustainability of many rural livelihoods. Appropriate adaptation measures, as well as alternative livelihood options and new economic opportunities, will be vital in building resilience.

Sophie Lashford

Strengthening adaptation in Namibia's vulnerable sectors will ensure that already sensitive sectors, such as agriculture and water, are not adversely affected by further stressors. Some of these stressors, such as more frequent and intense droughts and flooding, could be combated by stronger responses from government which do not perpetuate vulnerabilities and reliance on aid but improve the capacity and agency of local communities to adopt sustainable livelihood practices. Strong institutionalisation of climate change adaptation is needed across all sectors and levels of government to ensure shared efforts to limit the impacts on vulnerable sectors.

The potential impacts of global warming of 1.5℃ and higher in Namibia may have extensive knock-on effects in all economic sectors, severely affecting the livelihoods and well-being of communities. There is an urgent need to develop the capacity and agency of communities to adapt to the change of 1.5℃ and above. Through creating an enabling environment for community-based adaptation, government could ensure that isolated rural communities, which have the highest vulnerability, are able to adapt to current and future changes.

APPENDIX: Methodology

Climate zones for climate analysis were created by dividing countries into distinct aridity zones using the Global Aridity Index (using mean annual precipitation and mean annual evapotranspiration). Mean annual surface temperature, precipitation and climate extremes were analysed using data obtained from the WorldClim Global Climate Dataset.

Climate models were obtained from the 5th version of the Coupled Model Intercomparison Project (CMIP5) program. 24 CMIP5 GCM outputs for RCP were used to focus on temperature and rainfall means, as well as indices of climatic extremes (rainfall and temperature extremes) that directly relate to local climate change vulnerabilities. Using 1861-1900 as a base period for pre-industrial conditions, the years at which RCP 8.5 reached 1.0°C, 1.5°C, 2.0°C, 2.5°C and 3.0°C global warming above pre-industrial levels were defined.

For each model ensemble member, a 31-year running mean was applied to the entire time-series. The climatology at a given global warming level is defined by the year the running mean reaches that global warming level and then stays consistently above it. For the climate indices within each subset, we calculated area-averaged climatological means at given global warming levels to determine the change relative to pre-industrial levels. The non-parametric Wilcoxon Paired Signed Rank test (WPSR) for RCP8.5 was used to test for significant differences between the distributions of ensembles of the indices at 1.0°C, 1.5°C, 2.0°C, 2.5°C and 3.0°C.

Impacts on vulnerable sectors were determined by examining previous studies where impacts could either be assigned to a specific increase in global temperature, or an emission scenario (SRES and RCP) and time frame could be attributed to a specific rise in global temperature. Impacts for each temperature interval were interpolated using a linear regression using the R software for statistical computing.

A more detail description of this methodology can be viewed on the ASSAR Website.


Julia Davies

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