John Taolo Gaetsewe District Municipality

Climate Risk Profile Report based on the GreenBook

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Acronyms

°C	Degree Celsius
AFF	Agriculture, Forestry, and Fisheries
AR5	Fifth Assessment Report
CABLE	CSIRO Atmosphere Biosphere Land Exchange model
CCAM	Conformal-cubic atmospheric model
CDRF	Climate and Disaster Resilience Fund
CMIP5	Coupled Model Intercomparison Project 5
CoGTA	Department of Cooperative Governance and Traditional Affairs
CRVA	Climate Risk and Vulnerability Assessment
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEA	Department of Environmental Affairs
DM	District Municipality
DRR	Disaster Risk Reduction
DWS	Department of Water and Sanitation
EcVI	Economic Vulnerability Index
EnVI	Environmental Vulnerability Index
GCM	General circulation model
GRiMMS	Groundwater Drought Risk Mapping and Management System
GVA	Gross Value Added
GDP	Gross Domestic Product
IDRC	International Development Research Centre
IPCC	Intergovernmental Panel on Climate Change
km	Kilometre
JTGDM	John Taolo Gaetsewe District Municipality
l/p/d	Litres Per Person Per Day
LM	Local Municipality
MAR	Mean Annual Runoff
mm	Millimetre
NDMC	National Disaster Management Centre
PVI	Physical Vulnerability Index
RCP	Representative Concentration Pathways
SCIMAP	Sensitive Catchment Integrated Modelling and Prediction
SDF	Spatial Development Framework
SEVI	Socio-Economic Vulnerability Index
SPI	Standardised Precipitation Index
SPLUMA	Spatial Planning and Land Use Management Act, 2013 (Act No. 16 of 2013)
THI	Temperature Humidity Index
WMAs	Water Management Areas
WMO	World Meteorological Organisation
WRYM	Water Resources Yield Model

WUI	Wildland-Urban Interface

Glossary of Terms

Adaptation actions	A range of planning and design actions that can be taken by local government to adapt to the impacts of climate change, reduce exposure to hazards, and exploit opportunities for sustainable development (CSIR, 2019).
Adaptation planning	The process of using the basis of spatial planning to shape built-up and natural areas to be resilient to the impacts of climate change, to realise co-benefits for long-term sustainable development, and to address the root causes of vulnerability and exposure to risk. Adaptation planning assumes climate change as an important factor while addressing developmental concerns such as the complexity of rapidly growing urban areas, and considers the uncertainty associated with the impacts of climate change in such areas – thereby contributing to the transformational adaptation of urban spaces. Adaptation planning also provides opportunities to climate proof urban infrastructure, reduce vulnerability and exploit opportunities for sustainable development (National Treasury, 2018; Pieterse, 2020).
Adaptive capacity	"The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2022, p. 2899).
Climate change adaptation	"In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2022, p. 2898).
Climate change mitigation	"A human intervention to reduce emissions, or enhance the sinks, of greenhouse gases (GHGs)" (IPCC, 2022, p. 2915). The goal of climate change mitigation is to achieve a reduction of emissions that will limit global warming to between 1.5°C and 2°C above preindustrial levels (Behsudi, A, 2021).

Climate hazards	Climate hazards are a sub-set of natural hazards and a grouping of hydrological, climatological, and meteorological hazards. This includes the spatial extent and frequency of, among others, floods, fires, and extreme weather events such as extreme rainfall and extreme heat. Sometimes referred to as hydrometeorological hazards. The potential occurrence of a climate hazard may cause loss of life, injury, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (IPCC, 2022). Climate hazards can increase in intensity and frequency with climate change (Pieterse et al., 2023).
Climate risk	Risk implies the potential for adverse consequences resulting from the interaction of vulnerability, exposure, and a hazard. Relevant adverse consequences include those on “lives and livelihoods, health and well-being, economic and sociocultural assets, infrastructure and ecosystems” (IPCC, 2022, p. 144). In the IPCC’s 6th Assessment Report, it is confirmed that risks may result from “dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system” (IPCC, 2022, p. 132).
Coping capacity	“The ability of people, institutions, organizations and systems, using available skills, values, beliefs, resources and opportunities, to address, manage, and overcome adverse conditions in the short to medium term” (IPCC, 2022, p. 2904).
Disaster risk reduction	“Denotes both a policy goal or objective, as well as the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard or vulnerability; and improving resilience” (IPCC, 2022, p. 2906).
Exposure	Exposure implies the physical exposure of elements to a climate hazard. It is defined as the “presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected [by climate hazards]” (IPCC, 2022, p. 2908).
Mainstreaming	The process of integrating climate change adaptation strategies and measures into existing planning instruments and processes as opposed to developing dedicated adaptation policies and plans (Pieterse et al., 2021).

Resilience	“The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation” (IPCC, 2022, pp. 2920–2921).
Sensitivity	“The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)” (IPCC, 2022, p. 2922).
Vulnerability	Vulnerability is defined as the “propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including, sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (IPCC, 2022, p. 2927). Vulnerability refers to the characteristics or attributes of exposed elements, i.e., elements that are exposed to potential climate-related hazards. Vulnerability is a function of sensitivity and (coping or adaptive) capacity (Pieterse et al., 2023).

1. Introduction

This Climate Risk Profile report, as well as the accompanying Climate Change Adaptation Plan, were developed specifically for John Taolo Gaetsewe District Municipality (JTGDM), to support its strategic climate change response agenda. Both documents are primarily informed by the GreenBook, which is an open-access online planning support system that provides quantitative scientific evidence in support of local government's pursuit in the planning and design of climate-resilient, hazard-resistant settlements. The GreenBook is an information-dense resource and planning support system offered to South African local governments to better understand their risks and vulnerabilities in relation to population growth, climate change, exposure to hazards, and vulnerability of critical resources. In addition to this, the GreenBook also provides appropriate adaptation measures that can be implemented in cities and towns, so that South African settlements are able to minimise the impact of climate hazards on communities and infrastructure, while also contributing to developmental goals (See Green Book l Adapting settlements for the future).

The purpose and strategic objectives of the Climate Risk Profile and the Adaptation Plan are to:

- Build and further the climate change response agenda,
- Inform strategy and planning in the district and its local municipalities,
- Identify and prioritise risks and vulnerabilities,
- Identify and prioritise climate interventions and responses, as well as
- Guide and enable the mainstreaming of climate change response, particularly adaptation.

The Climate Risk Profile report provides an overview of the unique climate change needs and risks of the district based on the science, evidence, and information from the GreenBook. Climate change trends, hazards, and vulnerabilities are spatially mapped for the district, its local municipalities, and settlements. Finally, the report identifies the major risks that need to be prioritised and sets out adaptation goals to further inform the adaptation plan and its implementation.

1.1. Approach followed

The approach used in the GreenBook, and the Climate Risk Profile is centred around understanding climate-related risk. Climate-related risk implies the potential for adverse consequences resulting from the interaction of vulnerability, exposure, and the occurrence of a climate hazard (see Figure 1). "Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments, infrastructure, and services (including ecosystem services, ecosystems and species)" (Chen, et al., 2021, p. 64). The components of risk are dynamic. Climate hazards are driven by natural climate variability and anthropogenic climate change. Human activity contributes to Greenhouse Gas emissions that increase temperatures, which in turn affects changes in the occurrence of climate hazards such as drought, flooding, coastal flooding, and heat extremes. Planned as well as unplanned development and growth of our settlements drive the exposure of people, as well as the built- and natural environment to climate hazards. Vulnerability includes the inherent characteristics that make systems sensitive to the effects and impacts of climate hazards. Municipal risk is driven by vulnerability and exposure to certain climate-related hazards.

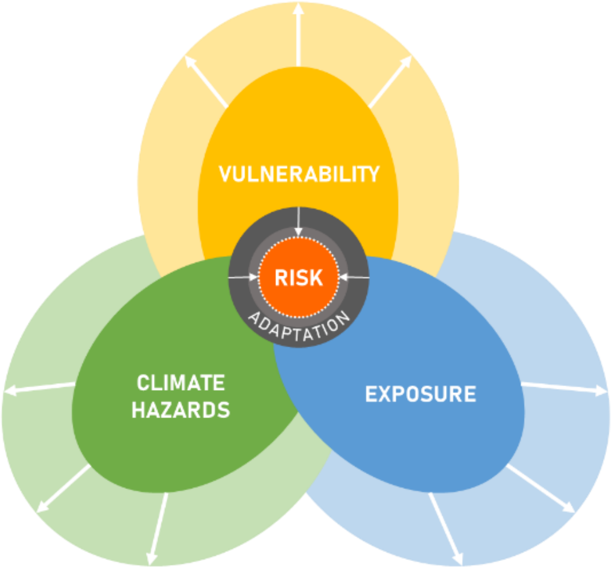


Figure 1: The interaction between the various components of risk, indicating the opportunity to reduce risk through adaptation (based on IPCC, 2014 and IPCC, 2021)

To understand climate risk across the municipal area, the exposure of settlements to certain climate hazards and their vulnerability are unpacked. In this Climate Risk Profile report multiple vulnerability indices are provided on the municipal and settlement level, as well as variables for the current and future projected climate. Climate-related hazards such as drought, heat extremes, wildfire, and flooding and the impact of climate on key resources are also set out for the district and its municipalities.

All information contained in this report is based on the GreenBook, unless otherwise specified. Information and data were derived using GIS analysis and modelling techniques using secondary data and is not based on local surveys. Additional information to this report is available for local municipalities through the GreenBook Municipal Risk Profile Tool. Municipalities are encouraged to consider both the information available in this report and on the Municipal Risk Profile tool to understand their risk profile. Access the GreenBook and its various resources and tools here: https://greenbook.co.za/

1.2. Policy framework

There are various regulatory and legislative requirements for climate change response [planning] in South Africa, at local government level. For instance, the Disaster Management Amendment Act of 2015, which aims to provide measures to reduce disaster risks through climate change adaptation and the development of early warning systems, requires each organ of state, provincial government and municipality to identify measures for, as well as indicate plans to invest in, disaster risk reduction (DRR) and climate change adaptation. The Spatial Planning and Land Use Management Act, No. 16 of 2013 (SPLUMA) outlines five principles intended to guide spatial planning, land development and land use management at all levels of planning, including local government level. Amongst them are the principles of (1) spatial resilience, which encourages "flexibility in spatial plans, policies and land use management systems, to ensure sustainable livelihoods in communities most likely to suffer the impacts of economic and environmental shocks" – some of which may be induced by the impacts of climate change, and (2) spatial sustainability, which sets out requirements for municipal planning functions such as spatial planning and land use management to be carried out in ways that consider protecting vital ecosystem features such as agricultural land, i.e., from both anthropogenic and natural threats, including the impacts of climate change, as well as in ways that consider current and future costs of providing infrastructure and social services in certain areas (e.g., uninformed municipal investments may lead to an increase in the exposure of people and valuable assets to extreme climate hazards).

Furthermore, the National Climate Change Response White Paper – which outlines the country's comprehensive plan to transition to a climate resilient, globally competitive, equitable and low-carbon economy and society through climate change adaptation- and mitigation, while simultaneously addressing the country's key priorities, including job creation, poverty reduction, social equality and sustainable development, amongst others – identifies local governments as critical role players that can contribute towards effective climate change adaptation through their various functions, including "[the] planning [of] human settlements and urban development; the provision of municipal infrastructure and services; water and energy demand management; and local disaster response, amongst others." (Republic of South Africa, 2011, p. 38). The Climate Change Bill (B9-2022) takes it further by setting out institutional arrangements for climate change response. Section 7. (1) of the Bill requires that all organs of state affected by climate and climate change align their policies, programmes, and decisions to ensure that the risks of climate change impacts and associated vulnerabilities are considered. Local government is a key player in climate change response as a facilitator and implementer to achieve effective climate response. The Bill requires that district intergovernmental forum to serve as a Municipal Forum on climate change that coordinates climate response actions and activities in its respective municipality. The Bill also sets out requirements for each district municipality to undertake a climate change needs assessment and a climate change response implementation plan. The Climate Risk Report and related Adaptation Plan, provided here, meet most of these requirements and provide the essential information needed by the district municipality to fulfil its obligations in terms of the Bill.

The National Climate Change Adaptation Strategy outlines several actions in support of climate change adaptation, that are applicable at municipal level, including the development and implementation of adaptation strategies and vulnerability reduction programmes targeting communities and individuals that are most at risk to the impacts of climate change; the development of municipal early warning systems; as well as the integration of climate change adaptation measures into municipal development plans and relevant sector plans. The National Climate Risk and Vulnerability Assessment Framework – which is aimed at all actors, including local governments – guides the development and review of climate risk and vulnerability assessments (CRVAs) to enable alignment, aggregation and comparison across all CRVAs, in an effort to inform an integrated and effective climate change adaptation response across all scales and sectors.

1.3. District Municipal context

The John Taolo Gaetsewe District Municipality (JTGDM) is situated in the Northern Cape Province and is bordered by The ZF Mgcawu and Frances Baard District Municipalities to the west and south; The North West Province (Dr. Ruth Segomotsi Mompati District Municipality) to the east and northeast; and Botswana to the northwest. JTGDM is the second smallest district in the Northern Cape, occupying only 7% of the province (27 498.9 km^2) (StatsSA 2016). Administratively, the JTGDM comprises three Local Municipalities namely The Gamagara Local Municipality; The Ga-Segonyana Local Municipality; and The Joe Morolong Local Municipality, which encapsulates the geographical area covered by the former District Management Area and the former Moshaweng Local Municipality.

The John Taolo Gaetsewe District has a total population of 272 454 (StatsSA, 2022). It has the third largest population size after the Frances Baard and ZF Mgcawu Districts (StatsSA, 2022). Gamagara and La-Segonyana are the most populous LMs in the district. Within the district's population, young children (0-14 years) make up 31,4% of the total population. The working-age population (15-64 years) accounts for 62,9%, while the elderly (65+ years) constitute 5,7%. The district's dependency ratio is reported at 59,0 with a sex ratio of 90,1 Education indicators reveal that 10,1% of individuals aged 20 and above have no formal schooling, while 5,5% have attained higher education qualifications. With regards to housing, the district hosts 66 347 households, with an average household size of 4,1. Formal dwellings dominate the housing landscape, representing 88,2% of the housing stock. Sanitation and waste management services are accessible, with 35,7% of formal dwellings equipped with flushing toilets connected to sewerage, and 29,1% receiving weekly refuse disposal services. Moreover, 28,7% of households enjoy access to piped water within their dwellings, while 91,3% have electricity for lighting.

The Gross Domestic Product (GDP) was R 15.9 billion in 2018 (up from R 8.82 billion in 2008), the John Taolo Gaetsewe District Municipality contributed 16.11% to the Northern Cape Province GDP of R 98.6 billion in 2018 and contributes 0.33% to the GDP of South Africa which had a total GDP of R 4.87 trillion in 2018. The key economic sectors in the district are mining, social services, agriculture, tourism, manufacturing, and construction. Mining is the largest employer followed by the agricultural sector (StatsSA 2022).

The JTDM falls entirely within the Savanna Biome. More specifically, the broad vegetation types for the area have been listed as Kalahari Thornveld, Kalahari Plains Bushveld/Shrubby Kalahari Dune Bushveld and Eastern Kalahari Bushveld. The natural environment in JTDM is in a fair condition, poor land use management has resulted in degradation of the resource base. There has been deterioration of the natural environment through overgrazing, poor fire regimes, wood harvesting, misuse of wetlands and encroachment by invasive plants and weeds.

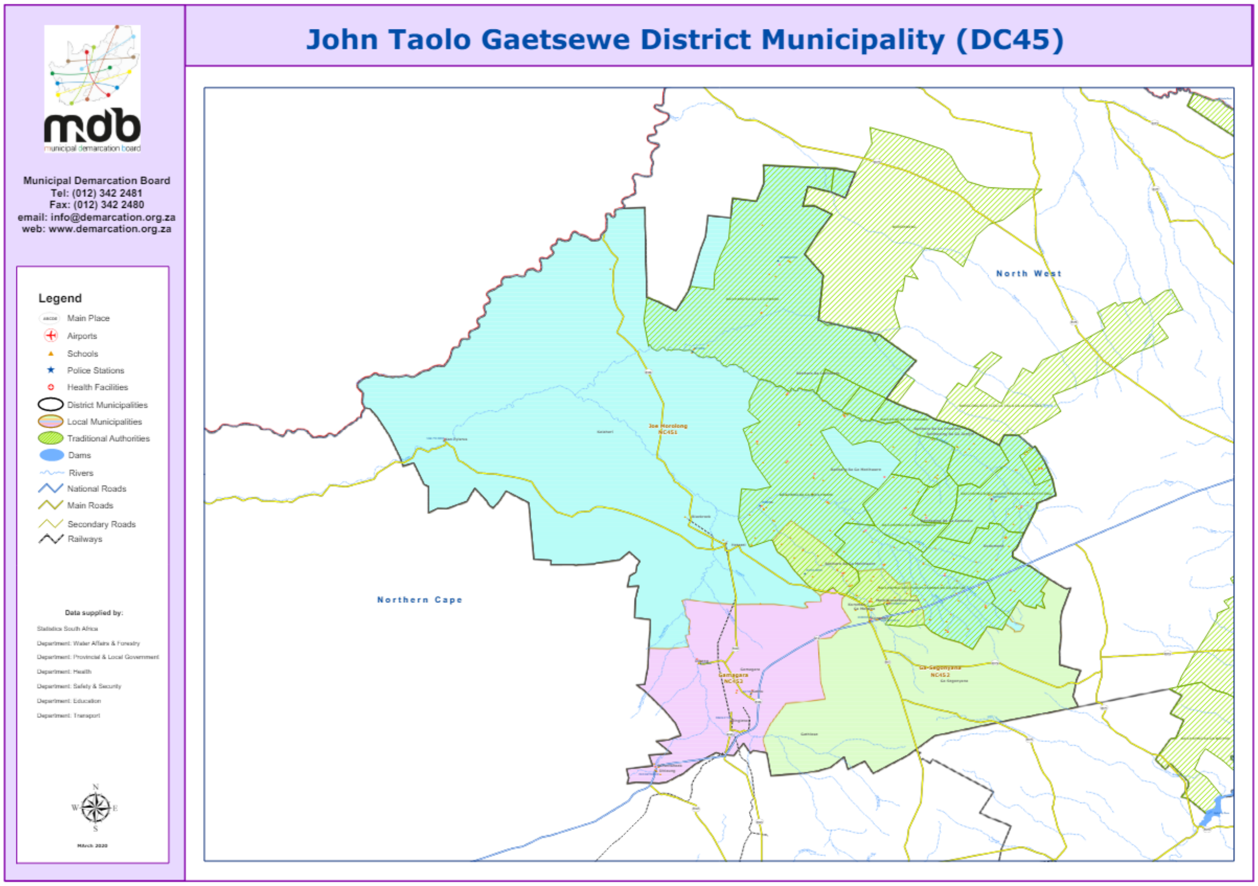


Figure 2: John Toala Gaetsewe Municipality (Municipal Demarcation Board, 2022), with Local Municipalities shaded in different colours

2. Baseline and future climate risk

This section starts with an overview of vulnerability and population change projections, unpacking the components of vulnerability on both the municipal and settlement level as well future population pressures. Thereafter the current and future climate is discussed in terms of temperature and rainfall across the District. Current as well as future exposure to drought, heat, wildfire, and flooding are set out. The impact of climate on key resources such as water and agriculture are also discussed for the municipalities in the District. Together this information provides an overview of current and future climate risk across the John Taolo Gaetsewe District to inform responsive planning and adaptation.

2.1. Vulnerability and population change

There are many factors that influence the vulnerability of our municipalities and settlements, some of which are unpacked in the following section. The current vulnerabilities for the John

Taolo Gaetsewe District, its local municipalities, and settlements are profiled using a framework which sets out indicators that can be used to profile the multi-dimensional and context-specific inherent vulnerability of settlements and municipalities in South Africa. The framework describes and quantifies, where possible, the inherent vulnerability of people, infrastructure, services, economic activities, and natural resources by setting out context and location-specific indicators that were specifically designed to support vulnerability risk assessments of South African municipalities. Population changes drive vulnerability into the future, and therefore population growth and decline of settlements across the District are projected to 2050. Spatial population projections are integral in determining the potential exposure and vulnerability of a population to hazards.

2.1.1. Municipal vulnerability

Municipal vulnerability is unpacked in terms of four vulnerability indices, each of which are described below and in Table 1, the vulnerability scores are provided for each of the municipalities in John Taolo Gaetsewe District.

The Socio-Economic Vulnerability Index (SEVI) shows the vulnerability of households living in the municipality with regards to household composition, income composition, education, mobility, health, access to basic services, access to social government services, political instability, and safety and security of households. A high vulnerability score indicates municipalities that house a high number of vulnerable households with regards to their ability to withstand adverse shocks from the external environment.

The Economic Vulnerability Index (EcVI) speaks toward the economic resilience of the municipality, and considers economic sector diversification, the size of economy, labour force, the GDP growth/decline pressure experienced in the municipality, as well as the inequality present in the municipality. The higher the economic vulnerability the more susceptible these municipalities are to being adversely affected by external shocks.

The Physical Vulnerability Index (PVI) relates to the built environment and the connectedness of the settlements in the local municipality. It is a composite indicator that considers road infrastructure, housing types, the maintenance of the infrastructure, densities, and general accessibility. A high physical vulnerability score highlights areas of remoteness and or areas with structural vulnerabilities.

The Environmental Vulnerability Index (EnVI) highlights municipalities where there is a high conflict between preserving the natural environment and accommodating the growth pressures associated with population growth, urbanisation, and economic development. The index considers the human influence on the environment, the amount of ecological infrastructure present that needs protection, the presence of critical water resources, environmental health, and environmental governance. A high vulnerability score highlights municipalities that experience increasing pressure relating to protecting the environment and allowing land use change due to growth pressures.

Each Local Municipality in the John Taolo Gaetsewe District is provided a score out of 10 for each of the vulnerability indices. A score higher than 5 indicates an above national average, and a score lower than 5 indicates a below national average for vulnerability. Scores are provided for both 1996 and 2011, where a lower score in 2011 compared to 1996 indicates an improvement and a higher score indicates worsening vulnerability. Trend data are only available for Socio-Economic Vulnerability and Economic Vulnerability

Table 1: Vulnerability indicators across John Taolo Gaetsewe Municipality for 1996 to 2011

LOCAL MUNICIPALITY	SEVI 1996	SEV 2011	Trend	EcVI 1996	EcVI 2011	Trend	PVI	Trend	EnVI	Trend
Gamagara	3.0	1.4	↘	6.1	4.8	↘	6.8	N/A	3.7	N/A
Joe Morolong	6.7	7.1	↗	9.7	9.4	↘	7.6	N/A	1.7	N/A
Ga-Segonyana	5.6	4.6	↘	5.9	6.8	↗	6.6	N/A	2.7	N/A

As outlined in Table 1, Gamagara LM's socio-economic vulnerability has decreased (improved) significantly between 1996 and 2011, with the LM currently having the lowest socio-economic vulnerability in the Northern Cape. Ga-Segonyana LM also experienced a decrease in socio economic vulnerability between 1996 and 2011 and has a score below the national average. Socio-economic vulnerability increased in Joe Morolong LM between 1996 and 2011. This means that when considering household composition, education and health, access to basic services and safety and security Joe Morolong LM has the highest number of vulnerable households in the Northern Cape. Gamagara LM experienced a downward trend in economic vulnerability for the period 1996 to 2011 and is currently ranked 8th out of 26 municipalities in the Northern Cape. Ga-Segonyana LM experienced an increase in economic vulnerability and is ranked 23rd out of 26 municipalities in the Northern Cape. Although Joe Morolong LM experienced a slight decrease in economic vulnerability for the period 1996 to 2011 it still has one of the highest economic vulnerability scores in the country and scored 208th out of 213 municipalities. Due to factors such as economic diversity, size of the economy, labour force, GDP growth rate and inequality present in the municipality the Joe Morolong LM is highly susceptibility to external shocks such as natural disasters (e.g. floods and droughts), global economic crises (e.g. recession) and pandemics such as COVID-19. Joe Morolong LM has the highest physical vulnerability score in the district and is ranked 22nd out of 26 municipalities in the Northern Cape. This indicates areas of remoteness and/or areas with structural vulnerabilities within the LM. Gamagara LM has the highest environmental vulnerability in the district and is ranked 23rd out of 26 municipalities in the Northern Cape which indicates some conflict in preserving the natural environment and accommodating growth pressures such as population growth, urbanisation and economic development.

2.1.2. Settlement vulnerability

The unique set of indicators outlined below highlight the multi-dimensional vulnerabilities of the settlements within the John Taolo Gaetsewe District and its local municipalities, with regards to six composite indicators. This enables the investigation of the relative vulnerabilities of settlements within the district.

A high vulnerability score (closer to 10) indicates a scenario where an undesirable state is present e.g., low access to services, high socio-economic vulnerabilities, poor regional connectivity, environmental pressure or high economic pressures. An indicator of growth pressure, providing a temporal dimension (15-year trend), was added to show which settlements were experiencing growth pressures on top of the other dimensional vulnerabilities up until 2011.

The Socio-Economic Vulnerability Index comprises of three indicators (and eight variables) that show the vulnerability of households occupying a specific settlement with regards to their (1) household composition (household size, age dependency, female/child headed household), (2) income composition (poverty level, unemployment status, and grant dependency of the households), as well as (3) their education (literacy and level of education).

The Economic Vulnerability Index comprises of five variables grouped into three indicators that highlight the economic vulnerability of each settlement with regards to (1) its size (GDP per capita and GDP production rates), (2) the active labour force (taking note of unemployed and discouraged work seekers), and (3) the GDP growth rate for the past 15 years.

The Environmental Vulnerability Index considers the footprint composition of the settlement taking the ration of built-up versus open spaces into account.

The Growth-Pressure Vulnerability Index shows the relative (1996-2011 growth rates) and anticipated pressure on settlements.

The Regional Economic Connectivity Vulnerability Index looks at the regional infrastructure of each settlement (measured through a remoteness/accessibility index), as well as the role of the town in terms of its regional economy.

The Service Access Vulnerability Index comprises of 10 variables grouped into four indictors, that show the level of services offered and rendered within a settlement and includes the settlement's (1) access to basic services (electricity, water, sanitation, and refuse removal), (2) settlement's access to social and government services (health access, emergency service access, access to schools, and early childhood development), (3) access to higher order education facilities, and (4) access to adequate housing.

A brief description of each local municipality within the district follows below.

Gamagara Local Municipality

The major settlements in this municipality are Olifantshoek, Sishen, Sishen Mine, Kathu and Dibeng. The settlement facing the greatest growth pressure is Sishen Mine, which also has very high economic and service access vulnerability. Dibeng has very high socio-economic vulnerabilities combined with high environmental pressure and poor regional connectivity,

Joe Morolong Local Municipality

The major settlements in this municipality are Hotazel and Blackrock, the LM also has seven Traditional Authorities. About 80% of the municipal area is Trust Land and therefore under the custodianship of Traditional Leaders (IDP, 2023-24). Settlements under Traditional Authorities experience high economic pressure and socio-economic vulnerability, as well as high growth pressure, with poor service access and regional connectivity. Hotazel has high growth pressure and high environmental vulnerability. The settlement of Blackrock has the poorest regional connectivity in the LM.

Ga-Segonyana Local Municipality

The major settlements in this municipality are Kuruman, Bankhara and Mothibistad, the LM also has two Traditional Authorities. The Mothibistad settlement is facing high growth pressure along with high economic vulnerability and environmental pressure. Bankhara has poor service access, and face high economic and environmental pressure along with high socio-economic vulnerabilities. The settlements under Traditional Authority have poor regional connectivity and high socio-economic vulnerabilities and experience high economic pressure.

2.1.3. Population growth pressure

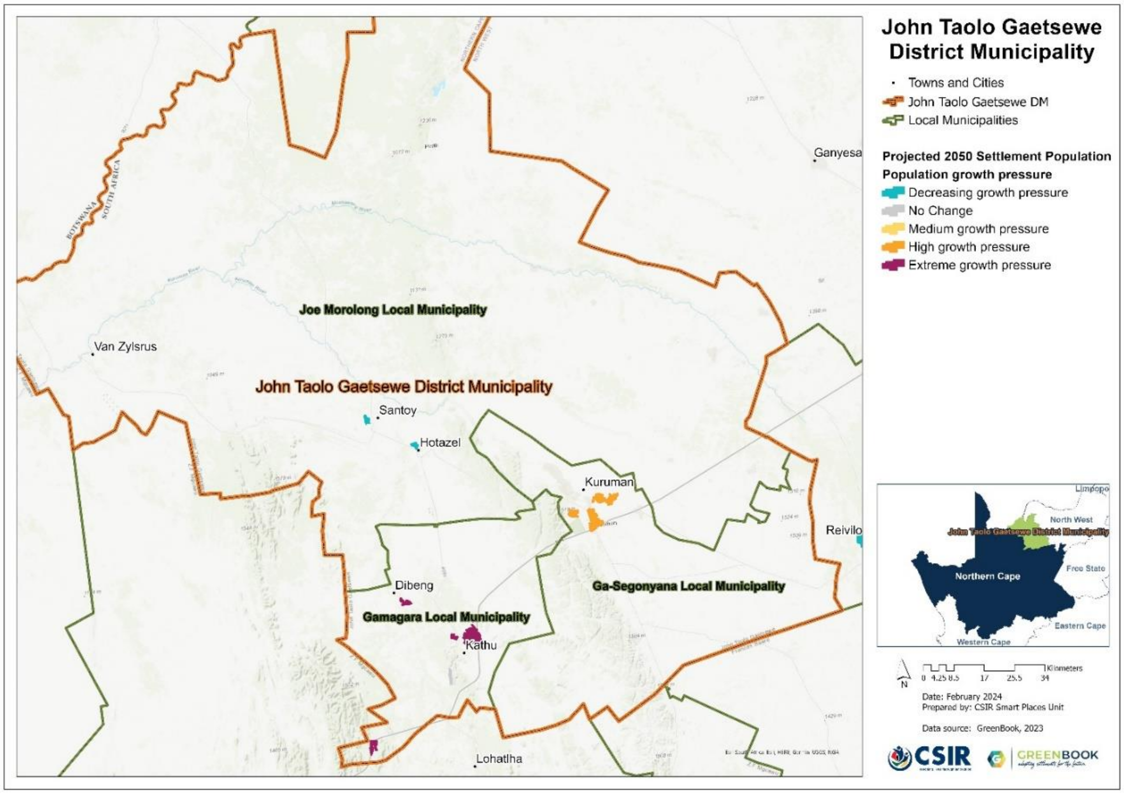
The core modelling components of the settlement growth model are the demographic model and the population potential gravity model. The demographic model produces the long-term projected population values at the national, provincial, and municipal scale using the Spectrum and Cohort-Component models. The spatially-coarse demographic projections were fed into the population potential gravity model, a gravity model that uses a population potential surface to downscale the national population projections, resulting in 1x1 km resolution projected population grids for 2030 and 2050. The availability of a gridded population dataset for past, current and future populations enables the assessment of expected changes in the spatial concentration, distribution, and movement of people.

Using the innovative settlement footprint data layer created by the CSIR, which delineates built-up areas, settlement-scale population projections were aggregated up from the 1 x 1 km grids of South African projected population for a 2030 and 2050 medium and high growth scenario. These two population growth scenarios (medium and high) are differentiated based on assumptions of their in- and out-migration assumptions. The medium growth scenario (Table 2) assumes that the peak of population influx from more distant and neighbouring African countries into South Africa has already taken place. The high growth scenario assumes that the peak of migrant influx is yet to happen.

Table 2: Settlement population growth pressure across John Taolo Gaetsewe District Municipality

Population per municipality	2011	Medium Growth Scenario	
		2030	2050
Gamagara	41 619	92 414	155 132
Joe Morolong	89 323	65 594	33 496
Ga-Segonyana	93 607	136 819	153 236
John Taola Gaetsewe DM Total	224 549	294 827	341 864

The District's population is projected to increase by 52 % between 2011 and 2050, under a medium growth scenario. Most of this growth will take place in the settlements within Gamagara and Ga-Segonyana LMs with Joe Morolong showing a decrease in population growth. Figure 3 depicts the growth pressures that the settlements across the district are likely to experience. The settlements within Gamagara LM are likely to experience extreme growth pressures with Ga-Segonyana LM likely to experience high population growth pressure and Joe Morolong LM experiencing decreasing growth pressure up to 2050.



Date: February 2024
Prepared by: CSIR Smart Places Unit
Data source: GreenBook, 2023

Figure 3: Settlement-level population growth pressure across John Taolo Gaetsewe Municipality

2.2. Climate

An ensemble of very high-resolution climate model simulations of present-day climate and projections of future climate change over South Africa has been performed as part of the GreenBook. The regional climate model used is the Conformal-Cubic Atmospheric Model

(CCAM), a variable-resolution Global Climate Model (GCM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). CCAM runs coupled to a dynamic land-surface model CABLE (CSIRO Atmosphere Biosphere Land Exchange model). GCM simulations of the Coupled Model Inter-Comparison Project 5 (CMIP5) and the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), obtained for the emission scenarios described by Representative Concentration Pathways 4.5 and 8.5 (RCP 4.5 and RCP 8.5) were first downscaled to 50 km resolution globally. The simulations span the period 1960–2100. RCP 4.5 is a high mitigation scenario (assuming a reduction in CO_2 emissions into the future), whilst RCP 8.5 is a low mitigation scenario (assuming "business as usual" emissions).

After completion of the 50 km resolution simulations described above, CCAM was integrated in stretched-grid mode over South Africa, at a resolution of 8 x 8 km (approximately 0.08° degrees in latitude and longitude). The model integrations performed at a resolution of 8 km over South Africa offer a number of advantages over the 50 km resolution simulations:

a) Convective rainfall is partially resolved in the 8 km simulations, implying that the model is less dependent on statistics to simulate this intricate aspect of the atmospheric dynamics and physics.
b) Important topographic features such the southern and eastern escarpments are much better resolved in the 8 km resolution simulations, implying that the topographic forcing of temperatures, wind patterns and convective rainfall can be simulated more realistically.

For more information on the climate simulations, see the GreenBook Climate Change Story Map and the full technical report.

For each of the climate variables discussed below:

a) The simulated baseline (also termed "current" climatological) state over South Africa calculated for the period 1961–1990 is shown (note that the median of the 6 downscaled GCMs are shown in this case).
b) The projected changes in the variable are subsequently shown, for the time-slab 2021–2050 relative to the baseline period 1961-1990.
c) An RCP 8.5 scenario (low mitigation) is shown.

2.2.1.Temperature

The model was used to simulate average annual average temperatures (°C) for the baseline (current) period of 1961–1990, and the projected change for period 2021–2050 under a RCP8.5 mitigation scenario.

The JTGDM experiences average annual temperatures ranging between 18 and 22 °C at the baseline, with higher averages found towards the north of Joe Morolong LM (Figure 4). The projections show an average annual temperature increase of 3°C across the district into the future, under a low mitigation, high emissions, scenario (Figure 5).

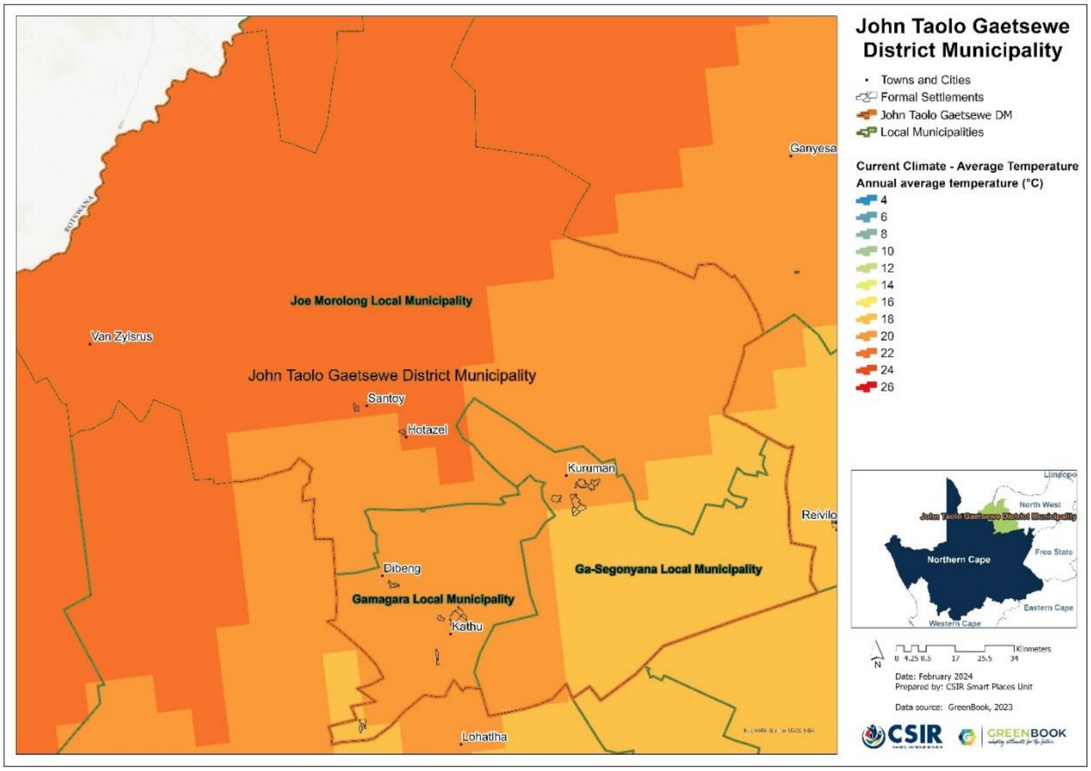


Figure 4: Average annual temperature (°C) for the baseline period 1961-1990 for John Taolo Gaetsewe District Municipality

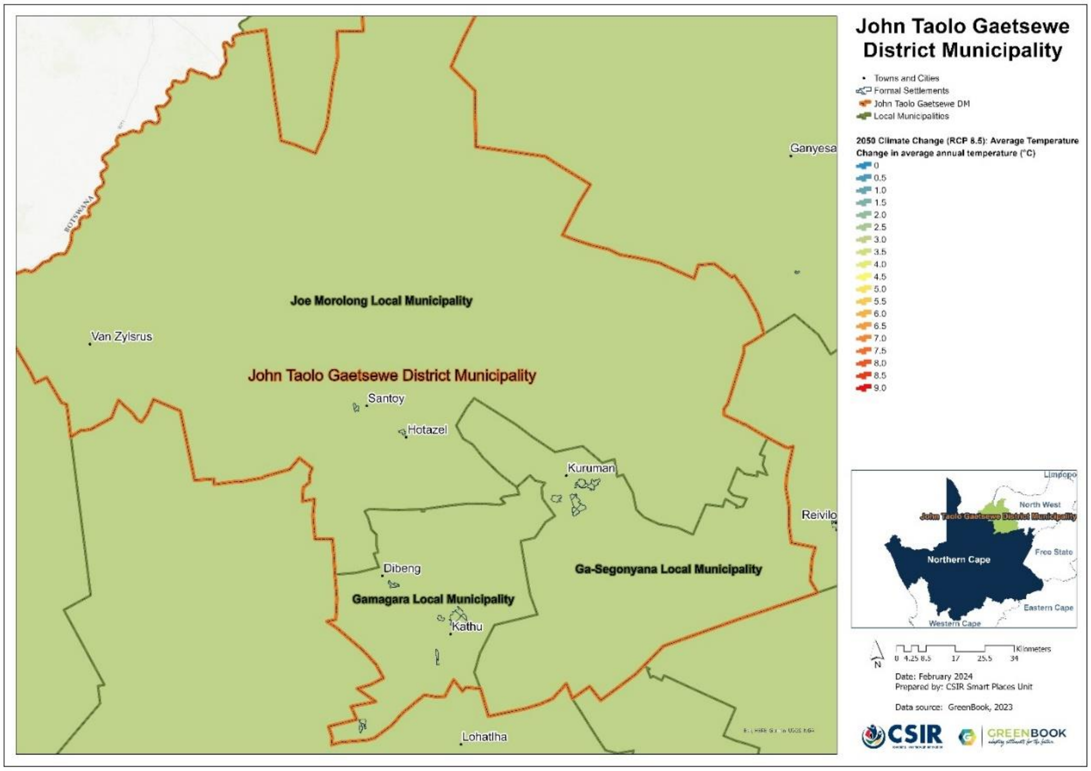


Figure 5: Projected changes in average annual temperature (°C) from the baseline period 1961-1990 to the future period 2021-2050 for John Taolo Gaetsewe District Municipality, assuming an RCP 8.5 emissions pathway

2.2.2. Rainfall

The multiple GCMs were used to simulate average annual rainfall (depicted in mm) for the baseline (current) period of 1961–1990, and the projected change from the baseline to the period 2021–2050 under an RCP8.5 emissions scenario. Model projections of precipitation manifest uncertain due to several factors, including model sensitivity to spatial resolution at which processes are resolved. At 8 X 8km horizontal resolution, for example, some processes (such as convective systems) that contribute to rainfall are not adequately resolved by the climate models. The precipitation projections therefore could reflect uncertainty in some locations since fine-scale processes that contribute to precipitation and its extremes are not captured. When the modelling ensemble approach used in the online GreenBook is considered, and the 10th, 50th and 90th percentiles, per grid point, agree on the directional change relative to the reference period, the signal is considered well developed and conclusive. In the case where the respective model percentiles show conflicting signs, the model ensemble manifest uncertainty and therefore reflect low confidence on which future model realisation/outcome is more likely. It is therefore critical to consider the ensemble distribution uncertainty when devising long-term adaptation strategies.

As displayed in Figure 6 the average annual rainfall under baseline condition for JTGDM is between 400 and 1200 mm, with higher averages found across the Ga-Segonyana LM. The projected future change in average annual rainfall is expected to range between -4.60 mm to 56.89mm (Figure 6). This means that for certain areas in the district rainfall might decrease by up to 4.60 mm which includes the settlements of Van Zylsrus, Santoy and Hotazel in Joe Morolong LM as well as Kuruman in Ga-Segonyana LM. While for other parts of the district, such as Gamagara LM and portions of Ga-Segonyana LM the average annual rainfall might increase by us much as 56.89mm. The projected changes in rainfall are small across the district, with some uncertainty.

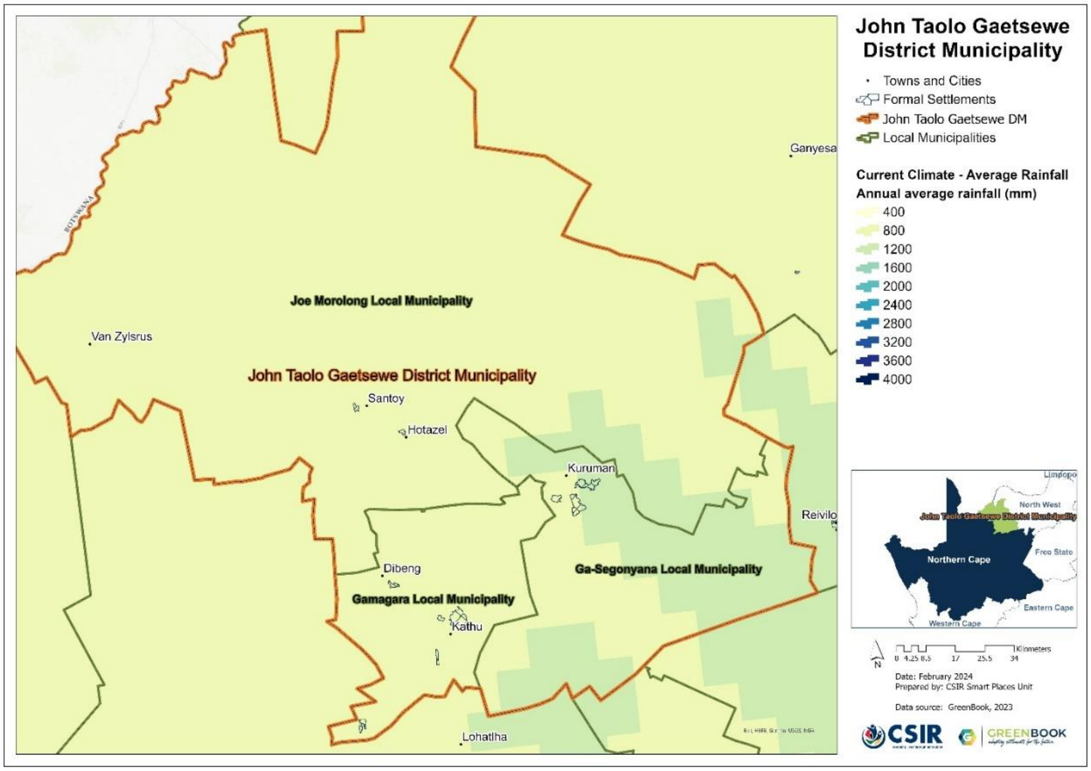


Figure 6: Average annual rainfall (mm) for the baseline period 1961-1990 for John Taolo Gaetsewe District Municipality

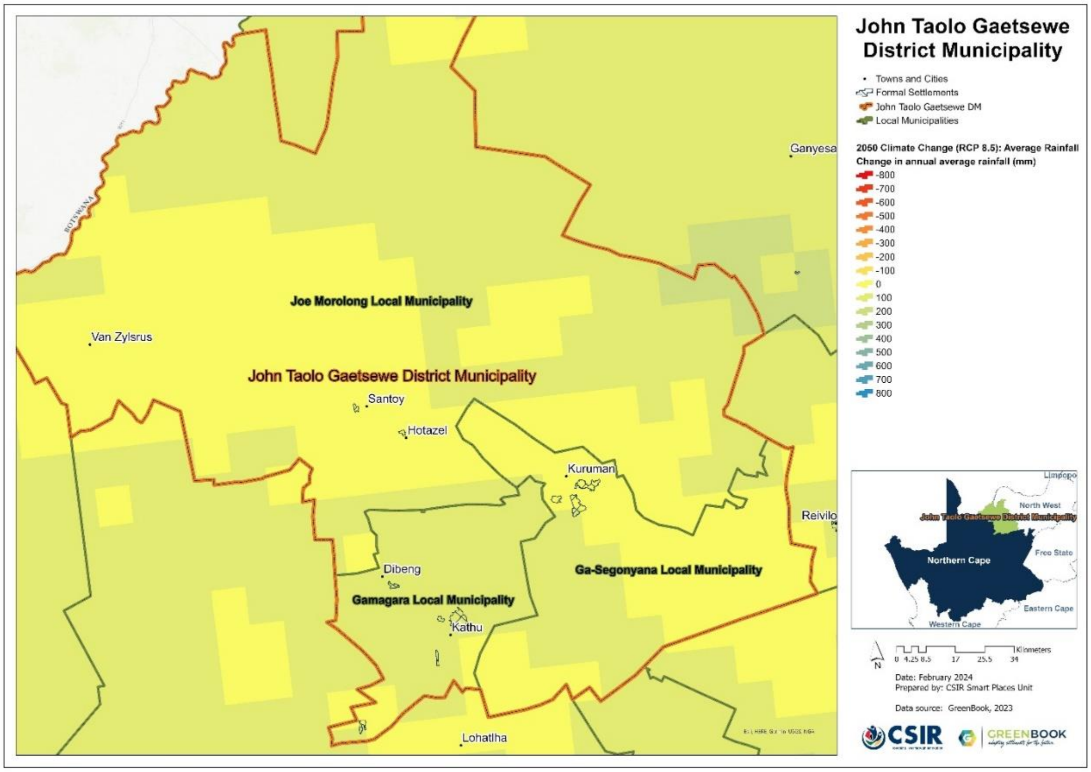


Figure 7: Projected change in average annual rainfall (mm) from the baseline period to the period 2021-2050 for John Taolo Gaetsewe District Municipality, assuming an RCP8.5 emission pathway

2.3. Climate Hazards

This section showcases information with regards to John Taolo Gaetsewe District Municipality's' exposure to climate-related hazards.

2.3.1. Drought

The southern African region (particularly many parts of South Africa) is projected to become generally drier under enhanced anthropogenic forcing, with an associated increase in dry spells and droughts. To characterise the extent, severity, duration, and time evolution of drought over South Africa, the GreenBook uses primarily the Standardised Precipitation Index (SPI), which is recommended by the World Meteorological Organisation (WMO) and is also acknowledged as a universal meteorological drought index by the Lincoln Declaration on Drought. The SPI, with a two-parameter gamma distribution fit with maximum likelihood estimates of the shape and scale parameters, was applied on monthly rainfall accumulations for a 3-, 6-, 12-, 24- and 36-months base period. The SPI severity index is interpreted in the context of negative values indicating droughts and positive values indicating floods. These values range from exceptionally drier (<-2.0) or wetter (>2.0) to near-normal (region bounded within -0.5 and 0.5).

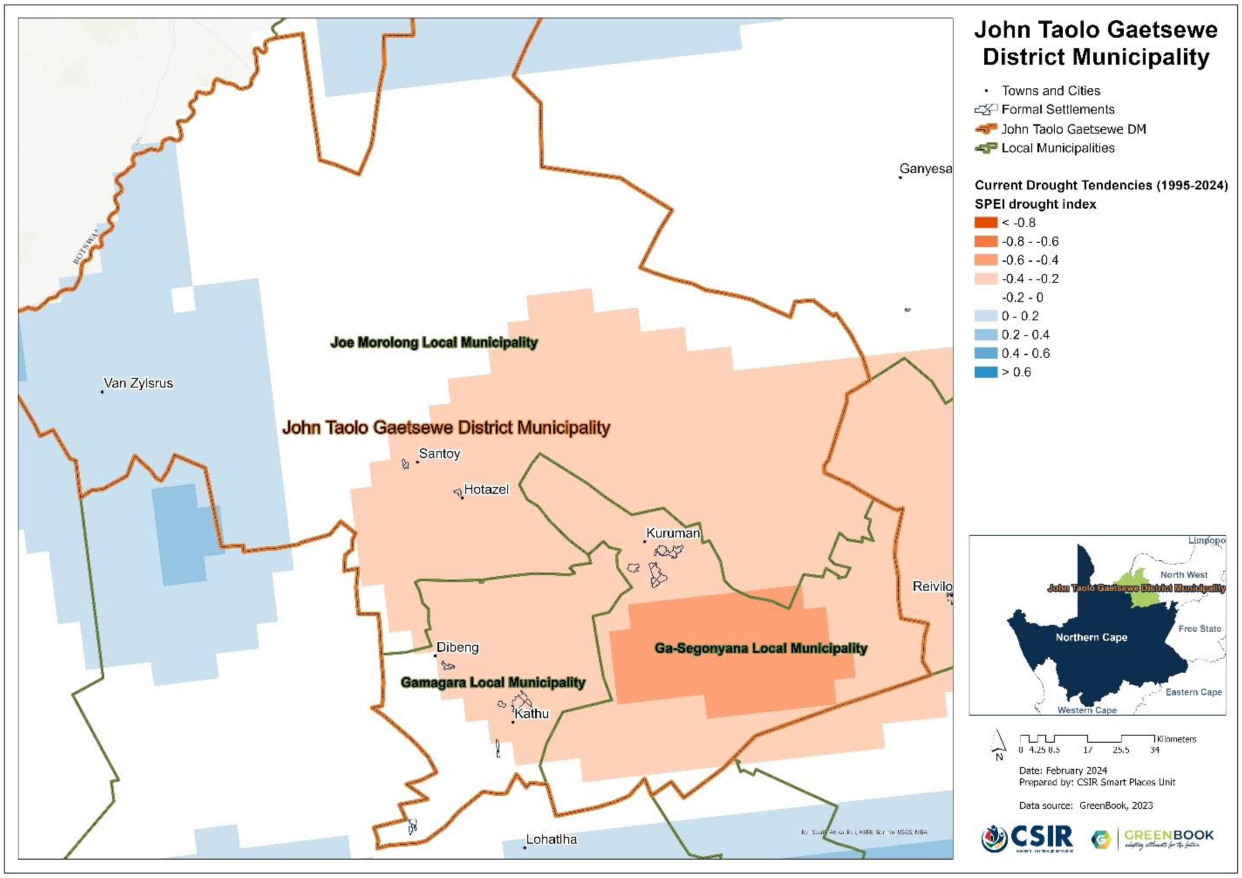


Figure 8: Projected changes in drought tendencies from the baseline period (1986–2005) to the current period (1995-2024) across John Taolo Gaetsewe District Municipality

Figure 8 depicts the projected change in drought tendencies (i.e., the number of cases exceeding near-normal per decade) for the period 1995-2024, relative to the 1986-2005 baseline period, under an RCP 8.5 “business as usual” emissions scenario (RCP 8.5). A negative value is indicative of an increase in drought tendencies per 10 years (more frequent than the observed baseline) with a positive value indicative of a decrease in drought tendencies.

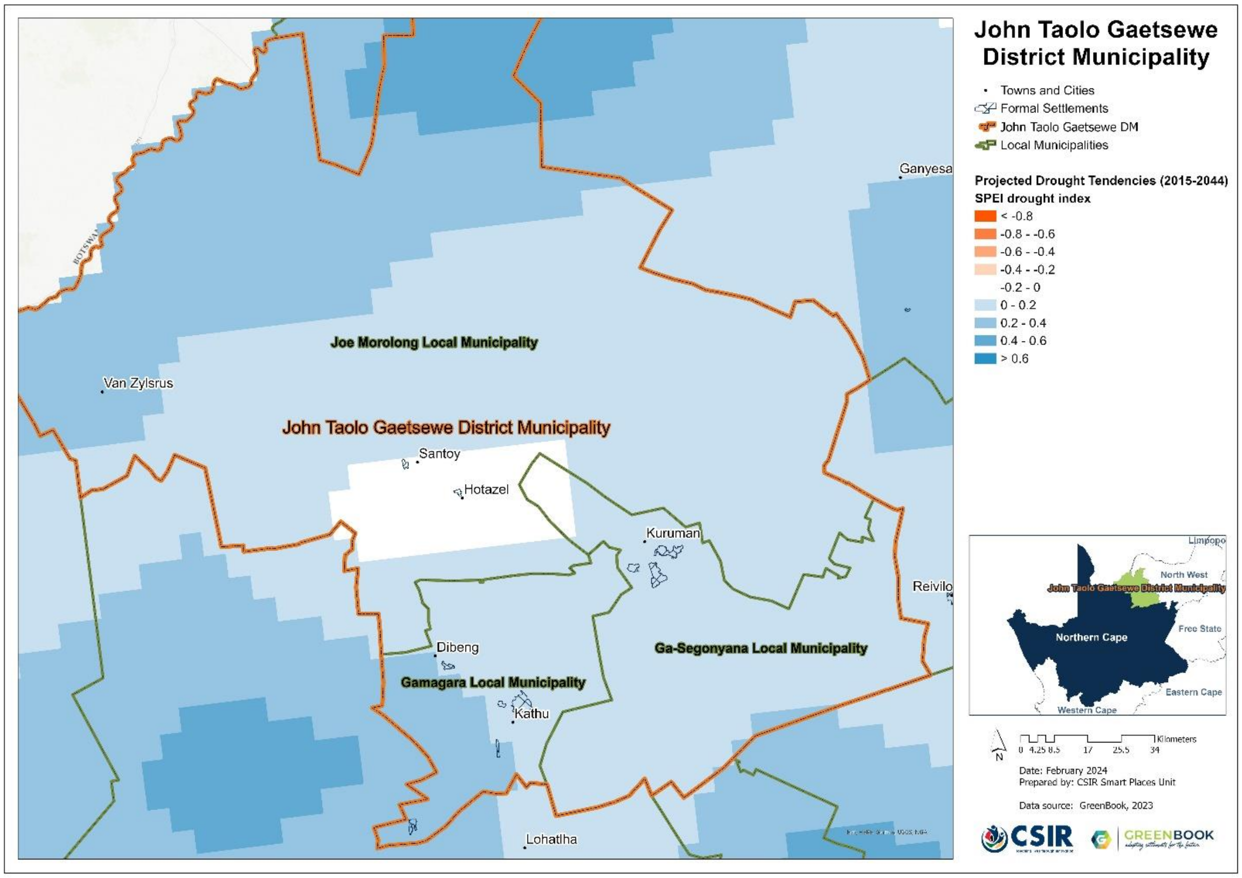


Figure 9: Projected changes in drought tendencies from the baseline period (1986–2005) to the future period 2015-2044 for John Taolo Gaetsewe District Municipality

Figure 9 depicts the projected change in drought tendencies (i.e., the number of cases exceeding near-normal per decade) for the period 2015–2044 relative to the 1986–2005 baseline period, under the low mitigation “business as usual” emissions scenario (RCP 8.5). A negative value is indicative of an increase in drought tendencies per 10 years (more frequent than baseline) into the future and a positive value indicative of a decrease. Figure 10 depicts the settlements that are at risk of increases in drought tendencies.

As displayed in Figure 8 the current drought tendencies for JTGDM ranges between -0.4 to -0.2 for a large part of the district which suggests a relatively mild level of precipitation deficit. This indicates slightly less precipitation in the district than what was expected for the period 1995-2024. The central parts of Ga-Segonyana LM had a SPI score ranging between -0.6 and -0.4

which indicates a moderate deficit in precipitation comparted to what was typically expected for the period 1995-2024. Future prediction of drought tendencies (Figure 9) indicates a slight increase in precipitation with SPI scores ranging between 0.2 to 0.4 for most of the district. Central parts of Joe Morolong LM are expected to have near normal conditions. Whereas parts of Gamagara LM are expected to have a moderate increase in precipitation compared to what is typically expected for time period 2015-2044. The projected settlement drought risk is very low for settlements in Gamagara and Ga-Segonyama LM's, with low settlement drought risk predicted for the settlements of Joe Moronlong LM.

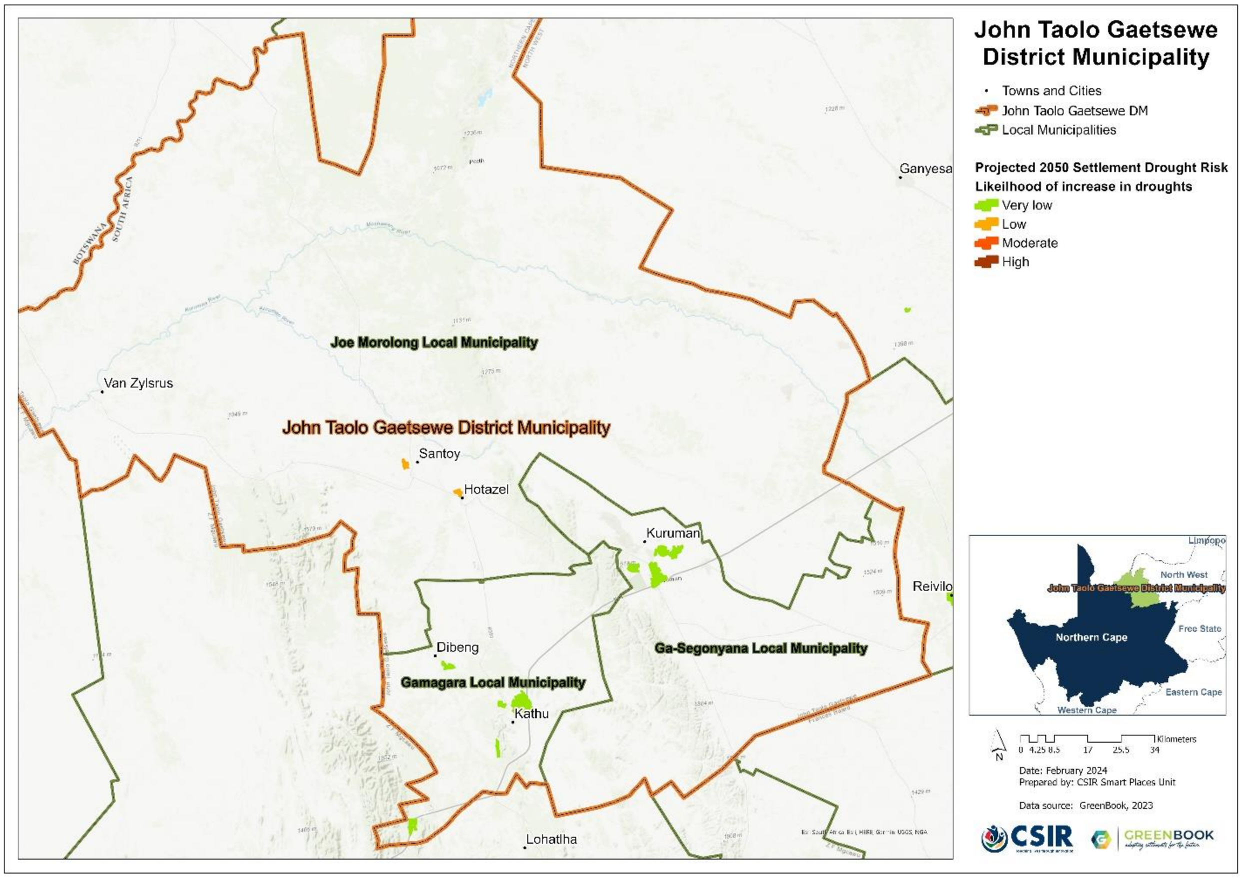


Figure 10: Settlement-level drought risk for John Taolo Gaetsewe District Municipality

2.3.2. Heat

With the changing climate, it is expected that the impacts of heat will only increase in the future. The heat-absorbing qualities of built-up urban areas make them, and the people living inside them, especially vulnerable to increasingly high temperatures. The combination of the increasing number of very hot days and heatwave days over certain parts of South Africa is likely to significantly increase the risk of extreme heat in several settlements.

The GCMs were used to simulate bias-corrected, annual average number of very hot days, defined as days when the maximum temperature exceeds 35° C per GCM grid point for the baseline (current) period of 1961–1990 (Figure 11), and for the projected changes for period 2021–2050 (Figure 12). The annual heatwave days map under baseline conditions (Figure 13) depicts the number of days (per 8x8 km grid point) where the maximum temperature exceeds the average maximum temperature of the warmest month of the year at that location by at least 5°C for a period of at least three consecutive days. The projected change in the number of days belonging to a heatwave for the period 2021–2050 (Figure 14), assuming a “business as usual” (RCP 8.5) emissions pathway is also shown.

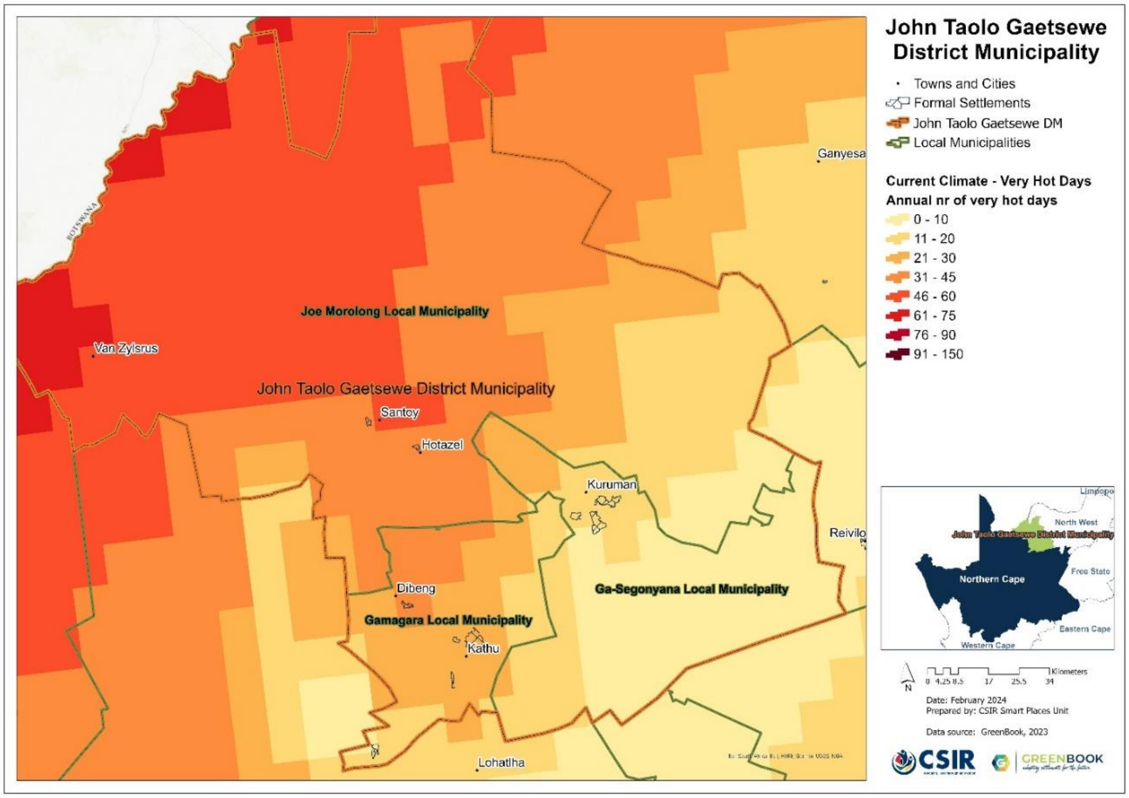


Figure 11: Annual number of very hot days under baseline climatic conditions across John Taolo Gaetsewe District Municipality with daily temperature maxima exceeding 35°C

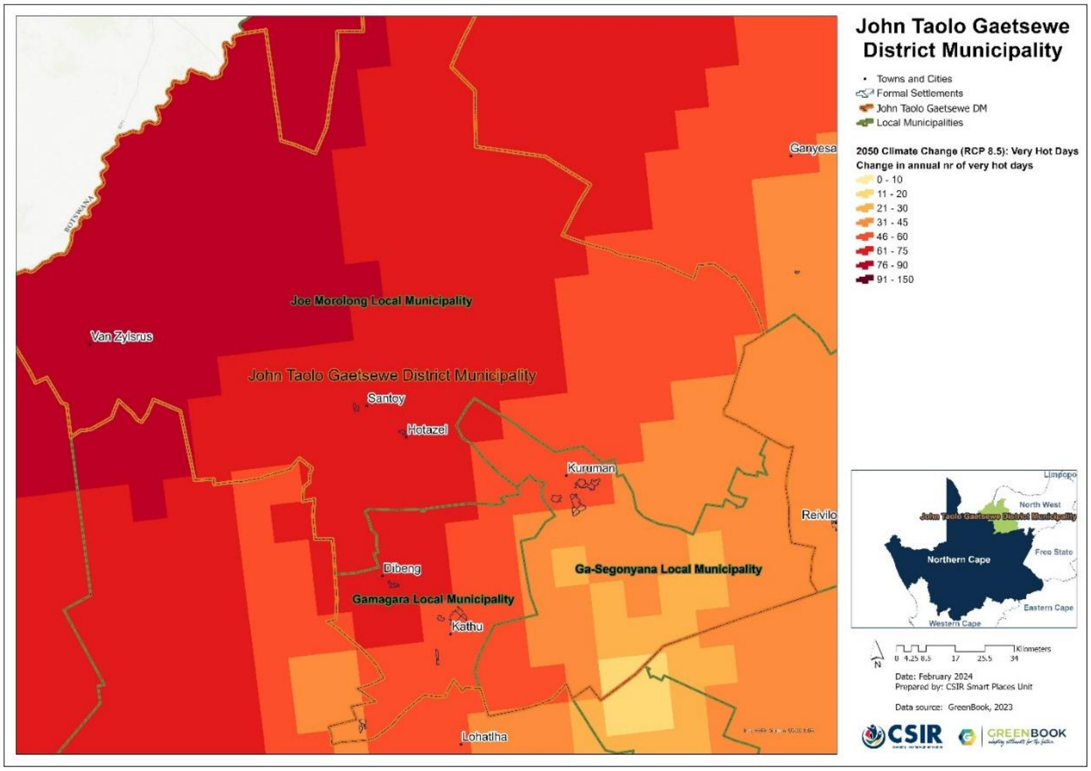


Figure 12: Projected change in annual number of very hot days across John Taolo Gaetsewe District Municipality with daily temperature maxima exceeding 35°C, assuming and RCP 8.5 emissions pathway

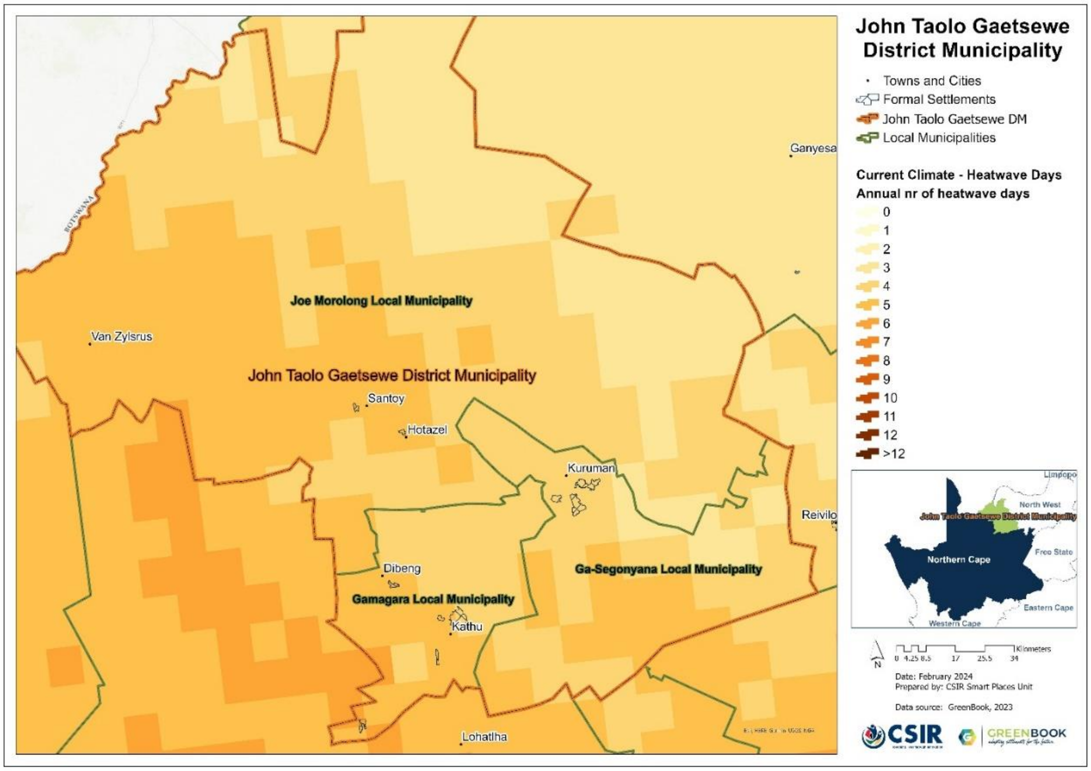


Figure 13: Number of heatwave days under baseline climatic conditions across John Taolo Gaetsewe District Municipality

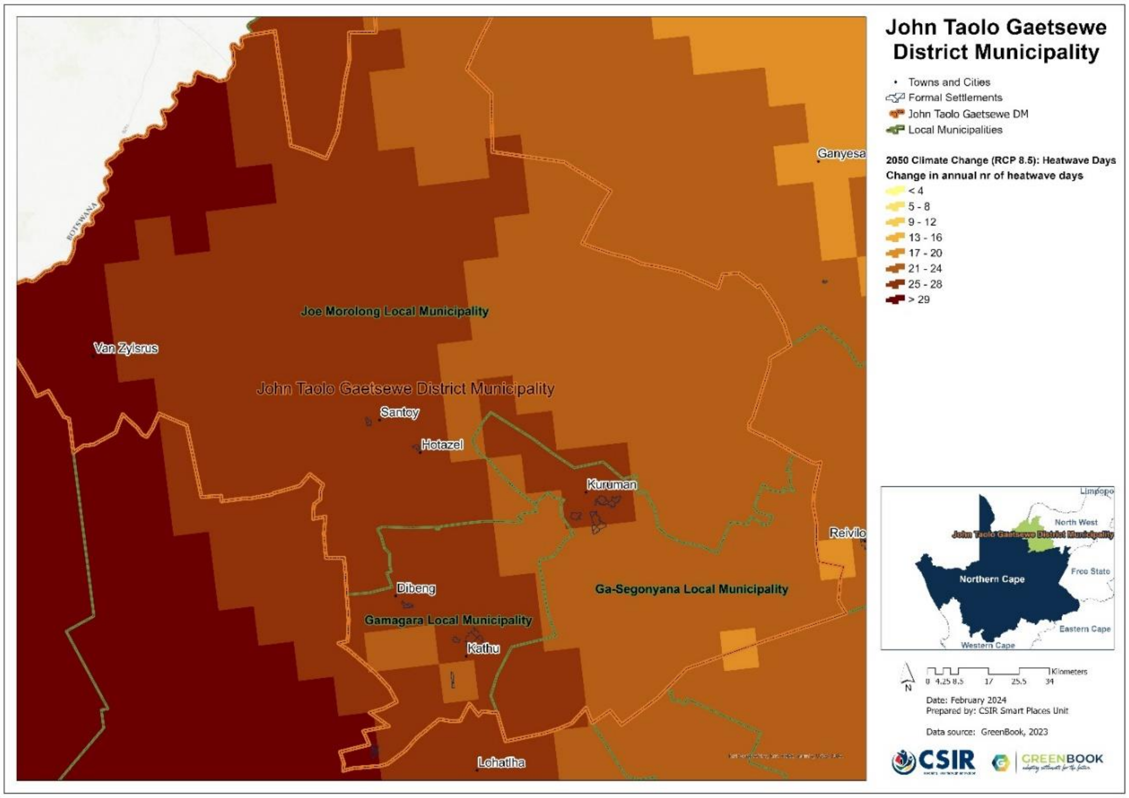


Figure 14: Projected change in annual number of heatwave days across John Taolo Gaetsewe District Municipality, assuming an (RCP 8.5) emissions pathway

As displayed in Figure 11 the number of very hot days under current conditions varies across the district with Gamagara LM currently experiencing between 21 to 30 very hot days per year. The upper parts of the Gamagara LM and the lower parts of Joe Morolong LM currently experiences between 31 and 35 very hot days, this increases by between 46 to 60 more very hot days in the upper parts of the LM. Ga-Segonyana LM has the lowest number of very hot days in the district and currently experiences between 0-10 very hot days per year. The projected change in the annual number of very hot days under a low mitigation scenario is expected to increase by between 21.40 to 65.50 more very hot days for Ga-Segonyana LM. Whilst for Gamagara LM the number of very hot days per year will increase by between 39.56 to 71.72 more days. The Joe-Morolong LM is expected to have the highest increase in very hot days in the district with the increase in the number of very hot days expected to range between 32.26 to 80.34 days per year (Figure 12). Similarly, the projected change in the number of days belonging to a heatwave for are also expected to increase. The JTGDM is projected to have more than 20 more days belonging to a heatwave in the period 2021–2050, compared to the baseline (Figure 14).

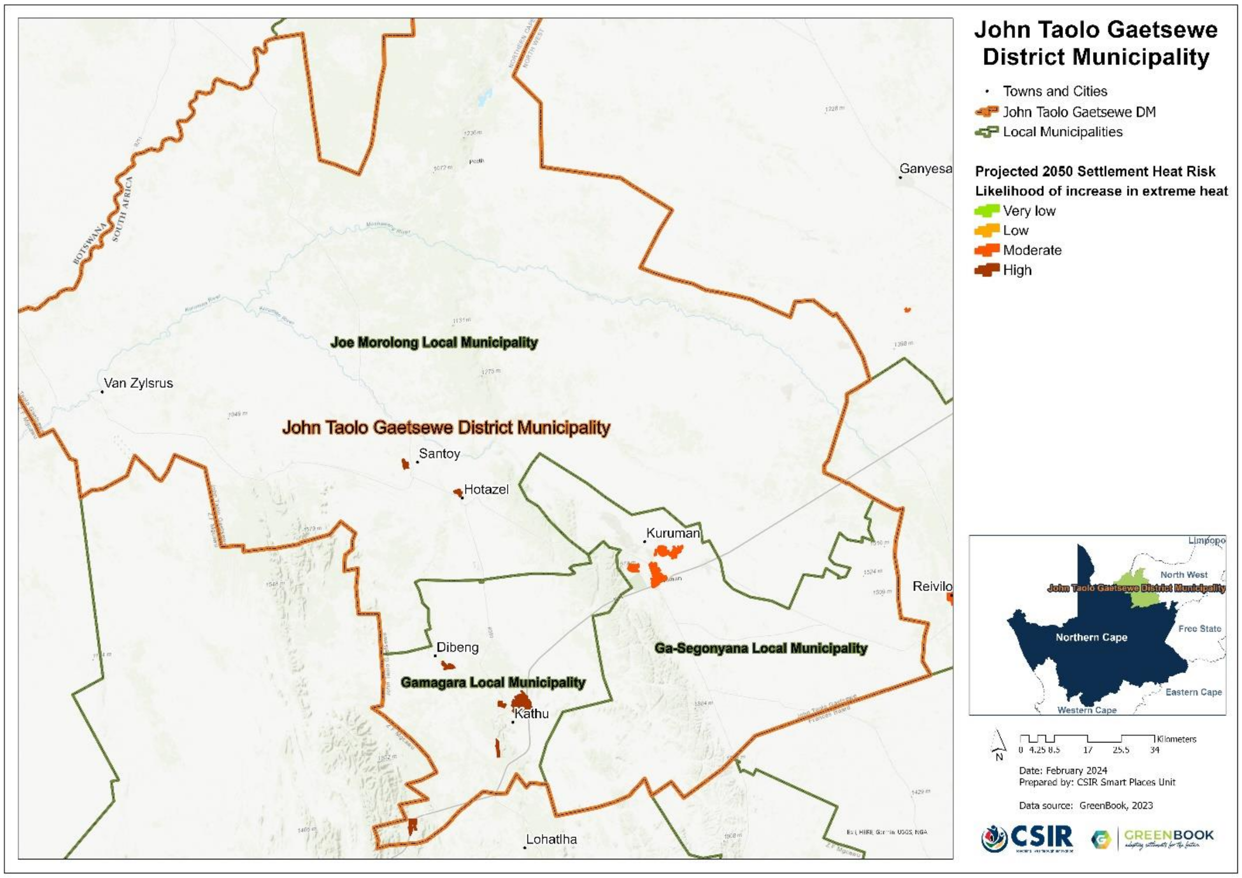


Figure 15: Settlement-level heat risk across John Taolo Gaetsewe District Municipality

Figure 15 depicts the settlements that are at risk of increases in heat stress. The settlements of Ga-Segonyana LM are expected to have a moderate level of heat risk whereas the settlements of Gamagara and Joe Morolong LM's have a high likelihood of increase in extreme heat.

2.3.3. Wildfire

Wildfires occur regularly in South Africa and often cause significant damage. The main reasons for recurring wildfires are that we have climates with dry seasons, natural vegetation that produces sufficient fuel, and people who light fires when they should not. Much of the natural vegetation requires fires to maintain the ecosystems and keep them in good condition. At the same time fires are a threat to human lives, livelihoods, and infrastructure. More and more people, assets and infrastructure are placed on the boundary or interface between developed land and fire-prone vegetation – what we call the wildland-urban interface (WUI) – where they are exposed to wildfires. The combination of climate and vegetation characteristics that favour fires, and growing human exposure, results in significant wildfire risk across the country, especially in the southern and eastern parts.

Fire risk is determined by combining the typical fire hazard for a fire-ecotype (i.e., likelihood, fire severity) and the social and economic consequences (i.e., the potential for economic and social losses). The typical fire hazard was used to develop a plausible fire scenario for each fire-ecotype, i.e., what a typical wildfire would be like. The fire scenarios were then combined with the vulnerability to estimate the economic and social consequences. A scale was used where the likelihood was rated from 'rare' to 'almost certain' and the consequences were rated from 'insignificant' to 'catastrophic' to determine a level of fire risk which ranged from 'low' to 'high'. The risks were then summarised for all the settlements within a local authority. Changes in the fire risk in future were accommodated by adjusting either the fire scenarios or the likelihood, or both. Figure 16 depicts the likelihood and the risk of wildfires occurring in the wildland-urban interface (the boundary or interface between developed land and fire-prone vegetation) of the settlement.

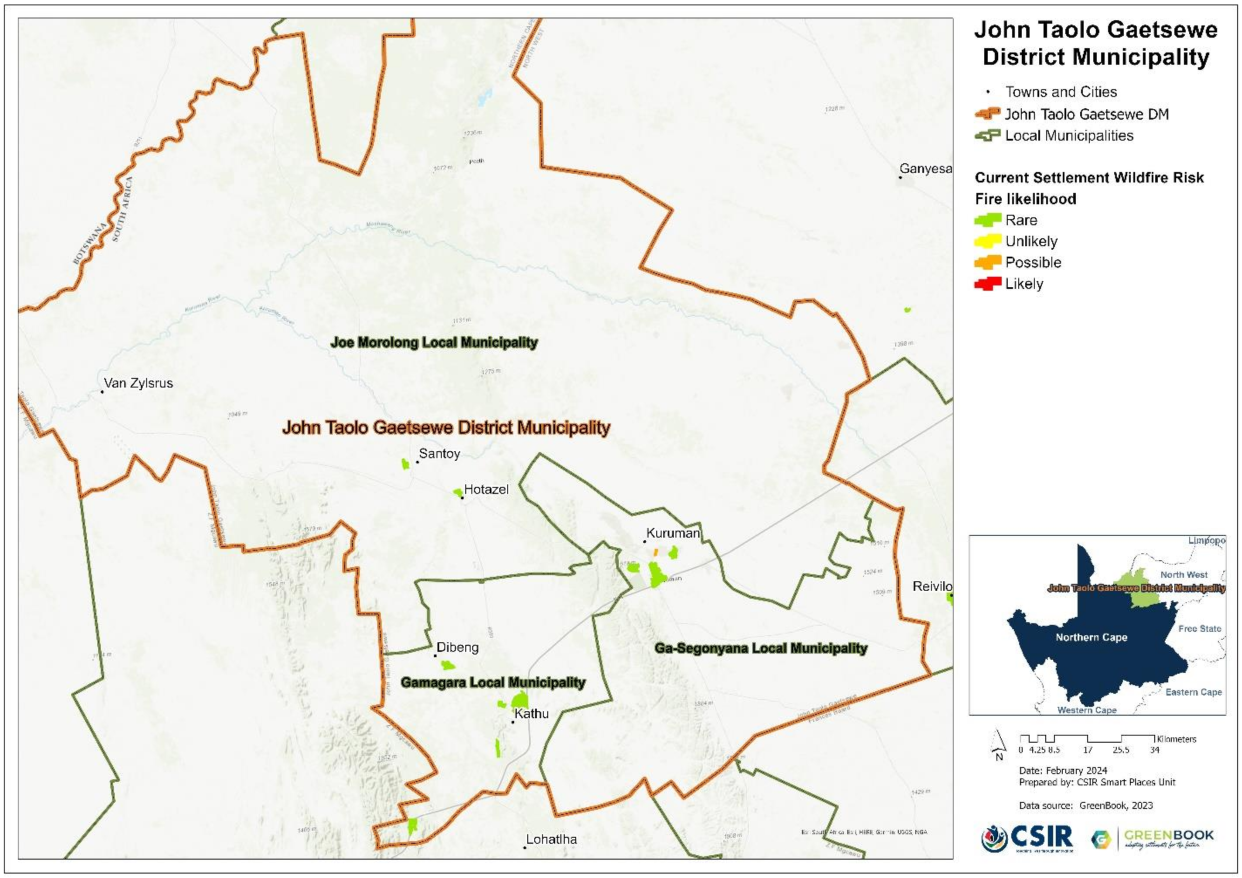


Figure 16 The likelihood of wildfires under current climatic conditions across settlements in John Taolo Gaetsewe District Municipality

The projected number of fire danger days for an 8 x 8 km grid-point under an RCP 8.5 "business as usual" emissions scenario was calculated. A fire danger day is described as a day when the McArthur fire-danger index (McArthur 1967) exceeds a value of 24. The index relates to the chances of a fire starting, its rate of spread, its intensity, and its difficulty of suppression, according to various combinations of air temperature, relative humidity, wind speed and both the long and short-term drought effects. Future settlement risk of wildfires is informed by the projected change in the number of fire danger days. Figure 17 depicts the settlements that could be at risk of increases in wildfires by the year 2050.

The likelihood of wildfires under current climatic conditions for the JTGDM is rare across all three LMs. The projected 2050 settlement wildfire risk for the district is low across the three LMs.

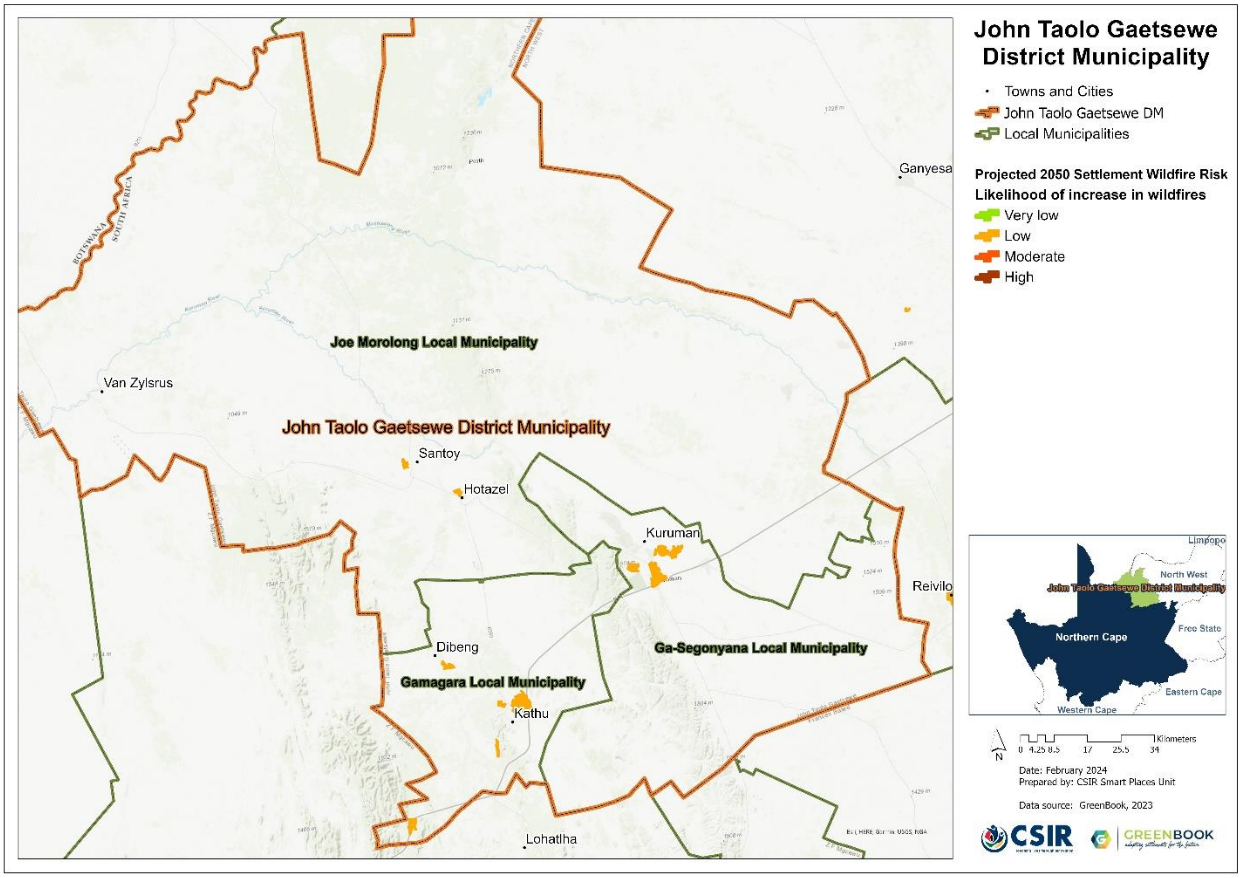


Figure 17: The likelihood of wildfires under projected future climatic conditions across settlements in John Taolo Gaetsewe District Municipality

2.3.4. Flooding

The flood hazard assessment combines information on the climate, observed floods, and the characteristics of water catchments that make them more or less likely to produce a flood. The climate statistics were sourced from the South African Atlas of Climatology and Agrohydrology, and a study of river flows during floods in South Africa (Schulze, 2008). The catchment characteristics that are important are those that regulate the volume and rate of the water flowing down and out of the catchment. The SCIMAP model was used to analyse the hydrological responsiveness and connectivity of the catchments and to calculate a Flood Hazard Index. Changes in the land cover, such as urbanisation, vegetation and land degradation, or poorly managed cultivation, reduce the catchment's capacity to store or retain water. More dynamic changes in land cover could not be considered in this analysis, such as for example, recent informal settlements that may increase exposure and risk. Additional local and contextual information should be considered to further enrich the information provided here.

Since the magnitude and intensity of rainfall are the main drivers of floods, and rainfall intensity is likely to increase into the future, it is projected that flood events are likely to increase into the future. Estimates of the extreme daily rainfall into the future were obtained from high-resolution regional projections of future climate change over South Africa. The settlements that are at risk of an increase in floods were identified using a risk matrix, which considered the flood hazard index and the projected change in extreme rainfall days from 1961-1990 to the 2050s.

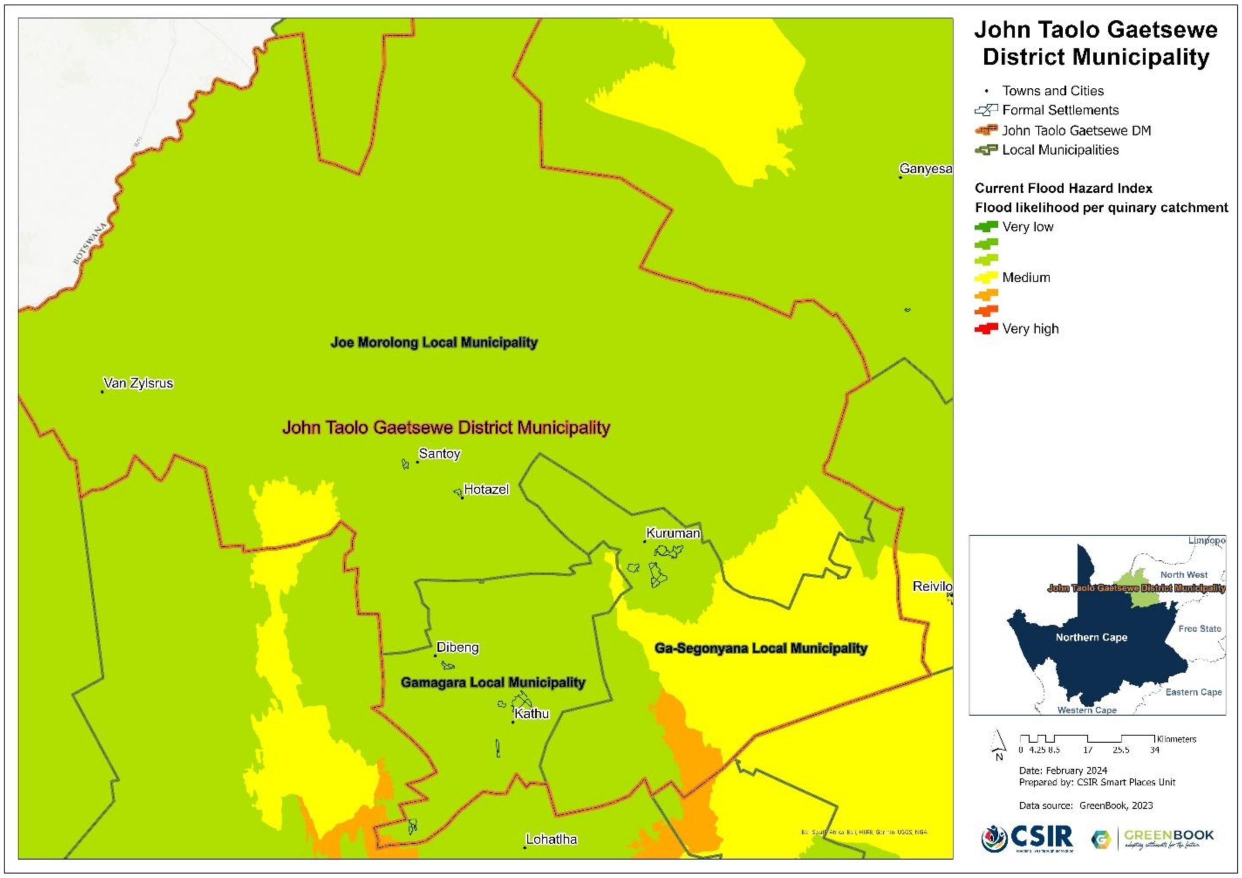


Figure 18: The current flood hazard index across John Taolo Gaetsewe District Municipality under current (baseline) climatic conditions

Figure 18 depicts the flood hazard index of the individual Quinary catchments present or intersecting with the District. The flood hazard index is based on the catchment characteristics and design rainfall, averaged at the Quinary catchment level. Green indicates a low flooding hazard, while red indicates a high flood hazard. The flood hazard potential for the district is generally low, with the Ga-Segonyana LM having a moderate to high flood hazard potential.

Figure 19 depicts the projected change into the future in extreme rainfall days for an 8 x 8 km grid. This was calculated by assessing the degree of change when projected future rainfall extremes (e.g., 95th percentile of daily rainfall) are compared with those under the current rainfall extremes. A value of more than 1 indicates an increase in extreme daily rainfalls. The predicted change in the number of extreme rainfall days is variable across the district. Gamagara LM has scores ranging between -0.56 to 0.06 days, this suggests a relatively small or insignificant change in the frequency of extreme rainfall events for the LM. Ga-Segonyana LM has scores ranging between -0.34 to 0.80 days which indicates small or insignificant change, suggesting minor fluctuations in the frequency of days with very heavy rainfall compared to what is currently experienced. Joe Morolong LM has scores ranging between -0.66 and 1.30 days, this indicates variability and uncertainty in extreme rainfall events for the LM, with the potential for decreases in rainfall for certain parts of the LM and increases in the frequency of days with very heavy rainfall for other parts.

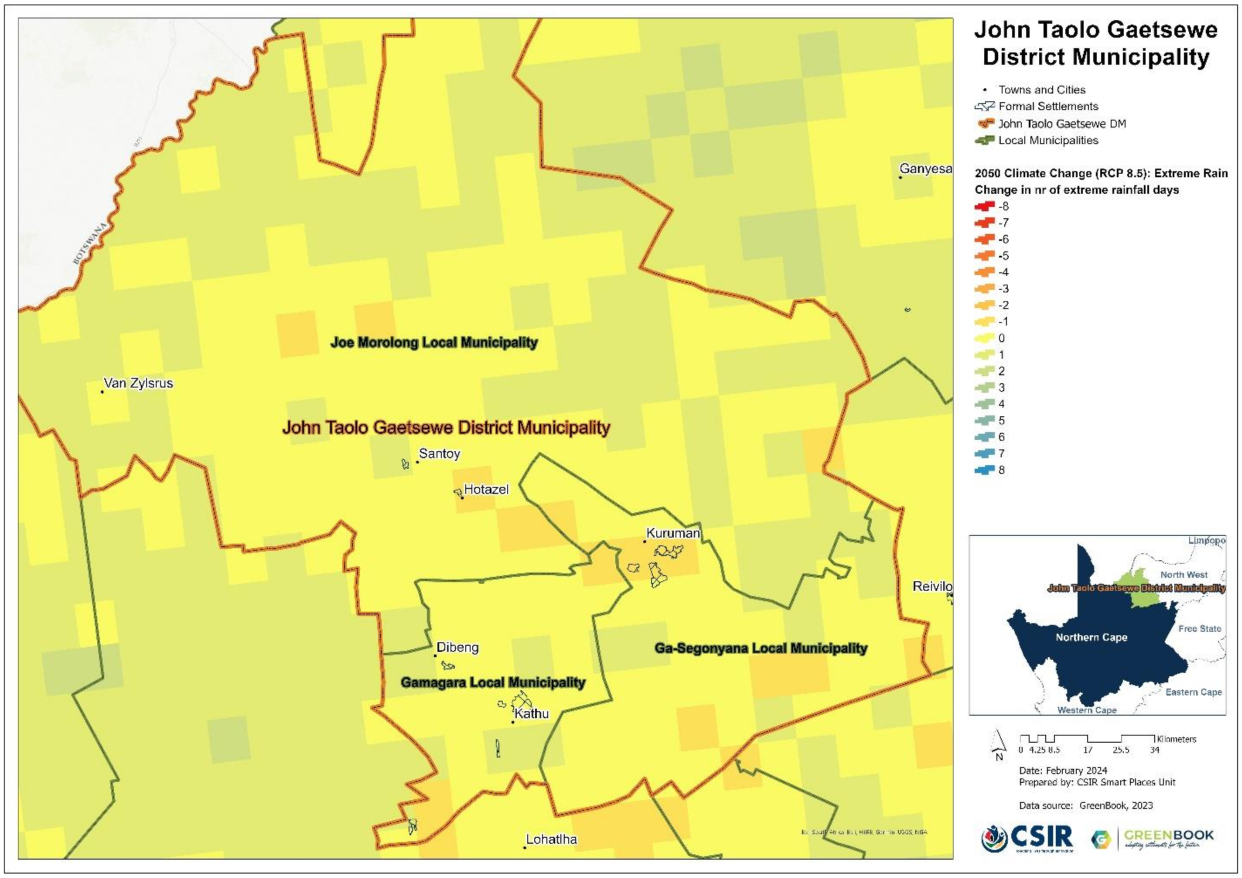


Figure 19: Projected changes into the future in extreme rainfall days across John Taolo Gaetsewe District Municipality

Figure 20 depicts the settlements that are at increased risk of flooding under an RCP 8.5 low mitigation (worst case of greenhouse gas emissions) scenario. All settlements across the district are expected to have a very low likelihood of increase in flooding in future.

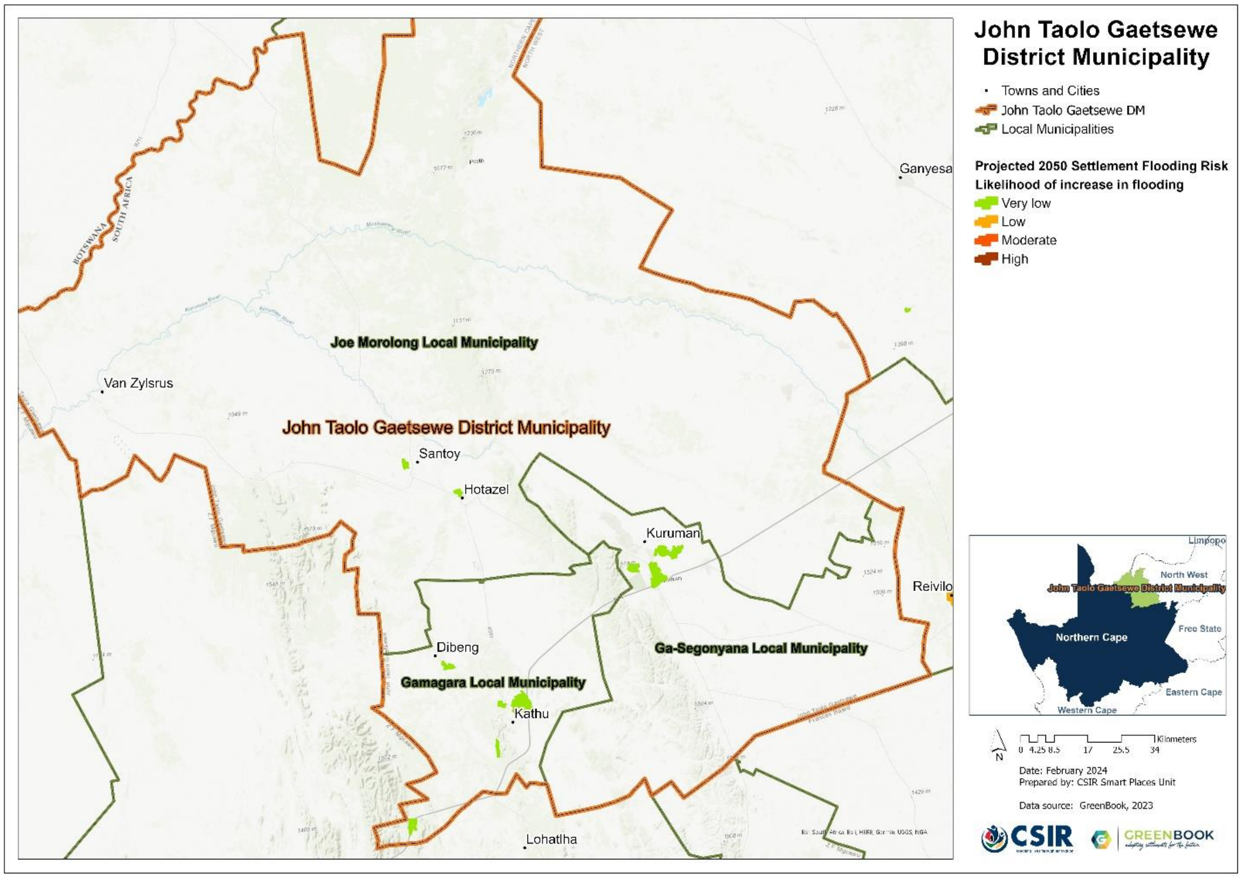


Figure 20: Flood risk into a climate change future at settlement level across John Taolo Gaetsewe District Municipality.

2.4. Climate impacts on key resources and sectors

To understand the impact that climate change might have on major resources, this section explores the impact that climate change is likely to have on the resources and economic sectors of the John Taolo Gaetsewe District Municipality.

2.4.1. Water resources and supply vulnerability

South Africa is a water-scarce country with an average rainfall of approximately 450 mm per year, with significant annual and seasonal variability. Rainfall also varies from over 1900 mm in the east of the country and in the mountainous areas, to almost zero in the west and northwest of the country. Conversion of rainfall to runoff is also low with an average mean annual runoff (MAR) of only 40 mm, one seventh of the global average of 260 mm per year. Runoff is even more highly variable than precipitation, both in space and time. Furthermore, demand for water is not evenly distributed, with most of the major water demand centres located far from the available water resources. This has resulted in a need to store water and to transfer water around the country to meet current and future demands.

Water availability is directly impacted by the climate and climate change. It is not just changes in precipitation that need to be considered, but also increasing temperatures that will lead to increased evaporation which could further reduce runoff and increase water losses from dams. Increasing temperatures will also impact on water demand, particularly for irrigation, but also from urban and industrial users. This could also contribute to reduced water security if existing systems are not able to meet these increasing demands. Increasing air temperatures will also increase water temperatures and hence increase pollution and water quality risks.

To obtain a high-level first order assessment of the relative climate change risks for water supply to different towns and cities across South Africa, a general risk equation was developed to determine the current and future surface water supply vulnerability that combines both climate change and development risks (i.e., due to an increase in population and demand). The current vulnerability of individual towns was calculated based on the estimated current demand and supply as recorded across the country by the Department of Water and Sanitation's (DWS) All Towns study of 2011 (Cole, 2017). The future vulnerability was calculated by adjusting the water demand for each town proportional to the increase in population growth for both a high and medium growth scenario. The level of exposure was determined as a factor of the potential for increasing evaporation to result in increasing demands, and for changes in precipitation to impact directly on the sustainable yield from groundwater, and the potential for impacts on surface water supply. These were then multiplied by the proportion of supply from surface and groundwater for each town. Exposure to climate change risk for surface water supply was calculated in two ways. The first was by assuming surface supply was directly related to changes in streamflow in the catchment in which the local municipality was located (E1) and alternatively (E2) taking into account the potential benefits offered by being connected to a regional water supply system by using the result from a national study of climate change impacts on regional water supply derived from a high level national configuration of the water resources yield model (WRYM) that calculated the overall impacts on urban, industrial and agriculture water supply to each of the original 19 (now 9) Water Management Areas (WMAs) in South Africa.

In South Africa, groundwater plays a key strategic role in supporting economic development and sustaining water security in several rural and urban settlements that are either entirely or partially dependent on groundwater supply. Groundwater is, however, a natural resource, the availability and distribution of which are highly influenced by climate variability and change. An analysis of the impact of climate change on potential groundwater recharge was conducted for the period 2031 to 2050. The Villholth GRiMMS (Groundwater Drought Risk Mapping and Management System) formulation (Vilholth et al., 2013), which implemented a composite mapping analysis technique to produce an explicit groundwater recharge drought risk map, was adapted to formulate a series of potential groundwater recharge maps for the far-future across South Africa. Finally, the future period 2031 to 2050 was compared with the historical period 1961 to 1990.

Figure 23 indicates the catchment(s) related to the district. The quaternary catchments serving the district include the Vaal Primary Catchment.

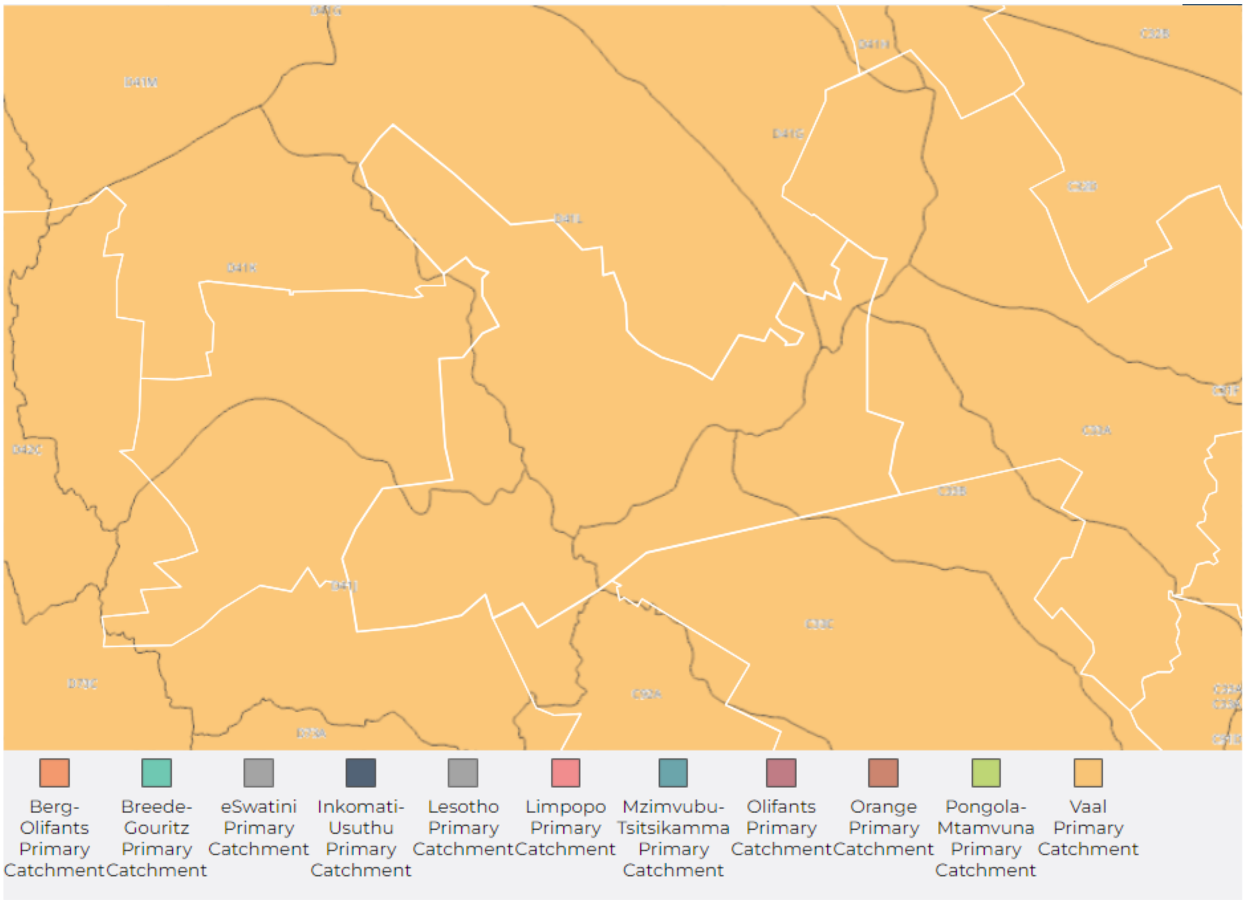


Figure 21: Quaternary catchments found in John Taolo Gaetsewe District Municipality

Figure 24 indicates where settlements get their main water supply from, be it groundwater, surface water or a combination of both sources. Settlements that rely on groundwater, either entirely or partially, are deemed to be groundwater dependent. In the John Taolo Gaetsewe District water sources are variable with settlements in the Joe Marolong LM largely surface water dependent, while the settlements in Ga-Segonyana LM, are groundwater dependent, and settlements in Gamagara LM use a combination of surface and groundwater sources.

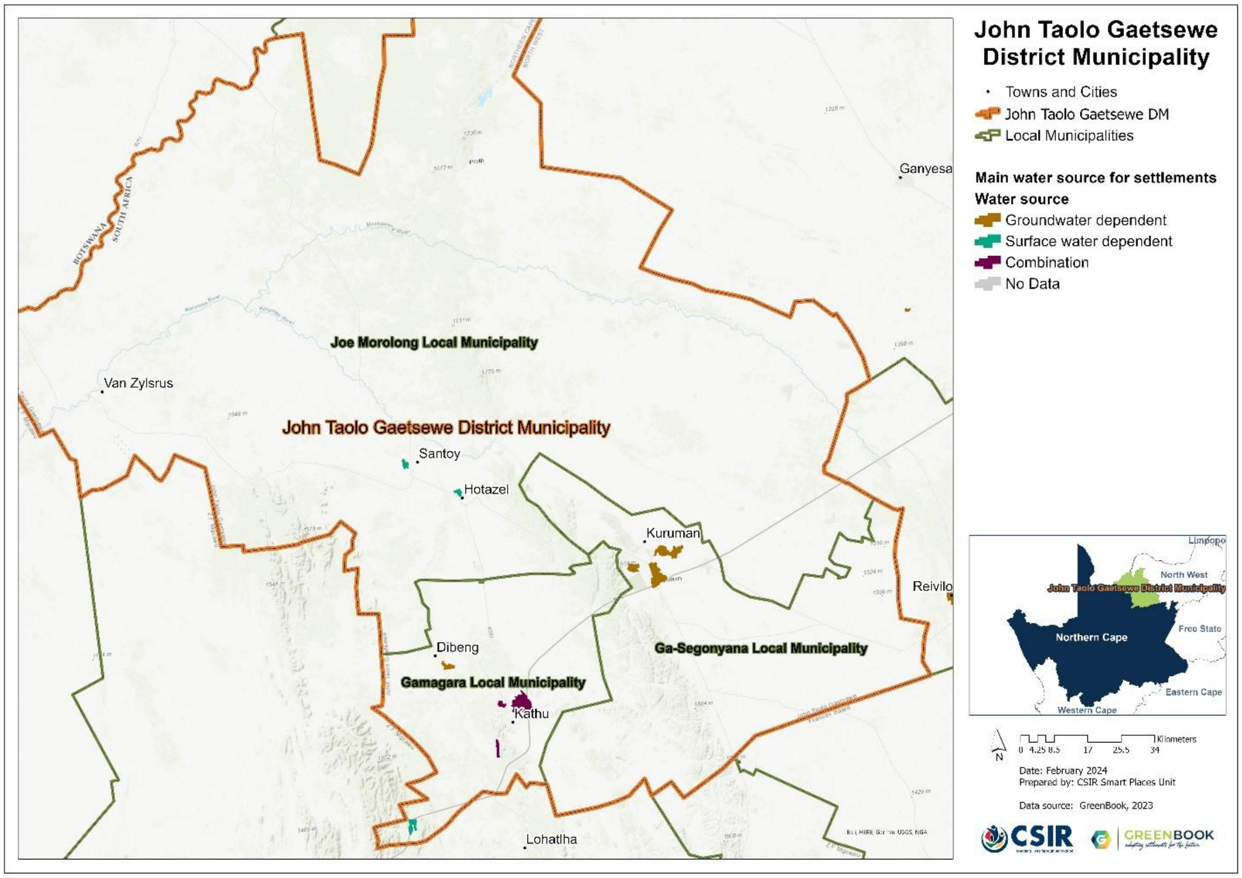


Figure 22: Main water source for settlements in the John Taolo Gaetsewe District Municipality

Figure 25 indicates the occurrence and distribution of groundwater resources across the District Municipality, showing distinctive recharge potential zones, while Figure 26 indicates the projected change in groundwater potential. Figure 27 indicates which groundwater dependent settlements that may be most at risk of groundwater depletion based on decreasing groundwater aquifer recharge potential and significant increases in population growth pressure into the future.

The groundwater recharge potential ranges between 2.69 and 3.16 for most of the district, which suggests a relatively high potential for groundwater recharge.

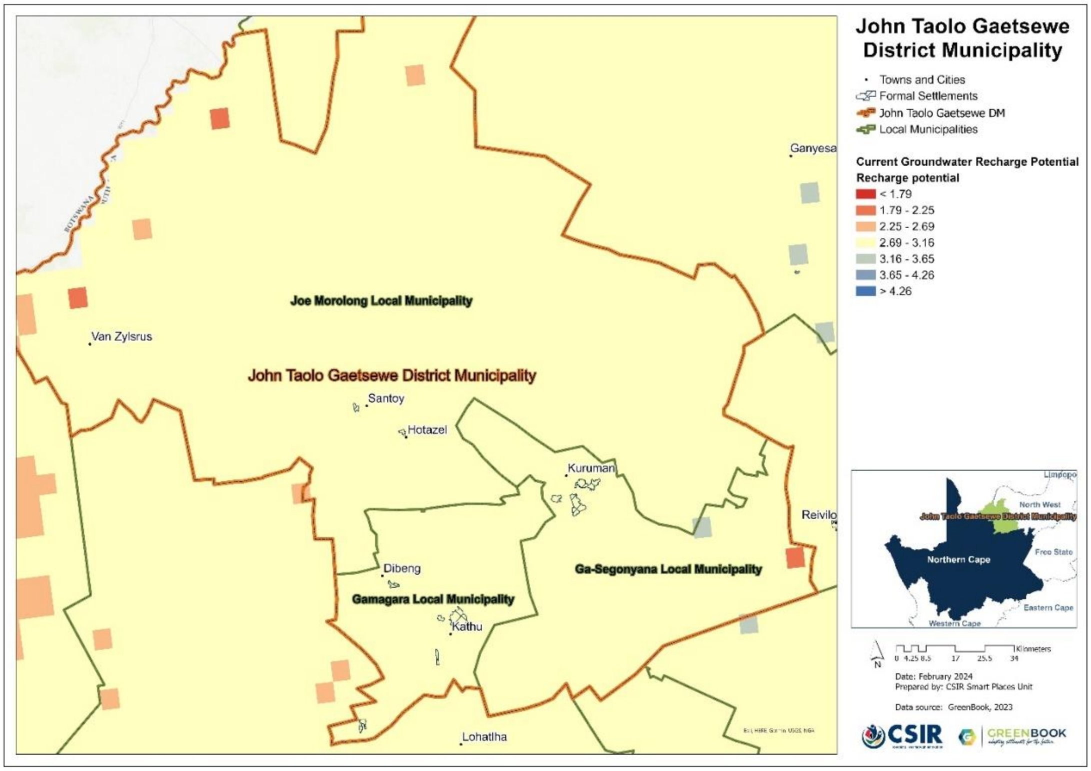


Figure 23: Groundwater recharge potential across John Taolo Gaetsewe District Municipality under current (baseline) climatic conditions

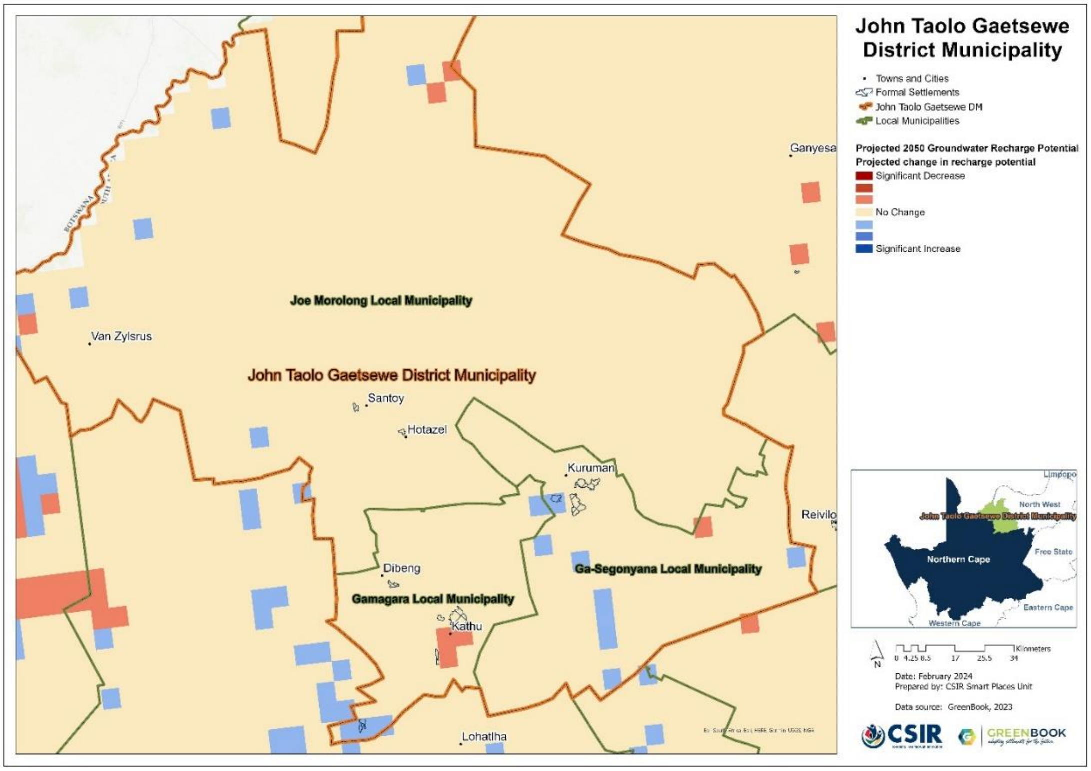


Figure 24: Projected changes in groundwater recharge potential from baseline climatic conditions to the future across John Taolo Gaetsewe District Municipality

The projected change in groundwater recharge potential for most of the JTGDM indicates that no change is expected in recharge potential. The Gamagara LM is expected to have a slight decrease in groundwater recharge in the area surrounding the Kathu settlement. Whereas certain pockets in the Ga-Segonyana LM are expected to have a slight increase in groundwater recharge. The groundwater depletion risk for the settlements in Gamagara and Ga-Segonyana LM's are moderate.

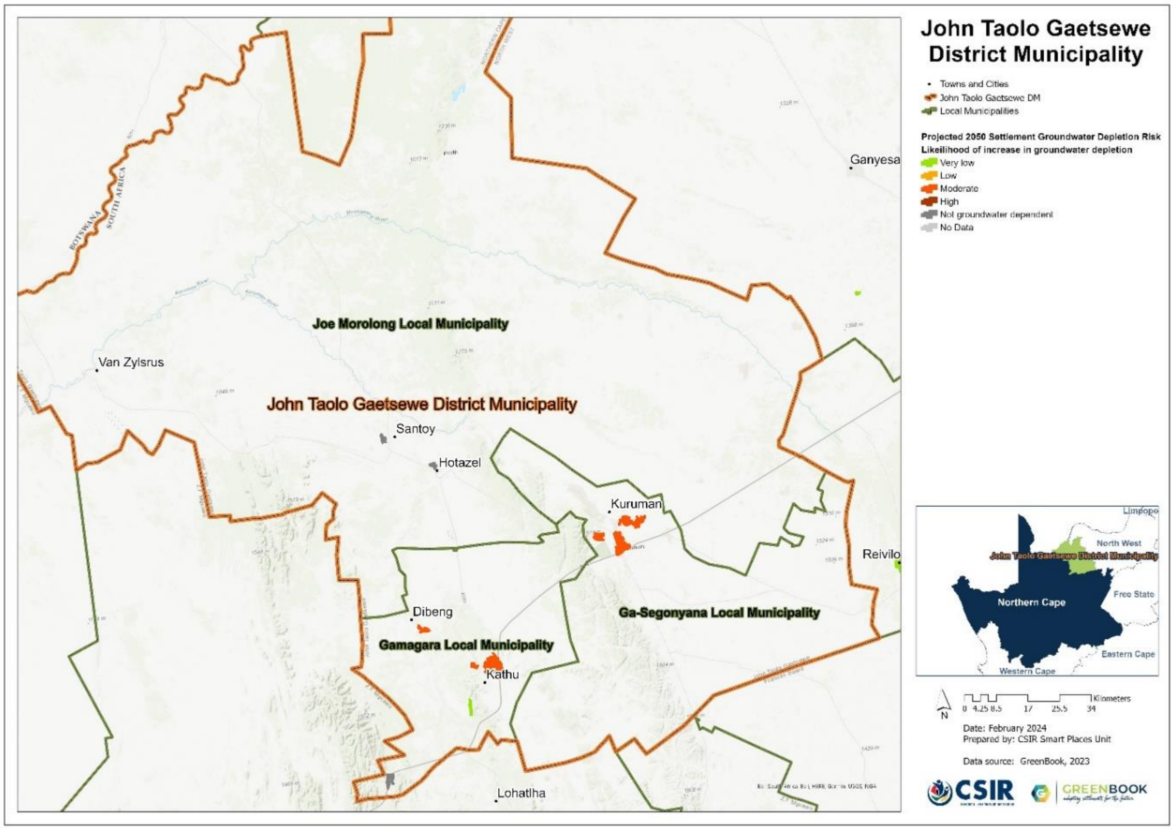


Figure 25: Groundwater depletion risk at settlement level across John Taolo Gaetsewe District Municipality

Table 3 provides an overview of current water supply vulnerability (i.e., demand versus supply) for the Local Municipalities in the John Taolo Gaetsewe District based on the data compiled for the Department of Water and Sanitation's (DWS) All Town's Study (Cole, 2017). A water supply vulnerability score above 1 indicates that demand is more than supply, while a score below 1 indicates that supply is meeting demand.

Table 3: Current water supply and vulnerability across john Taolo Gaetsewe District Municipality

Local Municipality	Water Demand per Capita (l/p/d)	Water Supply per Capita (l/p/d)	Current Water Supply Vulnerability
Gamagara	382.73	625.57	0.61
Joe Morolong	81.65	273.24	0.3
Ga-Segonyana	219.72	319.41	0.69

Current and future water supply vulnerability estimations are based on: 1) a local water supply perspective incorporating changes to population growth coupled with exposure to climate risk and 2) a regional water supply perspective, based on impacts of regional water supply assuming supply is part of the integrated regional and national bulk water supply network. The water supply vulnerability estimations do not consider the current state of water supply and reticulation infrastructure. The current context and conditions within each of the Local Municipalities need to be considered when interpreting the information provided in this report. See the GreenBook Municipal Risk Profile Tool for more information on surface water, change in precipitation, runoff, and evaporation. Water supply vulnerability per local municipality is discussed below.

Gamagara

Gamagara LM's water supply is currently meeting demand. Water supply vulnerability is however projected to increase into the future, this can be attributed to a projected decline in rainfall, increase in evaporation as well as expected population growth.

Joe Morolong

Joe Morolong LM's water supply is currently meeting demand with water supply vulnerability relatively low for the LM. In future water supply vulnerability is estimated to decrease even further due to a projected decrease in population growth.

Ga-Segonyana

Ga-Segonyana LM's water supply is currently meeting demand. Water supply vulnerability is projected to increase into the future due to a projected decline in rainfall, increase in evaporation and an increase in population growth.

2.4.2. Agriculture, forestry, and fisheries

Agriculture and food production is arguably the sector most vulnerable to climate impacts in South Africa. Many settlements in South Africa owe their existence to the primary sector of the country. Agriculture, forestry, and fisheries (AFF) form the bulk of the primary sector and act as catalysts for the economic development of secondary and tertiary sectors. Where these sectors are the primary economic activity in an area, they contribute to the local economy, employment, food security, and livelihoods. They also indirectly benefit from services such as health care, education, and basic infrastructure. In such regions, social and economic stability are linked with the profitability of the agricultural sector.

Climate change, through increased temperature and changing rainfall patterns, can have fundamental impacts on agriculture if the climatic thresholds of the commodities being farmed are breached. However, the nature and extent of these impacts depends on the type of commodity being farmed and the relative geographic location of the farmer with regard to the industries served, and also on the resources available to the farmer. The same climate impact can have different impacts on different commodities and farms. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as has been done in the past.

The methodological approach to understanding the impact of climate and climate change on AFF, consisted of four components. Firstly, the most important areas in terms of Gross Value Added (GVA) and employment for the AFF sector relative to the other sectors of the South African economy were determined. Secondly, an analysis of climate change scenarios was done using historical climate variables, as well as multi-model projections of future climates to help identify specific climate-related risk factors for agriculture within specific regions. Thirdly, crop suitability modelling was done to indicate how the area suitable for crop production under the present climate conditions might shift or expand under the scenarios of future climate change, in addition to using the Temperature Humidity Index (THI) to assess heat stress in livestock. Finally, the climate change analysis was used in conjunction with the crop modelling outputs to assess the potential impacts of climate change over a specific area, or for a specific crop, to give more detail on how predicted climate changes translate into location/crop specific impacts. This was developed at a local municipal level and guided by the outcome of the agricultural industry sector screening and climate scenario analysis.

The AFF sector contributes 0.4 % to the local GVA of the District (IDP, 2023-24). From a land-cover perspective, agriculture is the second most significant economic activity in the JTGDM, comprising of large commercial livestock farms and subsistence grazing activities. Agriculture does, not make a large contribution to the economy, nor does it provide a substantial amount of employment – only 4.67% of the employed population is active in this sector. The main agricultural commodities in the Ga-Segonyana LM are cattle farming, goat farming, poultry farming, game farming, meat processing, fruit and vegetable farming and leather tannery. Subsistence and survivalist farming predominate in the eastern half of the Joe Morolong LM. These activities consist mainly of livestock-keeping, poultry-rearing and planting of vegetables.

Below, the main agricultural commodities for each local municipality within the district is discussed in terms of what the impact of climate change might be on those commodities under an RCP 8.5 low-mitigation “business as usual” greenhouse gas emissions scenario.

Gamagara

In the Gamagara LM, the AFF sector contributes 0.87 % to the local GVA, which is a contribution of 0.1% to the national GVA for the AFF sector. Of the total employment, 4.82 % is within the AFF sector. The main agricultural commodities are beef cattle and maize for grain. Climate projections show a generally hotter and drier climate. A decline in rainfall can lead to deterioration of veld/forage quality and quantity. Whereas an increase in temperature can lead to reduced growth and reproduction performance in beef cattle due to heat stress. Increasing temperature can lead to potential yield reduction of maize used for grain production.

Joe Morolong

In the Joe Morolong LM, the AFF sector contributes 2.64% to the local GVA, which is a contribution of 0.16% to the national GVA for the AFF sector. Of the total employment, 14.63% is within the AFF sector. The main agricultural commodities are beef cattle and maize for grain. Climate projections show a generally hotter and drier climate. A decline in rainfall can lead to deterioration of veld/forage quality and quantity. Whereas an increase in temperature can lead to reduced growth and reproduction performance in beef cattle due to heat stress. Increasing temperature can lead to potential yield reduction of maize used for grain production.

Ga-Segonyana

In the Ga-Segonyana LM, the AFF sector contributes 4.01% to the local GVA, which is a contribution of 0.21 % to the national GVA for the AFF sector. Of the total employment, 12.8 % is within the AFF sector. The main agricultural commodities are beef cattle and maize for grain. Climate projections show a generally hotter and drier climate. A decline in rainfall can lead to deterioration of veld/forage quality and quantity. Whereas an increase in temperature can lead to reduced growth and reproduction performance in beef cattle due to heat stress. Increasing temperature can lead to potential yield reduction of maize used for grain production.

3. Recommendations

The greatest risk faced across the John Taolo Gaetsewe District are increases in temperatures with the risk of heat extremes ranging to between 21 to 80 more very hot days per annum by 2050 across the district. Severe and persistent heat can place significant stress on the ecology and livestock and have implications for both human comfort and health. People working outdoors, such as construction and farm workers, will be particularly vulnerable to increases in temperature which will also have negative impact on labour productivity. If adequate measures are not taken in adjusting housing and building design for increased temperatures it could potentially be fatal for humans.

The settlement areas of Gamagara LM are expected to experience extreme growth pressure while the settlements of the Ga-Segonyana LM are expected to have medium growth pressure up to 2050, this implies an increase in the exposure of people to heat stress. Extreme population growth pressure will also lead to increased competition for resources – which affects the adaptive capacity of the district and its inhabitants, thus making it more difficult for people to adapt to, respond to and recover from climate hazards and impacts.

Although the current water supply can meet the demands of the LMs in the JTGDM, water supply vulnerability is projected to increase into the future, this can be attributed to a projected decline in rainfall, increase in evaporation as well as expected population growth.

In response to these climate risks and impacts, the following adaptation goals are recommended:

1. To maintain and increase resilience and reduce the vulnerability of ecosystems and people to the adverse effects of climate change: To minimise the damage and loss stemming from the unavoidable impacts of climate change, it is essential to reduce the exposure and vulnerability of elements found in both human and natural systems present in the John Taolo Gaetsewe District to climate-related hazards and extreme events. Reducing exposure and vulnerability will therefore involve a combination of infrastructural, behavioural, and institutional changes. For human systems, this might involve building heat-resilient infrastructure designing buildings, transportation systems and public spaces with infrastructure features that mitigate heat buildup such as green roofs, reflected surfaces and shaded areas. Establishing cooling centres where people can seek refuge during extreme heat events, especially for vulnerable populations such as the elderly, children, and homeless individuals. Adaptation for the environment include implementing water conservation measures and efficient irrigation practices to ensure adequate water availability for ecosystems during heatwaves and droughts. For agricultural systems it would be important to promote climate-smart agricultural practices that improve soil health conserve water and enhance crop resilience to heat stress.

2. To increase the adaptive capacity of human settlements to climate change and extreme events: Implementing early warning systems to alert communities about upcoming heatwaves can help people prepare and take necessary precautions. Designing and retrofitting homes with features such as improved insulation, natural ventilation and shading to maintain comfortable indoor temperatures during heatwaves. Raising awareness about the risks of heat stress and educating the public on how to recognize and prevent heat-related illnesses. As well as ensuring healthcare facilities are equipped to handle an increase in heat related illnesses, including training medical personnel and stockpiling necessary supplies. Investing in monitoring networks and research to better understand the impacts of heat stress on ecosystems and identify effective adaptation strategies.

3. To develop climate-resilient, low-carbon, diverse and inclusive rural economies that are socially responsible, environmentally sustainable and that provide job opportunities for unskilled, semi-skilled and skilled local residences: Extreme increases in population projections as predicted for Gamagara LM can amplify the impacts of climate change. Keeping these growth pressures in mind it would be important for the JTGDM to put adaptation measures in place to ensure local residence are climate resilient. A climate-resilient rural economy would be one that can absorb and recover from climate shocks; that also contributes minimally to climate change. This might involve promoting

sustainable agricultural practices that are adaptive to changing climate conditions, investing in renewable energy sources, and encouraging diversification of the rural economy into sectors that are less climate sensitive. Furthermore, efforts to create more inclusive economies, that also provide job opportunities. at all skill levels, may involve training programs for local residents, policies to support small and medium enterprises, as well as the implementation of measures designed to ensure that the benefits of economic activities are equitably distributed.

4. To ensure that space is set aside for recreation, ecological support and stormwater management, and to guide decision making across all sectors: Increasing green spaces, parks and urban forests can lower urban temperatures through shade and evaporative cooling. Some of the actions the JTGDM can put in place is restoring and protecting natural habitats such as wetlands and forests which can buffer against extreme temperatures and provide refuge for wildlife.

5. To ensure water security for human consumption and irrigation under a changing climate: Given the water scarcity challenges in the country, developing comprehensive strategies both the quantity and quality of water resources is crucial. Moreover, the projected increases in average temperatures, reduction in rainfall and population growth in the JTGDM, are likely to result in adverse consequences that make it necessary for the district to take action to ensure water security for consumption and irrigation purposes in the face of climate change. Some of the actions that the JTGDM could take include water-saving technologies and practices in households, industries, and agriculture to reduce water demand. Investing in water storage infrastructure such as reservoirs, dams and groundwater recharge facilities to capture and store water during periods of abundance for use during dry spells. Developing alternative water sources such as desalination, rainwater harvesting, and wastewater reuse to supplement traditional water supplies. Implementing sustainable groundwater management practices to prevent over-extraction and depletion of aquifers, including regulations, monitoring, and recharge enhancement. Implementing measures to prevent and control pollution form industrial, agricultural, urban sources to protect water quality for human consumption and ecosystem health. Implementing integrated watershed management approaches to protect and restore water quality in rivers, lakes and reservoirs, including reforestation, riparian buffer zones and erosion control. The JTGDM should also invest in water treatment infrastructure and monitoring systems to ensure safe and reliable drinking water supplies, including regular testing for contaminants and pathogens.

These goals are not exhaustive and could be complemented by other strategies tailored to the specific context and needs of John Taolo Gaetsewe District in particular. The potential for success lies in integrating the goals (or the principles behind them) into all aspects of municipal decision-making and operations, as well as in engaging communities in these efforts.

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