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BASELINE ASSESSMENT

Vulnerability and Impact of Climate Change on Major Tourism Attractions and Activities

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REPORT

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
ADEME	French Agency for Environment and Energy Management
BBBEE	Broad-Based Black Economic Empowerment
BEEH	School of Bioresource Engineering and Environmental Hydrology
CDM	Clean Development Mechanism
CO2	Carbon Dioxide
CSAG	Climate Systems Analysis Group
DEA	Department of Environment Affairs
eCLAT	Experts on Climate Change and Tourism group
EFIEA	European Forum on Integrated Environmental Assessment
ENSO	El Niño Southern Oscillation
EMS	Environmental management system
EREC	European Renewable Energy Council
ESF	European Science Foundation
EU	European Union
FEDHASA	Federated Hospitality Association of South Africa
GCMs	General Circulation Models
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GIZ	German Co-operation for International Services
G-CRT	Golder Climate Risk Mapping Tool
GDP	Gross domestic product
HSSA	Haley Sharpe Southern Africa
HES	Hotel Energy Solutions
IPCC	Intergovernmental Panel on Climate Change
IH&RA	International Hotel and Restaurant Association
NATO	North Atlantic Treaty Organization
NDT	National Department of Tourism
MDTP	Maloti-Drakensberg Transfontier Conservation and Development Project
RCM	Regional Circulation Model
SAACI	South African Association for the Conference Industry
SANBI	South African National Biodiversity Institute
SATSA	Southern Africa Tourism Services Association
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VISIT	European Voluntary Initiative for Sustainability
WMO	World Meteorological Organization
WTO	World Tourism Organisation
WTTC	World Travel and Tourism Council
UNWTO	United Nations World Tourism Organisation

1.0 INTRODUCTION

Changes in climatic patterns are natural phenomena. However, there is increasing concern about the impact of climate change that has been brought about as a result of human activities (such as burning fossil fuels for energy, use of motor vehicles, etc.). Human-induced changes in climate have been acknowledged as a current global reality, and are the subject of significant global attention. Global changes in climate have already been observed that are generally consistent with model projections, and are likely to continue to occur for many decades to come even if mitigation efforts are successful due to lags and inertia in the global biosphere response.

Current climate models predict that South Africa will experience increasing temperatures, changing frequency, intensity and distribution of rainfall events, and sea level rise. Such changes will impact on key regional tourism drivers such as destination attractiveness, product content, business profitability, infrastructure planning and investment. Changes will manifest locally and will uniquely affect individual tourist destinations, communities and businesses.

South Africa is a country of extraordinary natural beauty, outdoor lifestyle and activities, warm weather and diversity in terms of culture, and is known as an affordable destination. The broad range of tourism activities, including ecotourism, cultural tourism, sporting activities, historical and geological attractions and business tourism make it a premier destination for domestic and local tourists.

The Department of Environment Affairs (DEA) and the National Department of Tourism (NDT), with support from the German Co-operation for International Services (GIZ), have identified the need to ensure the tourism industry has the capacity to build resilience against the potential impacts of climate change. The project was initiated through the realisation that a failure to respond to the threats of climate change will place an industry which currently contributes R 67 billion, or 3% of South Africa's gross domestic product (GDP) in jeopardy, and undermine industry's capacity to contribute to the economy. As such, the potential impacts of climate change on South Africa's natural attractions and tourism related infrastructure will need to be considered during the tourism industry's planning processes.

Golder Associates Africa (Pty) Ltd. (Golder), in partnership with Haley Sharpe Southern Africa (HSSA), was appointed on 20 September 2011 by the GIZ to conduct the *Baseline Assessment of the Impacts and Vulnerability of Climate Change on Major Tourism Attractions and Activities*.

This project represents the first step towards assisting the tourism industry to build its resilience and capacity to adapt to climate change impacts and to prepare for a carbon constrained future.

1.1 Project Approach

The project comprises a series of phases and tasks designed to achieve the objectives specified in the Terms of Reference. These phases and tasks are represented graphically in Figure 1.

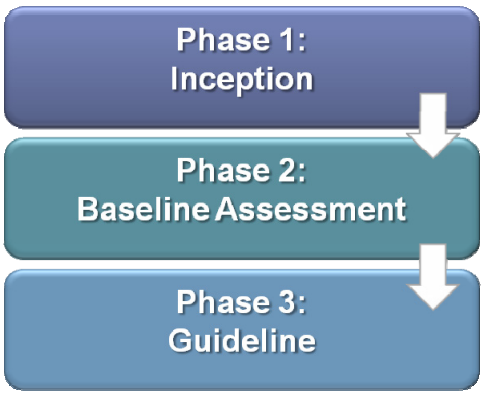

Figure 1: Overview of project phases and tasks

- **Phase 1**: Inception
- **Phase 2 (current phase)**: Baseline Assessment
  - Task 1: Identification and assessment of climate risk factors
  - Task 2: Tourism sector vulnerability to climate change
  - Task 3: Review of current response programmes and initiatives
  - Task 4: Vulnerability workshop
- **Phase 3**: Development of a guideline document

It is important to note that this project will not address the implications of climate change policies on tourism operators. Neither will it consider the global flow-on effects of climate change impacts and policies in other parts of the world and their potential effects on tourist arrivals and their destination choices. Some of these issues may be addressed in subsequent projects.

This report represents the Baseline Assessment phase and seeks to identify the climate risks to, and vulnerability of the tourism sector within South Africa. The report consolidates previous local and international studies regarding climate change and the tourism industry and presents new findings on the subject, specific to South African tourism attractions and activities.

The report is structured as follows:

- **Section 1**: Introduction;
- **Section 2**: A discussion on climate change and tourism (literature review);
- **Section 3**: Climate change in South Africa (projections for changes in climate and how this information is derived);
- **Section 4**: Impact and vulnerability assessment (incorporating results of a vulnerability workshop);
- **Section 5**: Responding to climate change;
- **Section 6**: Recommendations for future studies; and
- **Section 7**: Conclusion.

2.0 CLIMATE CHANGE AND TOURISM

A review of international literature highlights the importance of both weather and climate to tourism, as tourists often base their travel decisions on perceived and experienced climatic conditions. Specific weather conditions affect tourist seasons, tourism spending, whether tourists can participate in tourist activities, their level of satisfaction and their safety. In many destinations tourism is closely linked with the natural environment. Climate affects a wide range of the environmental resources that are critical attractions for tourism, such as snow conditions, wildlife productivity and biodiversity, water levels and quality. Climate also has an important influence on environmental conditions that can deter tourists, including infectious disease, wildfires, insect or waterborne pests, and extreme events such as tropical cyclones[1].

Climate change has the potential to exacerbate adverse weather conditions, but may also result in more favourable climates in some parts of the world. Environmental change due to anthropogenic climate change, extreme events and pressure on resources (e.g. water) may pose challenges for tourist destinations in the future.

[1] WTO and UNEP (2008) Climate Change and Tourism: Responding to Global Challenges. World Tourism Organization and United Nations Environment Programme. Printed by the World Tourism Organization, Madrid, Spain

2.1 Defining tourism

The United Nations World Tourism Organisation (UNWTO) is a specialised agency of the United Nations and the leading international organisation in the field of tourism defines tourism as "*a collection of activities, services and industries which deliver a travel experience comprising transportation, accommodation, eating and drinking establishments, retail shops, entertainment businesses and other hospitality services provided for individuals or groups travelling away from home*"

"*The sum of the phenomena and relationships arising from the interaction of tourists, business suppliers, host governments and host communities in the process of attracting and hosting these tourists and other visitors*"

UNWTO defines tourists as *"people travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes*".

Tourism is an inter-related system of supply and demand factors and a broad range of societal/environmental influences. These concepts are further discussed in the sections that follow.

2.1.1 Supply

The supply-side of tourism focuses on the most basic resources that attract tourists to a region and what the tourism industry has on offer by way of attractions, experiences and facilities. This includes the suppliers of the goods and services that enable the delivery of products to consumers (tourists and/or visitors) from their home to, and including all aspects of, the destination.

The tourism supply chain involves many components, such as accommodation, transport and excursions, bars and restaurants, handicrafts and other retail shopping and food production, as well as the infrastructure that supports tourism to, from, and at destinations (including water supply, access routes, waste management, energy provision, etc.).

Tourism agencies and operators have a significant influence on the supply chain and, as such, have the opportunity to promote enhanced sustainability performance as a critical factor of business management and continuity through business-to-business relationships.

2.1.2 Demand

The demand side of tourism comprises those needs and motivations that drive individuals to become tourists. Factors influencing the demand side include availability of disposable income, the motivation and ability to travel, as well as other emerging factors, i.e. destination preferences, quality expectations and booking behaviour. These factors are constantly evolving as personal choice, new destinations and new products with competitive prices compete with established tourism offerings.

Demand related to environmental performance

Transport by air, land and sea is considered to have a major environmental impact in the tourism industry. This environmental impact can affect demand if sought by tourists who are aware of and concerned about these issues. Ideally, plans should be put in place to promote a model change towards the use of forms of transport with lower environmental impacts. Examples include using trains instead of aeroplanes (for domestic travel) as the preferred form of transport for certain tourism products; however this is not always immediately possible due to cost and logistical implications.

2.2 Climate change and tourism: a global context

In terms of recreational tourism, it is acknowledged that tourists base their decisions to travel on whether a destination meets their interests and purpose of travel, and to a large extent on weather conditions at the destination at the time of their visit. As such, climatic trends (as determinants of subsequent weather conditions) influence a traveller's preferred destination, the timing, duration and frequency of the visit or visits. Furthermore, weather conditions will determine what sort of activities will be undertaken by the tourist, and within which levels of personal comfort, safety and stability.

The natural environment that exists within certain climatic conditions often underpins the attractiveness of a region as a destination. Climate change may have an impact on key regional tourism drivers such as destination attractiveness, product features and presentation, operational profitability, infrastructure planning and investment. Climate change can have a number of impacts on the natural, man-made and socio-economic environments within which the tourism sector and destinations function.

According to a National-Level Screening Exercise to Assess Tourism's Vulnerability to Climate Change[2] in New Zealand, these changes mostly manifest locally, and will uniquely affect individual tourist destinations, communities and businesses. The report indicates that the sensitivity of tourism to those climatic changes and their direct biophysical consequences depends on a range of factors including:

- How tourists respond to certain climatic conditions;
- How important weather and weather-related natural hazards are to tourism businesses for the successful operation of specific services and activities (e.g. scenic flights, cableways, etc.); and
- How tourism support, operational infrastructure and/or the utilization of natural resources such as water are relevant to their enterprise and how their operations might be temporarily or permanently affected as a result of climatic conditions and episodic events.

There are certain aspects that influence a visitor's experience at a destination. These include:

- **Transport** – all types of transport and associated accessibility infrastructure may be affected by weather events and climatic trends, e.g. cruise ships retained in port, airports closed and flights delayed, roads closed, rail services disrupted, and bridge crossings discontinued or delayed;
- **Activities** – both commercial and leisure activities may be affected e.g. cancellation of flights and boat cruises. Extreme tidal and dam, lake or river water levels may affect aquatic sports, recreational fishing, events and outdoor pursuits. Some commercial activities are vulnerable to high winds (sky diving, boat trips, bungee jumps, etc.), which impact on enjoyment of experiences and on visitors' safety;
- **Extremes** in temperature (hot and cold) and episodic extreme precipitation – these may determine whether suitable conditions prevail for active and passive recreational and niche interest pastimes. In instances when the probability of activity is lessened through adverse weather conditions, the tourist may question the merits of the destination and their degree of satisfaction whilst staying there. In some instances, however (e.g. higher volumes of snow in alpine areas), such extremes can improve the consumer desire to undertake in winter sports; and
- **Changes in weather patterns –** higher prevalence of days with rain or low level cloud cover can affect the attractiveness of a destination. Fewer sunny days will affect the appeal of a coastal destination in summer, for example. More erratic rainfall patterns potentially affecting vegetation and water supply can also affect the attractiveness of an area for tourists.

3.0 CLIMATE CHANGE IN SOUTH AFRICA

Modelling of climate change in South Africa is carried out by a limited number of institutions, but these are seen to be at the forefront of global research, modelling and responses, particularly in terms of adaptation. The processes used in the construction of the applied models used in this project are described in the sections which follow.

2 Becken S, Butcher G, Edmonds J, Hendrikx J, Hughey J, Reising A, Wilson J (undated) National-Level Screening Exercise to Assess Tourism's Vulnerability to Climate Change - and Environment & People Report. Foundation of Research, Science & Technology funded project. New Zealand.

3.1 Modelling Climate Change[3]

The use of General Circulation Models (GCMs) is one of the most widely applied methods through which climate change scenarios can be derived[4]. GCMs are able to simulate the most important features of the global climate at a large scale. However, owing to the low horizontal resolution and limited description of sub-grid processes, they often fail to characterise the potential changes at a more local scale[5]. More information is required at the local scale in order to assess local vulnerabilities to potential climate change and explore local adaptation options. Therefore, climate change impact studies rely on outputs from GCMs that are *downscaled* to an appropriate finer scale spatial resolution by linking the GCMs with regional climate characteristics. Interactions between the many processes that govern the Earth's climate are complex and extensive, and quantitative predictions of the impacts of increasing concentrations of greenhouse gases on climate therefore cannot be made through simple intuitive reasoning. For this reason, computer models, i.e. GCMs, have been developed, which are mathematical representations of the Earth's system, and in which physical and biogeochemical processes are described numerically to simulate the climate system as realistically as possible[6].

GCMs are global models which demarcate the earth into large-scale grids. The size of these grids, or horizontal resolution, is dependent on which GCM is being used. GCMs are founded on assumptions of the evolution of drivers of climate change, for example, the distributions of aerosols and greenhouse gases, and their respective concentrations in the atmosphere[6]. These depend directly upon natural and anthropogenic emissions, which are estimated through emission scenarios, developed using so-called "storylines"[7]. These storylines describe possible developments in global population growth and other aspects of the socio-economic system[6 8](See Figure 2). The emission scenarios are used to drive atmospheric chemistry and carbon cycle models that simulate changes in the concentration of greenhouse gases and aerosols. The resulting concentration scenarios are then input into GCMs which generate climate change scenarios that in turn drive models of the impacts on human and natural systems[8].

The 'A2' storyline was used in the generation of the GCMs used in this project. The 'A2' scenario represents a more divided world, characterised by:

- Uneven and regionally oriented economic development;
- Slower and more fragmented technological changes and improvements to per capita income;
- Continuously increasing population; and
- Perceptions that the environment only has a use value for human needs.

The 'A2' storyline represents the worst case scenario in human development where emissions are at their highest. It must be noted that, South Africa has already exceeded the emissions levels projected in this worst case scenario suggesting that it is not an unrealistic scenario around which to base this work.

[3]Chapter contributed by Prof Schulze, School of Bioresource Engineering and Environmental Hydrology (BEEH) at University of KwaZulu-Natal. Referencer: Schulze, R.E., Knoesen, D.M., Kunz, R.P. and Lumsden, T.G. 2011. General Circulation Models and Downscaling for South African Climate Change Impacts Studies: A 2011 Perspective. *In:* Schulze, R.E. 2011. ***A 2011 Perspective on Climate Change and the South African Water Sector***. Water Research Commission, Pretoria, RSA, WRC Report 1843/2/11, Chapter 2.1, 21 - 30.

[4] Perks, L.A. 2001. Refinement of Modelling Tools to Assess Potential Agrohydrological Impacts of Climate Change in Southern Africa. Unpublished PhD Thesis, University of Natal, School of Bioresources Engineering and Environmental Hydrology. Pietermaritzburg, RSA. pp 463.

[5] Bergant, K., Bogataj, L.K. and Trdan, S. 2006. Uncertainties in modelling of climate change impact in future: An example of onion thrips (Thrips tabaci Lindeman) in Slovenia. Ecological Modelling, 194, 244-255.

[6] Jacob, D. and van den Hurk, B. 2009. Climate Change Scenarios at the Global and Local Scales. In: Ludwig, F., Kabat, P., van Schaik, H. and van der Valk, M. (Eds) Climate Change Adaptation in the Water Sector, Chapter 3, 23-33. Earthscan, London, UK.

[7] Nakićenović, N., Alcamo, J., Davis, G., de Vries, B., Fenhann, J., Gaffin, S., Gregory, K., Grübler, A., Jung, T.Y., Kram, T., La Rovere, E.L., Michaelis, L., Mori, S., Morita, T., Pepper, W., Pitcher, H., Price, L., Raihi, K., Roehrl, A., Rogner, H.-H., Sankovski, A., Schlesinger, M., Shukla, P., Smith, S., Swart, R., van Rooijen, S., Victor, N. and Dadi, Z. 2000. Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Nakicenovic, N. and Swart, R. (Eds) Cambridge University Press, UK and New York, NY, USA. pp 599.

[8] Cox, P. and Stephenson, D. 2007. A changing climate for prediction. Science, 317, 207-208.

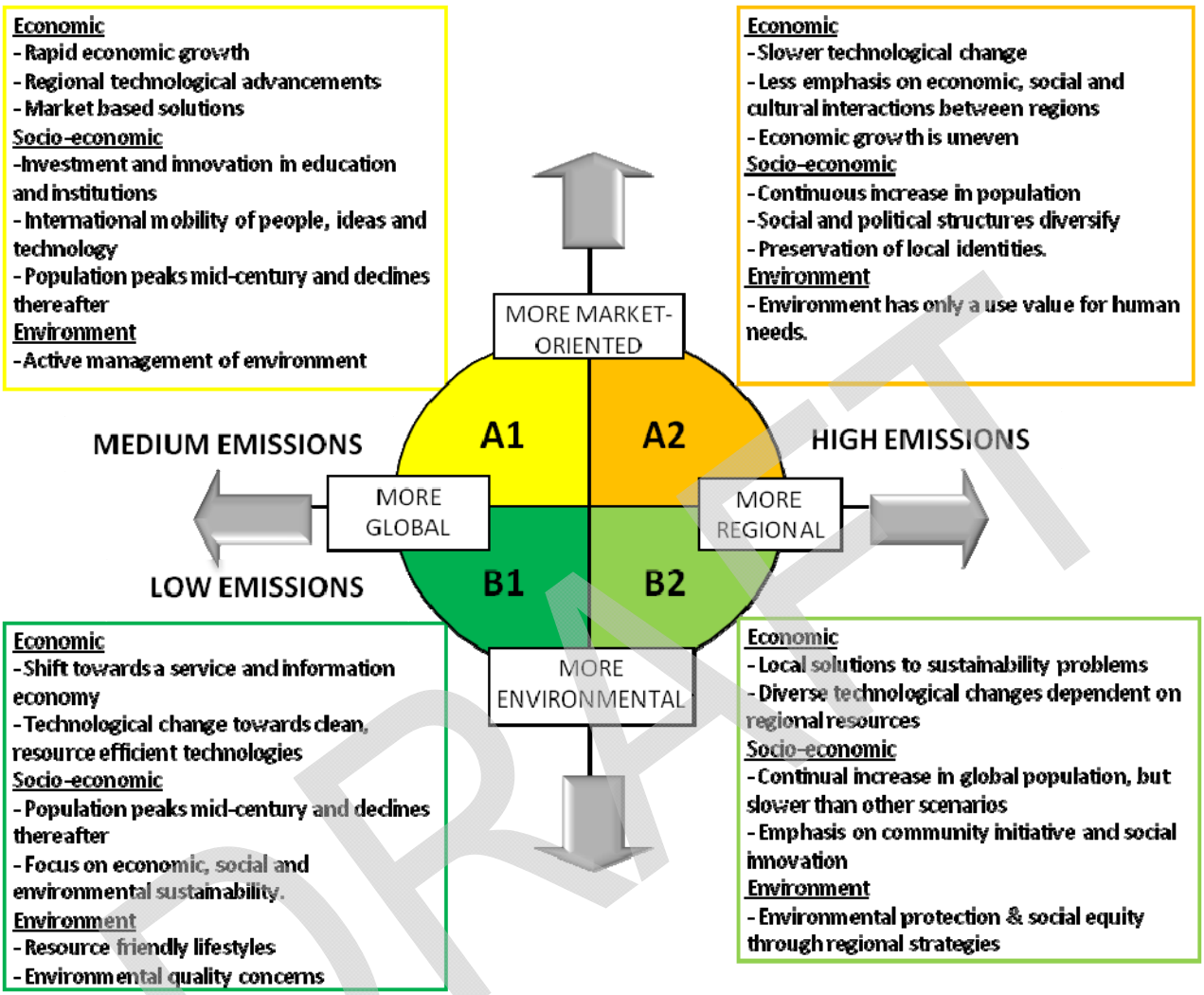

Figure 2: SRES scenarios [9]

3.1.1 Approaches to regional climate downscaling

The results from global models have limitations due to the extent of the grid sizes, implying that GCMs can be poor representations of climate changes occurring at a *regional level*. GCM results therefore need to be translated from the global to more local scales through the process of *regional climate downscaling*[10,11]. The term "*downscaling*" refers to techniques that enable the results of GCMs to be made relevant to local decision-makers and impact assessments[12]. Figure 3 illustrates the downscaling process, in which hydrology, vegetation and topographical data are represented at a local scale. Two approaches are commonly used to bridge the gap between large-scale and local-scale climate change scenarios, *viz*. *dynamic* downscaling and *statistical* or *empirical* downscaling[10,11].

[9] Nakićenović, N., Alcamo, J., Davis, G., de Vries, B., Fenhann, J., Gaffin, S., Gregory, K., Grübler, A., Jung, T.Y., Kram, T., La Rovere, E.L., Michaelis, L., Mori, S., Morita, T., Pepper, W., Pitcher, H., Price, L., Raihi, K., Roehrl, A., Rogner, H.-H., Sankovski, A., Schlesinger, M., Shukla, P., Smith, S., Swart, R., van Rooijen, S., Victor, N. and Dadi, Z. 2000. Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Nakicenovic, N. and Swart, R. (Eds) Cambridge University Press, UK and New York, NY, USA. pp 599.

[10] Hewitson, B.C., Engelbrecht, F., Tadross, M. and Jack, C. 2005. General Conclusions on Development of Plausible Climate Change Scenarios for Southern Africa. In: Schulze, R.E. (Ed) Climate Change and Water Resources in Southern Africa: Studies on Scenarios, Impacts, Vulnerabilities and Adaptation, Chapter 5, 75-79. Water Research Commission, Pretoria, RSA, WRC Report 1430/1/05.

[11] Giorgi, F., Diffenbaugh, N.S., Gao, X.J., Coppola, E., Dash, S.K., Frumento, O., Rauscher, S.A., Remedio, A., Seidou Sanda, I., Steiner, A., Sylla, B. and Zakey, A.S. 2008. The regional climate change hyper-matrix framework. EOS, 89(45), 445-446.

[12] UKCIP. 2003. Climate adaptation: Risk, uncertainty and decision-making. In: Willows, R.I. and Conell, R.K. (Eds) UKCIP Technical Report. UKCIP, Oxford, UK.

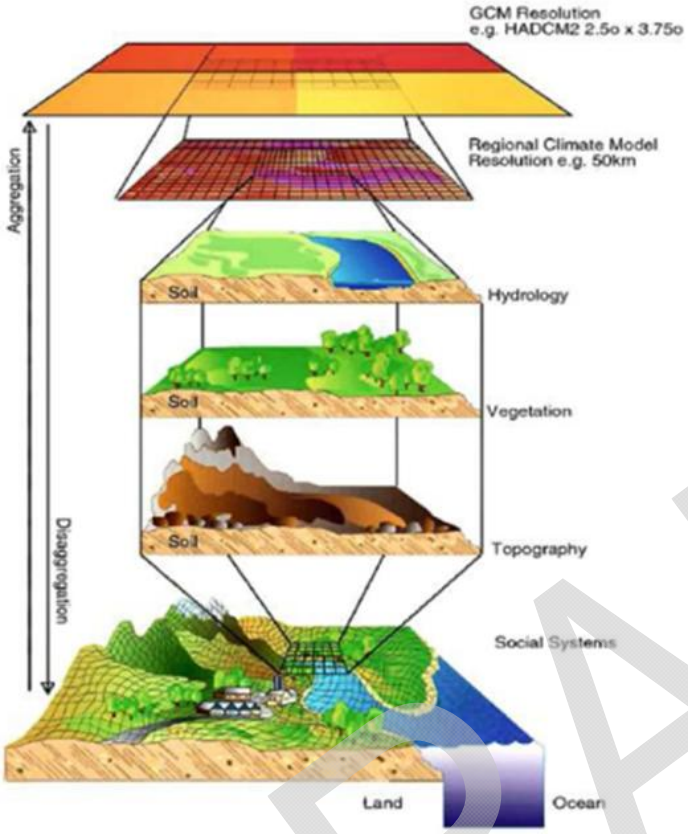

Figure 3: A Schematic Diagram of Downscaling GCMs

The climate change scenarios used for this project have been downscaled using empirical/statistical downscaling techniques developed for South Africa by the Climate Systems Analysis Group (CSAG) at the University of Cape Town. These were originally derived from global scenarios produced by five GCMs[13], all of which are derived from the Intergovernmental Panel on Climate Change's (2007) Fourth Assessment Report.

Statistical or empirical downscaling represents an empirical equivalent of the Regional Circulation Model (RCM), as seen in Figure 3. RCMs use the GCM fields to provide input to numerical representation of the climate system dynamics. Empirical downscaling seeks to do the same using empirical formulations derived from observational data[14]. Empirical downscaling involves developing a quantitative relationship between local-scale variables and large-scale atmospheric variables, which is subsequently applied to the GCM output to obtain local and regional climate change signals[6]. An advantage of this technique is that the GCM output can be downscaled to a point which is useful for obtaining projections, for example, for the modelling of rainfall at a particular site, which can then be input into a hydrological model. Furthermore, this technique is computationally far less demanding than the RCM approach[12]. A major disadvantage of this approach is the implicit assumption that these statistical relationships will remain stationary under a future climate[10,11].

3.1.2 Uncertainties inherent in global climate models

Uncertainties inherent in GCMs have been well documented[6,6, 8, 10,11]. In addition to the limitations resulting from uncertainties, GCMs are less capable of simulating second order atmospheric processes, such as

[13] CSAG, 2008. Climate Systems Analysis Group, University of Cape Town, RSA.

[14] Hewitson, B.C., Tadross, M. and Jack, C. 2005. Climate Change Scenarios: Conceptual Foundations, Large Scale Forcing, Uncertainty and the Climate Context. In: Schulze, R.E. (Ed) Climate Change and Water Resources in Southern Africa: Studies on Scenarios, Impacts, Vulnerabilities and Adaptation, Chapter 2, 21-38. Water Research Commission, Pretoria, RSA, WRC Report 1430/1/05.

precipitation, compared to those related to first order atmospheric processes, such as surface heat and vapour fluxes [15].

Some examples of GCM uncertainties include:

- Failure to simulate individual convective rainfall events, owing to the coarse spatial resolutions of GCMs, and the smaller spatial and temporal nature of convective rainfall, which poses problems in many parts of the world, including most of southern Africa, where convective rainfall is a dominant form of precipitation;
- Difficulty in simulating the intensity, frequency and distribution of extreme rainfall [16];
- Tendency to simulate too many light rainfall events (< 2 mm per day) and too few heavy rainfall events (> 10 mm per day), whilst maintaining a fairly realistic mean precipitation [16];
- Poor representation of major drivers of climate variability, such as the El Niño Southern Oscillation (ENSO) phenomenon[17], which is associated with a broad band of variability throughout southern Africa;
- Poor projection of climatological variables which represent other atmospheric conditions that lead to high magnitude precipitation and flood-producing events; and
- Many GCMs are available which vary in terms of their outputs as a result of the variables and calculations used in their generation.

In addition, global mean temperatures can be difficult to model at a local scale[6] therefore affecting subsequent estimations of potential evaporation. Uncertainty therefore surrounds the utility of direct GCM output in detailed hydrological studies where local precipitation, temperature and potential evaporation variables are primary inputs into hydrological models.

Significant discontinuity exists between the output from GCMs (spatial scales of 10,000 – 100,000 km^2) and the catchment scale (10 - 100 km^2), at which local decisions are sought and local adaptation options need to be considered. It is due to this discontinuity that downscaled GCM outputs need to be translated from the coarse regional scale to a catchment level [10,11]. For this project, this was achieved at the School of Bioresource Engineering and Environmental Hydrology (BEEH) at the University of KwaZulu-Natal with the use of the ACRU modelling system. Downscaled data was used as input to the ACRU model to derive hydrological parameters.

3.1.3 The ACRU modelling system

The downscaled rainfall and temperature station data produced by CSAG from the original GCMs was then input to the ACRU agrohydrological model in order to generate rainfall and temperature data at a quinary catchment level (fifth order catchment). ACRU[18] has been used extensively in Integrated Water Resource Management (IWRM) and climate change studies in southern Africa. It is considered to be the preferred simulation tool for this purpose, as it complies with many of the premises and principles required for modelling hydrological processes. ACRU comprises the following attributes (Figure 4 and Figure 5):

- It is a daily time step, conceptual-physical model:
  - With variables (rather than optimised parameter values) estimated from physically-based characteristics of the catchment; and

[15] Hardy, J.T. 2003. Climate Change: Causes, Effects, and Solutions. John Wiley & Sons Ltd, West Sussex, England. pp 247.

[16] IPCC, 2007. Intergovernmental Panel on Climate Change. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., Quin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (Eds) Cambridge University Press, Cambridge, UK. pp 996.

[17] Hulme, M., Doherty, R., Ngara, T., New, M. and Lister, D. 2001. African Climate Change: 1900-2001. Climate Research, 17, 145-168

[18] Schulze, R.E. 2011. The Hydrolgical Model Used in Climate Change Impact Studies on the South African Water Sector. *In:* Schulze, R.E. 2011. *A 2011 Perspective on Climate Change and the South African Water Sector*. Water Research Commission, Pretoria, RSA, WRC Report 1843/2/11, Chapter 2.3, 39-57.

- With the model revolving around daily *multi-layer soil water budgeting*.

- As such, the model has been developed essentially into a versatile total evaporation model (Figure 4), structured to be highly sensitive to climate drivers and to land cover, land use and management changes on the soil water and runoff regimes, and with its water budget being responsive to supplementary watering by irrigation, to changes in tillage practices, enhanced atmospheric CO_2 concentrations associated with climate change, or to the onset and degree of plant stress, which may change with global warming.

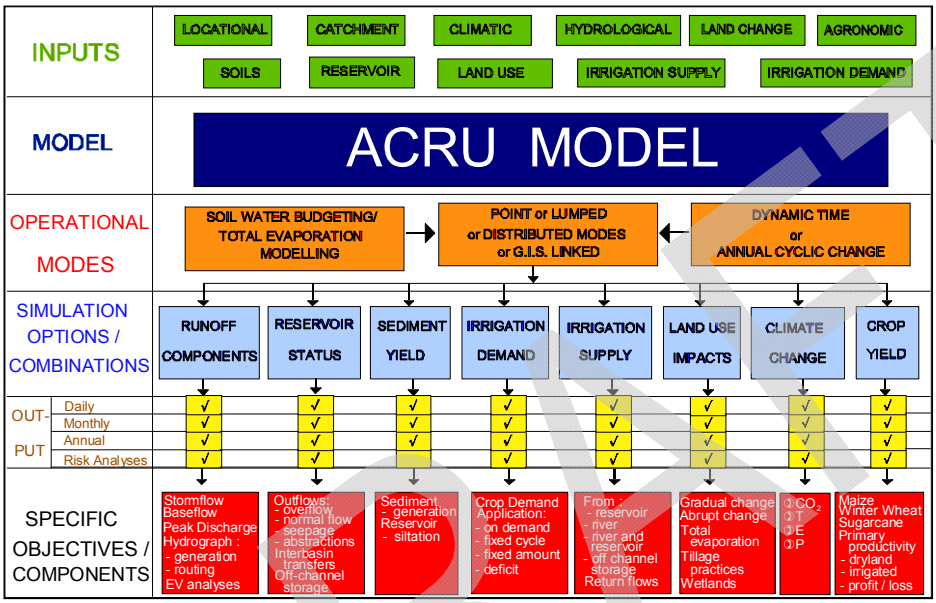

Figure 4: General Structure and multi-purpose function of the ACRU Model (After Schulze, 1995)

- *ACRU* is a multi-purpose model which integrates the various water budgeting and runoff production components of the terrestrial hydrological system (Figure 5). It can be applied as a versatile model for design hydrology (including flow routing through channels and dams), crop yield estimation, reservoir yield simulation, ecological requirements, wetlands hydrological responses, riparian zone processes, irrigation water demand and supply, water resources assessment, planning optimum water resource utilisation / allocation, conflict management in water resources and land use impacts - in each case with associated risk analyses - and all of which can respond differently with climate change;

- *ACRU* can operate at multiple scales as a *point* model or as a *lumped* small catchments model, on large catchments or at national scale as a *distributed* cell-type model with flows taking place from "exterior" through "interior" cells according to a predetermined scheme, with the facility to generate individually requested outputs at each sub-catchment's exit;

- The model includes a *dynamic input option* to facilitate modelling of hydrological responses to climate or land use or management changes in a time series, be they long term/gradual changes (e.g. urbanisation or climate trends), or abrupt changes (e.g. construction of a dam), or changes of an intra-annual nature (e.g. crops with non-annual cycles); and

- The *ACRU* model has been linked to the Southern African National Quaternary and Quinary Catchments Databases for applications at a range of scales in South Africa, Lesotho and Swaziland for climate change impacts and other studies.

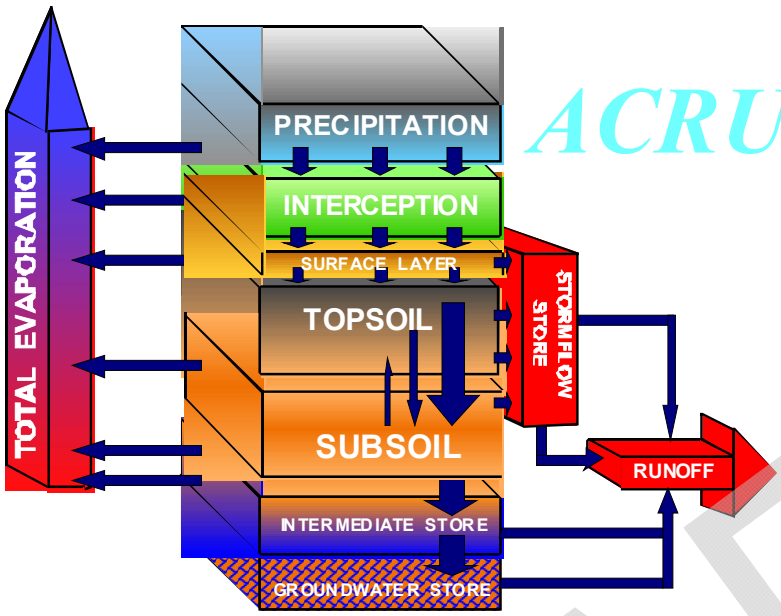

Figure 5: Schematic of major processes represented in the ACRU Model [19]

3.2 Climate projections for South Africa

In order to ascertain the climate change sensitivity of the tourism sector at each destination climate models were used to determine potential shift in climatic variables into the future. The quinary catchment level climate change projections were provided the School of BEEH at the University of KwaZulu-Natal. The projections were ready to use, having been downscaled by CSAG and fed through the ACRU agrohydrological model.

Projected changes in climate parameters, including projected temperature, rainfall and flood anomalies were assessed and mapped using ESRI AcrGIS 9.3, allowing the data to be expressed spatially. Five GCMs, listed in Table 1, were used in the assessment. These models are available at three time steps, namely:

- Present/historical: 1971 – 1990
- Intermediate future: 2045 – 2065; and
- Distant future: 2081 - 2100

It must be noted that statistically downscaled climate scenarios are not available for closer periods (for example, 2020) due to naturally occurring decadal variations such as El Niño and La Niña. These anomalies skew short term trends, reducing the confidence of the projection. Over longer intervals, for example, 30 years, these anomalies are mitigated by the overall climatic trends, increasing the confidence of the projection. It is for this reason the closest available timeframe is that of the intermediate future; 2045 – 2065.

Table 1: GCMs used for climate change projections presented in this project

Institute	GCM
Canadian Center for Climate Modelling and Analysis (CCCma), Canada	**Name:** CGCM3.1(T47) **First published:** 2005 **Website:** http://www.cccma.bc.ec.gc.ca/models/cgcm3.shtml
Meteo-France/Centre National de Recherches Meteorologiques	**Name:** CNRM-CM3 **First published:** 2004

[19] Schulze, R.E. 1995. Hydrology and Agrohydrology: A Text to Accompany the ACRU 3.00 Agrohydrological Modelling System. Water Research Commission, Pretoria, RSA, Report TT 69/9/95. pp 552.

Institute	GCM
(CNRM), France	**Website:** http://www.cnrm.meteo.fr/scenario2004/indexenglish.html
Max Planck Institute for Meteorology (MPI-M), Germany	**Name:** ECHAM5/MPI-OM **First published:** 2005 **Website:** http://www.mpimet.mpg.de/en/wissenschaft/modelle.html
NASA/Goddard Institute for Space Studies (GISS), USA	**Name:** GISS-ER **First published:** 2004 **Website**: http://www.giss.nasa.gov/tools/modelE
Institut Pierre Simon Laplace (IPSL), France	**Name:** IPSL-CM4 **First published:** 2005 **Website:** http://mc2.ipsl.jussieu.fr/simules.html

The five GCMs vary in the degree to which the projected changes are likely to occur. This chapter will present the average results of the five GCMs at the intermediate future (2045 – 2065) time step, providing a more conservative projection for the South African climatic parameters.

3.2.1 Rainfall

Rainfall is an extremely important hydrological factor in South Africa, which is generally a dry country with heavy reliance on regular rainfall for agricultural use, for the maintenance of its varied ecosystems and water supply for domestic use.

It should be noted that the distribution of rainfall across the country, both in spatial and temporal terms, is likely to change, in particular with higher rainfall projected for the winter period in the summer rainfall regions. This implies that rainfall is likely to become more erratic and less reliable when compared to current rainfall patterns. Furthermore, the rainfall is projected to fall in more frequent heavy, high energy rainfall events.

Mean annual rainfall

Mean annual precipitation for the country currently ranges from around 50 - 100 mm in the drier northeast of the country below the border with Namibia to far higher rainfall regions in eastern and northern KwaZulu-Natal and the Eastern Cape. The far west of the country is generally a winter rainfall region, with the east being a summer rainfall region. Areas such as the southern Cape experience rainfall all year round.

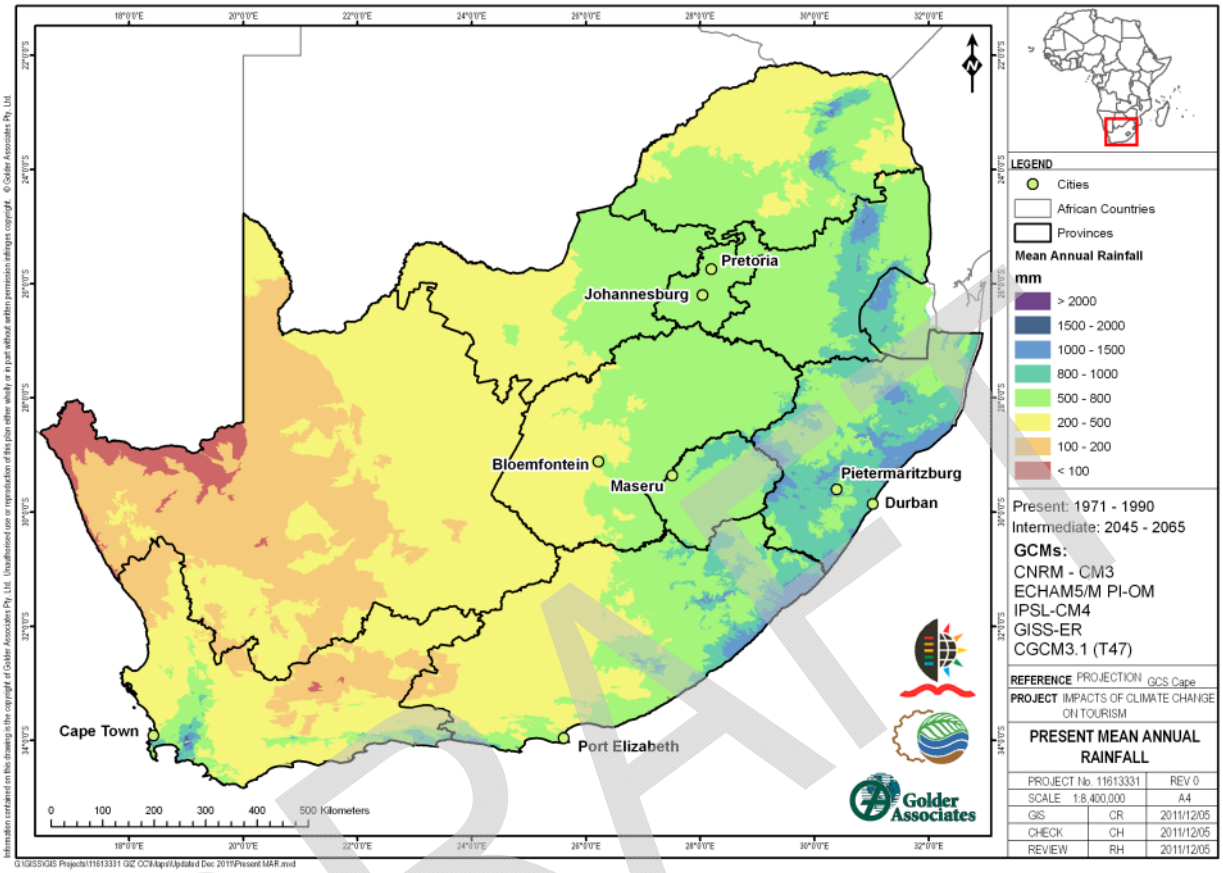

Figure 6: Modelled "present "(1970 -1990) mean annual precipitation (multiple GCMs)

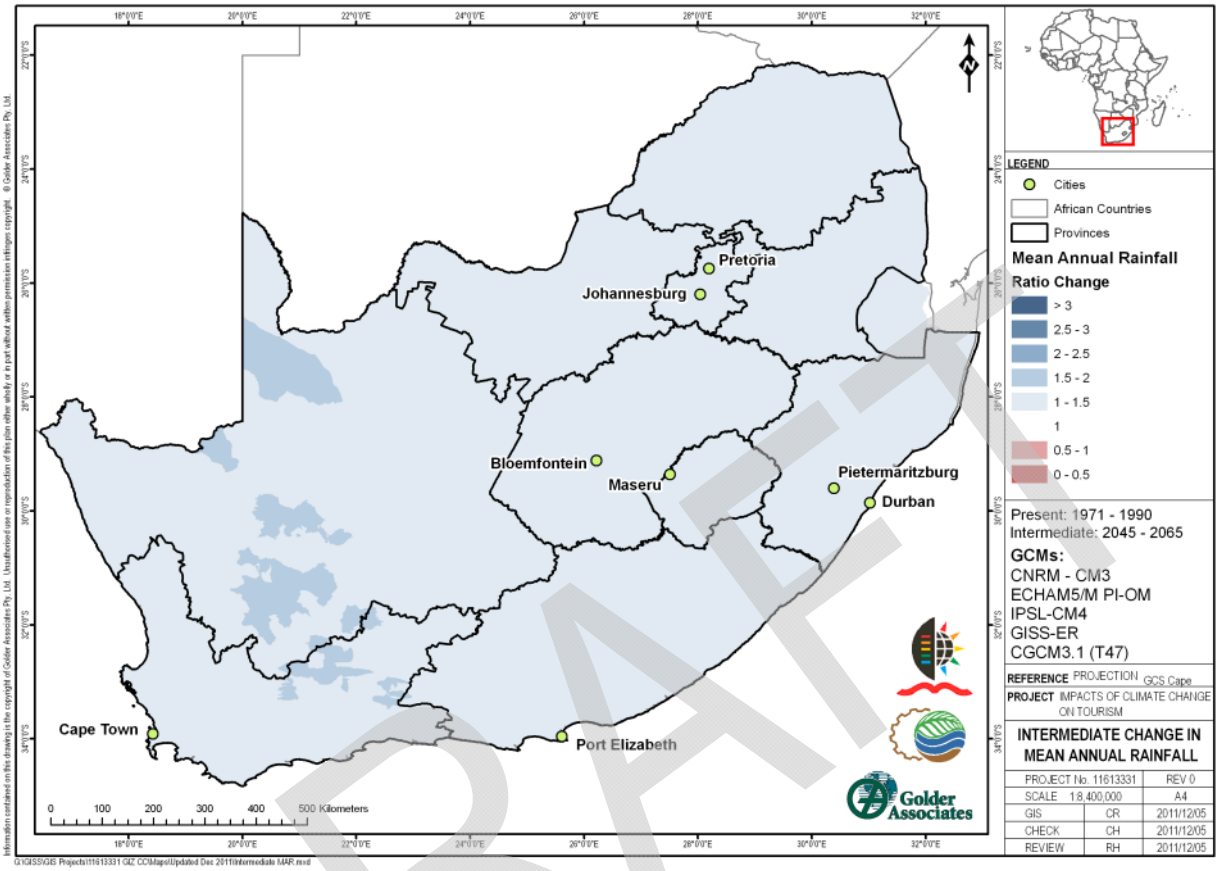

Figure 7: Projected Mean Annual Precipitation into the intermediate future (2045 – 2065, multiple GCMs)

Into the intermediate future, rainfall is projected to increase across the east of the country, and to decrease or remain the same across the western parts of the country.

Mean daily rainfall for January

The month of January is considered to be the month of maximum rainfall for the summer rainfall region (east of the country) and the month of minimum rainfall for the winter rainfall region (west of the country).

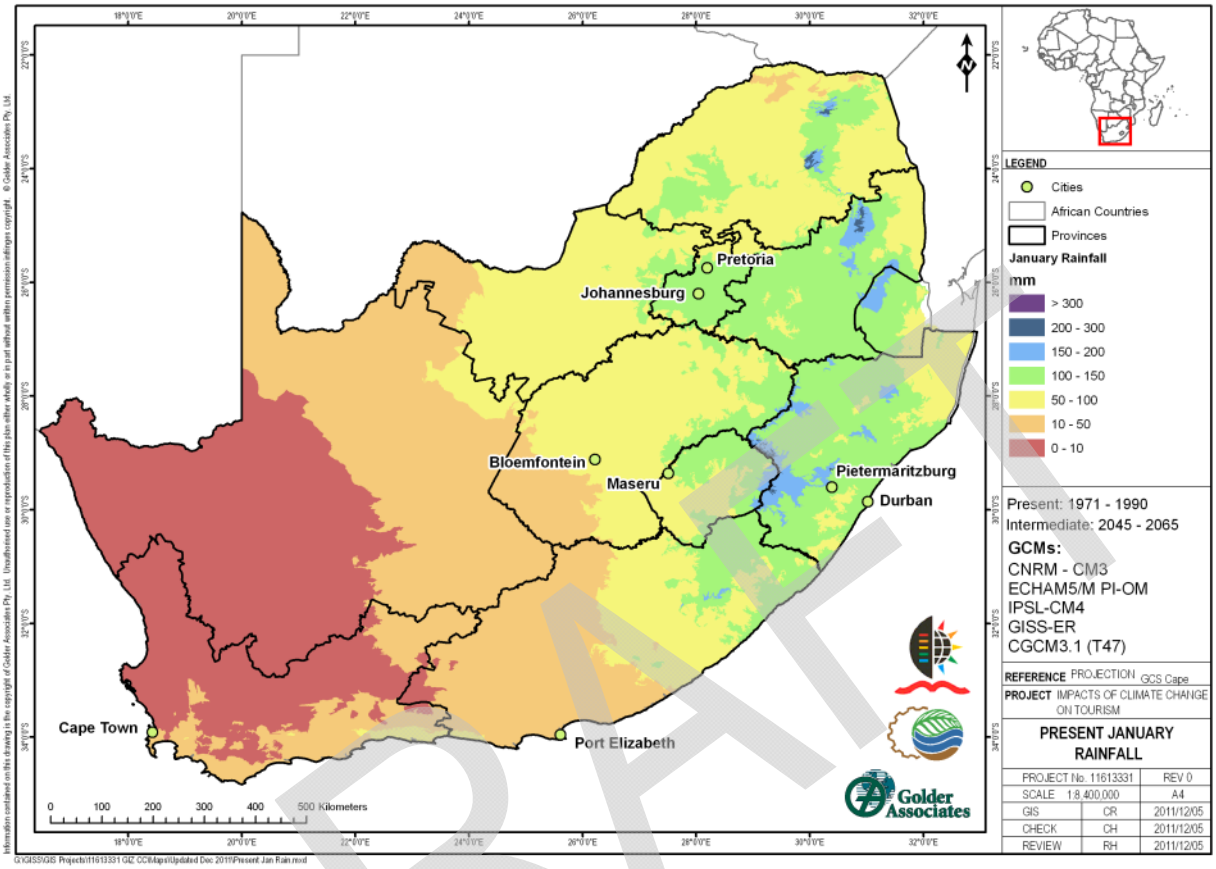

Figure 8: Modelled "present" average of mean daily maximum rainfall for the month of January (multiple GCMs)

It is evident from the modelled "present" scenario that the western portion of the country experiences little or no rainfall in the month of January. Areas in the east of the country experience higher average daily rainfall, which can be more than 100 mm per day. This rainfall is vital for crop growth within these areas and sustained agricultural supplies, as well as the health of ecosystems which feed biodiversity tourism. This rainfall is also important for the maintenance of water supply for domestic and other uses throughout the year.

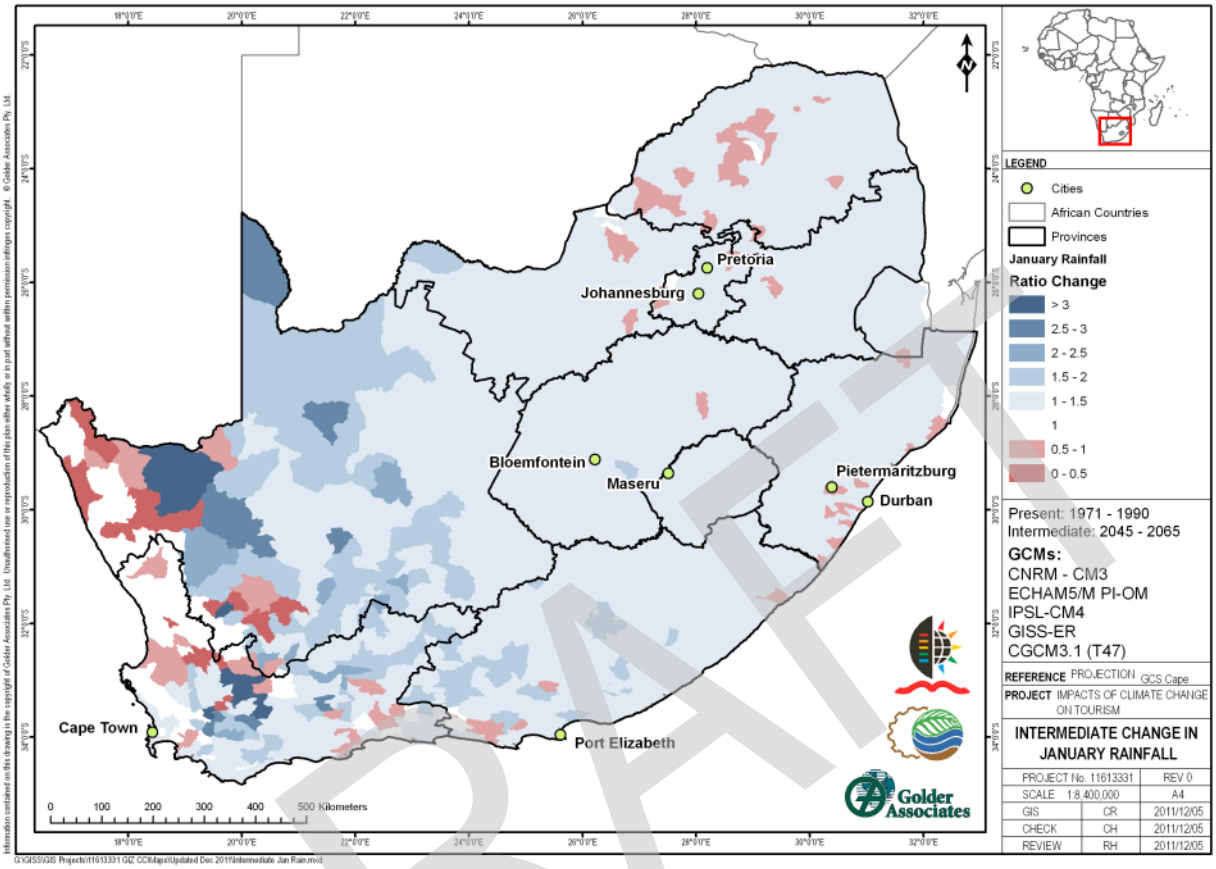

Figure 9: Projected mean of daily maximum rainfall for January into the intermediate future (2045 – 2065, multiple GCMs)

Mean daily rainfall for January is projected to decrease slightly across the country, but not significantly. Once again it should be noted that rainfall patterns are projected to change, with more rain falling in the east of the country, but at different times of the year and during high energy rainfall events.

Mean daily rainfall for July

The month of July is assumed to be the month of minimum rainfall for the summer rainfall region (east of the country) and the month of maximum rainfall for the winter rainfall region (west of the country).

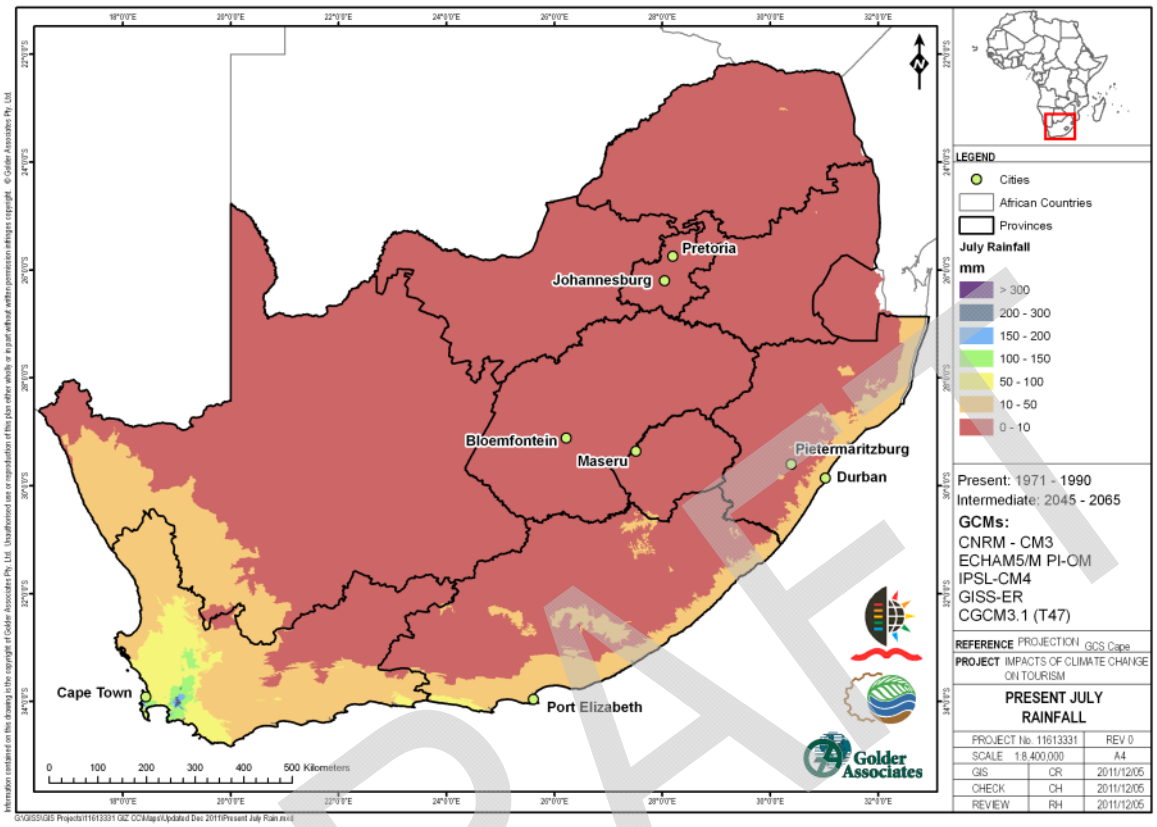

Figure 10: Modelled "present" average of mean daily minimum rainfall for the month of July (multiple GCMs)

Most of the country receives very little rainfall during the month of July, apart from in the southwest around the Cape Town area. This rainfall is vital for agricultural practices within the Western Cape, including wine farming, as well as important biodiversity hotspots such as the Cape Floristic Kingdom.

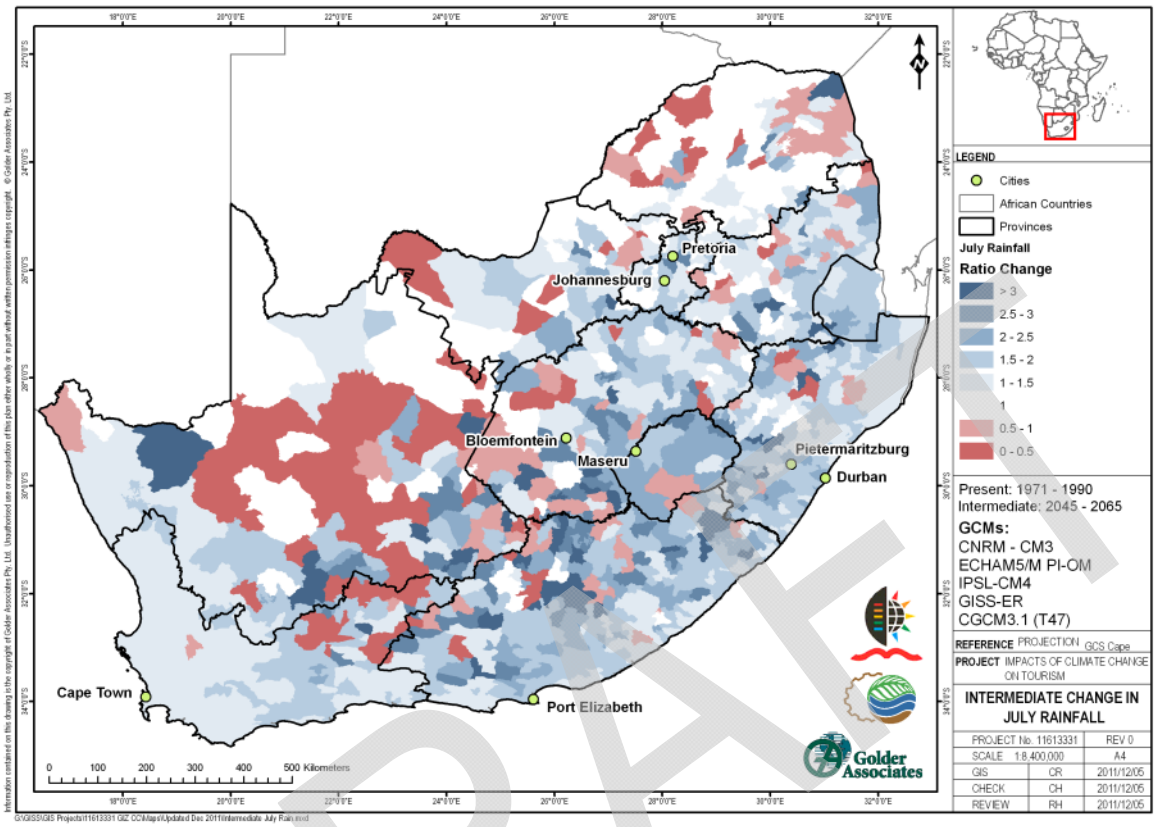

Figure 11: Projected mean of daily minimum rainfall for July into the intermediate future (2045 – 2065, multiple GCMs)

Into the intermediate future daily rainfall for July is projected to reduce slightly in the southwest of the country.

3.2.2 Temperature

South Africa has a mild climate, with generally warm temperatures seasons, conducive to plentiful agricultural yields, rich ecosystem diversity and pleasant weather for tourist activities.

Mean annual temperature

Mean annual temperature for the country currently ranges from between 5 and 10 degrees Celsius in the high alpine regions of the Drakensburg to up to 25 degrees Celsius in the northern parts of KwaZulu-Natal.

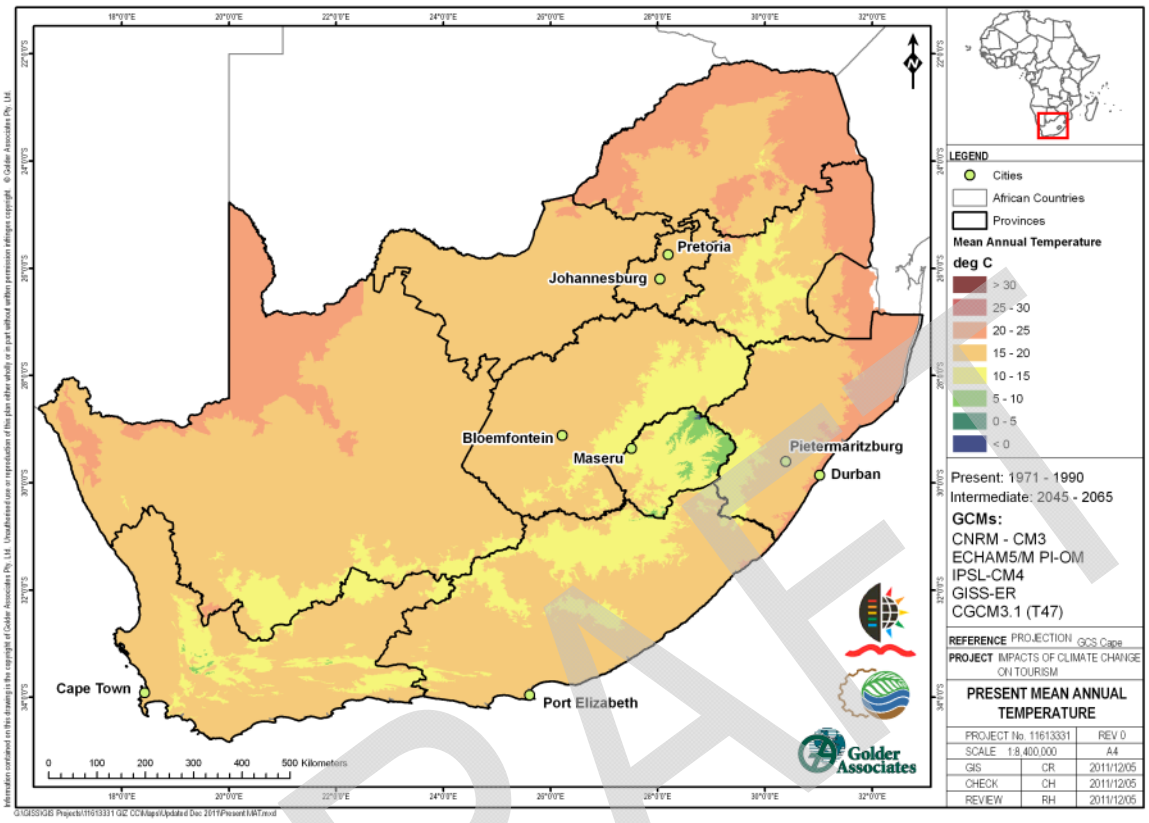

Figure 12: Modelled "present "(1970 -1990) mean annual temperature (multiple GCMs)

Into the intermediate future, mean annual temperatures are projected to increase across the country by approximately 2 degrees Celsius.

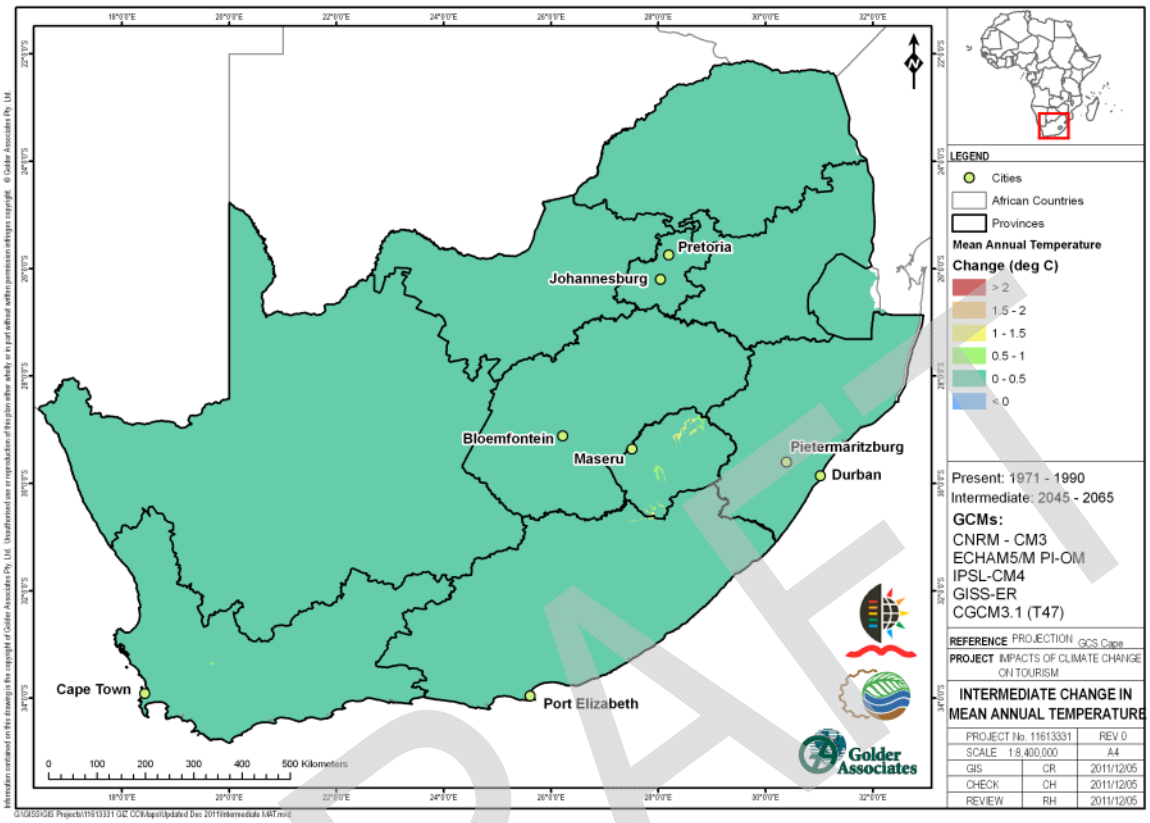

Figure 13: Projected Mean Annual Temperature into the intermediate future (2045 – 2065, multiple GCMs)

Mean daily maximum temperature for January

In this report, the month of January represents the month of warmest temperatures for the country. Mean daily temperatures for January for the northwest of the country reach up to 35 degrees Celsius, with most of the country experiencing mean daily temperatures between 25 and 35 degrees Celsius on an average day in January. These temperatures are highly favourable for outdoor tourism activities and travel.

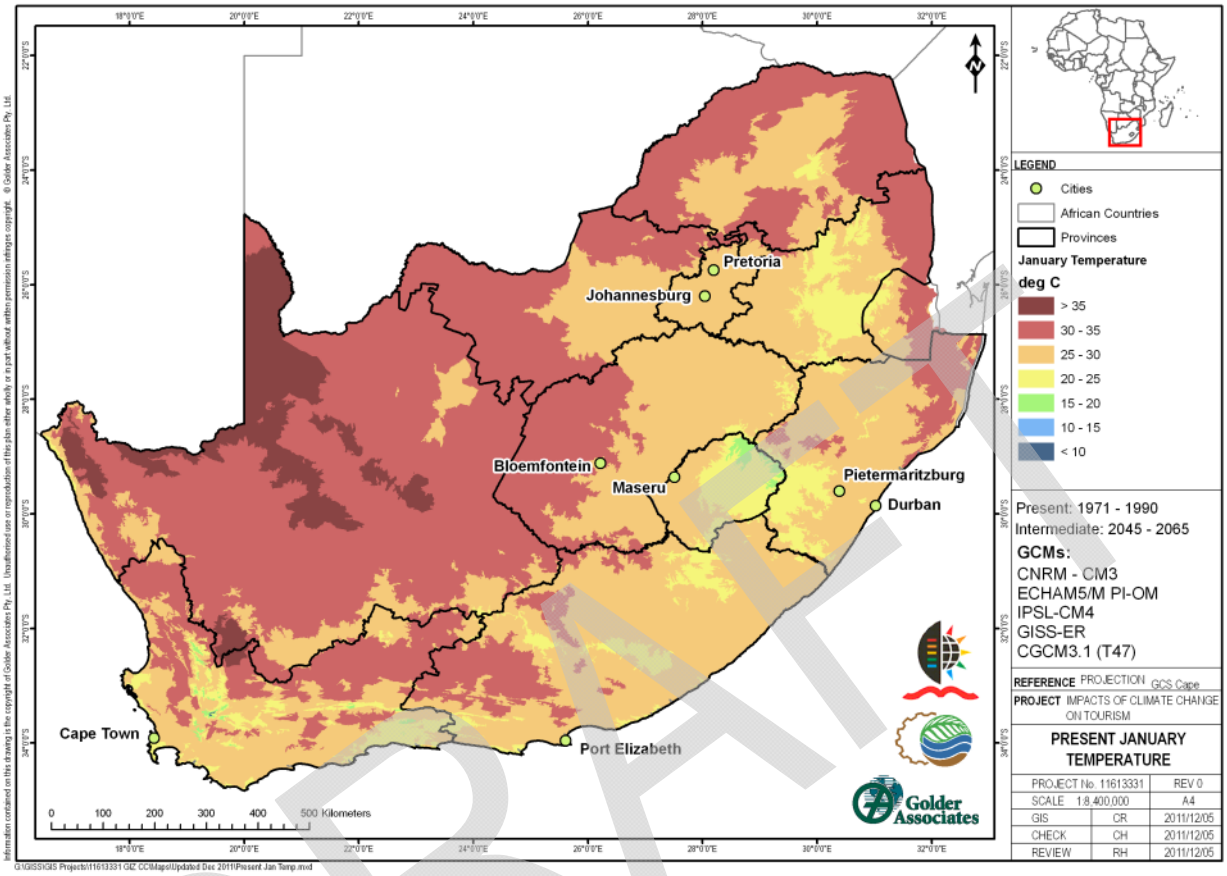

Figure 14: Modelled "present" average of mean daily maximum temperature for the month of January (multiple GCMs)

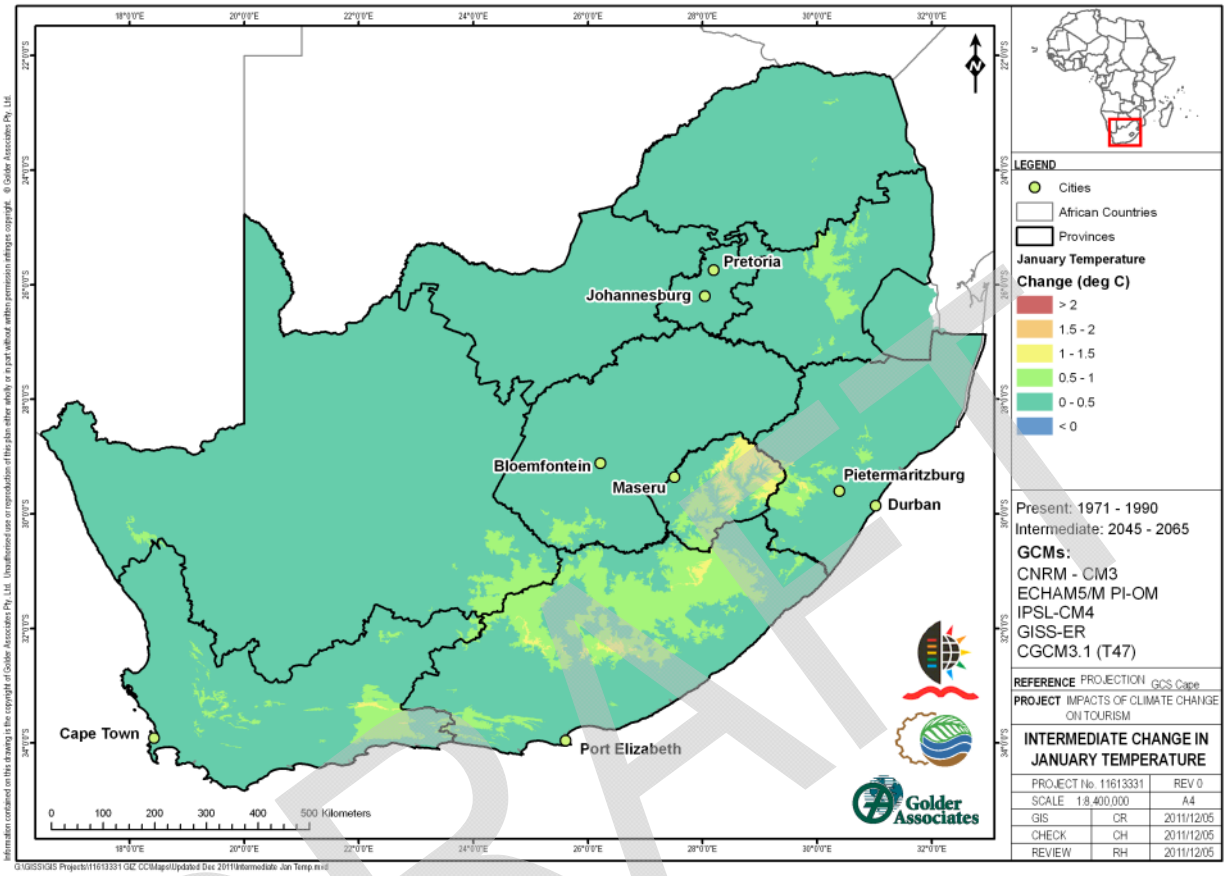

Figure 15: Projected mean of daily maximum temperature for January into the intermediate future (2045 – 2065, multiple GCMs)

Areas with high mean daily temperatures for January are projected to expand across the country, and although for certain parts of the country this could improve conditions for tourism, there could be areas in which discomfort indices become too high for pleasant tourism conditions, and where indirect effects on ecosystems and water supply could affect tourism potential.

Mean daily maximum temperature for July

In this report, the month of July represents the month of coldest temperatures for the country. Mean daily minimum temperature for the country currently ranges from between as low as -15 degrees Celsius in the high alpine regions of the Drakensburg to up to 15 degrees Celsius in the northern parts of KwaZulu-Natal.

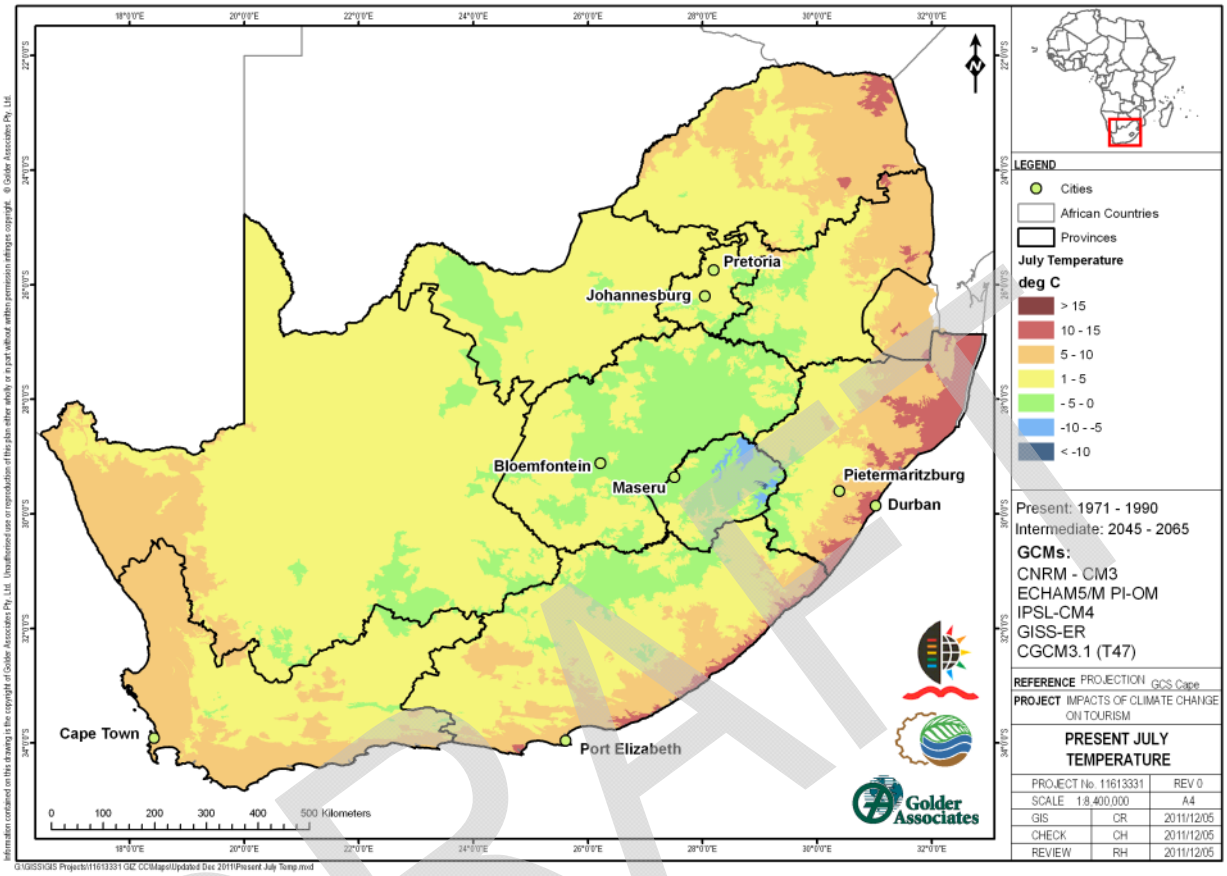

Figure 16: Modelled "present" average of mean daily minimum temperature for the month of July (multiple GCMs)

Into the intermediate future (2045-2065), a similar pattern is evident to the pattern for maximum daily temperature for January, with an expansion of areas with warmer minimum temperatures across the country. This could provide more pleasant temperatures in certain areas for tourism activities. However, this could also affect certain crop productivity related to food supply, and could also affect certain ecosystem functions, particularly in high altitude regions.

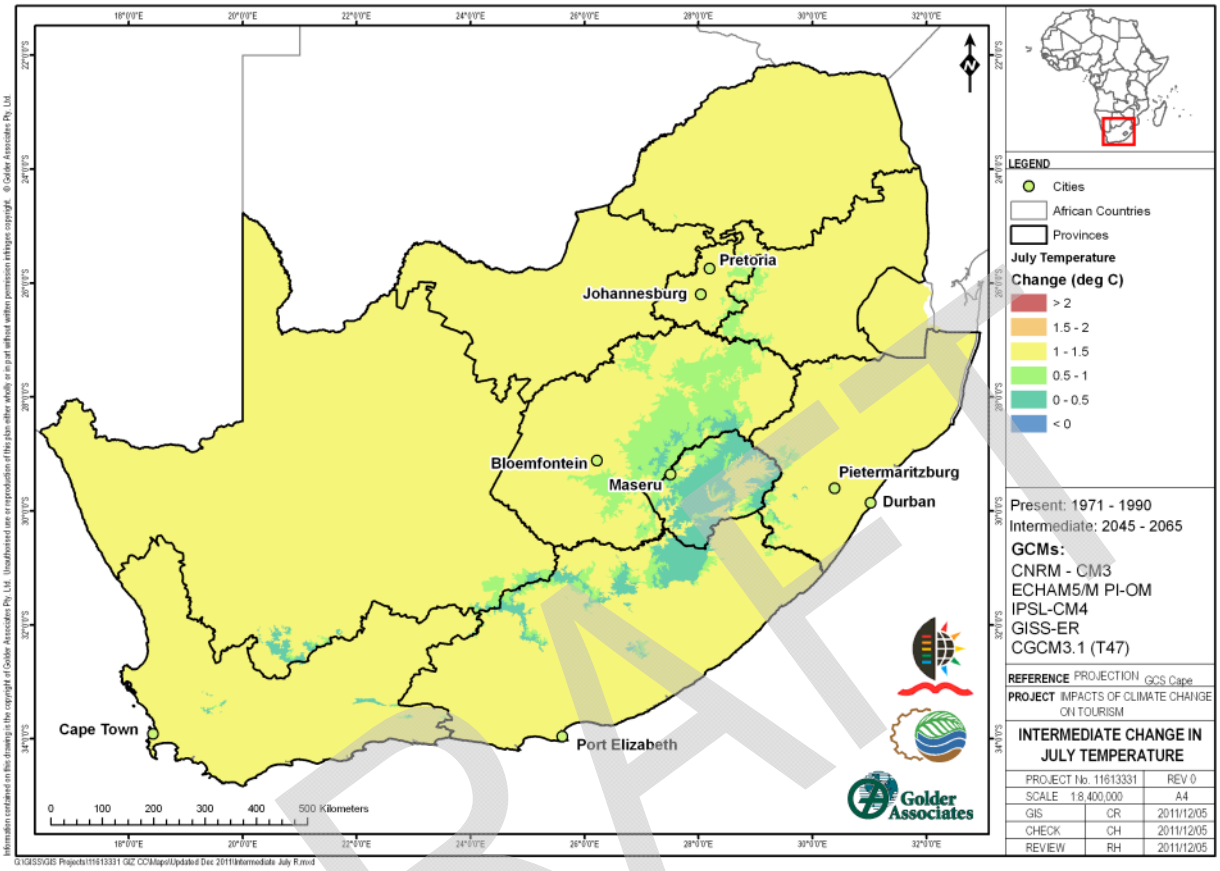

Figure 17: Projected mean of daily minimum temperature for July into the intermediate future (2045 – 2065, multiple GCMs)

4.0 IMPACT AND VULNERABILITY ASSESSMENT

The South African National Tourism Strategy[20] indicates that the natural environment is one of South Africa's greatest tourism resources, and therefore there is a need for the tourism industry to be actively involved in conserving and protecting the natural environment. The report states that visitors, both domestic and international, can be encouraged to participate in the protection and conservation of South Africa's natural environment, and to enjoy a responsible travel experience while in South Africa, that contributes to the achievement of sustainability measures (economic, environmental and social) of the various tourism businesses. Climate change and global warming are very much on the global agenda, and the tourism industry is likely to be threatened due to travel's high carbon emissions, as well as the physical impacts of climate change.

South Africa offers a number of key tourism experiences usually aligned to:

- Coastal or beach areas;
- Heritage and cultural experiences;
- Scenery, nature and wildlife;
- Urban landscapes; and

[20] Thornton G (2010) South African National Tourism Strategy

- Entertainment, events and leisure.

In relation to these elements, South Africa has a number of key tourism destinations (Figure 18), including[21]:

- **Cape Town and the Winelands**: Scenic beauty and nature-based tourism experiences. Cape Town, as a city that boasts accolades like "Second Best Beach City" in 2011 and "One of the World's 5 Bluest Sky Destinations", enjoys a moderate climate, which forms part of its appeal;
- **Garden Route:** The Garden Route stretches on the southern coast from Heidelberg to the Tsitsikamma Forest and Storms River. Adventure activities including scuba diving, abseiling, fishing, whale watching, etc. The Tsitsikamma National Park is located on the Indian Ocean shore and is considered to be one of South Africa's most dramatic protected areas, that combines marine and land attractions. The Tsitsikamma indigenous forests are a haven for birdlife[22,23];
- **KwaZulu-Natal (KZN) Coast:** The KZN coast stretches some 580 km in length, from the Mozambique border near Kosi Bay in the north to the Mtamvuna Estuary on the border with the Eastern Cape. The KZN coast is dominated by sandy beaches mostly located on the North Coast and rocky shores (in the South Coast). In addition to its scenic beauty and recreational opportunities, the KZN coast provides significant economic opportunities linked to the Ports of Durban and Richards Bay[23,24];
- **Maloti-Drakensberg Transfrontier Park:** The Drakensberg Mountains extend from just north of Hoedspruit in the Northern Province to Lesotho, with peaks that are 240 km long, creating the western border of KwaZulu-Natal. The Ukhahlamba-Drakensberg Park, a World Heritage Site, is a mountain range of spectacular natural beauty which is a major center of endemism and has a great diversity of birdlife and plants;
- **Gauteng:** The majority of visits to Gauteng are for business purposes, family visits or shopping. The province is considered to have a wide variety of tourist attractions, ranging from urban tourism, including shopping, music, dining and sport, to cultural and natural heritage. The province boasts the Blesbokspruit RAMSAR wetland in Ekurhuleni, the Cradle of Humankind World Heritage Site in north-western Gauteng and the Cullinan diamond mine in north-eastern Gauteng; and
- **Kruger National Park, Pilanesberg and Madikwe (and other large game reserves within the Wildlife Eco-Zone):** South Africa's game reserves provide some of the finest wildlife sanctuaries on the planet. The reserves provide Big Five sightings bird watching and feature numerous lodges and camps, ranging from comfortable to luxurious.

[21] A number of tourism-based websites were consulted in this section, including http://www.capetown.travel/guide/accolades_and_awards (online: accessed December 2011)

[22] KwaZulu-Natal Department of Agriculture, Environmental Affairs and Rural Development (DAEA&RD) and the Oceanographic Research Institute (ORI).2010. Garden Route Biodiversity Sector Plan for the George, Knysna and Bitou Municipalities.

[23] Vilnius (2006).Understanding our Coast: A synopsis of KZN's Coastal Zone.

[24] Vilnius (2006) Predicting and Managing the Effects of Climate Change on World Heritage, A joint report from the World Heritage Centre, its Advisory Bodies, and a broad group of experts. to the 30th session of the World Heritage Committee

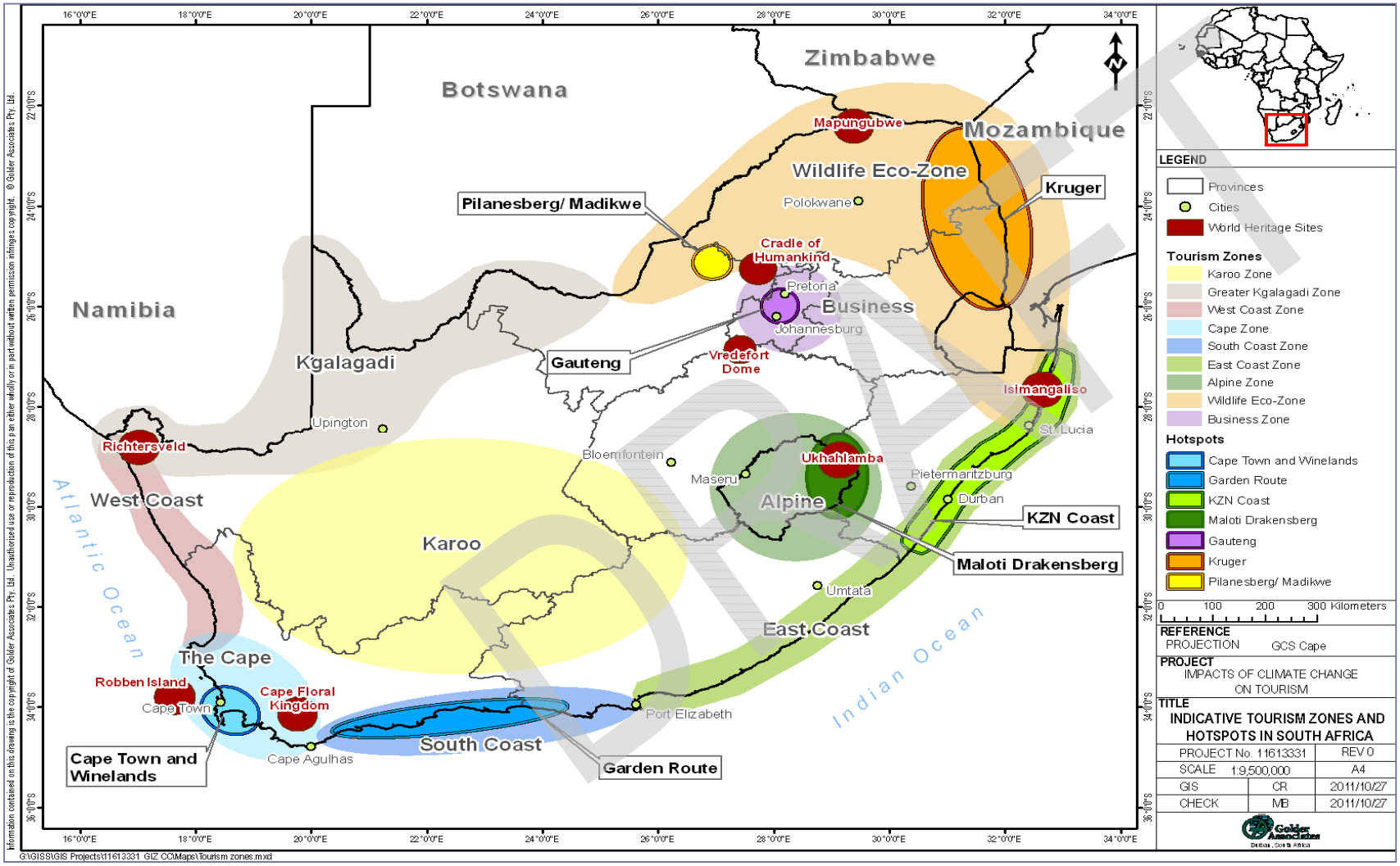

Figure 18: Map of tourism destinations in South Africa

4.1 Climate change and the South African tourism industry

According to the National Climate Change Response Green Paper[25], climate change impacts in the South African tourism sector are likely to manifest through:

- The degradation of environmental resources and conditions such as wildlife, the beach, heritage sites, scenic beauty and properly functioning ecosystems;
- Changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural production (e.g. food and wine tourism), increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases; and
- The implementation of national and/or international climate change mitigation policies may lead to changes in tourist mobility and flows. Additional international measures, such as the EU Directive on Aviation, and efforts to promote low carbon tourism destinations may also pose a significant risk to South Africa's tourism industry.

More specifically, Table 2 presents an assessment of the impacts that the projected potential climate changes could have on the country and its various resources, as well as the knock-on effects these impacts could have on the tourism industry.

A vulnerability workshop was held with stakeholders in November 2011 to further explore these vulnerabilities, and the results of this workshop are presented in the following section.

[25] National Climate Change Response: Tourism (2010) http://www.climateresponse.co.za/home/gp/5.5.3 (Online: Accessed December 2011)

Table 2: Climate risk factors and potential impacts

Projected change	Services and energy	Human health	Food security, water and agriculture	Business continuity	Biodiversity
An increase of 0 – 1.5 °C in daily maximum temperatures for January and 0 – 1.5 °C in daily minimum temperatures for July	■ Increase in requirements for cooling (air conditioning) in summer ■ Decrease in heating requirements in winter ■ Higher rates of refuse decay - more frequent waste collection required ■ Greater number of fires – service disruption and damage	■ Increase in heat-related vector and water-borne illnesses ■ Possible spread of malaria to previously unaffected areas (dependent on maintenance of spraying programmes) ■ Increase in requirements for cooling (air conditioning) in summer ■ Decrease in heating requirements in winter ■ Heat stress ■ Deteriorating air quality due to different dispersion patterns ■ Exacerbation of poverty, crime ■ Greater number of fires – safety hazard	■ Damage to crops ■ Need for better food hygiene (refrigeration) ■ Land use conflicts between agricultural land and conservation areas used for tourism ■ Changes in demand, supply and quality of water ■ Increased demand for water for irrigating green spaces (golf courses, parks) ■ Loss of certain crops	■ Larger numbers of visitors to coastal areas due to these areas having less extremes in temperatures – pressure on infrastructure and services	■ Impacts on species/ ecosystem goods and services which affect tourist attractions ■ Increase in the number and extent of invasive species in natural areas ■ Altitudinal migration of species ■ Extended range of pests and diseases
Increased frequency and intensity of short duration heavy rains	■ Local flooding, storm water overflow and ground and surface water pollution ■ Stress on sewage	■ Basement and foundation level flooding ■ Breeding of malaria and cholera vectors in	■ Damage to crops and reliability of harvest for food supply ■ Changes in	■ Golf courses, open space systems and other tourism infrastructure at risk of flooding	■ Parks and green spaces provide flood attenuation

Projected change	Services and energy	Human health	Food security, water and agriculture	Business continuity	Biodiversity
	systems and stormwater infrastructure ■ Increases in landslides and mudslides and associated damage to property ■ Increase in storms and lightning strikes affecting electricity supply and other services	ponding water	demand, supply and quality of water ■ Affected ability of dams to store and capture water ■ Erosion and sedimentation in green areas	■ Disruption of access routes ■ Increased insurance claims or inability to obtain insurance ■ Increase in business risk and emergency situations	
Prolonged periods with no rain and heat waves	■ Stress on sewage systems ■ Infrastructure heat stress ■ Increased cooling energy demand ■ Reduction in heating requirements ■ Increase in emergency services	■ Increase in cooling load ■ Increase in individual and family risk and emergency situations ■ Increased load on health care facilities	■ Reduced food production ■ Changing disease vectors and possible increase in food poisoning ■ Increased water demand and purification requirements ■ Increase in water-borne diseases	■ Fewer visitors due to higher temperatures and drought ■ Business risk to reduced water availability	■ Stress on green spaces and the critical loss of flood attenuation amongst other services

Projected change	Services and energy	Human health	Food security, water and agriculture	Business continuity	Biodiversity
Sea level rise	■ Increased erosion, and coastal flooding of infrastructure – access routes, buildings, services	■ Inundation of coastal resorts	■ Salination of agricultural lands – lower productivity ■ Disruption to estuarine functioning – change in marine ecosystems and attractions ■ Water supply and wastewater disposal disruption	■ Impact on beaches/tourist attractions ■ Inability to obtain insurance	■ Permanent inundation of some natural ecosystems. ■ Expected coastal erosion will increase the impacts on coastal vegetation which could potentially include destruction and displacement of sensitive dune vegetation leaving coastal infrastructure vulnerable
Carbon pressures	■ Pressure to reduce energy and carbon emissions (could be positive in terms of energy cost savings) ■ Carbon taxes could affect facility profitability ■ Carbon pressure on long haul flights could reduce passenger numbers coming to SA (especially from traditional markets of UK and Europe)	■ Pressure to use less energy (lower service delivery levels, air conditioning, transport, electricity supply)	■ Import of food constrained (“food miles”)	■ Need for changes in transport modes (away from motor vehicles) ■ Carbon taxes could discourage people from utilising private vehicles	■ Atmospheric carbon affecting species distributions – woody and invasive species favoured and encroachment into grassland areas, affecting traditional tourist attractions and game viewing

4.2 Vulnerability workshop

A vulnerability workshop was held at the South African National Biodiversity Institute (SANBI) Botanical Gardens in Pretoria, Gauteng on 24 November 2011 and was attended by the representatives listed in Table 3.

Table 3: List of attendees at the Tourism and Climate Change Vulnerability Workshop

NAME	REPRESENTING	EMAIL	TEL NO.
Mpho Moeti	Gauteng Tourism	mpho@gauteng.net	011 639 1600
Mbuyi Kona	Gauteng Tourism	mbuyiselo@gauteng.net	011 639 1600
Joseph Moloto	National Department of Tourism	jmoloto@tourism.gov.za	012 444 6428
Ndhuma Makamu	National Department of Tourism	nmakamu@tourism.gov.za	012 444 6428
Ramavhona Nkohiseni	Department of Environment Affairs	nramavhona@environment.gov.za	012 310 3177
Vincent Cupido	Northern Cape Department of Economic Development, Environment and Tourism	vincent.dtec@gmail.com	027 718 8800
Sipho Mampe	Northern Cape Department of Economic Development, Environment and Tourism	smampe@ncp.gov.za	082 414 0293/053 830 4839
Greg McManus	Heritage/FEDHASA	mac@heritagesa.co.za	082455 4161
Jennifer Seif	JHSA	jennifer@fairtourismsa.org.za	084 581 1056
Kevin Mearns	UNISA	kevin.mearns1@gmail.com	082 337 0074
YN Ndlhovu	SABS	yvonne.ndlhovu@sabs.co.za	073 446 4397
F Mtakati	SABS	Nkule.mtakati@sabs.co.za	083 776 6300
TJ Mbekeni	SANAS	thamsanqam@sanas.co.za	082 588 5740
T Mollo	SABS	tom.mollo@sabs.co.za	012 428 6101
Rob Hounsome	Golder Associates	rhounsome@golder.co.za	031 717 2790
Catherine Hughes	Golder Associates	chughes@golder.co.za	011 254 4984
Candice Russell	Golder Associates	carussell@golder.co.za	031 717 2790
Nosipho Malamlela	Haley Sharpe	nosipho@haleysharpe.co.za	031 764 0600
Mike O'Brien	Haley Sharpe	mike@haleysharpe.co.za	031 764 0600
Bhekithemba Langalibalele	National Department of Tourism		012 444 6514

The workshop was held in conjunction with a feedback session on the National Department of Tourism (NDT) Climate Action Plan, which has been released in draft, for comment[26].

The workshop was attended by various industry stakeholders, role-players and decision makers. The content presented at the workshop and discussion which followed was based on HSSA's knowledge of the tourism industry within South Africa, on Golder's knowledge of climate change science and the requirements for the NDT's draft Climate Action Plan.

The workshop aimed to achieve the following objectives:

- To highlight the tourism sector's vulnerability to climate change;
- To assess the industry perspectives on the tourism sector's vulnerability to climate change;
- To expose existing initiatives in progress across South Africa; and
- To provide a platform for discussion and co-operation for the response of the tourism industry to the threats and opportunities presented by climate change.

The Golder Climate Risk Mapping Tool (G-CRT) was used to guide the stakeholder group's discussion with regard to the tourism sector's vulnerability to climate change.

G-CRT is a screening matrix which is used to evaluate an industry or sector's business functions in relation to projected climate risk at a high level. Vulnerabilities is broadly assessed according to the following criteria, which deal with a range of business functions and their continuity in the event of a potential climate-related disruption:

- Governance and legal: Negative impacts to management of facilities and organisations, legal, regulatory and management responses;
- Competition and market: Business competitiveness, organisational and product success in the marketplace;
- Finance: Costs of operations and infrastructure within the sector. Wider economic impacts are not assessed here;
- Health, safety and environment: Negative impacts on human health and safety, including occupational health, as well as impacts on the receiving environment;
- Stakeholders and labour: Level of public response to operations, and relations with the workforce; and
- Infrastructure, process and logistics: Impacts on physical infrastructure relevant to the industry and disruptions to actual processes required during operations and transport processes.

The vulnerabilities explored through the G-CRT process are described in the sections which follow. For each section, the framing questions used to guide the discussion are provided above. The responses to the questions were derived from the discussions with stakeholders, and are comprised of the opinions of those stakeholders attending the workshop.

4.2.1 Governance and legal

Does the South African tourism sector have a forum at which climate change is discussed?

Is there an awareness programme run for the tourism industry in South Africa?

[26] National Department of Tourism (2011) Draft National Tourism and Climate Change Action Plan. National Department of Tourism. September 2011

The tourism industry within South Africa is reportedly particularly well organised in terms of communication and the grouping of various tourism bodies within the industry. This situation has improved over the past decade. There is a feeling that the relationship between government departments and the private tourism organizations and operators is not as robust and transparent as in past years.

Climate change issues are not discussed at the various levels within the sector. The sector is reportedly currently occupied with various other important aspects of the industry, including, for example, marketing and Broad-based Black Economic Empowerment (BBBEE) initiatives. In addition, the industry is currently experiencing a downturn when compared to the three past years. The controversy regarding climate change has also led to a certain resistance to discussion and response initiatives within the sector. Climate change and sustainability initiatives are seen as something of a "nice to have," rather than a necessity.

Are any tourism facilities known to be reporting or addressing its carbon emissions?

Are any companies disclosing their data?

Several of the larger international hotel chains and car hire companies are known to be recording and reporting on their carbon emissions according to the Global Reporting Initiative[27]. These initiatives are, however, new to the industry, but are becoming more common. There is a lack of awareness in terms of how to calculate carbon emissions and uncertainty as to which of the various Scopes of emissions (Scopes 1, 2 and 3[28]) to report. At this stage, the reporting is perceived to be largely for internal purposes, as an ethical initiative as opposed to being in response to international pressures or tourist expectations.

Are there any initiatives to control carbon emissions in the industry at facility level?

Initiatives to control carbon emissions are largely related to energy saving. Any initiatives are generally limited by conventional fuel and electricity within the country, although there are some examples of differential fuel use, including the mixing of standard fuel and biofuels, but this is generally on a small scale. Very few tourism facilities are separate from the national electricity grid, e.g. the Wild Coast. South Africa's neighbouring countries have reportedly had some successes in terms of the use of renewable energy sources or off-grid generators. There are some projects involving wind and solar power generation, but this is at a small scale.

Are tourist facilities currently prepared to deal with measurement of carbon emissions management?

Are there any courses in place?

There are no known initiatives within the industry in terms of climate change and carbon training. Private sector training of staff does take place, however this is largely in terms of the hospitality industry and does not deal with climate change preparedness or responsible tourism.

[27] The Global Reporting Initiative (GRI) is a network-based organization that produces a comprehensive sustainability reporting framework that is widely used around the world. GRI is committed to the Framework's continuous improvement and application worldwide. GRI's core goals include the mainstreaming of disclosure on environmental, social and governance performance (http://www.globalreporting.org/AboutGRI/WhatIsGRI/)

[28] Scope 1 - Direct emissions from sources that are owned or controlled by the company, Scope 2 - emissions from the generation of electricity purchased by the company, Scope 3 - allows for the reporting of all other indirect emissions (http://www.co2benchmark.com/wri-ghg-protocol-scope-definitions).

4.2.2 Competition and market

What initiatives are in place in terms of green marketing?

How might South Africa's reputation for high carbon emissions affect the tourism industry?

The stakeholders reported three known systems of certification within the tourism industry in South Africa[29], namely:

- Fair Trade;
- Heritage; and
- Greenleaf.

It was the general opinion of the stakeholders at the workshop that these initiatives have low market penetration.

These initiatives are reportedly aligned with the recently released South African National Standard: Responsible Tourism (SANS 1162:2011, September 2011), and there is reportedly a strong movement towards "culturally responsible tourism."

Fair Trade is a global movement that aims to improve production and trading conditions to benefit smallholders, farm workers and disadvantaged employees and artisans

The Heritage Environmental Management Company was established to provide operators of all types of businesses with an effective environmental management system (EMS) designed to reduce and limit the impact that their operations have on their environment

The Green Leaf Environmental Standard is an international standard that measures green accommodation, green business, green products, green conferencing and green events

In terms of South Africa's international reputation for high carbon emissions which could affect perceptions of potential visitors to the country, this issue is of concern. Visitors from western countries are becoming increasingly aware of countries' performance in terms of carbon emissions and "green" practices, and it is possible that tourists could choose not to visit South Africa for this reason. However, it is evident that numbers of visitors to South Africa are already in the process of changing from European travellers to those from more regional (neighbouring African) markets, and there are also strong indications that the emerging markets of India and China may be more important into the future.

What is the likelihood that international visitors will choose regional destinations over South Africa (e.g. visitors from the United Kingdom choosing to visit Spain or other countries)?

As mentioned above, numbers of tourists from neighbouring African countries and emerging markets are anticipated to increase, and traditional international visitors such as from the United Kingdom and Europe could decline, particularly with a view towards the likely increase in taxes on flights which will effect long haul destinations.

It is also important that planning for tourism takes into account the constant evolution of technology, for example the introduction of larger capacity aircraft by certain airlines into the country from eastern destinations. This indicates a continued healthy demand for tourism in the country.

[29] http://www.fairtradelabel.org.za/, http://www.heritagesa.co.za/, http://www.greenleafecostandard.net/ Accessed 07/11/2011

To what degree is the tourism sector reliant on international investment?

Could climate change-related factors affect international investment in tourism?

International investors generally operate within South Africa's borders under licence, although the tourism industry within the country is largely driven by domestic investment. Into the future however, international investment is certainly likely to be influenced by reputational issues associated with carbon management and responsible tourism.

4.2.3 Finance

To what degree are tourism facilities and transport routes reliant on external financing?

What is the risk to tourism as a result of refusal of insurance (particularly in terms of coastal facilities)?

Access to insurance is particularly important to tourism activities, for example:

- Hotels located on the coast (vulnerable to damage from storm surge);
- Resorts with thatched roofs which are vulnerable to lightning strikes;
- Hunting or game farming which involves the insurance of game animals.

It is likely into the future that compulsory mitigation measures will need to be put in place in order for facilities to obtain insurance in the future.

It is further likely that premiums for travel insurance could change with climate change risk, for example hiking trips in the Drakensberg during periods with high lightning risk.

4.2.4 Health, safety and environment

How could changes in weather conditions affect tourist visits to various parts of the country?

This could include heat/humidity/cold/rain? Could these visits be affected by extreme events?

Examples of areas within the country which are deemed to be vulnerable from a climate change perspective (sensitive ecosystems/flora and fauna, as well as areas highly dependent on good weather for tourism value) include (amongst others):

- ***Durban, KwaZulu-Natal and Eastern Cape coastal resorts***: cooler weather and cloud affecting ambient conditions, fishing, diving and water sport conditions;
- ***The Kruger National Park***: ecosystem, flora and fauna prevalence, weather conditions;
- ***The Richtersveld Transfrontier Park***: sensitive ecosystems, flora and fauna;
- ***Marine attractions such as whale watching, shark diving and the sardine run***: maintenance of healthy marine ecosystems and species prevalence is an important source of revenue in many parts of South Africa;
- ***Cape Floral Kingdom***: highly sensitive fynbos communities and tourist attractions, conditions at wine estates and for grape growth, weather conditions for visitors;

- ***Orange River***: sufficient river flow for river rafting and other activities; and
- ***Namaqualand***: flower season, highly dependent on weather conditions for economic turnover).

These changes are not all necessarily likely to be negative. There is likely however to be a tourism shift in terms of seasons and geographic location.

Could there be a risk with climate change in terms of health conditions, diseases or increased pest load?

Certain areas of the country may become more vulnerable in terms of malaria, however this is deemed unlikely as malaria is currently controlled through spraying programmes.

With higher temperatures, more frequent rain in most of the country and with this rain falling in the form of short, sharp events, there is likely to be collection of water in containers and depressions, leading to the breeding of disease vectors (such as cholera, etc.). Water-borne diseases are also likely to become more prevalent with warmer, wetter conditions more suited to their spread.

Discomfort is likely to become problematic for tourists, for example, humidity and heat can be unpleasant in Skukuza (Kruger National Park) during the month of January, and days with this type of discomfort are likely to become more prevalent.

4.2.5 Infrastructure, process and logistics

What are the main elements of the tourism supply chain?

How could these be affected by climate changes and/or extreme events?

Arguably, the most important element of the tourism supply chain is airline flights. Further important supply chain aspects include:

- Food;
- Infrastructure supply (building materials);
- Access provision – roads and bridges susceptible to weather damage and disruption, e.g. Van Reenen's Pass which, if closed, can disrupt the national N3 highway; and
- Water for irrigation (golf courses, green areas), domestic and wildlife consumption (as illustrated recently in the southern Cape)

In times of restricted water supply (droughts), it should be noted that large-scale establishments such as hotel chains are generally able to supplement their water supply through the import of water to the drought-stricken area. However, local communities and smaller establishments such as guesthouses are more vulnerable. It is possible that, to supplement water supply, deeper boreholes could be sunk. However it is not certain whether this practice would place major pressure on the groundwater resource, which could pose problems for sustained water supply into the future.

Access to facilities is an area of major concern, with large hotels reportedly carrying a stock of 5 - 7 days worth of food supply. Once again, smaller institutions may not have sufficient stock to maintain food supply should transport routes be disrupted due to heavy storms, for example.

Should certain climate projections become a reality, it is important to note that there could be conflict over water or food in poorer communities, which could also lead to the movement of "climate refugees". This,

despite having large-scale socio-economic consequences, could also impact on South Africa's image as a tourism destination if this leads to unrest.

Could future land use conflicts affect the tourism industry?

The conversion of natural land currently used to draw tourists (nature reserves) for agricultural land for example, due to changes in climate affecting suitability for agriculture.

At present, the tourism industry is known to be facing land use conflicts in the form of land claims (e.g. Dinokeng Game Reserve). There are known cases of this in Mpumalanga, KwaZulu-Natal and Limpopo. Although this issue is not currently related to climate change, it is important to note that with poorer conditions for agriculture and livelihoods, it is possible that communities will move into areas in better condition, which may include areas set aside for biodiversity conservation and tourism.

Potentially farmlands which are becoming marginal in terms of agricultural productivity may be converted to game farming, which could present increased opportunities for tourism.

An increased demand for biofuel in a carbon-constrained future could lead to the preferential use of land previously used for tourism for planting of crops for biofuel,

How could extreme events such as thunderstorms, lightning or hailstorms affect business processes?

Tourist facility accessibility and safety of access could be severely problematic into the future. Examples of facilities which may be vulnerable in this sense include key destinations such as Table Mountain, Robben Island and the Drakensberg.

The uncertainties in terms of access disruption and poorer weather conditions in coastal areas could lead to increased tourism benefits to the inland provinces of South Africa. The cruise ship industry is a fast growing sector in South Africa, and coastal conditions could affect South Africa's reputation as a destination for this type of tourism.

Although South Africa's inland provinces may benefit from poorer conditions at the coast, more frequent large inland storms (such as on the Highveld) could lead to more frequent electricity supply disruption, causing pressure on services such as wastewater treatment works and water supply pumps.

4.3 Summary of key vulnerabilities at the tourism hotspots

Figure 19 indicates the key tourism hotspots within South Africa, as well as a broad generalisation of the projected climatic changes in the country. In summary, the key vulnerabilities associated with these hotspots include:

- **Cape Town and the Winelands**: Weather conditions (drier, warmer), compromised crop growth in key economic sectors such as the wine industry, effects on biodiversity such as fynbos, accessibility issues in poor weather conditions (Table Mountain, Robben Island, etc.);
- **Garden Route**: Biodiversity effects, potential poor weather effects, water supply;
- **KwaZulu-Natal Coast**: Weather conditions, storm surge, infrastructure vulnerability, poor conditions for shipping and coastal recreation;
- **Maloti-Drakensberg Transfrontier Park**: Dangerous conditions for hiking and camping, increased frequency of fires, accessibility and safety, alpine biodiversity;

- **Gauteng**: Effects on business tourism, accessibility, continuity of electricity supply and access, potential unpleasant weather conditions; and
- **Kruger National Park, Pilanesberg and Madikwe (and other large game reserves within the Wildlife Eco-Zone)**: Uncertain biodiversity effects on flora and fauna – species composition and health, uncertain ecosystem and food chain effects, discomfiture indices, access.

The West Coast, Kalahari and Karoo areas are also highly vulnerable, particularly due to the fact that these are arid areas which may be prone to lower rainfall rates under climate change. Effects on these ecosystems may have far reaching effects, and lower water supply may have implications in terms of ease and comfort of visitors.

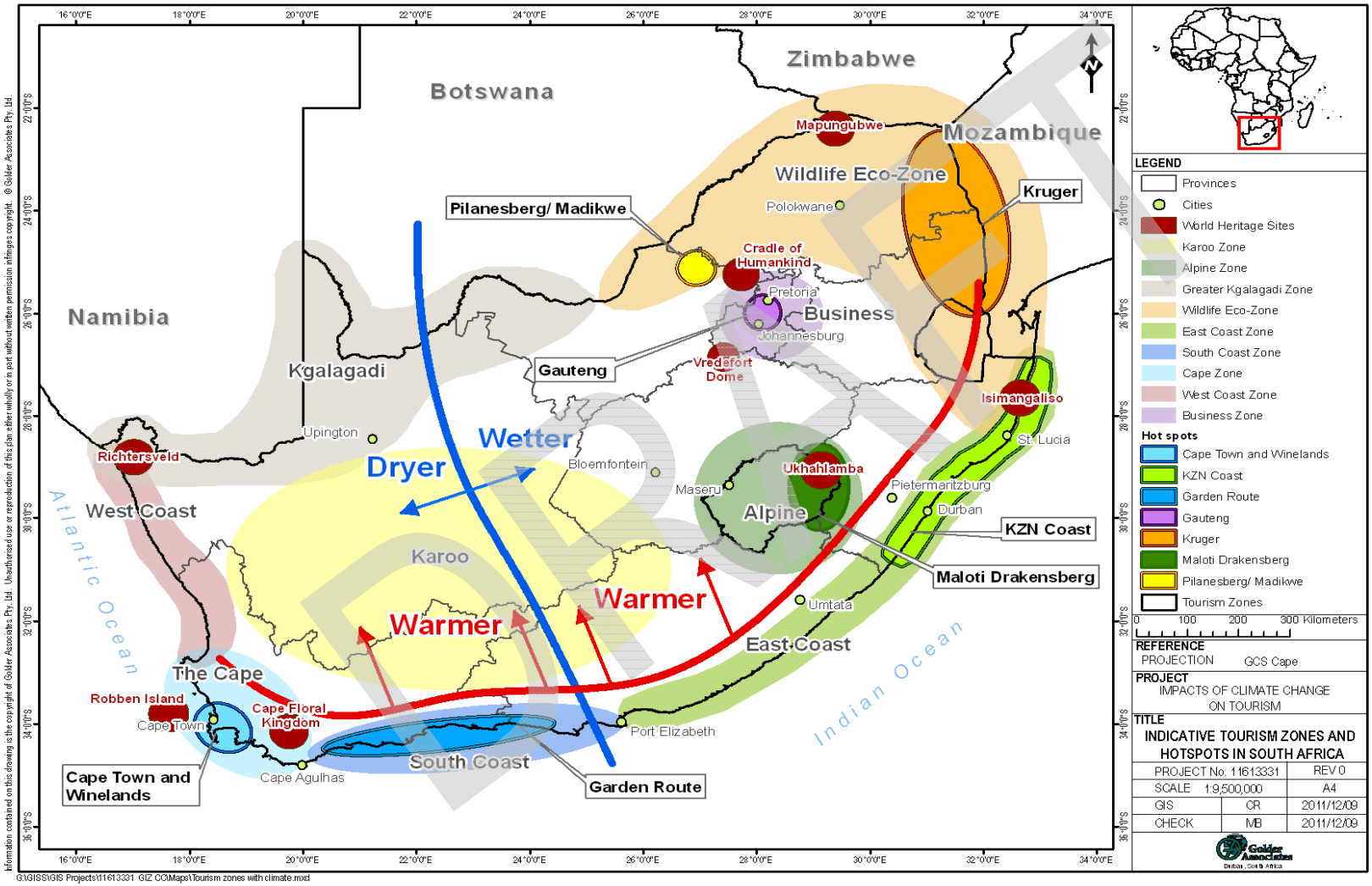

Figure 19: Tourism hotspots and broad climate change projections

5.0 TOURISM INDUSTRY'S RESPONSE TO CLIMATE CHANGE

The response of the tourism community to the challenge of climate change has increased significantly in recent years. Figure 20 presents a summary of some of the key milestones which have shaped the global tourism industry's response.

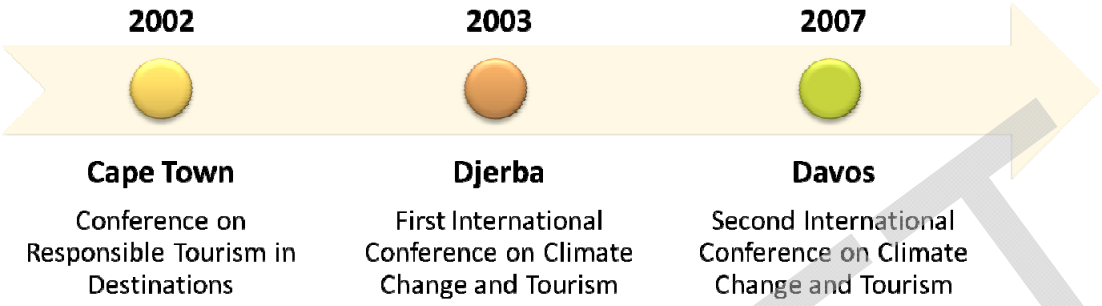

Figure 20: Milestones in the development of the tourism industry's response to climate change

The Cape Town Conference on Responsible Tourism in Destinations, held in 2002, was organised by the Responsible Tourism Partnership and Western Cape Tourism authority as a side event preceding the World Summit on Sustainable Development held in Johannesburg in the same year. The conference resulted in the development of the Responsible Tourism Declaration[30]. The key characteristics of responsible tourism, listed in the declaration, include:

- Minimises negative economic, environmental, and social impacts;
- Generates greater economic benefits for local people and enhances the well-being of host communities, improves working conditions and access to the industry;
- Involves local people in decisions that affect their lives and life chances;
- Makes positive contributions to the conservation of natural and cultural heritage, to the maintenance of the world's diversity;
- Provides more enjoyable experiences for tourists through more meaningful connections with local people, and a greater understanding of local cultural, social and environmental issues;
- Provides access for physically challenged people; and
- Is culturally sensitive, engenders respect between tourists and hosts, and builds local pride and confidence.

The Conference on Responsible Tourism in Destinations was followed by the First International Conference on Climate Change and Tourism in Djerba, Tunisia in 2003. The event was hosted by the World Tourism Organization (UNWTO), together with the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP), the United Nations Convention to Combat Desertification (UNCCD), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Government of Tunisia.

The Djerba conference aimed to develop awareness among government administrations, the tourism industry and other tourism stakeholders, highlighting both current, and anticipated climate change impacts affecting tourism destinations and the need to carefully consider the consequences of climate change

[30] http://www.responsibletourismpartnership.org Accessed 07/11/2011

mitigation policies on tourism as well as the responsibility of the tourism sector to be a part of the solution by reducing its greenhouse gas emissions[31].

Subsequent workshops supported by the European Science Foundation (ESF) (Milan, 2003), the North Atlantic Treaty Organization (NATO) (Warsaw, 2003), the European Forum on Integrated Environmental Assessment (EFIEA) (Genoa, 2004), and the Experts on Climate Change and Tourism group (eCLAT) (Netherlands, 2006, Paris, 2007), as well as the Helsingborg Meeting on Sustainable Tourism (Helsingborg 2007) and the Marrakech Task Force on Sustainable Tourism Development further contributed to the development of collaborative research and practical case studies by a network of international tourism stakeholders and scientists.

In March 2007, UNWTO, UNEP and WMO commissioned a review report on tourism and climate change, including impacts and adaptation, changes in tourism demand patterns, emissions from tourism, and mitigation policies and measures. The Executive Summary of this report (UNWTO-UNEP-WMO 2008) was presented during the Second International Conference on Climate Change and Tourism, which took place in Davos, Switzerland, 1-3 October 2007.

The conference resulted in the Davos Declaration, a document asking the tourism sector to "rapidly respond to climate change, within the evolving UN framework and progressively reduce its Greenhouse Gas (GHG) emissions"[32]. The Davos Declaration demands the simultaneous implementation of actions to mitigate the impact of tourism on climate change, adapt to current and future climate changes, to develop new or apply existing technology to enhance energy efficiency and to secure financial resources to ensure poorer regions or countries are also able to meet the recommendations.

In 2010 the South African National Climate Change Response Green Paper[33] was released. The Paper recommended responses specific to the challenges facing the South African tourism industry. These responses included:

- Mainstreaming climate change in tourism planning, policy and development;
- Building climate resilience and adaptive capacity of tourist attractions/destinations and encourage green tourism infrastructure investment;
- Promoting domestic tourism in order to counteract a decline/shift in international travel that may follow the implementation of transport mitigation policies in other countries;
- Encouraging both domestic and international visitors to participate in the protection and conservation of South Africa's natural environment and to enjoy a responsible travel experience;
- Promoting research, capacity building and awareness in the tourism sector;
- Supporting the establishment of energy efficiency programmes and the introduction of renewable energy into the tourism sector; and
- Establishing programmes that will allow tourists to offset the emissions generated through their travel to and in South Africa.

The following section will outline a selection of responsible/sustainable tourism programmes and initiatives currently underway locally and internationally which have been wholly or partly developed in response to the potential threats of climate change.

[31] Simpson, M C; Gossling, S; Scott, D; Hall, C M and Gladin, E. 2008. Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices. UNEP, University of Oxford, UNWTO, WMO: Paris, France

32 WTO and UNEP (2008) Climate Change and Tourism: Responding to Global Challenges. World Tourism Organization and United Nations Environment Programme. Printed by the World Tourism Organization, Madrid, Spain

[33] http://www.climateresponse.co.za/home/gp/5.5.3 Accessed 07/11/2011

5.1 Current programmes and initiatives

In addition to those mentioned above, there are a number of existing initiatives and programmes towards addressing climate change and tourism. A selection of these is presented below.

- **The Voluntary Initiative for Sustainability in Tourism** - The European Voluntary Initiative for Sustainability (VISIT) initiative was established in 2004. The concept behind the organisation is to facilitate a positive collaboration between distinct initiatives working towards achieving sustainability in tourism. Eight 'eco-labels' (based in the Netherlands, Italy, Denmark, Latvia, France, United Kingdom, Switzerland and Luxembourg) founded the organisation together with over 1,500 participating tourism enterprises, as well as strategic bodies as supporters and associates, e.g. the environmental management certificate: ECOCAMPING. In general, the eco-labels represent nationally based accommodation organisations in the tourism industry.

  The alliance between the labels within VISIT is based on mutual understanding and recognition and the agreement to adopt a common standard. This standard sets the framework by which credible tourism eco-labels should operate in Europe. This ensures the consumer has a reliable environmentally-friendly tourism choice and an indication that there are efforts to improve the destination towards more sustainability.

- There are several examples of studies carried out at regional or country level in terms of climate change and tourism, for example:

  Integrating Tourism into Adaptation to Climate Change in the Maldives – The project, still presently underway, was established in 2005 by the UNWTO, United Nations Development Programme (UNDP), Global Environmental Facility (GEF), and Maldives Government in response to the significant threats posed by climate change. These threats include: shoreline and beach erosion, reduced water availability, interrupted supply chain and coral bleaching, among others. The aim of this project is to further develop and demonstrate adaptation initiatives that will reduce the vulnerability of the tourism sector, and its natural and human resource base, to the impacts of climate variability and change. It will further seek to enhance the sustainability of the natural resource base and the capacity of operators and tourism dependent communities to respond to these challenges[34].

  Other studies include, for example:

  - Jackson I (2002) Workshop report and plan of action. Adaptation to Climate Change in the Caribbean Tourism Sector Workshop Grenada. Prepared for the Organization of American States (OAS);
  - Scott, D (2003) Climate Change and Tourism in the Mountain Regions of North America. 1st International Conference on Climate Change and Tourism, 9-11 April 2003, Tunisia;
  - Sookram S (2004) The Impact of Climate Change on the tourism sector in selected Caribbean Countries. ECLAC – Project Documents collection. Caribbean Development Report, Volume 2;
  - Payet, A (2007). A Final Report Submitted to Assessments of Impacts and Adaptations to Climate Change (AIACC), Project No. SIS90. Department of Environment, Victoria, Mahe, Seychelles. *(Case study available in Appendix B)*; and
  - Thomas, C. (2007) Climate Futures Adaptation Planning: An Example of Adaptation Planning for Coastal Tourism Operators in North Queensland *(Case study available in Appendix B).*

- **Leading the Challenge on Climate Change** – In February 2009, the Travel & Tourism industry leaders released the vision for, and commitment to, tackling greenhouse gas (GHG) emissions through the World Travel and Tourism Council (WTTC) publication 'Leading the Challenge on Climate Change'. The

[34] http://sdt.unwto.org/en/content/projects-0 Accessed 07/11/2011

report also underscores the important role of partnership in attaining the vision defined by WTTC and calls for an alignment of goals and efforts among leaders of industry, employees, customers and policy-makers in both the commercial and public domain[35].

- **Responsible Tourism Policy and Action Plan** - In 2009, the City of Cape Town adopted the Responsible Tourism Policy and Action Plan, in an attempt to encourage positive economic, social and environmental management. A Responsible Tourism Charter was signed by the City of Cape Town and leading trade associations including: the Federated Hospitality Association of South Africa (FEDHASA), the Southern Africa Tourism Services Association (SATSA), the South African Association for the Conference Industry (SAACI) and Cape Town Tourism, which commits each signatory to work actively on the priority issues for Responsible Tourism and report on their progress[36].

- **Climate Change: A Joint Approach to Addressing the Challenge**[37] –On 11 November, 2010 the WTTC has launched its climate change policy recommendations outlining clear principles for governments, guiding them towards fostering an enabling environment for the sustainable development of our industry while recognising its immense economic and developmental importance.

- **Hotel Energy Solutions Initiative**[38] – The Hotel Energy Solutions (HES) is a UNWTO-initiated project, funded and supported by the Intelligent Energy Europe, and implemented by UNEP, International Hotel and Restaurant Association (IH&RA), European Renewable Energy Council (EREC) and French Agency for Environment and Energy Management (ADEME). The objective of the initiative is to increase energy efficiency by 20% and the use of renewable energies by 10% in SMEs across the European Union (EU).

  After three years of testing and research, the HES developed an innovative online application in 2011; the "Hotel Energy Solutions E-toolkit". The application provides hoteliers with a report assessing their current energy use and recommends appropriate renewable energy and energy efficiency technologies. Additional features of application include a carbon footprint and return on investment calculator. In addition, an educative section called "Energy School" deepens knowledge on sustainable practices and technologies available, along with a variety of informative publications and communication materials to sensitize guests and staff.

- **TUI Travel airline project**[39] - On 6 October 2011 the TUI Travel airline subsidiary, Thomson Airways, flew the Birmingham - Arrecife (Lanzarote) route with an aircraft powered partly by biofuel. By using biofuels, Thomson Airways hope to strengthen its position at the forefront of sustainable aviation. The airline already boasts one of the highest load factors in the UK aviation sector; with carbon emission values significantly lower than average emission rates in the industry. Thomson Airways subsidiary plans to expand its use of sustainable biofuels across its fleet over the next three years, with daily flights using the biofuel commencing in early 2012.

5.2 Potential limitations

5.2.1 Climate change uncertainty

It is important to note that, at present, the scale and uncertainty of climate change projections make it difficult to make important investment decisions and to institute costly measures to mitigate and adapt to climate change. It is therefore important that current climate trends and conditions are taken into account and that mitigation and adaptive measures are practical. Furthermore, the use of natural systems (such as the use of healthy wetlands as opposed to construction of walls) for flood attenuation should be encouraged.

[35] http://www.wttc.org/activities/environment/. Accessed 07/11/2011

[36] http://www.sustainabletourism.net). Accessed 07/11/2011

[37] http://www.wttc.org/activities/environment/). Accessed 07/11/2011

[38] http://www.hotelenergysolutions.net/ Accessed 07/11/2011

[39] http://www.tui-group.com/en/company/topics/biofuel_aircraft Accessed 07/11/2011

5.2.2 Communication and co-operation

A limitation to effective climate change response is an apparent lack of communication and co-operation between governmental and private sector role-players in the industry.

5.2.3 Capacity building

There is a need to improve the capacity of small and medium enterprises to adapt to the effects of climate change and general responsible tourism, relative to governments and larger operators. However it is clear that there is a need for awareness raising and response capacity building in the field of environmental management which, in turn should build resilience to climate change.

6.0 RECOMMENDATIONS FOR FUTURE STUDIES AND INITIATIVES

As a result of the baseline assessment process, the following recommendations are made for future studies and programmes:

- A clear area of vulnerability is the apparent lack of communication and co-operation between government tourism bodies and the private sector. A structured communication system and forums in which the opinions of the private sector are sought and taken into account during decision making will assist with this alignment. The compilation of a **communication strategy** is recommended, as well as meetings within each of the provinces (and perhaps nationally) at least twice a year in which climate change vulnerability and response is discussed;
- There are major opportunities for **"green" and "low carbon" tourism**, in which international visitors in particular can be given the opportunity to offset their carbon footprint for the long haul flight and in-country travel through investing in tree planting projects and/or community upliftment projects. This could be an excellent opportunity for government and the private sector to co-operate, and provide marketing opportunities;
- It is recommended that an investigation is carried out into **alternative energy sources** which could potentially be facilitated for tourism operators at a small-scale, in which the set up of, for example, solar water heaters or biogas facilities could be incentivised or made easier. The team tasked with this effort could draw on successes from neighbouring countries, and the government could be involved in terms of feeding into the national grid and reducing reliance on coal-fired power;
- It is recommended that a short-term research programme be conducted into the **emerging tourism markets to South Africa**, in terms of investment and tourists. This could aid in marketing strategies and the shaping of tourist products according to demand;
- A further short-term research project is recommended in terms of the **insurance climate for the tourism industry in South Africa**. This should investigate the opinions of the insurers themselves, and the various mitigation and/or adaptation requirements, particularly for small-scale operators. This could potentially indicate the ways in which insurance premiums could be lowered for tourist facilities, should certain measures be put in place to ensure climate change resilience. The study could make recommendations in terms of a green climate fund or tourism tax or levy for this purpose;
- It is clear that a **programme to create awareness** of climate change (but within a broader framework of environmental management) would be of considerable use within the tourism industry. This could either be in the form of an independent course, or be facilitated within existing hospitality courses, which is possibly the most appropriate method as this would mainstream the issues within traditional tourism-based training courses. This effort could assist with capacity building in terms of climate change adaptation, but also responsible tourism in general (environmentally friendly practices, recycling, water conservation, etc.) and
- A further short-term project (perhaps through a university) could assess **tourist perceptions of climate change and carbon management** and to which measures tourists are likely to respond in terms of environmental management and responsible tourism.

7.0 CONCLUSION

An altered climate will change the tourism industry, both within South Africa and internationally. This is in part due to tourism's dependence on natural assets and the built environment, both of which are vulnerable to the physical impacts of climate change. However, the impacts of these costs will also percolate through the economy in the form of financial risks with rising insurance premiums, changes to business financing and the need for business to manage the potential risks of climate change. Consumer demand may also be affected by perceptions of climate change and carbon emissions, and the response by industry and the South African government.

The tourism sector in South Africa may need to adopt different investment patterns and business models in order to remain commercially viable.

This report presents a baseline assessment of climate change vulnerabilities which may affect the tourism industry in South Africa. Further studies and recommendations for co-operation and awareness raising are provided, and it is anticipated that these endeavours may assist in building resilience in the tourism industry into the future.

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- World Heritage Convention Committee (WHCC). 2006. The Impacts of Climate Change on World Heritage Properties. 29th session World Heritage Convention Committee (Decision 29 COM 7B.a – Annex 1). Expert Meeting of the World Heritage Convention on the Impacts of Climate Change on World Heritage, March 2006.

APPENDIX A

Document limitations

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APPENDIX B

Case Studies

1. Seychelles and Comoros
2. North Queensland

1. Seychelles and Comoros

Source: Payet, A (2007). A Final Report Submitted to Assessments of Impacts and Adaptations to Climate Change (AIACC), Project No. SIS90. Department of Environment, Victoria, Mahe, Seychelles.

Tourism has become one of the largest earners of foreign exchange in the Seychelles. Since the islands lack natural resources, it depends mostly on tourism as a major source of foreign exchange. According to Payet (2007), such a dependency on single economic sector emphasizes the high vulnerability of the island states should climate change severely affect the tourism industry.

Payet (2007) further identifies economic and environmental factors such as economic recessions, natural disasters and wars as the external factors that affect tourism in Seychelles. The focus of the reviewed paper was on determining the impact of climate on tourism in Seychelles with a specific focus on the resources that support tourism, which is the coastal and marine environment. The following sites were selected as part of the study:

- Beau Vallon (on Mahé);
- St. Anne Island,
- Curieuse Marine Park;
- La Digue Island;
- Bird Island;
- Port Glaud (on Mahé); and
- Aldabra

The criteria used to select study sites included (i) current and potential importance of tourism in that particular site; (ii) presence of fisheries communities; (iii)sites of ongoing/past research projects (long term data availability); (iv) representation of key ecosystems and species; (v) within or close protected areas; and (vi) relevance to coastal management areas. At the study sites, the two main systems of focus were the coastal ecosystems and coastal human settlements.

- Coastal ecosystems - It has been classified into mangrove ecosystem, seagrass beds, coral reef, the beach ecosystem, and the plateau / shelf
- Mangrove ecosystem – at least seven species of mangroves are found in Seychelles. One of the ecological functions of the mangroves is to provide nurturing ground for larvae of certain species of fish and invertebrates. They also help in controlling erosion through trapping of sediments. It has also been noted indicated that because of lack of data on erosion rates and linkages to mangroves ecosystems that prevents any further assumptions. Mangroves also play a role in stabilizing water supply, for rivers and groundwater. This is very important since in Seychelles, the fresh water resources are extracted from rivers
- Seagrass beds – at least 13 species have been identified. As a shelter and nursery habitat, seagrass provide refuge for a number of marine organisms such as small fish and invertebrates in the early stages of their life cycle. They also protect reef ecosystem from sediment and organic loading shocks, which may come from terrestrial sources such as river discharges. They also generate large amounts of oxygen (one square meter of seagrass can generate up to 10 liters of oxygen per day); therefore they need to be considered in climate change mitigation.
- Coral reef – they are classified into three main groups, fringing reefs; atolls and platform reefs. The main threat to coral reef has been described as the coral bleaching which happened in 1998. The services of coral reefs are categorized into (i) physical infrastructure services such as coastal protection; (ii) biotic services both within ecosystems (e.g. habitat maintenance) and between

ecosystems (e.g. biological support through mobile links); (iii) bio-geo-chemical services such as nitrogen fixation; (iv) information services (e.g. climate record); and (v) social and cultural services.

- Beach ecosystem – the importance of beaches is Seychelles is over-emphasized. Without its beaches, Seychelles would not have been a well-known tourist destination. It provides habitat for numerous species of plants and animals. It also serves as an important breeding ground for animals which are not permanent residents of the system. The main granite islands of Seychelles: Mahé, Praslin and la Digue, which respectively covers 154, 37 and 10 square kilometers, are experiencing natural beach erosion which is aggravated in some places by unwise practices such as land reclamation, sand extraction and hard construction on the seashore. It is anticipated that 75 beaches of these inhabited and important tourists islands might disappear or at least be seriously affected by shoreline recession, within the next 10 years

Coastal Human settlements

Payet (2007) explains how the population of Seychelles have grown over the years from an initial population of 28 persons to 84 000 peoples. It is indicated that almost all of the coastal plains are heavily built or developed and reclamation of coastal areas for additional land is common practice. The population density in Seychelles is about 163 persons per square kilometer. According to Payet (2007), the uncontrolled and rapid expansion of towns and villages on all the three main granitic islands has led to overwhelmed transport, communications, water supply, sanitation and energy utilities.

The paper further identify stakeholders and interest groups that would be concerned about the impact of climate change on tourism as tourists, conservationists, tourism developers, fishermen, politicians, Seychelles public and future generations.

The climate in Seychelles archipelago is strongly influenced by the ocean, mainly through the following processes:

- Monsoonal wind shifts induced by seasonal pressure changes over the Indian Ocean;
- Changes in the position and intensity of the South Indian Ocean tropical anticyclone;
- Seasonal migrations and changes in intensity of the complex intertropical troughs; and
- Ocean currents and sea surface temperature patterns in the equatorial Indian Ocean.

According to Payet (2007), studies have shown that in Seychelles there has been the following changes:

- Substantial climate variability over the past 100 years;
- For the past 25 years, there has been an increase in mean air temperature in Mahe Island, the main granitic island; and
- The annual rainfall, rainfall regime, mean length of dry season and frequency of dry periods have all significantly changed.

It is indicated that the patterns in some climatic variables, such as surface air temperature, precipitation and wind strength are all expected to be internally consistent, but since all the forms of data used to examine climate change and variability suffer from problems of quality and consistency, further studies is required. The report further indicates that before trying to describe a range of future climates for Seychelles, it is important to examine trends of the level of climatic variability that the Seychelles has been subjected to over the recent generations.

The report discusses the scientific methods and data used for estimating climatic scenarios in Seychelles. It states that the following approaches would be adopted to estimate the climatic scenario in Seychelles for the four times slices 2020s, 2050s, 2080s, and 2100s by using:

- The MAGICC/SCENGEN software of which 3 GCMs with various levels would be selected to include two options of greenhouse gas emissions scenarios;
- Two IPCC Special Report on Emission Scenarios storylines; and
- Scenario Scatter Plots – the emphasis is on using multiple scenarios in impacts assessments, where the scenarios span a range of possible future climates, rather than designing and applying a single 'best guess scenario'.

It is concluded that the following changes are expected to be brought about by the climate scenarios experiments:

- The future changes in Seychelles climate
- Increase of surface air temperature: Maximum and minimum temperatures are expected to increase for all seasons
- Changes in annual and seasonal rainfall: Preliminary results showed that dry season is becoming drier and wet season wetter. Rainfall could either rise or fall. Most models predict an increase in wet season.
- Changes in climate variability (ENSO events) and extreme events are likely to be more frequent
- Increase in the frequency of occurrence and severity of extreme events: An increase in increase intensity of extreme events. A rise in sea surface temperature and a shift to El-Nino conditions could expand the cyclone path equatorward.
- Increase in frequency of El-Nino and La Nina-like conditions: The balance of evidence indicates that ENSO events may occur more frequently leading to higher either average rainfall over the Seychelles during an intense El-Nino and abnormally low rainfall during an intense La Nina

Changes in sea level rise

While there is growing uncertainties among the experts that climate change is occurring, uncertainties remain about the magnitude and timing of the changes. For Seychelles, these uncertainties are magnified because the area of Seychelles usually falls below the levels of resolution of the GCMs used. Uncertainties increase with time: projections for 2100 are less certain than projection for 2050.

In order to assess the impact and vulnerability, the following activities were conducted:

- **Coastal flooding** - The study focused on Anse Volbert and Beau Vallon. The research instruments used included a questionnaire, interviews and mapping. The results showed that in both study sites, most of the infrastructures are located within the coastal plains and are therefore prone to flooding. For Beau Vallon, it was found that the existence of marshes around the area did help to reduce the risk of flooding and this was especially the case in the areas of the coral strand and Beau Vallon Bay Hotel. However, there were other tourism infrastructures especially smaller hotels, guesthouses and restaurants where flooding were still posing threat. The main cause for this was said to be the drainage systems that has been badly designed and managed. In Anse Volbert, the majority of the stakeholders interviewed indicated that they have had trouble with flooding in the past and that in some cases some establishments were frequently affected by floods. Some of the infrastructure had actually been built in flood plains, which meant that every time the water level rises they are at risk.

  According to Payet (2007), if climate change floods occur in greater frequency causing more and more damage, this will affect Seychelles reputation as one of the top tourism destinations in the world, and will also have negative effects on the country's economy. Coastal flooding also has negative impact on infrastructure such as tourism, shops, banks and car rentals. It also impact negatively on road infrastructure, health and sanitary issues, as well as local community.

As mitigation measures, some establishments and individuals have already tried to mitigate these problems by adapting mostly their infrastructures as well as practices. These include improving drainage system and raising the level of their buildings, often by the use of pillars. Creation of coastal barriers has also been cited as another option to mitigate rise in sea level. However, it is also important to note that this method is said to be very expensive, therefore it still remains a major concern for many people.

One of the major weaknesses with respect to predicting climate change scenarios is the lack of long term data.

- **Coastal erosion** - It is indicated that by using an Excel model based on Gourlay's equations for a single reef, all parameters were tested for their sensitivity in influencing changes to final energy reaching the shore. Any or all parameters can be changes as desired to reflect any reef, and results can be displayed interactively. Values for each parameter can be substituted and substitutions with some extreme values are illuminating. For parameter testing, one other variable at a time was changed, with others held constant. All reefs were standardized at 100m with a steep seaward reef profile (Kp = 0.78) and with intermediate roughness represented by a friction of fw=0.15. The mean standard still water depth (hr) over the reef used was 0.85m, which is the mean tidal range in the Seychelles tide, reef flat generally grow upwards to approximately mean low water level, and high tide situation was selected.

  The study differentiates among different types of reefs profiles such as their heights; roughness and slope of the edge of the reef, most reefs where waves break. It is indicated that in Seychelles most reefs vary over distance a distance of a few meters from one profile type to the other, and back again. It has been note that all reef slopes prior to the mortality of 1998 are assumed to have had a sharp reef crest. These have now become more round as well as deeper, so the values of the reef profile have declined to values calculated in 2004. In future, while it is likely that erosion will continue to round-off the reef crest, it is clear that in the turbulent area, and most such rounding has already taken place as most coral skeletons from here have already been completely removed. Over the next decade, it is indicated that, it is likely that change will be small and not easily estimated; it is conservatively assumed that no further change to Kp will take place.

  Seagrasses have also been cited, in this study, as important parts of reef flats in Seychelles. They form beds which may adjust to sea level. Therefore, sections of the reef flats dominated by seagrass were assumed to have raised the gradual rise in sea level such that there was no increase in still water depth where seagrasses covered 100% of a zone.

- **Coral Recovery** - Coral reef monitoring was conducted at 78 sites in the Seychelles granitic islands from November 2000 to February 2004 as part of the coral reef component of the Global Environmental Facility sponsored by Seychelles Marine Ecosystem Management Programme. Sites were monitored biannually, annually or as one-offs for greater geographical coverage. The findings indicate that monitoring the recovery coral reefs from the devastating effect of the 1998 mass coral bleaching event in Seychelles inner islands began in 2000. The positive trend in recovery was being observed despite the fact that the reefs were again affected by coral bleaching events in 2002 and 2003 brought about sustained and elevated sea-surface temperatures. The combined data for carbonate and granitic reef showed exponential increase in mean live hard coral cover. However, there are considerable differences in the rate of recovery between carbonate and granitic reefs. The granitic reefs are experiencing a strong exponential increase in live hard coral cover whereas carbonate reefs are experiencing a weak linear increase.

Some of the main conclusions drawn from the study included:

- **Coastal flooding** – it is concluded that with the increasing change in climate, the risk of having more frequent flash floods in the coastal plains of the granitic islands of the Seychelles is quite high. There have been many concrete examples where flooding events have severely affected many tourism establishments and related businesses, often taking month for repairs and for the business to recover. According to Payet (2007), frequent events such as floods can have serious impediment on many

tourism businesses and as a result this may directly affect the country's economy. Proper planning for developments and routine maintenance of existing drainage systems will help avoid flood occurrences.

- **Coastal erosion** – it is concluded that the potential for further reef reduction given continuing coral mortality is clear, but few quantitative numbers are available. In the present study, increased depth of the reef is restricted to the heights of the living corals. However, erosion of the reef flat platforms themselves is also possible. It is further indicated that some of the major changes to shorelines are occurring from sea level rise. The equivalent of a localized sea level rise caused by a lowering of these reef flats in the Seychelles is greater than the global rate by an order of magnitude or greater. Even though this affect only the seaward zones of each reef flat in the Seychelles, its consequences appear to be significant.

- **Coral recovery** – the analysis of monitoring data since 2000 (2 years post bleaching) indicates very clear that coral reefs in the Seychelles inner islands are recovering. The greater stability of granite reefs over carbonate reef is thought to be an important factor for the observed differences. However, it is important to note that all the reefs will continue to be exposed to future coral bleaching events, such as those that were recorded in April 2002 and 2003. It also important to note that there is no scientific explanation with regards to the increase rate of recovery observed on granitic and carbonate reefs after the 2002 bleaching event and granitic reefs after the 2003 event, although it may indicate the acquisition of resilience by the reef.

Adaptation

According to Payet (2007), adaptation strategy is concerned with the responses to both adverse and positive effects of significant threats, such as human intervention or climate change. The approach for the study is based upon two distinctions: systems responses to threats that are automatic or built-in (termed autonomous adjustments) or responses that require deliberate policy decisions, termed as adaptation strategies.

The study has also used both the national data on tourism and meteorology to explore the adaptation options for tourism in Seychelles. It is indicated that rainfall cycles in the Seychelles show a tendency for two dry periods for this century, one in early 1900 and the other in the 1940s. It is further indicated that predictions for future dry periods cannot be accurately predicted using that information, but by analyzing monthly data from the Pte. Larue Rainfall station for a long series of years, an indication of frequency of dry periods of different durations and in particular, extreme droughts can be calculated. Records over an 80 year period, 1891 to 1970, indicate that no dry periods of more than six months have ever been recorded on the granitic islands, and such dry periods on average rarely exceed four months.

The six generic types of behavioral adaptation strategy for coping with the negative effects of the threats that have been identified are as follows:

- Prevention of loss: this involves anticipatory actions to reduce exposure of a particular biodiversity unit to the existing or emerging threat.

- Tolerate loss: the exposure unit can absorb the threat without long-term damage. This approach takes advantage of the assimilative capacity and rapid recovery of the unit and can be used in the context of the coral reefs as a way to increase resilience.

- Spreading or sharing loss: options aimed at distributing the impacts spatially or over a larger proportion of the population

- Changing use or activity: option which involves switch in resource use or management so as to allow the unit to recover

- Changing location where conservation of a particular unit is considered more important than actual location, options could involve migration corridors

- Restoration or aims to restore a system to its original functional condition following damage or modification. Coping is limited here, as systems remain susceptible to the threat

According to Payet (2007), most island climatology is dictated by the ocean, and tourism itself is depended on coastal and marine resources, it is important that further research involving both qualitative and quantitative methods are used to explore potential risks of global climate change impacts in order to increase the understanding of their likelihood of occurrence and the consequences if they should occur. Exploring the complexities and linkages among various driving physical and socio-economic factors has also been cited as a key to facilitating and enabling effective adaptation. It is also indicated that there are expectations, though there is still a lot of skepticism, that climate change may present new opportunities for tourism growth and development. Opportunities may include opportunities for new forms of tourism, expansion of tourism activities into new areas and ironically, an increase in severity of wintry weather and overcrowding of local tourist areas may create more demand for tropical tourism.

Four adaptation strategies for tourism in small islands states to changes in precipitation and temperature have been proposed as follows:

- Long-term sustainable planning and management of tourism infrastructure
- Diversify recreational tourism resources
- Offer unique experience and refrain from tourism intensification
- Capacity building and coordination

The report further indicates that implementation of the above-mentioned efforts requires financial and technical resources. It is indicated that an estimated USD 21 million in net present value terms over the next 15 years will be required to implement such an adaptation strategy in Seychelles.

The study also adopted a NAIADE (Novel Approach to Imprecise Assessment and Decision Environments). This offered an opportunity to manage various types of data to address the multidimensionality of sustainable tourism. It is a discrete multi-criteria method whose impacts 9or evaluation) matrix may include crisp, stochastic or fuzzy measurements of performance of a scenario (or an alternative option) with respect to an evaluation criterion. NAIADE as a powerful tool for conflict analysis in determining sustainable alternatives to development requires a good understanding of all the mathematics underpinning and fuzzy sets of theory. Therefore, the tool has tended to remain restricted among academics and not widely adopted by managers and others in mapping conflicts. A sensitivity analysis was also undertaken to address some of the short comings of the NAIADE.

Using NAIADE analysis – the results concluded that from an impact analysis, the moderate conservation approach is seen as the most sustainable pathway in the short-term or without adaptation to climate change. However, further analysis of coalition formation, indicated that the issue of emerging climate change, pushes the tendency towards a strengthening of conservation as the most appropriate means to adapt to climate change and sustain tourism in the long-term.

The study conclude by stressing the importance of sustainable tourism development which involves the harnessing of the powerful earning power of tourism to promote sound environmental management, economic development and social progress, without compromising the integrity of existing ecosystems and social fabric. It is also argued that though environmental sustainability is a key determinant of sustainable tourism but that is not enough, since benefits from tourism are not equally distributed, that is addressing poverty in developing countries. Four policy recommendations have been proposed to address the issue, that is (i) poverty alleviation at the centre of national strategies; (ii) increase access for the poor to tourism benefits; (partnerships); and (iv) donor role of the international community. It is however not clear as to how sustainability will be achieved under these conditions and whether changes to the sustainability strategy would be required for adaptation to climate change.

The role of protected/conservation areas in achieving sustainable tourism has also been highlighted. It is indicated that a reduction in overseas conservation grants, including those from multilateral agencies, has important implications for conservation of ecological important sites and islands in Seychelles. The findings of the study, after exploring different scenarios, show that sustainability is not determined by the type of

tourism happening in an area but rather by ensuring two important baseline- conservation of the natural environment and addressing social conflict or stakeholder orientations.

For the mass tourism destinations, it is argued that by creating new attractions or finding natural resources that have not yet been exploited, tourism decline can be reversed. This strategy has however been criticized based on the fact that it will only protract the situation into the near future. Therefore, they proposed the strategies based on (i) identify market segments to maximize benefits; (ii) improving tourism attractiveness of the destination; (iii)better land-use planning and reconstruction of tourism infrastructure; and (iv) reducing impacts of overcrowding. The study acknowledges these strategies as critical for sustainable tourism in the long-term, but these are the determining factors. Payet (2007) recommends that a combination of post-fordist tourism (a tourism which offers tourist independence and flexibility with a desire for green tourism) together with improved land-use planning, restoration of degraded landscapes and improvement in environmental quality or minimization could contribute to sustainable tourism development.

The study also highlights the important role of technology transfer in addressing several issues. However, it is also further indicated that technological implementation can only address sustainability from an efficiency perspective, largely ignoring the equity perspective. The study concludes by stressing the important role played by tourism as an economic driving force in Seychelles. It further indicates that it is important that if tourism moves towards sustainability, then some of the positive aspects of intensification of the economy may be compensated for.

2. North Queensland

Source: Thomas, C. (2007) Climate Futures Adaptation Planning: An Example of Adaptation Planning for Coastal Tourism Operators in North Queensland

The Climate Futures Adaptation Plan is a planning package developed by CSIRO and Tourism Queensland specifically for coastal tourism operators in Cairns and Airlie regions. It is also aimed at assisting other people from other businesses and regions so that they can see how such a tool could be useful for their context (Thomas, 2011).

Thomas (2011) provide a Climate Futures Tool that was designed to used in a workshop setting where tourism stakeholders and others learn and share about how to prepare for climate change. This includes provision of information on climate science, climate variability, explaining the difference between adaptation and mitigation, as well as demonstration on how to use the Climate Futures Storylines. This will enable tourism operators to identify potential impacts to their business and develop adaptation actions appropriate their individual needs.

Climate Future Storylines are developed from scientific climate projections to provide a window into a comprehensive range of possible futures.

According to Thomas (2011), even if we succeeded in reducing the level of greenhouse gas emissions in the future, the greenhouse gas already in the atmosphere will continue to contribute to rise in temperature, resulting in short and long term climate change. This shows a strong case for businesses to plan and implement adaptation actions. Adaptation planning can help a business to create competitive advantage and cost saving, improve liability management, reduce investor pressure, manage regulations and increase the health, wellbeing and reliability of the working force, customer base and community. Since climate change impacts vary across different businesses, the effects are, therefore, best evaluated on a sectoral and geographic basis for a range of climate projections.

For the purpose of the reviewed document, they have developed a storylines encompassing a range of projections relevant to the tourism sector in Cairns-Airlie Beach regions. Those projections can be used as a reference point when undertaking adaptation planning for individual businesses outside the above-mentioned areas. After looking at the story lines, the worksheet can be used to tailor responses for specific situations. A table that is used in conjunction with the Climate Future storyline is referred in the report as a *Your Business Response*. The *Your Business Response* is a planning tool developed to help businesses to customize and plan their response to climate change. It contains examples of potential impacts associated with the Climate Future storylines, as well as space to add impacts and adaptations that are specific to each business. Timing and cost columns are also provided to allow businesses to plan and budget their business responses. The notes section can be used to record things such as reasons why task should take effect now or later, the type of support or conditions that need to exist before they can be implemented, or note to possible problems.

It is indicated that tourism business impacts relate to climate risks at the local level as well as a range of other issues such as where to build infrastructure, whether suppliers / inputs are reliant on climate sensitive sectors, and whether demand may be affected by climate change. There are a number of ways that business tourism can choose to adapt to change business environment. A few of those are discussed below:

- **Bear losses** – it means doing nothing to reduce the impacts of change but instead accepting that there may be losses if negative changes occur. People may choose this option if the costs of adaptation measures are very high or very unlikely compared to the expected damage. This option means that a business is committing to a certain level of damage if the change does not take place.
- **Share losses** – it means adaptation that involves sharing the losses among a wider community, for example by accessing public relief, rehabilitation, and reconstruction funds, or through insurance. Using insurance can lessen the impact of extreme events on policy holders that reduce their exposure to such risks, including those that posed by climate change. However, poorly designed premiums that

do not adequately reflect the underlying risk can be unhelpful, or even promote actions that unintentionally worsen impacts. For these reasons, relying on insurance is unlikely to be the best plan.

- **Prevent impacts** – it means preventing the expected effects. For example, an operator can install water tanks to prevent water shortages in drier futures, undertake beach nourishment to prevent erosion of foreshore resources and infrastructure, etc. The success of these responses depends on the severity of climate change.

- **Change use** – most tourism activities rely directly or indirectly on natural resources. If the continuation of an activity is impossible or too risky (e.g. if the change and/ or severity of coral bleaching is considered too high for diving business to be viable), it may be useful to change the way the resource is being used or even change to a resource that is less risky. For example, dive operator can change from reef diving to other adventure based activities such as bare-boating or bushwalking, or change the timing of high season periods to respond to shifts timing of seasonal weather.

- **Change location** – change the location of business activities to a place with less change or less severe risks. For example, to respond to potential impacts to customer demand as a result of coral bleaching, a tour operator may change which reefs they take divers to but maintain the same business location (i.e. the change is limited to non-administrative activities and is a matter of kilometers). To respond to cyclones or floods, the same tour operator might need to move their permanent structures to higher ground

- **Inform and communicate** – new research, regulations and technology and information sessions are being developed all the time. Tourism demand depends on maintaining an appealing and interesting experience for visitors. Operators can do a lot manage the misperceptions that prospective tourist might develop from negative or misleading media exposure, unfamiliarity with tropical climates, or stereotypes that can't be fulfilled. Operators can also communicate regularly with the local community to troubleshoot any problems or concerns they may have about tourists and tourist activities, ensuring that tourists are always warmly welcomed and the industry supported.

According to Thomas (2011), planning can only begin once adaptation has been collected in the *Your Business Response*; they need to be organized into a more detailed plan. The tourism business can think about how to adapt to climate change within their own operations and supply chains, in partnership with surrounding communities, and in collaboration with global markets.

Examples of how business can interact with the community to adapt to climate change include: supporting local councils and community groups to develop emergency response and health plans (which keep the workforce healthy), developing relationships with the local community to ensure supply during road closures, developing relationships with the local community to ensure that tourists and tourist activities are welcomed, wanted and their presence enjoyed by the community, or working with councils and community to reduce pressure on coral reefs.

Examples of how a business can work with global market to adapt to climate change include: changing high season periods to accommodate shifts in seasonality internationally, or educating prospective visitors about how best to enjoy the unique environment.

It is further indicated that for an adaptation plan to be effective and worthwhile, thought needs to be given to flexibility, costs, feasibility and timing. A good adaptation planned not to be static or set in stone, but has to respond to an increasingly understanding of the business, as well as changing nature of scientific, political, financial and social environment. An adaptation plan therefore can be reviewed each year or in every five years.

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