BRYPAAL SOLAR POWER (PV) PROJECT
NOVEMBER 2017

Climate and Solar Radiation Report

Remainder of Portion 4 of the farm Brypaal No. 134

Division Kenhardt
Northern Cape Province

Prepared for:

Vintage Energy Pty (Ltd)

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TITLE AND APPROVAL PAGE

Project Name	EIA for the proposed development of a 100 MW PV Solar Facility on the farm Brypaal, Northern Cape Province.
Report Title	Climate and Solar Radiation Report
DEA Reference	14/12/16/3/3/2/1019
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Client	Vintage Energy Pty Ltd
Client Representative	Mr. Jan Du Preez

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Report Reference		2017/BES/SR/15

Authorisation	Name	Signature	Date
Author	Frik Erasmus		22 November 2017
Approved by			
Author's Affiliations	See Appendix A		

CONTENT

DESCRIPTION OF THE CLIMATE OF THE BRYPAAL PV SOLAR PROJECT FOCUS AREA

PART A

1. (1) A specialist report prepared in terms of these Regulations must contain-

(a) details of-
(i) the specialist who prepared the report; and

EAP:	**Mr. Frik Erasmus**		
Professional affiliation/registration:	**South African Council for Natural Scientific Professions (SACNASP):** **Prof. Nat. Sci. : 400120/05**		
Contact person (if different from EAP):	**Me. Cindy Faul**		
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(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

The EAP, Mr. Erasmus has been involved in environmental studies, research, environmental management, compilation of Basic assessments EIA/EMP'S, EMP environmental auditing for the past 30 years.

Qualifications (Highest):

M.Sc. (Geography); M.Sc (Environmental Management & Analyses) Prof. Natural Scientist (Reg. No. 400120/05) SACNASP; Member of the IAIASA (See C.V for more detail in Appendix A).

(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;
I , Frederik Johannes Erasmus declares, that I am an independent specialist that do not have any vested interest in the project.

(c) an indication of the scope of, and the purpose for which, the report was prepared;
Description of the climate of the study area has been done by using existing info sources from Weather SA such as the WB28, WB 42, WB 43 reports and the Dept. of Environmental Affairs. The description of the Solar Project in relation to climatic regions, mean annual precipitation, temperature, potential evaporation, seasonal variation in wind direction and wind speed and solar radiation (solar resource) have been described. This was done in order to indicate that the proposed PV Solar Project do occur within a part of the country that is ideally suited for solar projects. Also it is important to get a indication of the amount of rainfall (in order to plan for surface run-off measures, utilizing of the water sources, etc.) Info on the wind regime could help in determining if dust from the surrounding environment, including the man-made features, such as the gravel road is going to have a impact on the PV facility (therefore planning for location of the PV solar facility, environmental management measures), etc..
(cA) an indication of the quality and age of base data used for the specialist report;
Description of the climate of the study area has been done by using existing info sources from Weather SA such as the WB28, WB 42, WB 43 and the Dept. of Environmental Affairs.

(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;
Existing impacts are related to farming with particular reference to the utilization of the site for grazing for sheep. An small piece of the site is being occupied by a quarry (provincial roads department), resulting in a change in topography through the creation of a depression. The topography on the focus area for the PV solar project will be altered to a minimum as the topography is flat and will involve the minimum earth works during site preparation. The impact on soil and vegetation cover will be restricted to an demarcated surface area that is really required for the construction of the PV solar project and associated infrastructure. Rehabilitation will be done on disturbed areas and vegetation will be allowed to grow on the facility, but managed by means of grass cutting, firebreaks where required.

(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;
An site visit was conducted during July 2016. Majority of climatic info has been obtained from exiting sources, such Weather SA publications and DEAT. The outcome of the assessment is not dependant on what season it is.
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;
Description of the climate of the study area has been done by using existing info sources from Weather SA such as the WB28, WB 42, WB 43 reports and the Dept. of Environmental Affairs. The specialist report will form part of the EIA Report as an Appendix.

(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;

It is important to describe the climate of the PV project focus area. This was done in order to indicate that the proposed PV Solar Project do occur within a part of the country that is ideally suited for solar projects.

It is also important to get an indication of the amount of rainfall (in order to plan for surface run-off measures, utilizing of the water sources, etc.) Water is needed during the construction phase and then for maintenance (regular cleaning of PV solar panels). Rainfall is scarce and alternative ground water sources could possibly be the water source.

So the **project have a specific sensitivity to certain environmental factors**, such as dust.Info on the wind regime could help in determining if dust from the surrounding environment, including the man-made features, such as the gravel road is going to have a impact on the PV facility (therefore planning for location of the PV solar facility, environmental management measures(EMM), etc.. An buffer zone along the stretch of the road with additional EM measures could possibly be part of the solution.

Sensitivity of the environment to the project will dictate the ultimate location of the PV Solar project in relation to the occurrence of certain surface run-off features, vegetation species, etc. (See reports on Flora of the study area).

(g) an identification of any areas to be avoided, including buffers;
Topographical features that need to be avoided are **“dry stream water courses**” that are draining towards the Salt River. The majority of the proposed project area (study area) lies between 860-880m above sea level and sloping towards the western side with a height of 860m towards 840m above sea level. The project area on the western side is more dissected by dry water courses, draining the project surface area towards the Sout River. So the **project have a specific sensitivity to certain environmental factors**, such as dust. Info on the wind regime could help in determining if dust from the surrounding environment, including the man-made features, such as the gravel road is going to have a impact on the PV facility (therefore planning for location of the PV solar facility, environmental management measures(EMM), etc.. An **buffer zone** along the stretch of the road with additional EM measures could possibly be part of the solution. **Sensitivity of the environment to the project** will dictate the ultimate location of the PV Solar project in relation to the occurrence of certain surface run-off features, vegetation species, etc. (See reports on Flora of the study area). **See map (Part B).**
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
See Part B for topographical map indicating “ dry water courses” that forms part of the Salt River drainage basin that should be avoided. The majority of the proposed project area (study area) lies between 860-880m above sea level and sloping towards the western side with a height of 860 towards 840m above sea level. The project area on the western side is more dissected by dry water courses, draining the project surface area towards the Sout River.

(i) a description of any assumptions made and any uncertainties or gaps in knowledge;
None.

(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;
It is important to describe the climate of the PV project focus area. This was done in order to indicate that the proposed PV Solar Project do occur within a part of the country that is ideally suited for solar projects. It is also important to get an indication of the amount of **rainfall** (in order to plan for surface run-off measures, utilizing of the **water sources**, etc.) Water is needed during the construction phase and then for maintenance (regular cleaning of PV solar panels). Rainfall is scarce and alternative ground water sources could possibly be the water source. So the **project have a specific sensitivity to certain environmental factors**, such as dust. Info on the wind regime could help in determining if dust from the surrounding environment, including the man-made features, such as the gravel road is going to have a impact on the PV facility (therefore planning for location of the PV solar facility, environmental management measures(EMM), etc.. An buffer zone along the stretch of the road with additional EM measures could possibly be part of the solution. **Sensitivity of the environment to the project** will dictate the ultimate location of the PV Solar project in relation to the occurrence of certain surface run-off features, vegetation species, etc. (See reports on Flora of the study area).

(k) any mitigation measures for inclusion in the EMPr; **(l) any conditions for inclusion in the environmental authorisation;** **(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;**
(For k & m) The surface area required for the PV project and associated infrastructure should be selected and demarcated by a surveyor with definite beacons and which is correlated with a project plan. No surface should be disturbed unnecessarily. Disturbed surface areas should be rehabilitated. No silt from such areas should be allowed to end-up in dry stream courses. Berm walls need to be put in place. Daily inspections required during the construction phase. The project have a specific sensitivity to certain environmental factors, such as dust. Info on the wind regime could help in determining if dust from the surrounding environment, including the man-made features, such as the gravel road is going to have a impact on the PV facility (therefore planning for location of the PV solar facility, environmental management measures(EMM), etc.. An buffer zone along the stretch of the road with additional EM measures could possibly be part of the solution. Sensitivity of the environment to the project will dictate the ultimate location of the PV Solar project in relation to the occurrence of certain surface run-off features, vegetation species, etc. (See reports on Flora of the study area).

(n) a reasoned opinion— **(i) whether the proposed activity, activities or portions thereof should be authorised;** **(iA) regarding the acceptability of the proposed activity or activities; and** **(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;**
There is no reason from a climatic point of view that the PV Solar project should not be authorised. The climatic conditions makes it ideal for the construction and operation of such a facility on the Brypaal project focus area. The availability of a sufficient water resource for construction and maintenance purposes should be found in this low rainfall area. The project have a specific sensitivity to certain environmental factors, such as dust. Info on the wind regime could help in determining if dust from the surrounding environment, including the man-made features, such as the gravel road is going to have a impact on the PV facility (therefore planning for location of the PV solar facility, environmental management measures(EMM), etc.. An buffer zone along the stretch of the road with additional EM measures could possibly be part of the solution.

(o) a description of any consultation process that was undertaken during the course of preparing the specialist report; **(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and** **(q) any other information requested by the competent authority.**
The specialist report will ultimately form part of the EIA Report as an appendix. Comments will be invited on the EIA Report documents.

PART B : DESCRIPTION OF THE CLIMATE OF THE BRYPAAL PROJECT FOCUS AREA

1.1 Climatic Region W (Desert)

<u>Region W and SWAs - Desert and poor steppe</u>

This region occupies about half of the Northern and Western Cape Province, southern South West Africa and the Namib desert further north**. The rainfall is unreliable, amounts to about 250 mm (10 inches) per year in the interior and decreases to an insignificant 50 mm (2 inches) or less towards the west coast.** In the interior the precipitation is mainly due to convectional showers in summer and autumn occurring on about two days per month, whilst on or near the coast the sparse rainfall occurs mainly in winter. Single very rare heavy showers can account for as much as the normal annual precipitation. Hail is seldom recorded in this region. Snow occurs about five times per annum on the southern mountain ranges (around Sutherland) but is rare on the western escarpment, though this type of precipitation has been recorded in the Namib as far north as Walvis Bay.

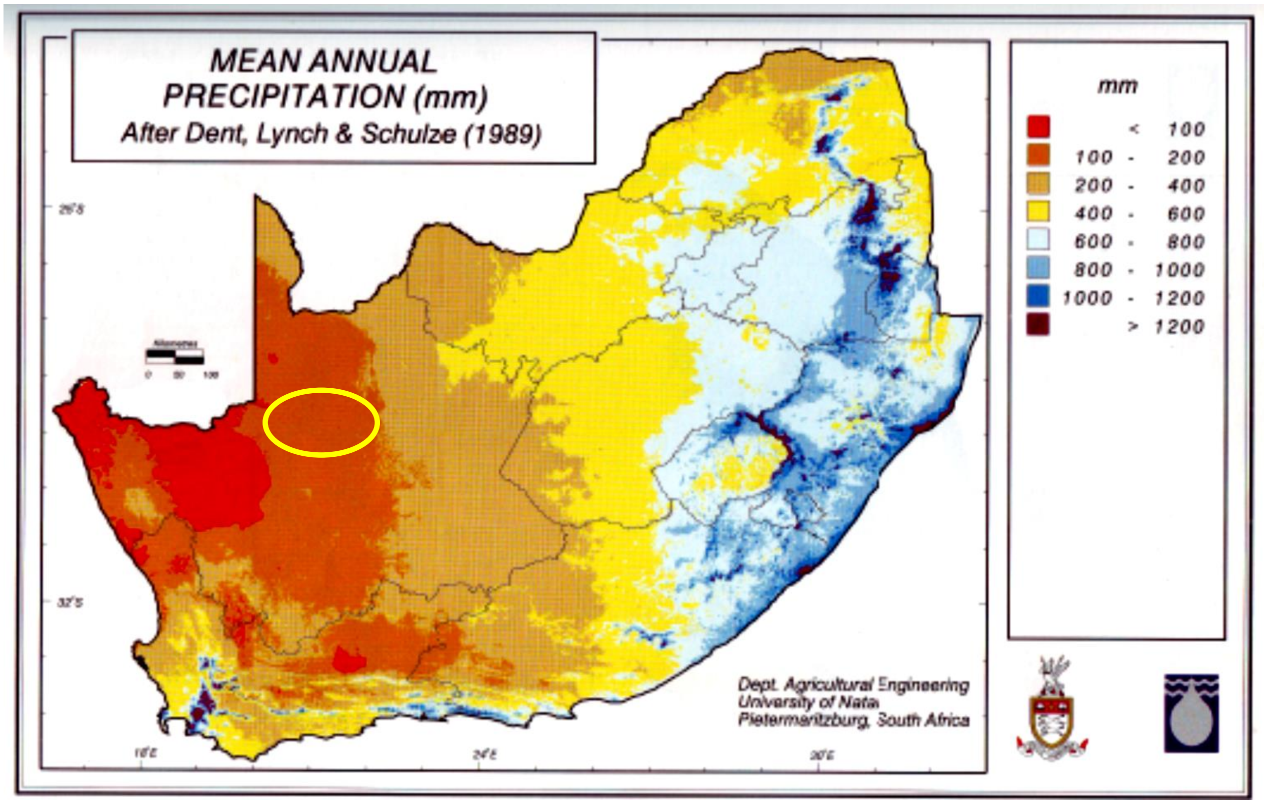
Due to the cold Benguela current the west coast is frequently *foggy.* Fog advances onto the coastal flats (sometimes as far as 20-30 miles inland) during the night and recedes seaward in the forenoon; this diurnal motion is connected with the intense heating of the land during three day and cooling at night due to terrestrial radiation. The moisture necessary for maintaining the prolific (wild flower) vegetation which adorns the countryside in the western Cape (Namaqualand) after a fortuitous winter shower, is probably largely due to condensation from low clouds and fog.

Temperatures are subject to great variation both seasonal and diurnal. The average daily maximum temperature in January is of the order of 35˚C (95˚F) and in July 18˚C (64˚F), whilst extremes can reach respectively 46˚C (115˚F) and 32˚C (90˚F). Average daily minima are about 17˚C (63˚F) in January and 3˚C (37˚**F) in** July; extremes can reach 5˚C (41˚F) and -10^{0}C (14˚F) respectively. On the interior plateau frost is common in winter. One of the hottest areas in South Africa is found in the Orange River Valley around Goodhouse and one of the coldest spots is Sutherland in the Roggeveld. In the Kalahari and Southwest Africa one sometimes encounters dust storms similar to the"haboob" of the Sudan, whilst the coastal belt is subject to hot easterly winds and sandstorms which are decidedly unpleasant. The latter occur mainly during the winter season when an anticyclone is established over the interior.

Source: WB28.

Fig. 161: Climatic Regions / Klimaatstreke

1.2 DISTRIBUTION of MAP (MEAN ANNUAL PRECIPITATION) IN SOUTHERN AFRICA:



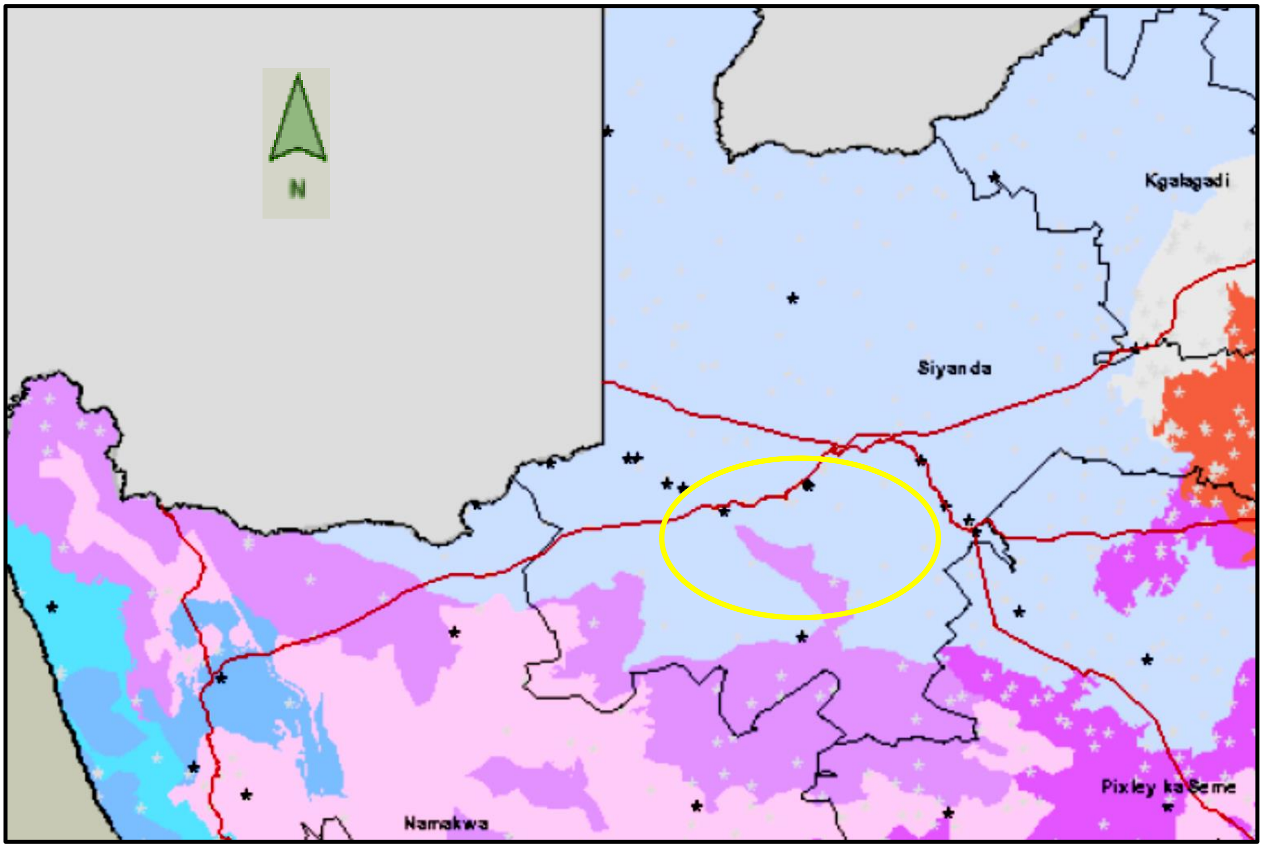
The overall feature of the distribution of MAP over southern Africa is that it decreases fairly uniformly westwards from the escarpment across the interior plateau. Between the escarpment and the ocean in both the southern and the eastern coastal margins there is the expected complexity of rainfall patterns induced by irregularities of terrain. **About 35% of southern Africa receives less than 300 mm per annum as a result of the presence of subtropical high pressure cells which inhibit rainfall generation because of predominantly subsiding air**, while only about 7% has a MAP exceeding 800 mm. Perusal of the statistics indicates that KwaZulu-Natal is the wettest province, while the Western Cape has the highest variability of MAP within any of the provinces, and the highest individual point rainfall at an estimated 3345 mm per annum.

Mean Annual Precipitation (mm)							
Province / Country	Mean Value	CV (%)	Maximum Value	Minimum Value	Exceedence Probability		
					20%	50%	80
Northern Province	527	28	2031	200	616	517	411
Mpumalanga	736	24	1933	341	851	695	618
North-West	481	21	782	246	584	485	377
Northern Cape	202	43	540	20	284	185	129
Gauteng	668	38	900	556	693	670	638
Free State	532	22	1689	275	634	524	422
Kwazulu-Natal	845	20	196	417	973	819	707
Eastern Cape	552	43	1722	96	768	528	332
Western Cape	348	72	3345	60	477	282	65
Swaziland	815i	27	1690	451	997	832	705
Lesotho	701	21	1796	361	791	689	589

Mean Annual Precipitation : Mapping

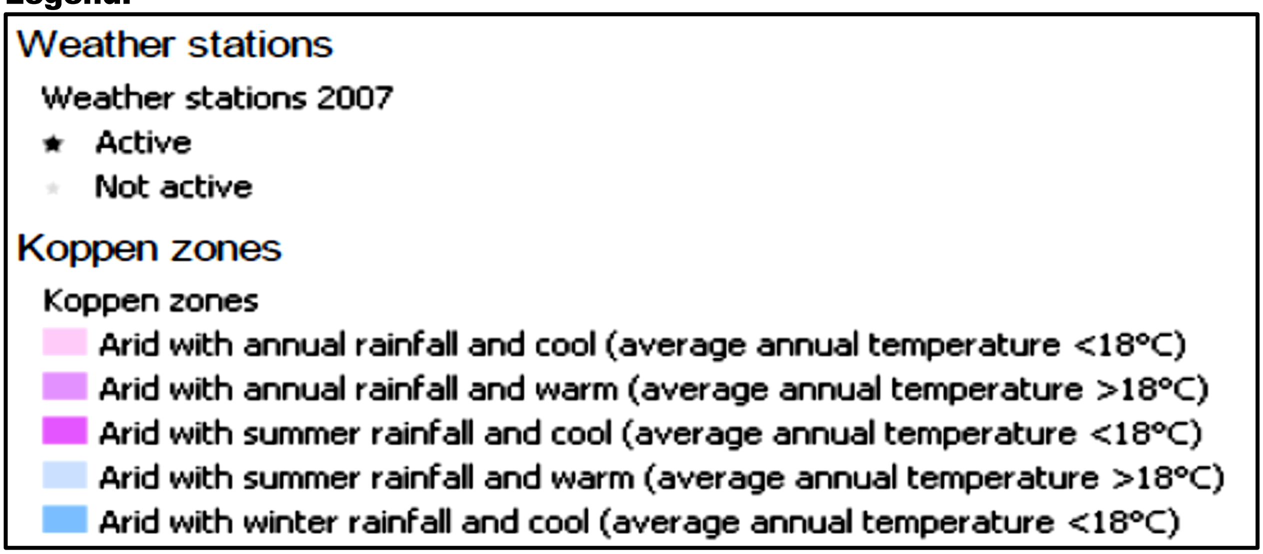
Dent, Lynch and Schulze (1989) divided South Africa, Lesotho and Swaziland into 34 regions, each of which was considered relatively homogeneous in relation to "controls" of rainfall distributions. These controls included altitude (and its influence on orographic lifting), distance from sea (as an index of continentality), aspect, terrain roughness and direction of prevailing rain bearing winds. Using data from over 6000 rainfall stations, equations for MAP were developed for each region, from which 1' x 1' of a degree gridded values of MAP were generated.

1.3 KöPPEN CLIMATE ZONE CLASSIFICATION:

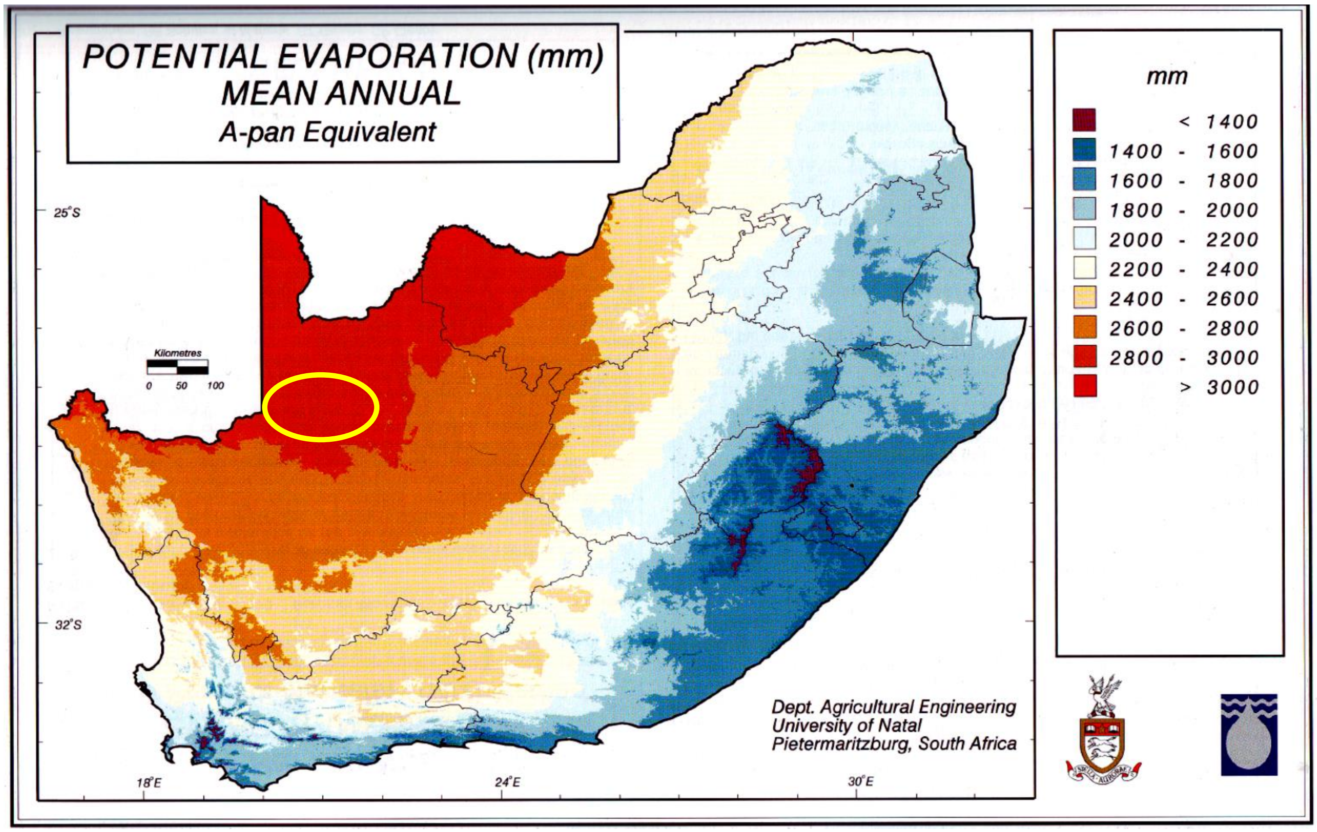


Source: Agric agis (2016)

Legend:



1.4 POTENTIAL EVAPORATION (mm) MEAN ANNUAL (A-pan Equivalent):



Distribution of Mean Annual A-Pan Equivalent Potential Evaporation:

Mean monthly January to December A-pan equivalent evaporation values were summed at each of the 437 000 grid points covering southern Africa to give a mean annual value. Intra-provincial statistics were then performed on those values.

Mean annual potential evaporation "lows" are around 1400 mm in the Drakensberg and 1600-1800 mm along the eastern and southern coastal areas, with a general southeast-northwest increasing trend culminating in highs exceeding 3 000 mm per annum in the northwest.

Monthly A-Pan Equivalent Potential Evaporation:

Mean Annual A-Pan Equivalent Potential Evaporation (mm)							
Provincel Country	Mean Value	CV (%)	Maximum Value	Minimum Value	Exceedence Probability		
					20%	50%	80%
Northern	2218	6	2592	1896	2349	2205	2084
Mpumalanga	1946	6	2335	1 37	2044	1935	1856
North-West	2646	8	3058	2116	2882	2637	2424
Northern Cape	2690	6	3028	1890	2846	2702	2546
Gauteng	2118	3	2372	1960	2238	2176	2121
Free State	2233	11	2677	1152	2474	2235	2017
KwaZulu-Natal	1770	8	2097	1067	1882	1788	1643
Eastern Cape	1930	15	2616	1232	2262	1849	1661
Western Cape	2230	13	2714	781	2477	2308	1943
Swaziland	1904	5	2078	1607	977	1914	1827
Lesotho	1634	12	2070	1975	83	6 6	1475

1.5 LOCATION OF THE SOLAR PROJECT SITE IN RELATION TO CLIMATIC REGIONS AND MAP (MEAN ANNUAL PRECIPITATION):

The solar project site occur within the Northern Cape , District of ZF Mgcawu on Portion 4 of 134 of the Farm Brypaal. The project site occurs within a dry (ARID) region (W)(BWk) that receives a mean annual precipitation of between 100 and 200 mm annually. The mean value for the Northern Cape is 202 mm/annum.

The mean annual A-Pan Equivalent Potential Evaporation (mm) is in the order of 2690mm/annum.

1.6 CLIMATIC DATA FOR LOCAL WEATHER STATIONS AS REPRESENTATIVE OF THE CLIMATIC CONDITIONS THAT THE BRYPAAL SOLAR PROJECT SITE IS EXPERIENCING:

With particular reference to:

- **Upington, Pofadder , Augrabies.**

Climate data:

Upington

Position: 28° 24' S 21° 16' E

Height: 836m

Period: 1961-1990

This climatological information is the normal values and, according to World Meteorological Organization (WMO) prescripts, based on monthly averages for the 30-year period 1961 – 1990

Month	Temperature (° C)				Precipitation		
	Highest Recorded	Average Daily Maximum	Average Daily Minimum	Lowest Recorded	Average Monthly (mm)	Average Number of days with >= 1mm	Highest 24 Hour Rainfall (mm)
January	42	36	20	10	24	4	33
February	42	34	20	9	35	6	59
March	41	32	18	5	37	6	46
April	38	28	13	2	26	5	52
May	34	24	8	-2	10	2	26
June	29	21	5	-5	4	2	13
July	29	21	4	-6	2	1	7
August	33	23	6	-7	4	1	40
September	39	27	9	-2	4	2	19
October	40	30	13	2	9	3	22
November	41	33	16	5	17	3	51
December	43	35	19	6	17	4	42
Year	**43**	**29**	**13**	**-7**	**189**	**37**	**59**

Source: Weathersa.

Climatic data for Pofadder:

CLIMATE OF SOUTH AFRICA WB 42 CLIMATE STATISTICS 1961 - 1990

Number: 0247668A4 Name: **POFADDER ϕ = 29° 8' S λ = 19° 23' E HT: 989 m Period: 1961-1990

TABLE 1 - AIR TEMPERATURE IN DEGREES CELSIUS

	AVERAGE OF DAILY				MAXIMUM (TX) P = 27 Years											
	MAX	MIN	MEAN	RANGE	HIGHEST (TXX)			AVERAGE NUMBER OF DAYS WITH TX						LOWEST (TXN)		
	TX	TN	(TX+TN)/2	TX - TN	MAX	YY/DD	MEAN	>=35	>=30	>=25	>=20	>=15	<10	MEAN	MIN	YY/DD
J	33,0	16,6	24,8	16,4	40,6	88/02	38,3	9,2	26,1	30,4	31,0	31,0	0,0	25,9	17,8	61/28
F	32,4	17,2	24,8	15,2	39,6	88/04	37,3	7,3	22,0	27,4	28,2	28,2	0,0	24,8	20,1	74/21
M	30,1	16,0	23,0	14,1	39,2	87/02	35,6	2,4	18,1	27,8	30,3	31,0	0,0	21,5	14,9	81/25
A	25,4	12,4	18,9	13,0	35,7	83/03	31,6	0,1	3,4	17,8	26,4	29,6	0,0	17,0	11,2	72/30
M	21,4	8,6	15,0	12,8	31,3	87/01	27,6	0,0	0,2	6,7	19,6	28,5	0,0	13,4	10,4	83/21
J	17,8	5,7	11,8	12,1	26,0	90/02	23,8	0,0	0,0	0,2	10,4	22,6	0,7	10,7	7,0	63/30
J	18,0	5,1	11,6	12,9	27,6	85/31	24,1	0,0	0,0	0,3	11,6	23,4	0,6	10,3	7,3	79/20
A	20,0	6,0	13,0	14,0	31,0	82/30	27,1	0,0	0,0	4,4	16,0	26,3	0,3	11,5	7,9	81/29
S	23,6	8,6	16,1	15,0	35,2	84/24	31,1	0,1	3,0	12,6	22,6	28,7	0,0	14,0	9,7	64/14
O	26,5	10,9	18,7	15,6	37,9	80/10	34,2	0,6	7,8	20,0	27,5	30,8	0,0	16,8	13,2	84/05
N	30,0	14,0	22,0	16,1	39,4	85/19	36,2	3,1	16,6	26,3	29,5	30,0	0,0	21,6	16,4	74/06
D	32,1	15,5	23,8	16,6	40,5	89/26	38,1	7,3	22,8	29,9	30,8	31,0	0,0	24,4	18,7	84/04
YR	25,8	11,4	18,6	14,5	40,6	88/02	39,0	30	120	204	284	341	2	9,0	7,0	63/30

MINIMUM (TN) P = 27 Years												
HIGHEST (TNX)			AVERAGE NUMBER OF DAYS WITH TN						LOWEST (TNN)			
MAX	YY/DD	MEAN	>=20	<15	<10	<5	<0	<-5	MEAN	MIN	YY/DD	
26,7	90/31	23,3	6,4	10,8	1,1	0,0	0,0	0,0	9,8	6,4	61/29	J
26,9	87/08	23,4	7,0	8,4	0,9	0,0	0,0	0,0	10,0	5,6	68/17	F
25,5	77/21	22,6	4,7	11,6	1,9	0,1	0,0	0,0	8,4	4,4	86/24	M
22,3	72/06	19,2	0,4	21,5	8,0	0,9	0,0	0,0	5,1	0,5	62/23	A
18,2	87/11	15,0	0,0	29,6	20,0	4,8	0,0	0,0	2,5	-0,4	73/30	M
15,1	82/30	12,3	0,0	29,8	26,8	13,5	0,7	0,0	0,2	-2,7	78/19	J
17,4	73/31	11,9	0,0	30,9	28,5	15,4	1,2	0,0	-0,6	-3,0	85/12	J
15,6	80/04	13,0	0,0	30,7	26,4	13,1	1,1	0,0	-0,4	-2,7	72/12	A
20,0	63/30	16,2	0,0	27,3	19,3	6,0	0,3	0,0	1,5	-1,2	74/03	S
22,3	80/11	18,7	0,4	25,1	13,5	2,3	0,0	0,0	3,6	1,6	84/06	O
26,3	85/18	21,5	2,2	17,4	5,6	0,3	0,0	0,0	6,6	4,0	64/21	N
25,7	90/10	22,9	4,5	13,8	2,7	0,0	0,0	0,0	8,3	5,0	84/05	D
26,9	87/08	24,4	26	257	155	56	3	0	-1,4	-3,0	85/12	YR

TABLE 2 - PRECIPITATION (and FOG), DRY- AND WETBULB TEMPERATURES, RELATIVE HUMIDITY and CLOUD COVER

	PRECIPITATION (R mm) P = 27 Years													
	MONTH	24 HOUR MAX		TOTAL PER MONTH / YEAR				AVERAGE NO. OF DAYS WITH R (mm) >=						
	TOT	RXX	YY/DD	MAX	YEAR	MIN	YEAR	0,1 AVE	0,1 MAX	0,1 MIN	1	5	10	30
J	9	41	72/05	77	1976	0	1988	1,8	10	0	1,0	0,5	0,2	0,0
F	19	77	74/21	146	1974	0	1986	2,8	9	0	2,0	1,0	0,7	0,1
M	22	40	61/26	77	1975	0	1979	3,8	7	0	2,6	1,3	0,7	0,1
A	21	52	77/12	101	1990	0	1981	2,7	10	0	1,7	1,1	0,7	0,1
M	7	38	68/15	70	1968	0	1986	2,2	8	0	1,0	0,4	0,2	0,0
J	7	27	70/18	40	1961	0	1985	1,9	5	0	1,0	0,4	0,3	0,0
J	6	42	79/11	42	1979	0	1989	1,8	4	0	0,8	0,2	0,2	0,1
A	3	14	62/20	17	1962	0	1989	1,8	7	0	0,6	0,2	0,1	0,0
S	6	20	80/24	27	1964	0	1986	1,6	5	0	1,0	0,3	0,1	0,0
O	5	27	81/19	43	1981	0	1989	1,6	4	0	1,0	0,4	0,1	0,0
N	4	14	85/27	18	1963	0	1986	1,4	5	0	0,8	0,5	0,1	0,0
D	8	46	63/07	83	1985	0	1989	1,4	8	0	0,8	0,3	0,2	0,1
YR	117	77	74/21	277	1974	38	1966	24	40	12	14	7	4	1

P = 22 Years				TEMPERATURE (°C)						REL. HUM. (%)					CLOUD			
AVE NO. OF DAYS WITH				DRY BULB P = 27 Years			WET BULB P = 26 Years			P = 27 Years					IN EIGHTHS P = 24			
TH	HA	SN	FOG	08	14	20	08	14	20	08	14	20	MAX	MIN	08	14	20	
1,8	0,0	0,0	0,0	20,3	30,8	29,0	14,0	17,6	16,6	52	26	25	81	10	1,4	1,6	1,6	J
1,6	0,1	0,0	0,2	19,8	30,4	28,4	14,2	17,9	16,8	56	29	28	85	11	1,6	1,7	2,0	F
2,4	0,1	0,0	0,5	18,1	28,4	25,6	13,5	17,2	16,0	60	33	34	89	14	1,9	1,9	2,1	M
1,5	0,1	0,0	0,8	14,1	24,1	20,3	10,7	14,8	13,3	65	37	41	92	18	2,1	2,1	1,8	A
0,7	0,0	0,0	1,4	10,0	20,2	15,3	6,9	11,7	9,6	63	37	42	93	20	1,9	1,9	1,5	M
0,5	0,0	0,0	1,5	7,0	16,6	11,8	4,6	9,8	7,3	69	42	49	96	22	1,8	1,7	1,3	J
0,5	0,1	0,0	1,7	6,5	16,6	12,0	3,9	9,4	7,1	65	38	43	94	17	1,6	1,4	1,0	J
0,6	0,0	0,1	1,8	7,7	18,4	14,0	4,7	10,1	7,9	62	32	36	94	13	1,7	1,5	1,2	A
0,6	0,0	0,0	0,6	11,2	21,9	17,8	7,3	12,0	10,2	59	29	32	92	11	1,9	1,7	1,4	S
0,7	0,1	0,0	0,4	14,6	24,7	21,0	9,5	13,6	11,9	54	26	27	86	9	1,9	2,1	1,7	O
1,0	0,0	0,0	0,1	18,3	28,0	24,8	12,1	15,4	14,1	50	25	26	81	10	1,6	1,7	1,6	N
0,6	0,0	0,0	0,0	20,0	30,2	27,7	13,2	16,6	15,4	48	24	24	81	9	1,1	1,3	1,4	D
13	1	0	9	14,0	24,2	20,6	9,5	13,8	12,2	59	32	34	97	6	1,7	1,7	1,5	YR

Period = years covering the data for all the columns of both tables. P = Average number of years covering the data in the columns concerned. $\overline{TX}$ = Average maximum, $\overline{TN}$ = Average minimum air temperature
TXX = Highest maximum, MAX = highest in P years. TXN = Lowest maximum, MIN = lowest in P years. TNX = Highest minimum, MAX = highest in P years. TNN = Lowest minimum, MIN = lowest in P years.
$\overline{}$ = MEAN = AVE = AVERAGE e.g. $\overline{08}$, $\overline{14}$, $\overline{20}$ = MEANS of observations which were made on these hours (SAST). YY/DD = Year/Day of occurrence of the extreme in the previous column.
(Number of days (NOD) with TX >= 10) = (NOD in the month - NOD with TX < 10). TH = Thunder, HA = Hail, SN = Snow, FOG = fog. > signifies greater than, >= signifies greater than or equal to.
(Number of days (NOD) with TN < 20) = (NOD in the month - NOD with TN >= 20). < signifies less than, <= signifies less than or equal to.

Climatic data for Augrabies Waterfall:

CLIMATE OF SOUTH AFRICA WB 42 CLIMATE STATISTICS 1961 - 1990

Number: 0281606 0 Name: AUGRABIES WATERFALL ϕ = 28° 36' S λ = 20° 21' E HT: 626 m Period: 1984-1990

TABLE 1 - AIR TEMPERATURE IN DEGREES CELSIUS

	AVERAGE OF DAILY				MAXIMUM (TX) P = 6 Years												MINIMUM (TN) P = 6 Years												
	MAX	MIN	MEAN	RANGE	HIGHEST (TXX)			AVERAGE NUMBER OF DAYS WITH TX						LOWEST (TXN)			HIGHEST (TNX)			AVERAGE NUMBER OF DAYS WITH TN						LOWEST (TNN)			
	$\overline{TX}$	$\overline{TN}$	$(\overline{TX}+\overline{TN})/2$	$\overline{TX}-\overline{TN}$	MAX	YY/DD	MEAN	>=35	>=30	>=25	>=20	>=15	<10	MEAN	MIN	YY/DD	MAX	YY/DD	MEAN	>=20	<15	<10	<5	<0	<-5	MEAN	MIN	YY/DD	
J	37,1	21,1	29,1	16,0	44,0	85/02	41,7	24,3	31,0	31,0	31,0	31,0	0,0	31,5	30,0	86/27	29,0	85/03	27,0	18,8	0,2	0,0	0,0	0,0	0,0	15,9	14,7	86/06	J
F	35,0	20,8	27,9	14,2	41,9	87/18	40,1	16,6	25,4	28,0	28,1	28,1	0,0	27,8	24,0	89/11	30,5	90/02	26,5	17,4	0,7	0,0	0,0	0,0	0,0	15,1	13,2	90/23	F
M	33,4	18,7	26,0	14,7	41,4	88/02	39,7	13,7	25,0	29,7	30,8	31,0	0,0	24,9	19,5	89/31	26,8	87/02	24,3	13,2	4,7	0,7	0,0	0,0	0,0	11,7	8,0	89/31	M
A	28,6	14,5	21,6	14,1	37,3	87/03	36,0	1,8	14,2	22,5	28,8	30,0	0,0	19,9	17,8	88/25	23,0	85/02	21,7	3,0	16,8	3,3	0,0	0,0	0,0	7,9	5,4	85/25	A
M	26,1	10,5	18,4	15,8	34,3	87/10	31,9	0,0	4,2	21,2	29,2	31,0	0,0	18,5	15,8	90/22	18,5	90/20	16,7	0,0	28,5	14,0	1,0	0,0	0,0	5,8	3,5	89/28	M
J	20,6	5,3	12,7	15,0	28,3	90/01	26,3	0,0	0,0	2,3	18,2	27,8	0,0	14,1	11,2	90/29	15,8	90/02	13,6	0,0	29,8	27,0	15,8	0,0	0,0	1,2	0,0	89/28	J
J	20,7	4,3	12,4	16,3	30,5	85/31	27,6	0,0	0,2	6,0	17,7	28,2	0,0	11,6	10,9	87/21	16,5	87/18	12,0	0,0	30,4	29,6	20,6	0,8	0,0	-0,2	-2,0	86/04	J
A	24,2	6,8	15,5	17,4	33,4	90/27	30,8	0,0	3,2	15,3	25,0	30,8	0,0	16,0	13,6	85/03	17,0	90/08	13,6	0,0	30,6	26,7	8,4	0,1	0,0	2,1	-1,0	85/04	A
S	27,2	10,3	18,8	16,9	39,5	84/30	36,2	3,0	10,1	19,0	27,6	30,0	0,0	18,0	15,0	89/06	19,5	84/29	16,8	0,0	26,1	15,0	0,6	0,0	0,0	4,6	1,0	89/07	S
O	30,1	13,8	21,9	16,3	38,3	86/22	37,0	5,1	17,3	26,3	30,5	31,0	0,0	20,6	18,0	84/05	23,7	85/11	20,7	2,0	19,2	5,5	0,0	0,0	0,0	7,8	5,5	84/08	O
N	33,9	17,7	25,7	16,0	42,3	85/18	40,5	14,3	24,8	28,6	29,8	29,9	0,0	24,0	19,4	89/15	27,3	85/19	24,9	9,9	8,5	0,0	0,0	0,0	0,0	11,4	10,1	90/24	N
D	35,4	19,3	27,3	16,2	46,0	84/31	42,6	18,3	28,6	30,7	31,0	31,0	0,0	27,8	24,0	88/24	28,8	90/28	26,6	12,9	2,6	0,1	0,0	0,0	0,0	12,9	8,5	84/05	D
YR	29,4	13,6	21,4	15,7	46,0	84/31	43,3	97	184	261	328	360	0	11,6	10,9	87/21	30,5	90/02	27,2	77	198	122	46	1	0	-0,3	-2,0	86/04	YR

TABLE 2 - PRECIPITATION (and FOG), DRY- AND WETBULB TEMPERATURES, RELATIVE HUMIDITY and CLOUD COVER

	PRECIPITATION (R mm) P = 5 Years															P = 0 Years				TEMPERATURE (°C)						REL. HUM. (%)					CLOUD			
	MONTH	24 HOUR MAX		TOTAL PER MONTH / YEAR				AVERAGE NO. OF DAYS WITH R (mm) >=								AVE NO. OF DAYS WITH				DRY BULB P = 6 Years			WET BULB P = 0 Years			P = 0 Years					IN EIGHTHS P = 0			
								0,1			1	5	10	30																				
	TOT	RXX	YY/DD	MAX	YEAR	MIN	YEAR	AVE	MAX	MIN						TH	HA	SN	FOG	$\overline{08}$	$\overline{14}$	$\overline{20}$	$\overline{08}$	$\overline{14}$	$\overline{20}$	$\overline{08}$	$\overline{14}$	$\overline{20}$	$\overline{MAX}$	$\overline{MIN}$	$\overline{08}$	$\overline{14}$	$\overline{20}$	
J	2	7	85/12	7	1985	0	1990	0,5	2	0	0,5	0,2	0,0	0,0						24,8														J
F	13	19	89/10	68	1989	0	1988	2,2	6	0	1,8	1,0	0,8	0,0						23,9														F
M	20	40	85/12	41	1985	9	1986	3,0	5	2	2,0	1,0	0,5	0,2						21,7														M
A	15	27	90/21	50	1990	3	1985	3,2	5	2	2,5	1,2	0,3	0,0						17,3														A
M	2	4	85/20	4	1989	0	1990	1,4	3	0	1,0	0,0	0,0	0,0						12,5														M
J	1	5	86/01	6	1986	0	1990	0,5	3	0	0,2	0,0	0,0	0,0						7,3														J
J	2	8	87/18	8	1987	0	1990	0,5	2	0	0,3	0,2	0,0	0,0						6,2														J
A	1	9	86/29	9	1986	0	1990	0,2	1	0	0,2	0,2	0,0	0,0						9,8														A
S	0	2	87/18	2	1987	0	1990	0,4	2	0	0,3	0,0	0,0	0,0						13,9														S
O	7	27	88/31	27	1988	0	1990	1,1	4	0	0,9	0,4	0,1	0,0						18,4														O
N	10	26	89/15	26	1989	0	1990	1,3	4	0	0,9	0,6	0,4	0,0						22,6														N
D	10	23	85/18	62	1985	0	1990	1,0	4	0	0,9	0,7	0,4	0,0						23,6														D
YR	83	40	85/12	172	1985	38	1986	15	24	15	11	5	3	0						16,8														YR

Period = years covering the data for all the columns of both tables. P = Average number of years covering the data in the columns concerned. $\overline{TX}$ = Average maximum, $\overline{TN}$ = Average minimum air temperature
TXX = Highest maximum, MAX = highest in P years. TXN = Lowest maximum, MIN = lowest in P years. TNX = Highest minimum, MAX = highest in P years. TNN = Lowest minimum, MIN = lowest in P years.
$\overline{\ }$ = MEAN = AVE = AVERAGE e.g. $\overline{08}, \overline{14}, \overline{20}$ = MEANS of observations which were made on these hours (SAST). YY/DD = Year/Day of occurrence of the extreme in the previous column.
(Number of days (NOD) with TX >= 10) = (NOD in the month - NOD with TX < 10). TH = Thunder, HA = Hail, SN = Snow, FOG = fog. > signifies greater than, >= signifies greater than or equal to.
(Number of days (NOD) with TN < 20) = (NOD in the month - NOD with TN >= 20). < signifies less than, <= signifies less than or equal to.

1.7 WIND SPEED AND DIRECTION FOR THE UPINGTON WEATHER STATION

(Source :*Climate of South Africa. Surface Winds. WS43.* South African *Weather Service. Pretoria. South Africa.)*

1. Introduction

Initially, the measurements of wind speed and direction in South Africa have been carried out using the Dines anemograph, placed at elevations between 10 and 15 metres. This changed, however, with the advent of automatic weather stations since the late 1980's, when the R M Young electronic wind sensors have also been installed. As a result, most stations with long records have data forthcoming from both measuring devices. Data from the relatively new automatic weather stations have maximum record-lengths of about 14 years and more at present. While this can be considered a relatively short period of data, it is still useful for the determination of average wind conditions, while a more ideal spatial distribution of data is also obtained.

2. Annual variation of wind direction

Wind roses for The Upington weather recording station, showing the relative wind frequency from 16 directions, classified in certain velocity intervals. **These are given for the months January, April, July and October representing summer, autumn, winter and spring respectively**.

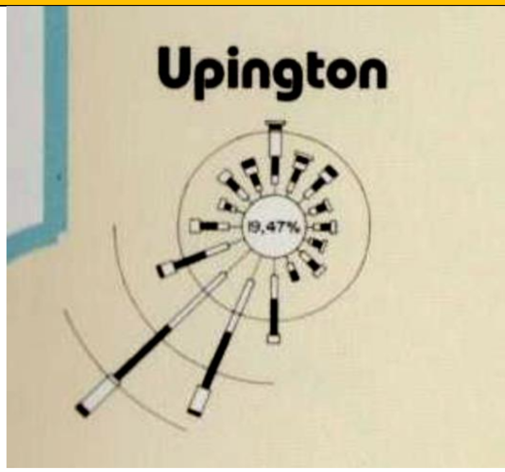
The wind roses for Upington show a marked change in wind direction from one season to another. In the north-western interior, e.g. **Upington, winds are mainly from the south-west during summer and from the north during winter.**

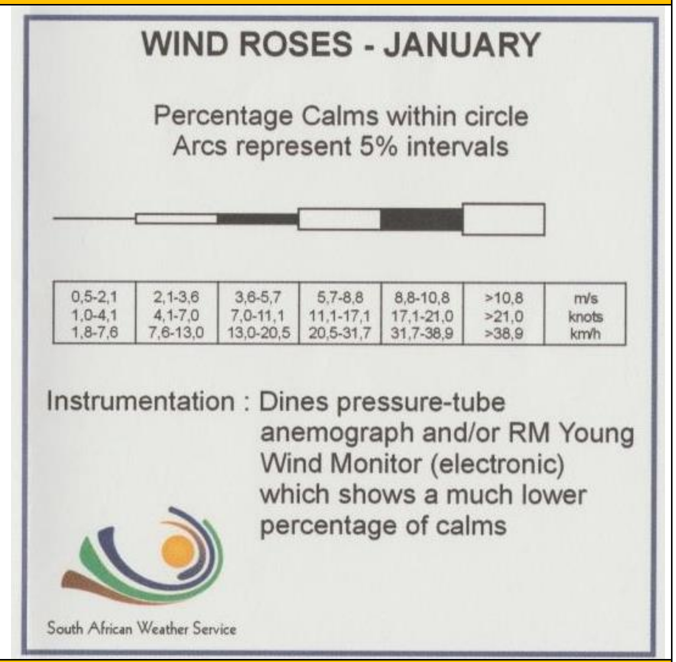
3. Mean wind velocity for each direction

From the wind data examined, it seems **that the strongest winds do not necessarily coincide in direction with the prevailing wind**. This is particularly true over the interior where winds from the south-west, although infrequent, very often are the strongest. This is due to the fact that very strong southerly to south-westerly winds of short duration are almost always associated with thunderstorms. In coastal regions the directions of strongest winds coincide with the most frequent winds, possibly because the direction of winds there are not as variable as in the interior.

JANUARY

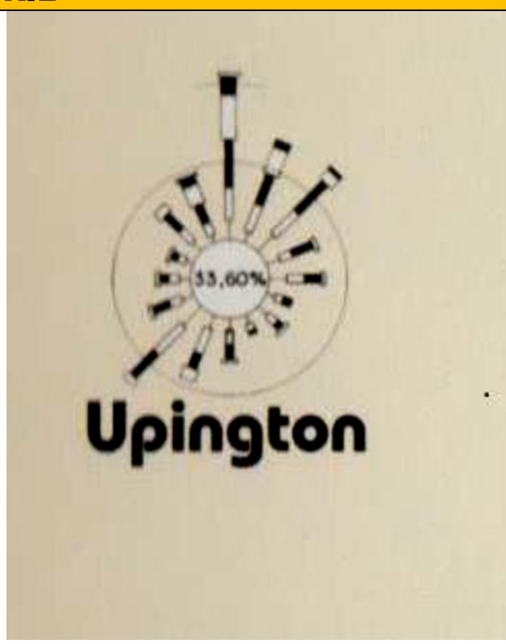
1

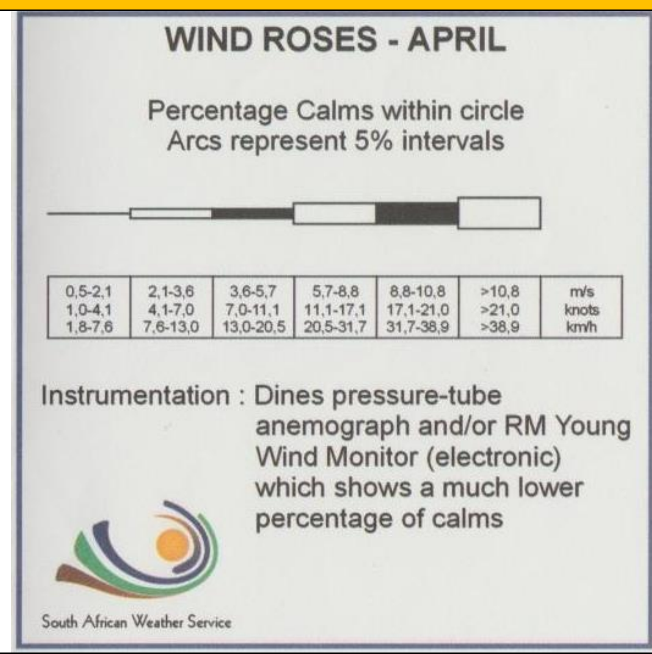




APRIL

2





JULY

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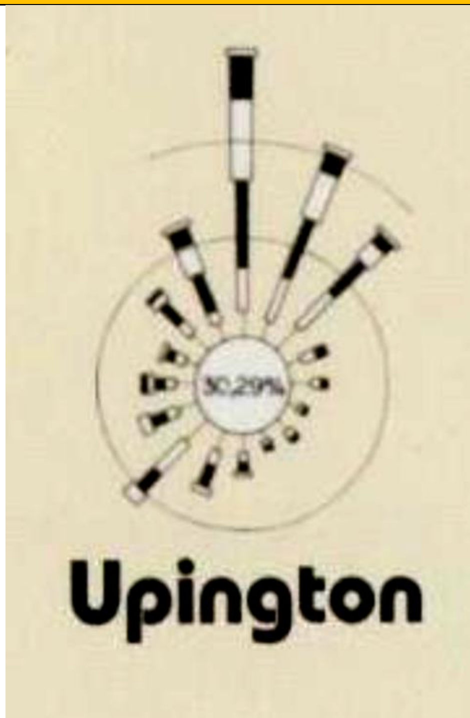
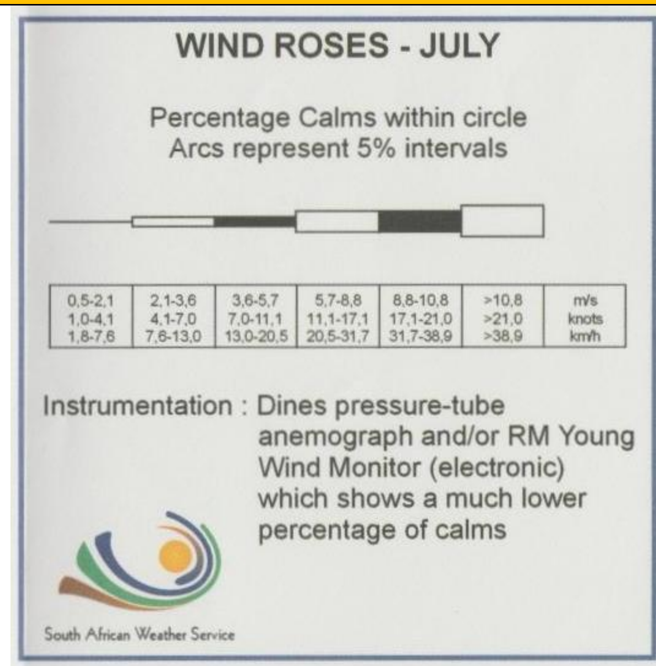
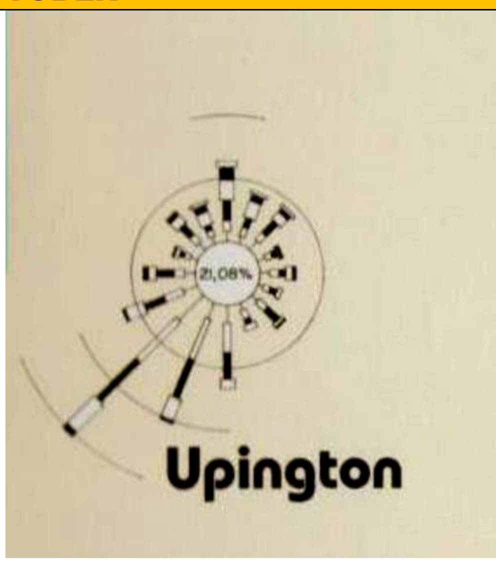
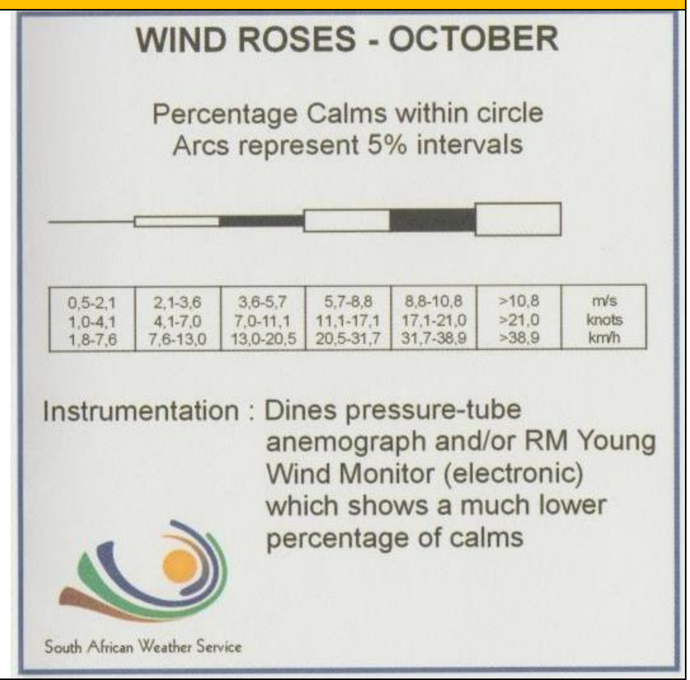


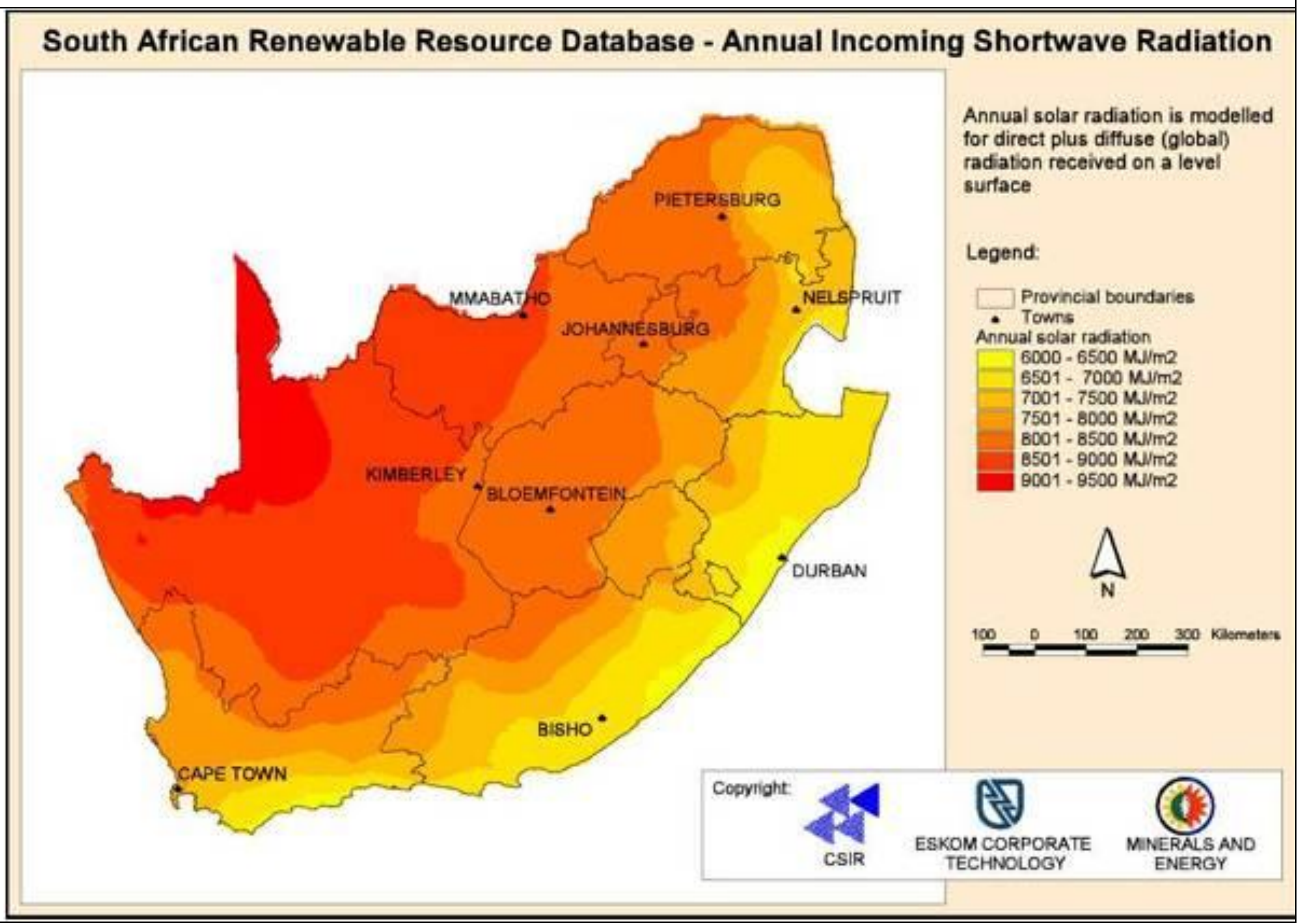


OCTOBER

4





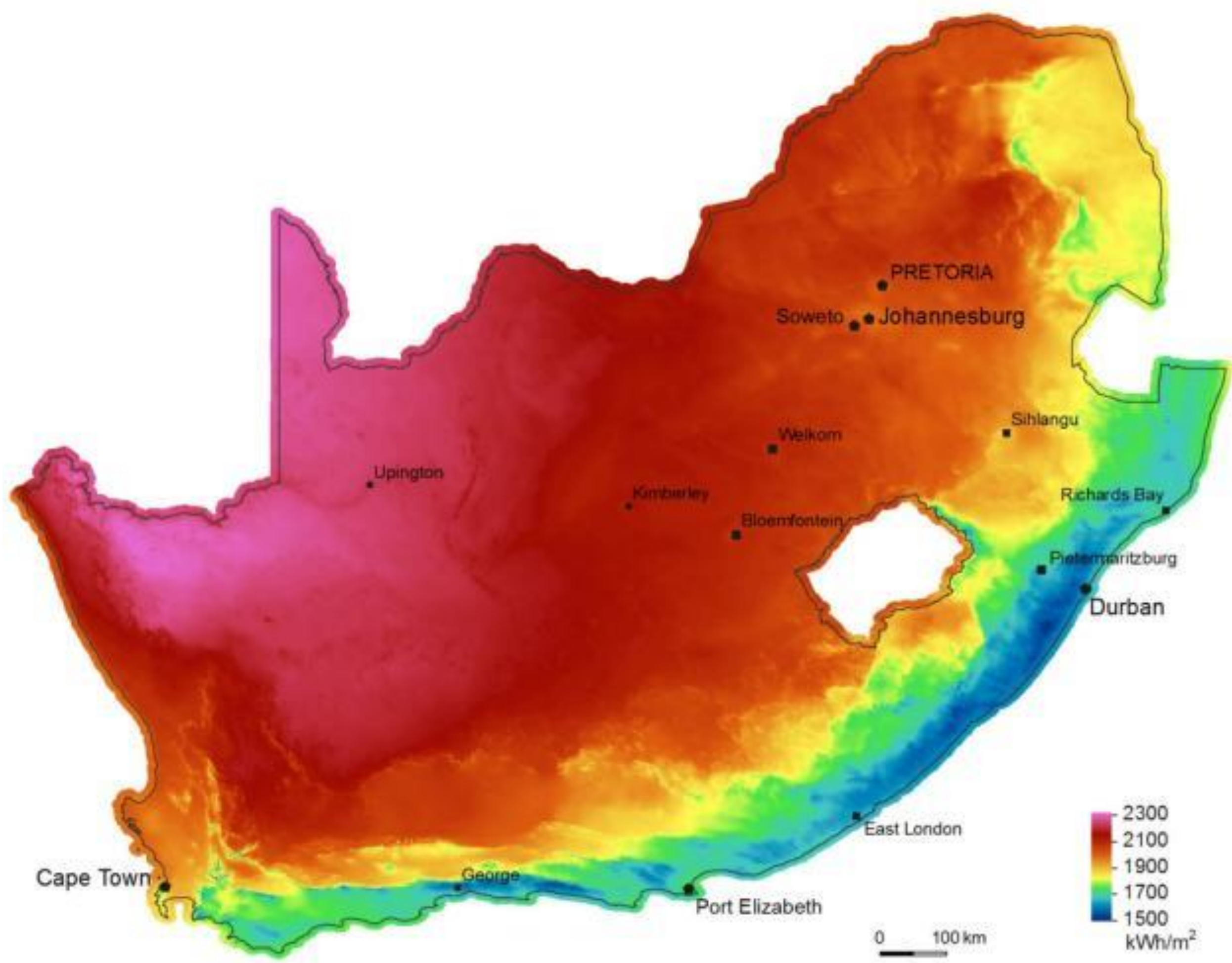
1.8	**State of Renewable Energy in South Africa 2015 (Dept. of Energy)**
1.8.1	**South Africa is fortunate in that, over and above its rich coal resources, it is also well endowed with non-depletable RE sources, notably solar and wind. The country has an average of more than 2,500 hours of sunshine per year and average direct solar radiation levels range between 4.5 and 6.5kWh/m2 per day, placing it in the top-3 in the world.**
1.8.2.	Solar potential knowledge base for strategic decision making Solar power technology is weather dependent. A thorough understanding of climate of a region is a good starting point for strategic decisions relating to development of solar projects. A generic solar resource map may not show a complete picture. A detailed analysis of solar resource, meteorological, geographic data and PV power potential help identification of the most suitable locations for deployment of solar power plants. The analysis considers uncertainty of resource estimates, occurrence of extreme climatic conditions, seasonal climate variability, as well as geographic limitations on deployment of solar plants. Regional solar energy potential study is a base for defining strategies made by governments, investors and project developers.
1.8.3	

1.9	DESCRIPTION OF THE SOLAR RESOURCE
1.9.1	**SOLAR DATA FROM THE DEPARTMENT OF ENVIRONMENTAL AFFAIRS**

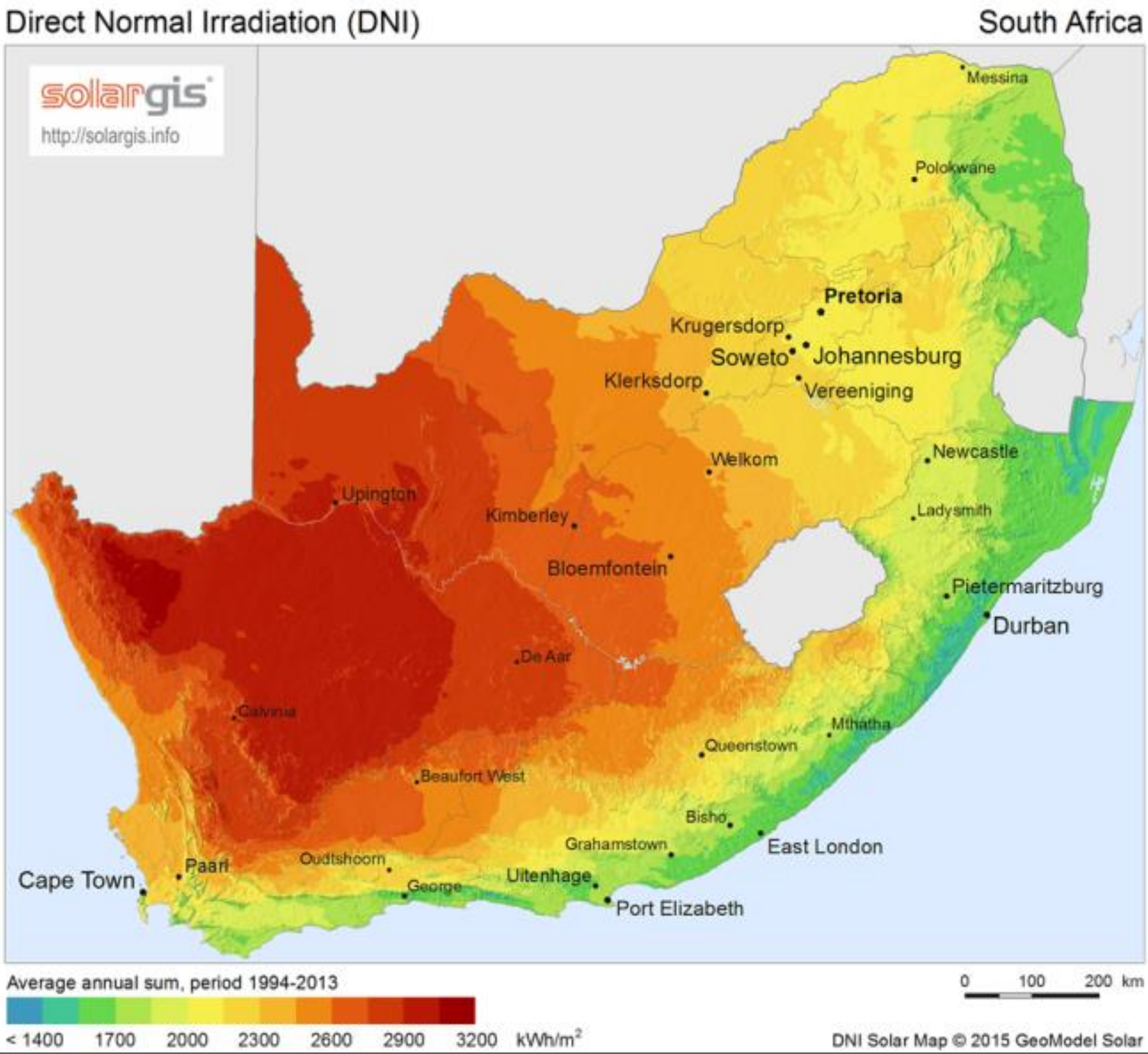
The Department of Environmental Affairs obtained an open license from GeoModel Solar to make the following digital maps available for public use provided the source is always acknowledged.

The digital maps are: Name	Raster data set	Description
Global Horizontal Irradiance:- **MAP 2.1**	SolarGIS_GHI_South_Africa	Global Horizontal Irradiance (GHI) is the total amount of shortwave radiatio received from above by a surface horizontal to the ground. The Global Horizontal Irradiance (GHI): solar irradiance dataset in units of kWh/m2/annum with high resolution. Resolution 250m x 250m.

Source: SolarGIS map © 2013 GeoModel Solar.

MAP 2.1	**Global Horizontal Irradiance:** SolarGIS_GHI_South_Africa Global Horizontal Irradiance (GHI) is the total amount of shortwave radiation received from above by a surface horizontal to the ground. The Global Horizontal Irradiance (GHI): solar irradiance dataset in units of kWh/m2/annum with high resolution. Resolution 250m x 250m.
	

1.9.2	New solar resource maps for South Africa
	High quality measured solar data is available in the public domain for the _rst time Written by Centre for Renewable & Sustainable Energy Studies on 20 July 2016 Stellenbosch University, in cooperationwith GeoSUN Africa and GeoModel Solar, this week released updated solar maps for South Africa. The German Government, through their development agency the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), made funding available for this task, as well as to install six radiometric stations in South Africa, in areas where high accuracy ground measurements were not available.Solar resource data from these stations as well as other stations were used by the Slovakia-based company GeoModel Solar to update the existing SolarGIS satellitederived solar resource database, from which these maps are constructed. This week, two maps were released, showing Direct Normal Irradiation (DNI) and Global Horizontal Irradiation (GHI). The DNI map is used by developers of CSP (concentrating solar power) thermal power stations as well as CPV (concentrating photovoltaic) power stations to evaluate the available resource in an area for their technology. The highest DNI predicted in South Africa is now 3 200 kWh/m2 per annum in the Northern Cape. The accuracy-enhanced database shows DNI values higher, up to 10% in some areas, compared the previous database, positioning South Africa as an excellent candidate for CSP power stations. The updated yearly GHI is also higher at about 3%, confirming vast and unique potential for photovoltaic (PV) power. This is the _rst time in the history that such a large number of high-quality ground-measured data sets were used to update the satellite-based solar maps in Africa. Up to fourteen radiometric station's data were used, from Durban and Vryheid in KwaZulu/Natal, to Port Elizabeth, Graaf-Reinet, Vanrhynsdorp, Sutherland and Stellenbosch in the Western and Eastern Cape to Bloemfontein, Aggeneys and Upington in the Northern Cape and Free State. In the northern part of the country, data from Sasolburg, Pretoria and Lephalale were used. The maps will be available on the website of the Southern African Universities Radiometric Network (http://www.sauran.net/) (SAURAN). This network consists of 12 radiometric measurement stations in Southern Africa and on the island of Reunion equipped with top-class instrumentation to measure solar irradiation and other meteorological parameters. The measured data and the new solar maps are made publically available on the SAURAN website, for free download. "This is the _rst time that high quality measured solar data is available in the public domain. This is a great example how foreign public funding can support the important solar energy industry in South Africa" said Dr Soeren David, Progamme Manager of the South African – German Energy Programme who funded the project. The main purpose of making the data available is to promote the use of solar energy in SADC countries and to improve the accuracy of satellite-derived solar data available for the area. The purpose of placing the maps in the public domain is to make it possible for industry and public to assess the solar resource at any site of interest in the country. By providing accurate information the maps support cost-e□ective decision-making already in the preliminary stages of a solar power project development. Once an area and a technology is identi_ed, a more detail assessment is required. This is usually based on a full analysis of more than 20 years of history of satellite-derived solar data, available for the region through GeoSUN Africa. "Reducing uncertainty of solar resource data is one of the imperatives to make solar energy less expensive and more effective. Satellite-based models and ground measurment stations are two pillars of monitoring infrastructure that guarantee sustainable quality of solar data", said Dr Marcel Suri, Managing Director of GeoModel Solar. Prof Wikus van Niekerk, the Director of the Centre for Renewable and Sustainable Studies (CRSES) at Stellenbosch University, said: "These new maps come at a very opportune time in South Africa as there is a lot of interest from companies, farmers and individual home-owners to install rooftop PV systems. With the current prices of PV systems and the cost of electricity charged by most municipalities it is now less expensive to generate one's own electricity from photovoltaic modules". The long-term effort and

<table>
<tr><td></td><td>focused collaboration on this project between the different universities, GeoSUN Africa, GeoModel Solar and the GIZ made this project success. We also thank those companies who contributed data to develop these new maps, including Eskom, Sasol, Exxaro and Ripasso. The new maps and the SAURAN network will continue to add value to the Southern African solar energy industry and research community for many years to come.” Maps can be downloaded from the CRSES website (http://www.crses.sun.ac.za/research-publications</td></tr>
<tr><td>MAP 2..1</td><td>
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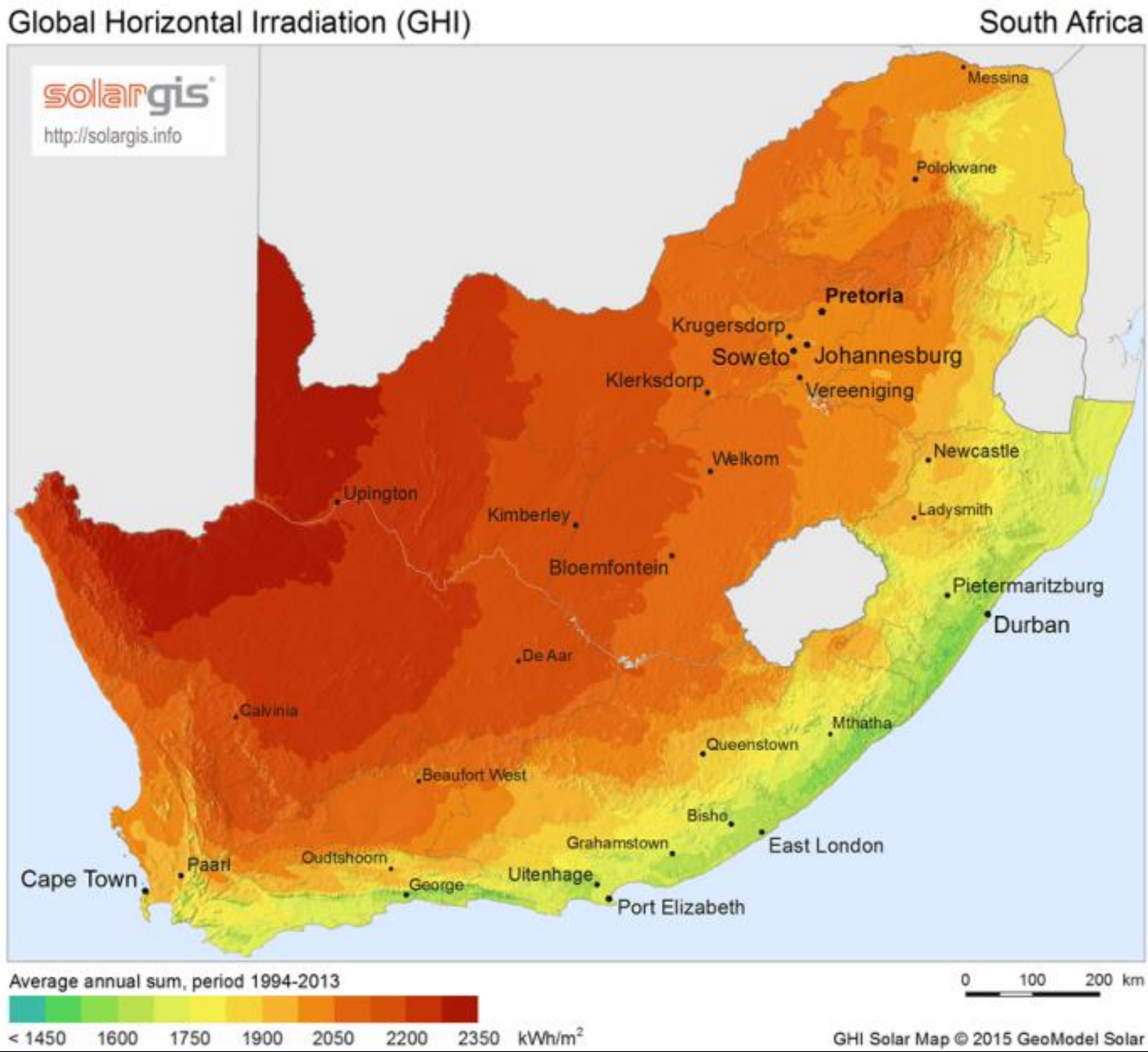
MAP 2.2



Global Horizontal Irradiation (GHI)
South Africa
solargis
http://solargis.info
Messina
Polokwane
Pretoria
Krugersdorp
Soweto
Johannesburg
Klerksdorp
Vereeniging
Newcastle
Welkom
Ladysmith
Upington
Kimberley
Bloemfontein
Pietermaritzburg
Durban
De Aar
Calvinia
Mthatha
Queenstown
Beaufort West
Bisho
East London
Grahamstown
Oudtshoorn
Paarl
Cape Town
George
Uitenhage
Port Elizabeth
Average annual sum, period 1994-2013
< 1450 1600 1750 1900 2050 2200 2350 kWh/m²
0 100 200 km
GHI Solar Map © 2015 GeoModel Solar

Appendix A	Curriculum vitae (F.J.Erasmus)

CURRICULUM VITAE

PERSONAL DETAILS:

APPLICANT: FREDERIK JOHANNES ERASMUS (FRIK)

ID NO: 641031 5016084
MARITAL STATUS ; Married

Details of spouse:
Name: Margaretha Johanna Erasmus (Professional Social Worker)
Date of Birth: 1969-05-08

Dependants: Wife and 3 children
Nationality: South African citizen

OCCUPATION:

Research Scientist (Geographer), Teacher (Geography),
Principal Environmental Officer, Group Environmental Co-ordinator,
Environmental consultant (Environmental Management, etc.).

Address:

5 Bloem Street
Mierderpark
Potchefstroom
2531

Cell: 082 460 8934

E-mail: sumsar@worldonline.co.za

1) <u>QUALIFICATIONS:</u>

1	**ST.10 MATRIC CERTIFICATE** (Geography (HG), Biology (HG), Physical science(HG), Mathematics(HG), Afrikaans(HG), English (HG)).	1982	Dr. Malan Meyerton
2	**B.Sc** (Geography , Botany , Soil Science, Zoology, Chemistry, Statistics, etc.)	1985	P.U.for C.H.E
3	**Honn. B.Sc** ((Physical geography),Geomorphology, Hydro-geography, Climatology, Agricultural geography, etc.) Project: ***"Die verband tussen reënval in Januarie en Februarie en die Mielieproduksie in die Potchefstroomse Landrosdistrik."*** (Statistical analyses of climatic data versus maize production data for the magisterial district of Potchefstroom).	1986	P.U.for C.H.E
4	**M.Sc " The Geomorphology of a section of the Mega-Kalahari)** ABSTRACT: From this study it is clear that the Mega-Kalahari experienced various dry and wet climates in geological time. These variations in the climate manifest in the geomorphology, which is associated with a desert climate. The Mega-Kalahari also been influence by wet climate conditions, as is indicated by the presence of drainage features, such as rivers and pans. The Mega-Kalahari is the result of weathering, sedimentation and the redistribution of sand and alluvium in the Mega-Kalahari basin. It is clear from the study that the interpretation of Landsat imagery **(remote sensing using satellite imagery)** can be effectively used in geomorphological studies. It must, however, be supplemented by the use of small scale **aerial photography.**	1991	P.U.for C.H.E

5	**M.Sc (Environmental Management and Analyses)** ***(See Geography & Environmental studies)*** **Project:** **AN ENVIRONMENTAL MANAGEMENT SYSTEM FOR HIKING TRAILS IN THE GOLDEN GATE HIGHLAND NATIONAL PARK** (Physical field work, erosion studies, Compilation of ISO14000 Environmental Management System, Environmental management programme, Environmental legislation, Rehabilitation, Mapping, Technical drawings, statistical analyses, etc.)	**1997**	**P.U.for C.H.E** *(Now known as the NWU)*
	ABSTRACT: The type and extent of the physical deterioration (erosion) of the hiking trail/ rock type associations in the Golden Gate Highland National Park and the possible reasons for the deterioration are clear from the results of the empirical study. Erosion can be directly attributed to the influence of the hikers' walking action. The extent of erosion varies between different hiking trail/rock type associations. Through a correlation analysis between erosion values and certain topographical variables, ideal sampling points were identified and the results can be used as criteria for the future planning of hiking trails. Differences between the field and path measurements for plant nutrient status, textural composition and soil compaction, are clear evidence of the physical deterioration of the hiking trails that can be directly attributed to the influence of the hikers. Physical limitations experienced by the hikers can also contribute to the increase in the erosion of a particular trail section. Current measures to stop erosion are not adequate. Therefore certain suggestions are made. The installation of a permanent walking path segments could be a solution. **In** order to stop or mitigate any further deterioration of the hiking trails in the Golden Gate Highlands National Park and to prevent other negative environmental influences, an environmental management system has to be implemented by the Park management. The implementation of an environmental management system will ensure a balance between recreation and conservation.		

2) OTHER RELEVANT COURSES COMPLETED:

1	Short course in Environmental Management	P.U.for C.H.E (NWU)
2	Course in Water Quality Management in Industry and Mining	University of Pretoria
3	Using Satellite Imagery to get more from GIS	CSIR
4	Basic Principles of Ecological Rehabilitation and Mine Closure	Centre for Environmenta l Management (NWU)

Note: Proof of certificates could be provided if requested.

3) PREVIOUS WORK EXPERIENCE:

1) Work as a student every university holiday	Municipality of Meyerton (*Working with the Mr. Everson (accountant) and Mr. J. Jacobs (internal auditor, etc.)*)	1983-1986
2) Researcher	47 Terrain Evaluation Unit	1987-1988
3) Research Scientist (Geographer)	Dept. of Botany and Soil Science (P.U. for C.H.E). *(Dept. of Bodemkunde)_*	1989-1993
4) Teacher (Geography) (Grade 8-12)	Hoërskool Oosterland (Secunda) Temporary Geography post. Registered at the TED as a teacher.	Sept.-Des 1993
5) Principal Environmental Officer	Directorate Mine Rehabilitation (HQ in Pta) Northwest-Regional Office	1994-97 1997-2001
6) Group Environmental Co-ordinator	Durban Roodepoort Deep Ltd. (HQ).	2002 up to 2004.
7) Environmental Consultant/ specialist	*F.J.Erasmus trading as* Celtis Environmental Solutions	2005-current

Total: 29 years

4.1) Research Scientist	Dept. of Botany and Soil Science (P.U. for C.H.E).	1989-1993

PROJECTS:

- **Geomorphology of a section of the Mega Kalahari**
- (Remote sensing, Landsat imagery, classification of geomorhological landscape features, indicating relationship between current and paleo-climatic conditions, stabilization of dunes with vegetation, soil development, sand drift potential, aeolian and fluvial processes , active and paleo-dune fields, pans , rivers)

- Report on the **Geographical features of the Northern border** of Southern Africa.

- Compilation of a **terrain-geomorphological map of Namibia** (using Landsat satellite imagery and topographical maps.)

- Determination of the **erosion potential of various types of asbestos** by means of rainfall simulator study (for Prof. Kobus van der Walt, Dept. of Geography and Environmental studies).

- Determination of the **influence of vermiculite** with regard to run-off and infiltration on different types of soil (for the Institute for Reclamation Ecology).

- Determination of **nano-relief features on selected pre Karoo slopes** (with reference to possible application within **vehicle mobility studies** for Gerotek).

- **Comparative analyses of terrain roughness** and the classification of 2 rock types by using a terrain roughness wheel meter in conjunction with Gerotek.(for Mr. J.M. Hattingh, Dept. of Botany & Soil Science).

- Inputs with regard to slope analyses, drainage, geology, topography and climate within the Soil report for the Gutshwa study area in Kangwane.

- Field studies with a mobile rainfall simulator. Results presented as part of a poster presentation in conjunction with Dr. Koos Henning, titled:" The correlation between soil- and vegetation degradation in the semi-arid grasslands."

- Presenting practical classes with regard to **map reading and remote sensing.**

- Assisting during **soil surveys** (Mr. Koos Pauer, Dept of Botany and Soil science).

4.2) Principal Environmental Officer	Directorate Mine Rehabilitation (HQ in Pretoria) & Northwest-Regional Office, Sub-Directorate Mine Rehabilitation	1994-97 1997-2001

PROJECTS:

- Investigation with regard to the **Rehabilitation of Waste Rock Dumps** at the Palabora Mining Company.
- Investigation with regard to **alternative rehabilitation methods** in order to mitigate the dust problem at a slimes dam at the Prieska Copper mine.
- **Investigation towards environmental auditing and monitoring in the mining sector.**
- **Compilation of the Strategy on environmental auditing and monitoring for the mining sector.**
- Compilation of the **audit procedure guideline** for the mining sector.
- Investigation towards the need for **environmental management systems** within the mining sector.
- Comparative investigation with regard to **gold slimes dams, waste rock dumps and rehabilitation methods**.
- **Recommendation and development of an environmental course for DME officials. Compilation of the study plan.**
- Also involved in the development and presentation of **orientation course for environmental officers.**
- Compilation of the **standard EMP's** for prospecting, the dimension stone industry and waste rock crusher operations.
- Investigation with regard to Granite mines (rehabilitation, etc).
- Investigation towards **definitions** for environmental management and rehabilitation.
- Investigation towards **relevant legislation** with specific reference to the environment, **since 1893**.

- Investigation towards the establishment of an **environmental management information system.**
- Investigation towards the compilation of **guidelines with regard to environmental monitoring.**
- Investigation towards **alternative strategy** with regard to environmental management in the **small scale mining sector**.
- Investigation towards the **use of remote sensing as a important tool** with regard to **monitoring of gold slimes dams**.

DUTIES AS THE PRINCIPAL ENVIRONMENTAL OFFICER (NW REGIONAL OFFICE):

- **Handling of the EMP approval process (Minerals Act, 1991).**
- **Terrain visits and recommendations with regard to compilation of EMPR's for prospecting and mining activities.**
- **Inputs given with regard to EMPR's during State department consultation meetings with consultant and mining company.**
- **Evaluation and recommendations with regard to EMPR documents.**
- **Consultation with all relevant state departments , such as DWAF, NDA, DEAT, etc.**
- **Evaluation of financial provision for rehabilitation and implementation of the EMP (Part 6).**
- **Conducting various field investigations with regard to particular issues/complaints pertaining to environmental management, rehabilitation, pollution, etc. Compilation of reports with recommendations (corrective actions). ETC.**
- **Conducting regular inspections.**
- **Attending mine environmental management forum meetings.**

4.5) Group Environmental Co-ordinator	Durban Roodepoort Deep Ltd.	2002 up to 2004.

Duties as the ENVIRONMENTAL CO-ORDINATOR:

- Compilation of **ENVIRONMENTAL MANAGEMENT PROGRAMMES** (DRD NW OPERATIONS, Blyvooruitzicht addendum to the EMP with regard to reclamation of slimes dams and the expansion of an existing operational slimes dam. Liaison with authorities and consultant for specialist studies).
- **EMP Auditing (EMPPA) and inspections**
- Compilation of **strategy and guideline documents** with regard to **rehabilitation of gold slimes dams and opencast mining activities**.
- **Monitoring** of rehabilitation **contract work**.
- Determination of **rehabilitation project cost estimates**.
- Compilation of a **Strategy for waste management** at the Blyvooruitzicht mine.
- Various environmental investigations and recommendations.

4.6) Environmental consultant	Celtis Environmental Solutions	Since 2005 & Still active

Duties as a ENVIRONMENTAL CONSULTANT (CELTIS ENVIRONMENTAL SOLUTIONS):

- **Compilation of EIA/EMP's for various mines like** :
- Goldfields (Kloof,Libanon, Leeudoorn mine), Crown mines, Hemic Ferrochrome, Assore (Wonderstone, Rustenburg Minerals, Zeerust Chrome), etc.
- Kelgran granite , Xstrata Chrome and various prospecting activities for EES.
- Diamond mines, diamond prospecting activities, reclamation of slimes dams at Machavi mine, various sand mines, granite & marble mines for DERA) , etc.
- Compilation of EIA/EMP's for various diamond mines (Koppie-Alleen, etc.) , Middelvlei Gold prospecting operation, Project proposal for an integrated water management plan for Kao mine, etc. (for the CEM).
- Compilation of Scoping reports, EIA/EMP's for slimes dam operation at Rievly silica, and Witfontein slimes dam complex (Mintails) as part of the Fraser Alexander project team.
- Conducting various EMPPA audits, construction audits, etc., for Mine waste solutions, Crown mines, Hernic Ferrochrome, DERA, GCS, etc.
- Compilation of rehabilitation cost estimate reports on a annual basis for Crown, various diamond mines (DERA), etc.
- Compilation of closure documentation for various opencast mining operations at Samancor Buffelsfontein, Hemic Elandsfontein, Lafarge Lichtenburg, Crown (Fleurhofdam) reclamation operation, etc.
- Compilation of NEMA Basic Assesment reports for diesel tank facilities. Compilation of 24G reports for cattle feedlots.
- Compilation of the Golfields Kloof Mine Environmental Disaster Management Framework.
- Land use survey along the Leeuspruit, Kariegarivier(with special reference to water use)(for Goldfields Kloof mine).
- Land use survey along the Wonderfonteinspruit, Kraalkopspruit (with special reference to water use)(for Goldfields Driefontein mine).

- **Land use survey along the Theronspruit, Boschluisspruit (with special reference to water use)(for Goldfields Beatrix mine).**
- **Compilation of hazardous substances inventory. Environmental hazard classification and indicating specific handling requirements/operational procedures (for Driefontein mine).**
- **Conducting the GN704 audits (for the DWA) for ERGO operation.**
- **Conduction the Tlokwe Waste Landfill Permit Audit.**
- **Compilation of various NEMA BAR/EMP Reports for DERA for sand and granite operations.**
- **ETC.**

Note: Proof of projects/documents could be provided if requested.