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Temperature and Short- wave Irradiation Trends in Ikogosi Climatic Change Pattern

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Abstract. Every living or non-living thing has its unique temperature consequent of absorption of electromagnetic radiation, light. The source of this molecular kinetic is Solar energy incident on Earth's surface, the sole supplier of life on the planet. This phenomenon markedly determines the climatic conditions in our habitat. Atypical of previous much-required characteristic balance in nature, myriads of surface processes, ranging from evaporation, photosynthesis and even terrestrial carbon uptake effects are becoming altered in nature. These effects on long-term timing of events defines global warming, it distinguishes the diurnal from seasonal course of surface temperatures and shortwave radiation which contains larger quantity of energy and longwave radiation which holds less amount of energy. Earth's emitted longwave radiation, also has major practical implications on solar energy technologies, agricultural productivity, profound environmental, societal, and economic implications. There is cumulative evidence that the volume of solar radiation incident on the Earth's surface is not constant but experiences substantial decadal variations. In view of the certainty of unpredictability of these climatic changes, a positive recourse lies in utilizing these enormous natural forces to solve Man's energy crisis challenge. Thus, this study uses meteorological data from MERRE to investigate the prospect of shortwave radiation in Ikogosi SW Nigeria and its implications technologically and environmentally in the future of energy prospecting first locally, and on a spatial scale.

1. Introduction

The greenhouse effect is deep-rooted on amplified absorptions of greenhouse gases, such as CO_2 [1]. The effect of this is a direct reduction in the amount of outward-bound longwave radiation to space. Consequently, this energy amasses in the climate system giving rise to the warming of the planet [2]. Although several climatic models on CO_2 explain global energy accumulation as being a product of an upsurge in absorbed solar radiation, this merely gives a broad understanding of the specific [3]. In general, conservation of Global energy is prerequisite for understanding Earth's climatic changes especially in the wake of safety of lives and economic losses. This calls for reckoning, beginning with diverse discrepancies in atmospheric composition that bring about left-over energy imbalance at the top of atmosphere to drive global warming, and ultimately to part of this radiation that is left to sink in the world ocean as artificial lake for energy build-up [4]. The sun gives off shortwave radiation from its tremendously hot temperature. This short wave gets transmitted as either ultraviolet rays, characteristic of sunburn and visible light [5]. Once in the Earth's atmosphere, clouds and the surface of the Earth absorb the radiation, the ground surface gets warm and in turn re-emits this energy as longwave radiation in the form of infrared rays. Most of the Sun's incident light is absorbed while some is reflected, the effect determines a good or bad World food harvest and comfort in our environment [6]. In another perspective, bodies of open water are repositories of virtually all the sunlight dropping on them. Thus, the depth of infiltration of absorption is determined by both the wavelength of the light and optical properties of the body of water. These optical properties and solar attenuation are influenced by the density of the water, either on account of its sedimental composition or plankton, this affects the volume of aquatic food available annually [7]. In temperate regions, Albedo effect of fresh snow has about the highest value amongst all-natural substances on the land, in reflecting over 80% of solar radiation, this accounts for differences in crop production, architectural designs of houses and energy usage relative to the tropics [8]. Lush foliage absorbs powerfully in the visible spectrum, but reflect in the near-infrared range, and dormant flora reflect up to 25 % of visible light, while sand in the desert can reflect as much as 40% of total incoming shortwave radiation, this provides crucial information to Engineers, Medical Scientists and Economists in developing fiscal policies [9]. Bringing these facts together, transpiration, the process whereby Plants lose water vapor through the course of taking carbon dioxide from the atmosphere is affiliated with photosynthesis. This describes the positive solitary use of carbondioxide in the entire ecosystem. As foliage repetitively adjusts the production of biomass against environmental stresses of temperature, sunlight, and water availability, a measure of stability can be attained in the erratic weather conditions [10-11]. In addition, altitudinal differences bring about progressive variations in Earth's radiation budget owing to reflectivity of land and other surfaces. This thereby creates huge possibilities for the surface energy balance and the distribution of surface heating in mountainous areas, which is the prospect this research seeks to investigate from Ikogosi perspective.

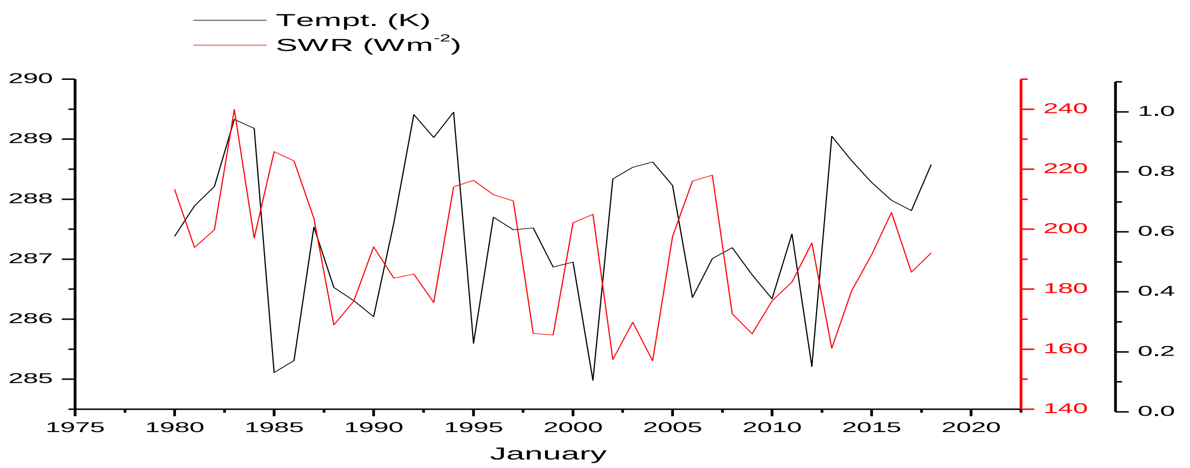
2. Methodology

In order to obtain the relationship between diurnal temperature and short-wave irradiation, average monthly temperature (K) and incoming shortwave radiation (W m^{-2}) data were obtained for Ikogosi for thirty-eight years. The pattern for this duration of time symbolizes a characteristic pattern in the source data obtained from MERRE, and plotted with software programs to elicit the direct correlation between the two afore-mentioned parameters. Details of further analysis required for actualizing the set objective in this study was actualized with curve fitting regression analysis and analysis of variance (ANOVA) with ORIGIN software. This clearly depicted variational trends in Earth's radiation budget for all the months of the year as stipulated by the curves, significant for interpreting future climatic trends in Ikogosi SW Nigeria.

3. Results and Discussion

3.1. Temperature Vs SWR Plots

4. In Figure 1, a notable pattern is observed all through the months of the years for which this study is carried out. SWR shows a tendency of being equal or even higher than the surface temperature of the atmosphere. This is especially true for May, June, November and December. This results in the following aftermaths, bulk surface temperature which is higher than skin layer temperature. There is high cloud cover producing a high volume of condensation. In order to explain the reason why SWR is higher than the temperature, a seeming deviation from conservation principles, it is imperative to employ the albedo effect. This is a tendency in which Ikogosi experiences high reflection of solar radiation from its landmass. Eventually, more of this incident radiation is returned to space, and Ikogosi surface temperature drops. There are several points of intersection between the two parameters, these are initial protrusion of turbulence which balance off at the points. They are short-lived for all the months of the year, to create the energy equilibrium nature requires for balance.


Tempt. (K)
SWR (Wm^{-2})
290
289
288
287
286
285
240
220
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140
1.0
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0.6
0.4
0.2
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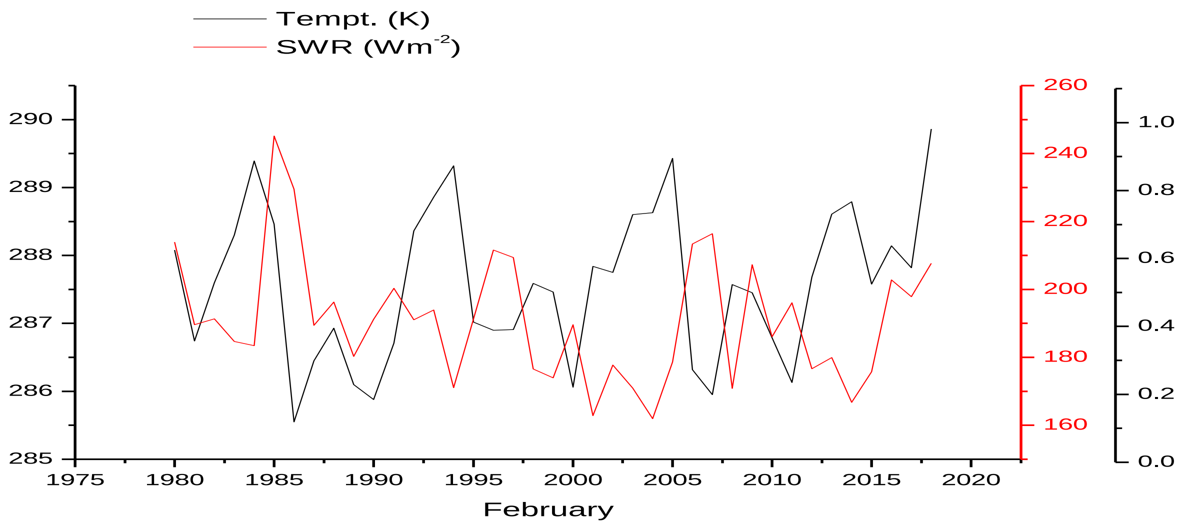
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
January


Tempt. (K)
SWR (Wm^{-2})
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260
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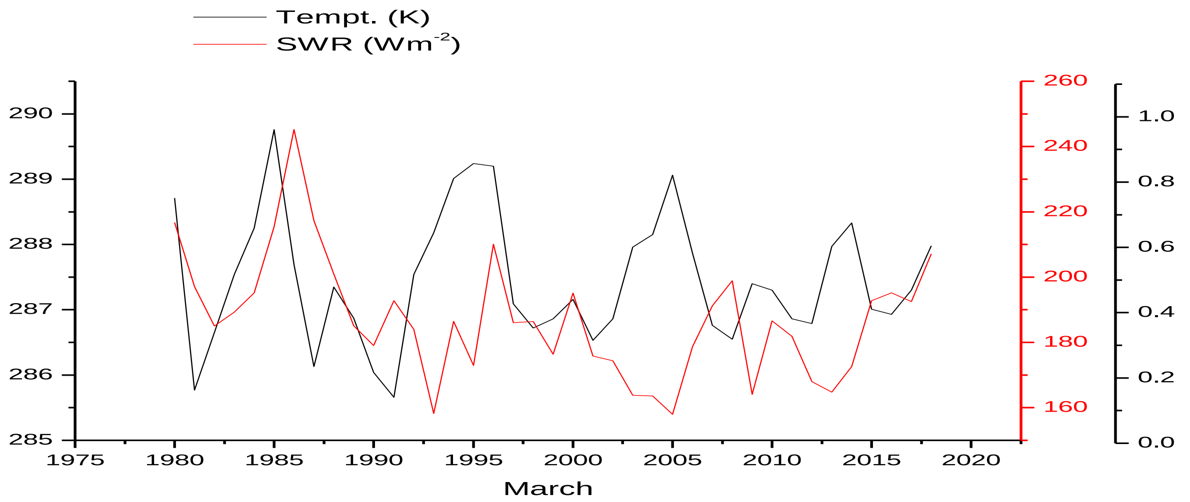
February


Tempt. (K)
SWR (Wm^{-2})
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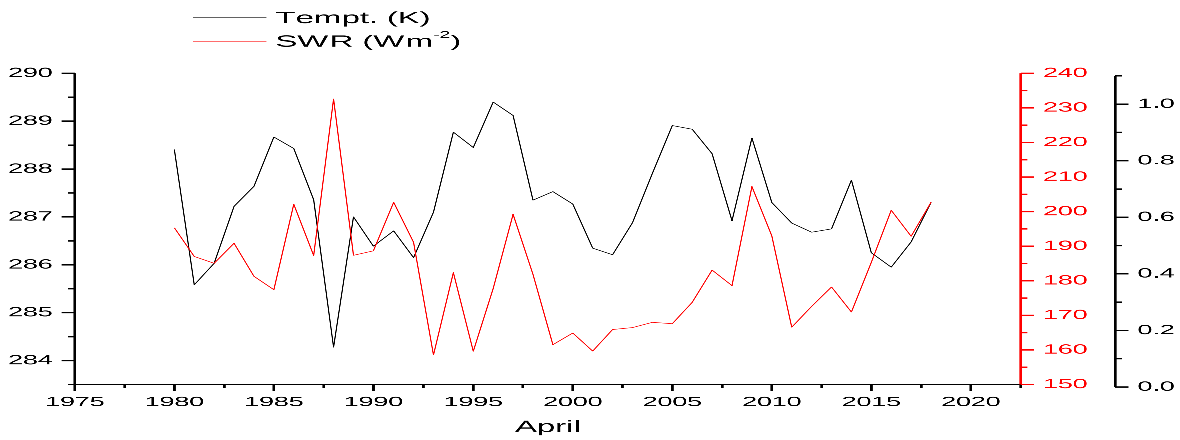
March


Tempt. (K)
SWR (Wm^{-2})
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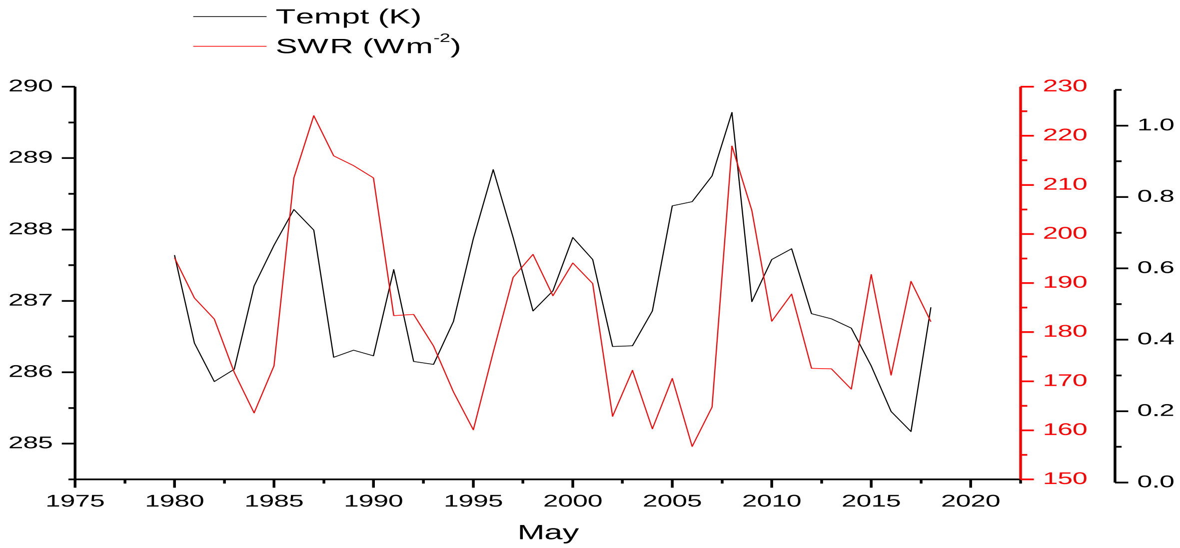
289
288
287
286
285
284
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
April
240 230 220 210 200 190 180 170 160 150
1.0 0.8 0.6 0.4 0.2 0.0


Tempt (K)
SWR (Wm^{-2})
290
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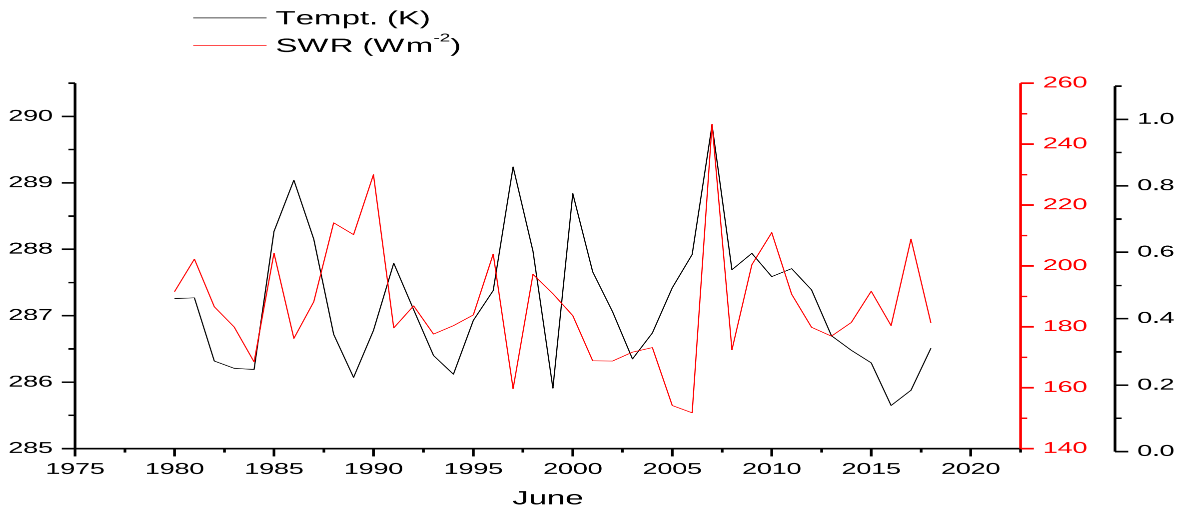
285
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
May
230 220 210 200 190 180 170 160 150
1.0 0.8 0.6 0.4 0.2 0.0


Tempt. (K)
SWR (Wm^{-2})
290
289
288
287
286
285
1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
June
260 240 220 200 180 160 140
1.0 0.8 0.6 0.4 0.2 0.0

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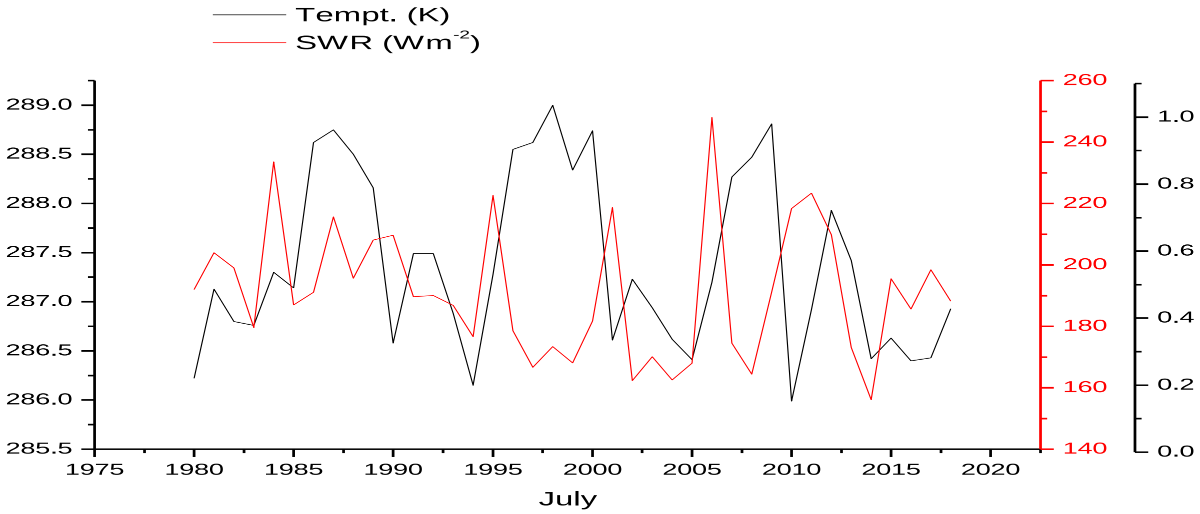

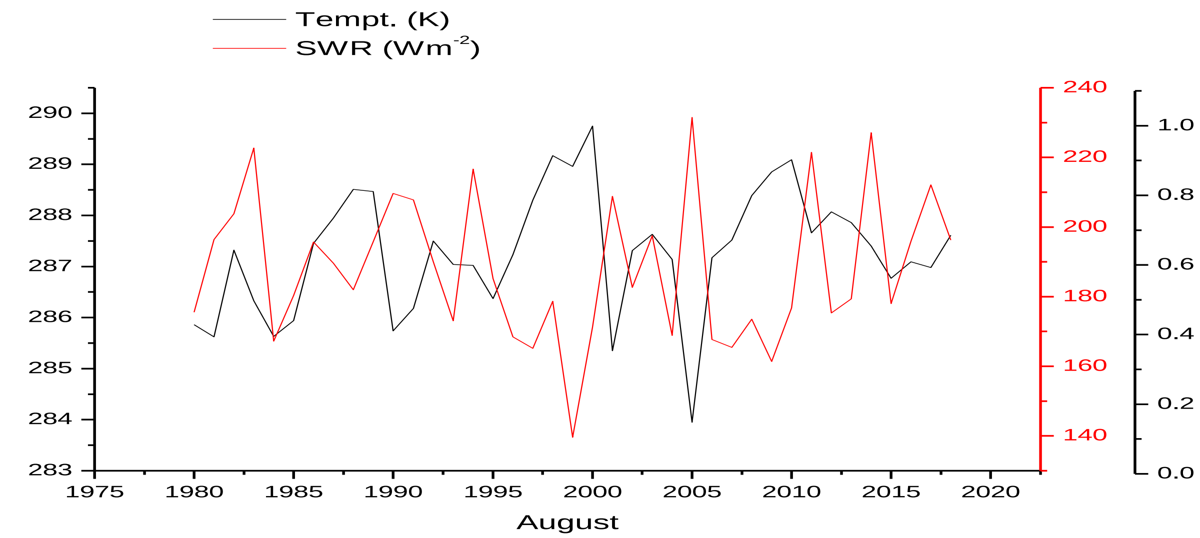

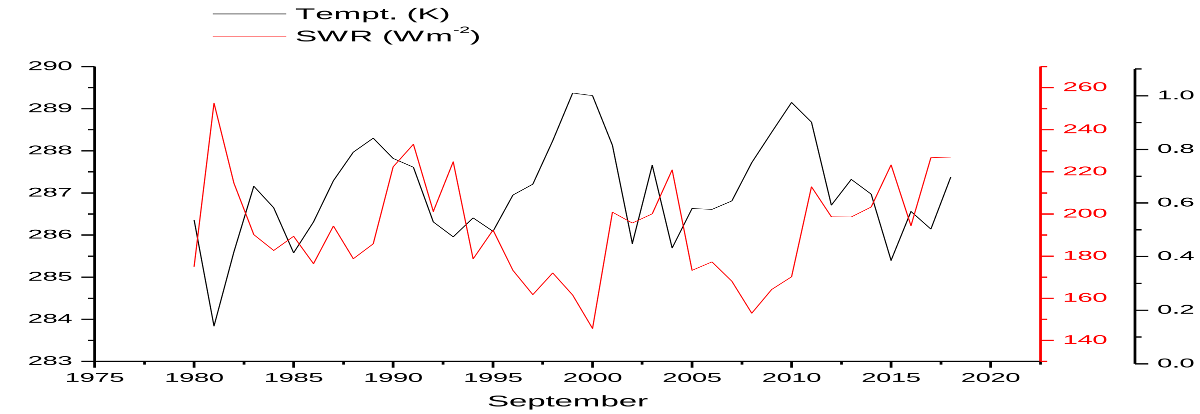

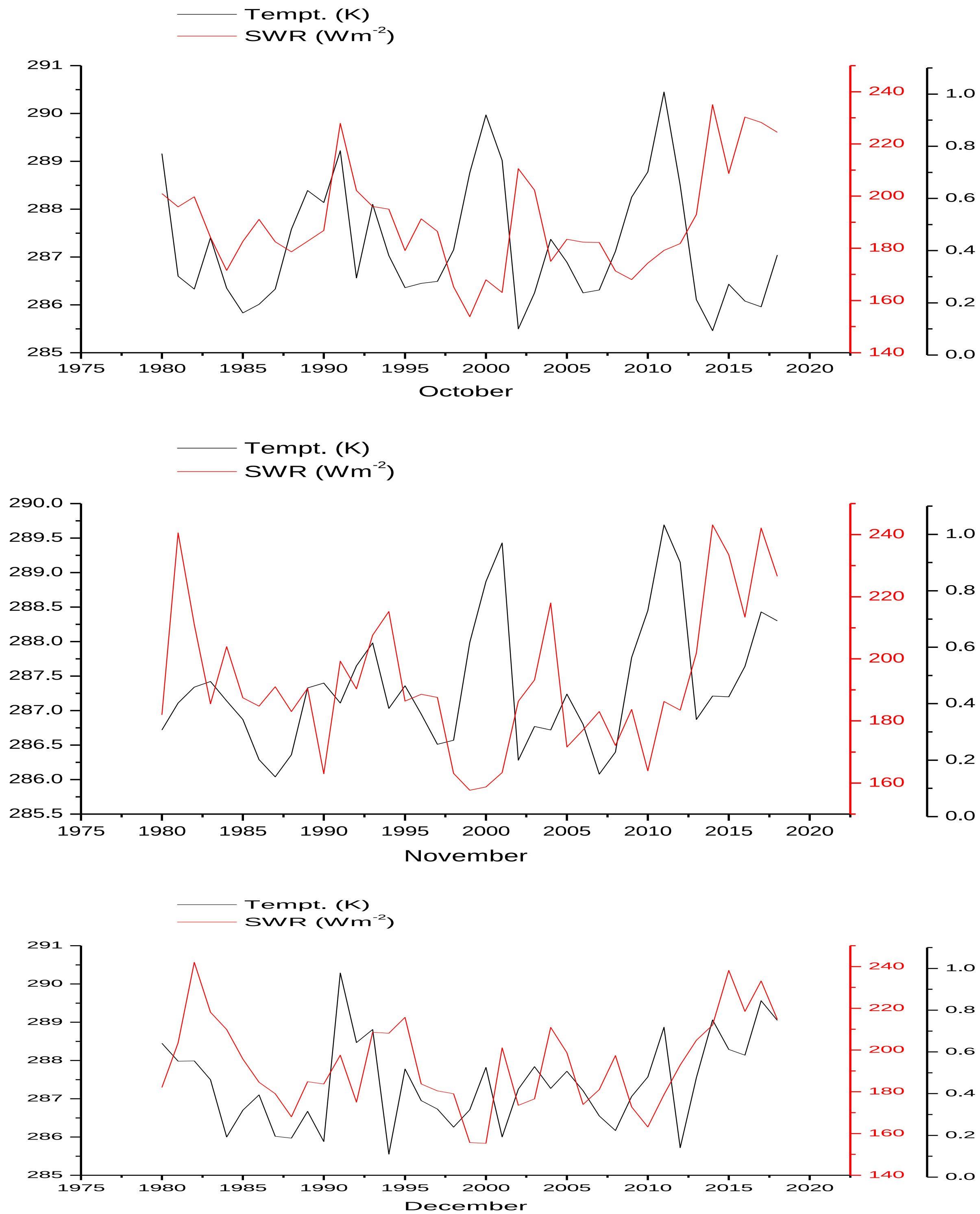

Figure 1: Albedo effect in Ikogosi Temperature-SWR weather patterns

3.2. Curve fitting regression analysis of Ikogosi Temperature-SWR relationships

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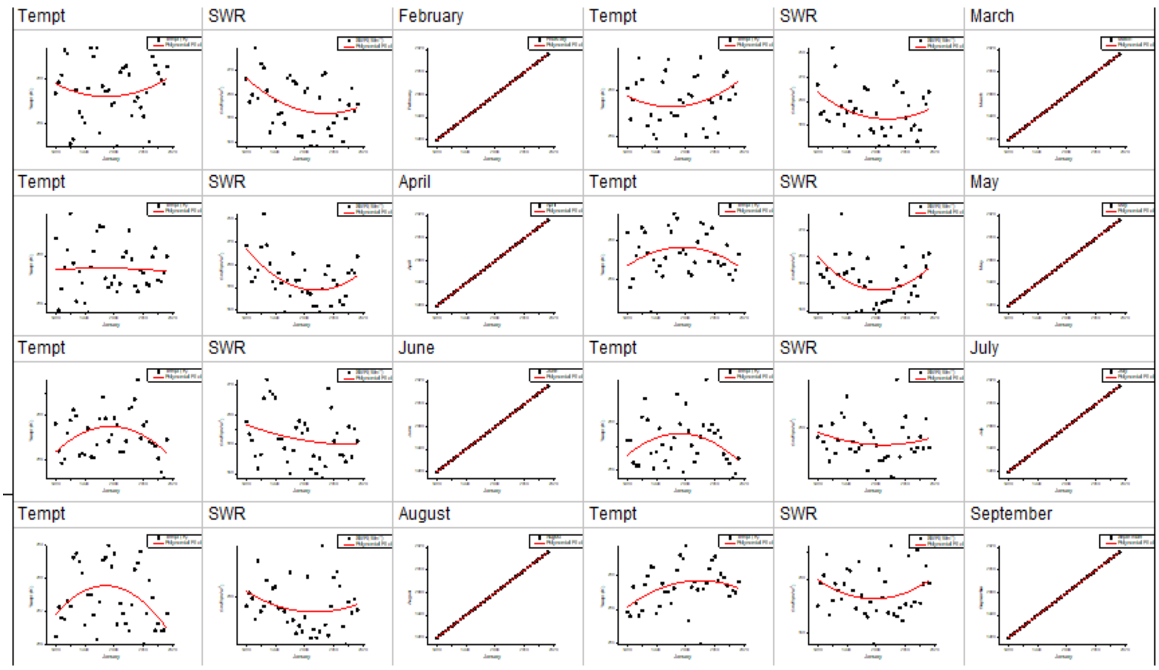
The curves show the line of best-fit for each month, this illustrates a non-linear relationship between SWR and temperature. The shape is predominantly exponential growth or logarithmic decay in all the months. In mathematics, this translates to a quadratic function. A single exception to this observation occurs in April Temperature, where SWR changes is directly proportional to temperature changes. The future implications of these fluctuations in Ikogosi climatic future lies in the albedo effect. Ikogosi landmass is highly reflective, thus more radiation is sent back to space consequently, bringing about the cooling effect observed. This is largely on account of the dense foliage present, deforestation and other industrial activities could decrease these albedo effect, if they are not regulated as illustrated by Figure 2.

3.3. Statistical Analysis of Ikogosi Temperature-SWR Regression Curves

In evaluating the goodness-of-fit of simulated SWR versus temperature for the set points depict no outlier but a perfect fit in all the months as shown in Figure 2. This means that, this result can be used in a statistical context useful in prediction of future models or in testing hypotheses. The measure of wellness of the model is adjudged excellent based on this variation from the mean being approximately equal to unity. The adjusted R squared negative value observed does not indicate any adverse situation but indicates a valid measure.

3.4. Analysis of variance (ANOVA) of Ikogosi Temperature-SWR data

The ANOVA is a collection of statistical model outcomes, it separates the data into two distinct groups, Pr. > 0.0012 and Pr. < 0.979. Most of the months fall within the latter class, which is the systematic factor, SWR in this case study.



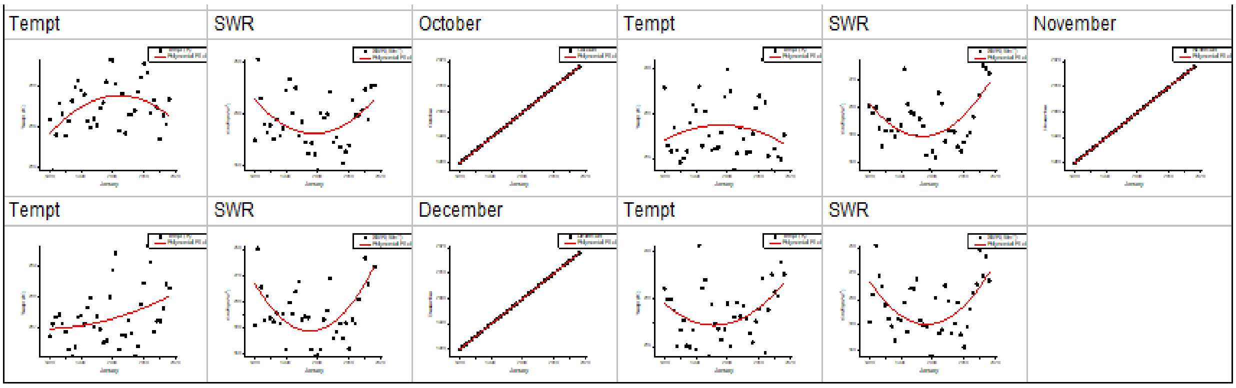


Figure 2: Curve fitting of Ikogosi Temperature-SWR weather trend

Table 1: Statistical Analysis of Temperature-SWR of Ikogosi

	Intercept		B1		B2		Statistics
	Value	Standard Error	Value	Standard Error	Value	Standard Error	Adj. R-Square
Tempt	7834.10981	7207.9645	-7.55681	7.21173	0.00189	0.0018	-0.02108
SWR	164024.48418	111703.084	-163.2658	111.76145	0.04067	0.02795	0.12698
February	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	8598.43184	6190.0212	-8.33225	6.19326	0.00209	0.00155	0.02576
SWR	159396.72771	100266.53307	-158.92003	100.31892	0.03966	0.02509	0.06521
March	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-702.57586	5752.85354	0.99223	5.75586	-2.486E-4	0.00144	-0.05429
SWR	256214.00961	89044.7216	-255.55028	89.09124	0.06377	0.02228	0.26444
April	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-10481.65131	6230.40273	10.77552	6.23366	-0.0027	0.00156	0.02543
SWR	230656.04301	82434.26659	-230.37574	82.47734	0.05757	0.02063	0.15392
May	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-12747.57135	5352.71152	13.04326	5.35551	-0.00326	0.00134	0.09412
SWR	41381.02069	100044.31616	-40.86421	100.09659	0.01013	0.02504	0.00382
June	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-11021.91031	5444.3158	11.32144	5.44716	-0.00283	0.00136	0.06258
SWR	98776.84248	110666.4519	-98.48178	110.72427	0.02459	0.02769	-0.02373
July	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-11489.30851	4762.4498	11.79474	4.76494	-0.00295	0.00119	0.11842
SWR	136580.69202	121721.17208	-136.15082	121.78477	0.03398	0.03046	0.00721
August	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-9735.81745	6532.63699	9.99942	6.53605	-0.00249	0.00163	0.08304
SWR	189851.34286	116202.21328	-189.74195	116.26293	0.04745	0.02908	0.01729
September	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-15584.49201	6144.0802	15.85662	6.14729	-0.00396	0.00154	0.15392
SWR	360598.87962	128635.99417	-360.61499	128.7032	0.0902	0.03219	0.13349
October	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	-7841.73649	7275.22082	8.13795	7.27902	-0.00204	0.00182	-0.01833
SWR	343740.6523	95272.11543	-344.13135	95.32189	0.08618	0.02384	0.26669
November	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	2848.18918	4878.93849	-2.59042	4.88149	6.54986E-4	0.00122	0.08581
SWR	474699.48934	105477.37358	-475.11291	105.53248	0.11893	0.0264	0.34568
December	-2.91271E-12	5.00398E-12	1	5.0066E-15	-7.85654E-19	1.25227E-18	1
Tempt	14985.80877	5987.00027	-14.73007	5.99013	0.00369	0.0015	0.1474
SWR	409032.62852	103654.80647	-409.24409	103.70896	0.10241	0.02594	0.27068

Table 2: ANOVA of Ikogosi Temperature-SWR data

		DF	Sum of Squares	Mean Square	F Value	Prob>F
Tempt	Model	2	1.97588	0.98794	0.60774	0.55007
	Error	36	58.52136	1.62559		
	Total	38	60.49724			
SWR	Model	2	2938.53634	1469.26817	3.76343	0.0328
	Error	36	14054.6315	390.40643		
	Total	38	16993.16784			
February	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	3.6021	1.80105	1.50229	0.23625
	Error	36	43.1592	1.19887		
	Total	38	46.7613			
SWR	Model	2	1462.95195	731.47597	2.32542	0.11225
	Error	36	11324.03317	314.55648		
	Total	38	12786.98512			
March	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	0.04462	0.02231	0.02155	0.9787
	Error	36	37.27827	1.03551		
	Total	38	37.32289			
SWR	Model	2	3885.311	1942.6555	7.83056	0.0015
	Error	36	8931.1112	248.08642		
	Total	38	12816.4222			
April	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	3.63319	1.8166	1.49568	0.23769
	Error	36	43.72415	1.21456		
	Total	38	47.35734			
SWR	Model	2	1895.06698	947.53349	4.45648	0.01865
	Error	36	7654.28613	212.61906		
	Total	38	9549.35311			
May	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	5.33226	2.66613	2.97404	0.06377
	Error	36	32.27281	0.89647		
	Total	38	37.60508			
SWR	Model	2	672.00435	336.00218	1.07293	0.35269
	Error	36	11273.89475	313.16374		
	Total	38	11945.8991			
June	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	4.20753	2.10376	2.26842	0.11807
	Error	36	33.38687	0.92741		
	Total	38	37.5944			
SWR	Model	2	428.91932	214.45966	0.55966	0.57629
	Error	36	13794.98105	383.19392		
	Total	38	14223.90037			
July	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	5.04164	2.52082	3.55218	0.03909
	Error	36	25.54759	0.70966		
	Total	38	30.58924			
SWR	Model	2	1055.11322	527.55661	1.13802	0.33171
	Error	36	16688.65694	463.5738		
	Total	38	17743.77016			
August	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	7.26574	3.63287	2.72074	0.07936
	Error	36	48.06912	1.33525		
	Total	38	55.33487			
SWR	Model	2	1127.46194	563.73097	1.33431	0.27605
	Error	36	15209.60502	422.48903		
	Total	38	16337.06696			
Septembe r	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	10.52773	5.26387	4.45661	0.01865
	Error	36	42.52094	1.18114		
	Total	38	53.04868			
SWR	Model	2	4066.47956	2033.23978	3.92715	0.02866
	Error	36	18638.63701	517.73992		
	Total	38	22705.11657			
October	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	2.17934	1.08967	0.65798	0.52401
	Error	36	59.61856	1.65607		
	Total	38	61.7979			
SWR	Model	2	4492.81346	2246.40673	7.90988	0.00142
	Error	36	10223.99793	283.99994		
	Total	38	14716.81139			
November	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	4.14631	2.07316	2.78352	0.07516
	Error	36	26.81266	0.7448		
	Total	38	30.95897			
SWR	Model	2	7684.37602	3842.18801	11.03757	1.82651E
	Error	36	12531.63538	348.10098		
	Total	38	20216.0114			
Decembe r	Model	2	4940	2470	3.15267E33	0
	Error	36	2.82046E-29	7.83462E-31		
	Total	38	4940			
Tempt.	Model	2	9.61094	4.80547	4.2848	0.02142
	Error	36	40.37455	1.12152		
	Total	38	49.98549			
SWR	Model	2	5413.46504	2706.73252	8.05156	0.00129
	Error	36	12102.30312	336.17509		
	Total	38	17515.76816			

Conclusion and Recommendation

The high albedo observed means Ikogosi land surface reflects a major percentage of the radiation that falls on it and absorbs the rest. Forests have a low albedo, this condition affirms that the area is rich in vegetation. This type of increase in albedo will ultimately result in supplementary drop in Ikogosi temperature. This condition if promoted, in turn will cause a further increase in the albedo and substantial reduction in the greenhouse gas concentrations in Ikogosi atmosphere. In view of this result, our model prescription is:

1. Demarcation of new forest cultivation for foliage, economic and health impact.
2. Proper inventory of forest reserves and evaluation by Federal and State Government, to certify their present condition.

3. Illegal felling of forest trees should be a punishable offence.
4. A new constitutional change incorporating Ministry of Forest and Revenue, ranking equally with Minister of Petroleum resources, to curtail the debilitating effect of climate change globally.

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Author Credit
Abodunrin T.J –Formal Analysis and writing, Emetere M.E.- Resources and software

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