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Influence of Rainfall as an Environmental Factor on the Distribution of Faunal Biodiversity in Nallamala Forest (Kurnool District), Andhra Pradesh

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ABSTRACT

Climate change ordinarily indicates a change in behaviour of the weather elements over an area during a time span. The change is attributable directly or indirectly to human activities or the natural causes that have the effect of altering the atmospheric composition. One aspect of this complexity is that climate change will impact unevenly across the ecosystems that prove vulnerable to climate changes. Biodiversity means variation of life forms within a given ecosystem. The present work attempts to trace down the nature of interrelationship between the climate change and faunal biodiversity especially with regard to rainfall variations in Nallamala forest (Kurnool district) of Andhra Pradesh. Rainfall is also one of the limiting factors of the species expansion that determines its distribution in boundaries of the area. The trend of rainfall time-series data indicates a decreasing trend in the rainfall pattern over forest and agricultural and grassland areas from 2014 along with northern, central and southern Western Ghats.

INTRODUCTION

Biodiversity is the variation of life forms within a given ecosystem. Most of the biodiversity of the Earth is located around equator due to its high temperature and rainfall. It is a parameter for the health of environment. It is the outcome of over 3.5 billion years of evolutionary development shaped by the natural processes. Greater biodiversity implies better health. All the genetic variation present in wild population is potentially useful for important domestic animals and plants, and therefore, should be preserved. India has a rich and varied heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. Among the 25 hotspots of the world, two are located in India extending into neighbouring countries; the Indo-Burma region (covering the Eastern Himalayas) and the Western Ghats/Sri Lanka. These areas are particularly rich in floral wealth and endemism, not only in flowering plants but also in reptiles, amphibians, swallow tailed butterflies and some mammals.

Environment is a combination of all the nature's gifts without even the trace of human contribution to it. Ecosystem services have emerged as an integrated framework for managing ecosystems in an increasingly human dominated world (Harris et al. 2006, Lele et al. 2013). Defined as the benefits natural systems provide to humans, this 'nature for people' paradigm has been increasingly adopted by governments and non-profit organizations to frame, plan and allocate resources (Posner et al. 2016). There is a notable division between those that see ecosystem function as something that can be quantified in monetary terms versus those that explicitly reject one dimensional valuation schema as being both impossible and undesirable (Pascual et al. 2017). The process of development without integrating the environmental concern has generated the risk of very delicate and slow, but of very sensitive nature in the form of by-product that the whole world feels as a climate change. One aspect of this complexity is that climate changes will impact unevenly across the ecosystems that prove vulnerable to climate changes (Edward 2006). It affects the physical condition of the environment as well as representatives of the ecosystem in various forms and contents.

The linkages between climate change and biodiversity being very fragile can only be maintained by taking precautionary measures through appropriate law and strict adherence thereto in the process of assessment and mitigation, let it gets too late. The determination of the environmental factors is a large problem and the data should be habits, habitat preference, and analysis of the conditions in the habitat, exact range and the results of the experiments upon the effect of altering the intensities of environmental factors.

The present work attempts to trace down the nature of interrelationship between the climate change and biodiversity (fauna), especially with regard to the amount of rainfall variations in Nallamala forest (Kurnool district)

of Andhra Pradesh. Nallamala Hills stretching across five districts across portions of Kurnool, Prakasam, Nalgonda, Guntur and Kadapa of the State of Andhra Pradesh are renowned for being rich in biodiversity (Rao 1998). Nallamala is a group of low hill ranges in the central part of Eastern Ghats. From the Palnad basin in the north to the Tirupati basin in the south, the Nallamala runs a distance of 430 km with an average width of 30 km (Anon 1965). The altitude ranges from 200 to 950 m. An unbroken chain of rugged hills with precipitous cliffs encompassing an area of about 7640 km^2 forms the range. The humus content is almost negligible as the black soil occurs in plains where cultivation is practiced (Krishnan 1956). The vegetation is typically of southern tropical dry deciduous and southern tropical moist deciduous forest types intermingled with shrubs (Champion & Seth 1968). The climate is generally hot and dry with temperatures rising up to 43°C to 45°C during May and dips down to 8°C in December. Average rainfall in this region is between 600 and 1000 mm.

Though several research activities and surveys were made in the area of study, i.e. Nallamala forest (Kurnool district) of Andhra Pradesh regarding the characterization, quantification of the species diversity; the study of distribution of the species of fauna (biodiversity) with regard to variations in the amount of rainfall is required with utmost importance. Hence, this work was selected.

MATERIALS AND METHODS

Amount of rainfall was recorded with Ombrometer (rain gauge) for the period 2017-2018 and for 2014-2017 based on the secondary data. Quantification of biodiversity (fauna) was done.

i. For mammals, reptiles and birds using sampling method: Total area of population subdivided into sampling unit as 'circlet'.
ii. For amphibians, fishes, butterflies, moths and coleopterans especially beetles using tagging method: By adopting the formula:

$$\frac{\text{Total population size}}{\text{No. of marked animals in the population}} = \frac{\text{Total caught in the sample}}{\text{No. of marked animals in the sample}}$$

GPS location of Nallamala forest (study area) is:

DMS:	15°40'41'N, 78° 47'10'E
Decimal:	15.678056, 78.786111
Geo URI:	geo: 15.678056, 78.786111
UTM:	44P 2627061734564

RESULTS AND DISCUSSION

The Western Ghats are home to a rich variety of flora and fauna. The Sahyadri also has 330 varieties of butterflies (11% endemic), 156 species of reptiles (62% endemic), 508 types of birds (4% endemic), 120 species of mammals (12% endemic), 289 varieties of fish (41% endemic) and 135 species of amphibians (75% endemic). Nallamala forest supports a wide variety of animals, birds, insects, reptiles and amphibians (Murthy 1968 and Agrawal & Bhattacharya 1976). The reserve is home to many charismatic animals like tiger, leopard, sloth bear, wild dog, jackal, ratel, porcupine, giant squirrel, mouse deer, four horned antelope, sambar, spotted deer, nilgai and wild boar.

The impact of climate change is multiple and long term process like sea level rise, uncertain rainfalls, temperature increase, forcing the changes in biodiversity and the basic capabilities of the future generation (IPCC 2007 and CBD 2010). It is a complex network of changes before the world. Adaptation of species to climate change in the past took place mostly by shifting of their distribution boundaries to higher or lower latitude, or up and down the mountain slopes, depending on whether the climate became warmer or colder. If the temperature increases by 4.1°C, the expected outcome is even more dramatic; distribution area for 229 species will decrease by 50% and for 70 species by 95% (Waldock et al. 2018).

One analysis of compendia of fossil taxa suggests that biodiversity declines with increasing global temperatures (Mayhew et al. 2008), but the focus without reference to other variables like rainfall has drawn criticism. Ecologists are also worried about the amount of rainfall variations in the Western Ghats (Upadhye 2016). Rainfall is one of the limiting factors of the species expansion besides temperature that determines its distribution in boundaries of the area.

The variations in the amount of rainfall have been recorded for 2017 and for January and February 2018 at the selected area, i.e. Nallamala forest (Kurnool district), Andhra Pradesh (Table 1). Secondary data are obtained for the years 2014, 2015 and 2016.

The rainfall/precipitation varied with different seasons across different months, with little significant increase during southwest monsoon for the months of June to September of 2016 and 2017; and with significant decrease in the years 2014 and 2015 when compared to normal rainfall. The amount of rainfall during northeast monsoon for October to December 2017 also followed the similar pattern as that of southwest monsoon of 2016 and 2017, but decrease was higher during the northeast monsoon of 2014, 2015 and 2016.

It is evident from the data of variations in the amount of rainfall and quantification of biodiversity (fauna) during

Table 1: Rainfall (mm) of Nallamala forest (Kurnool district), Andhra Pradesh during 2014-2018.

S.No.	Month/period	2014-2015			2015-2016		2016-2017		2017-2018	
		Normal Rainfall (mm)	Actual Rainfall (mm)	% of Deviation	Actual Rainfall (mm)	% of Deviation	Actual Rainfall (mm)	% of Deviation	Actual Rainfall (mm)	% of Deviation
1	June	77.2	49.2	-36	45.2	-41	131.8	71	101	31
2	July	117.2	79.7	-32	51.3	-56	116.6	-1	55.5	-53
3	August	135.0	111.5	-17	77.9	-42	74.7	-45	157.3	17
4	September	125.7	73.4	-42	157	25	143.7	14	161.4	28
	Southwest monsoon	455.1	313.8	-31	331.2	-27	466.8	3	475.2	4
5	October	114.5	67.7	-41	47.0	-59	9.0	-92	153.6	34
6	November	27.6	18.8	-32	26.6	-4	2.5	-91	1.7	-94
7	December	7.5	1.9	-75	3.6	-52	3.1	-59	0.0	-100
	Northeast monsoon	149.6	88.4	-41	77.2	-48	14.6	-90	155.3	4
8	January	2.7	1.7	-37	5.5	104	0.3	-89	0.0	-100
9	February	2.0	19.9	895	0.1	-95	0.0	-100	0.3	-85
	Winter period	4.6	1.8	-61	5.6	22	0.3	-93	0.0	-100
10	March	5.7	7.1	25	1.1	-81	10.4	82	-	-
11	April	17.0	36.7	116	0.9	-95	11.9	-30	-	-
12	May	38.5	19.9	-48	62.4	62	26.8	-30	-	-
	Hot weather period	61.2	63.7	4	64.4	5	24.3	-60	-	-
	Total	670.5	467.7	-30	478.4	-29	506.0	-25	-	-

Table 2: Faunal biodiversity found in Nallamala forest (Kurnool district), Andhra Pradesh during 2017-2018.

S.No.	Group	Number of species in Nallamala forest 2016-2017	% Loss/% Increase in species when compared to previous year (2017-2018)	% Loss/% Increase in number
1.	Mammals	50	- 1-2	- 20-30
2.	Birds (Aves)	200	+ 4-5	+ 25-35
3.	Reptiles	54	+ 1-2	+ 10-20
4.	Amphibians	18	+ 0-1	+ 40-50
5.	Fishes	55	± 0-1	± 0-1
6.	Butterflies	89	± 1-2	± 0-1
7.	Moths	57	± 0-1	± 0-1
8.	Coleoptera (Beetles)	45	± 0-1	± 0-1

'±' indicates 'no significance'

2017-2018 (Table 1 & Table 2) that there is a low significant marked increase/decrease when compared to 2016-2017 and the adaptability of the different species of biodiversity (fauna) is expected healthy with respect to poikilotherms and homeotherms except mammals accordingly. Whereas, with regard to butterflies, moths and coleopteran (beetles), there is no significant increase/ decrease, because of their less tolerance capacity to complex environmental factors here, especially rainfall when compared to the said groups of fishes, amphibians, reptiles and aves. Hence, there is little significant deviation with regard to number of the species diversity and species richness.

Response of living organisms on each individual environmental factor can be described as per Shelford's theoretical model. As numerical values of organism's response, a variety of processes of living organisms and characterizing properties can be used, for example, mobility, number of organisms, intensity of metabolism and intensity of reproduction. But as values characterizing factor's performance, intensity of a factor is used. Interaction of factors becomes apparent in the way that at the influence of one factor at the same intensity the reaction of an organism is different, depending on exposure intensity of other factors as observed with the mammals in the present study.

Studies have also revealed that the alterations in the hydrological cycle affect the availability and quantity of freshwater and have become a serious issue in the 21st century and can be justified with the observations of the present study. The marginal nature of the environment,

however, means that even minor changes in rainfall patterns could have major impacts on wildlife (Hoffman 2015). The gloomy status is evident from the decline of dense forests with native species in the northern, central and southern Western Ghats by 2.84%, 4.38% and 5.77%, respectively.

Experts also say that the consequences of climate change would be in the shift in precipitation patterns (#rainfall) and hydrological processes as is evident from the present study during 2017-18 which influence the spatial and temporal distribution of runoff, soil moisture and groundwater reserves, and increase in the frequency of droughts. In other words, each environmental factor has an optimum intensity and unfavourably affects the animal at intensities either above or below the optimum. It is possible that changes in temperature and moisture (rainfall) either directly or through effects on the flora, are the factors which the environment sufficiently control the north-west distribution of forms on great continents, but this remains to be proved (Mayhew et al. 2012). From the ecological and physiological viewpoint, it is necessary to consider the environment as a complex "the sum of all the contacts, which an organism or a group of organisms establishes with the forces and matter of its surroundings, either organic or inorganic" (Case 1991).

If the environmental relations of an animal are complex, it must follow that any feature of the environment may alter the whole existence of the form and may cause extinction barrier to migration or ecesis. Because of this similar situation, the organisms of different groups in the study area have been migrated to different habitats, especially mammals, as the rainfall became barrier to their normal physiological activities after a span of one year threshold limit which normally leads to their distribution. Current anthropogenic climate change and the need to quantify its effects have brought to the notice the long-recognized role of global climate in driving change in taxonomic richness (Mayhew 2011). It is important to review and modify relevant environmental policies and in parallel develop strict regulatory frameworks to ensure that environmental and social impacts are minimized and mitigated (Webb et al. 2012).

Hence, we conclude that further investigation is necessary in this regard with respect to physiological, behavioural aspects of the faunal biodiversity in response to the influence of the said variations in the amount of rainfall on their distribution in the Nallamala forest, Kurnool district of Andhra Pradesh.

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