Research Article

Analysis of Meteorological Trends of Yeldari Reservoir from Tropical Locality of Maharashtra State (India) to Evaluate Influence of changing Climate on Ichthyofauna Diversity

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ABSTRACT

Present investigation carried out to evaluate influence of changing climate with uneven meteorological trends to Ichthyofauna diversity of Yeldari reservoir of Parbhani district of Maharashtra for conservation purpose. Meteorological parameters like atmospheric temperature, humidity, evaporation and rainfall were studied for four consecutive years from 2016- 2019. During the investigation period of minimum atmospheric temperature (9.8°C) observed during December 2017 and maximum (42.5°C) observed May 2019. Lowest humidity (12%) observed during April 2017 and April 2019 while Highest humidity (88%) observed during September 2016, August 2018 and September 2019. Rate of evaporation observed minimum (2.8 mm) during September 2019 and maximum (16.6 mm) during May 2016. Annual rainfall was recorded as 926 mm in 2016, 735 mm in 2017, 744 mm in 2018 and 971 mm in 2019. In the investigation past and present meteorological trends are analysed to predict impacts on Ichthyofauna diversity of Yeldari reservoir. The results of investigation showed that, climate change and variation in meteorological parameters increased problems and threats to fish life.

Keywords: Climate change, Meteorological parameters, Yeldari reservoir, Fish diversity, Temperature, Rainfall.

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INTRODUCTION

Recently there are drastic changes observed in climate of Earth on global and regional scales. The climate has very complex relationships with the seasonality including variations of temperature, rainfall and day length.[1] Climate change is one of the most important global environmental challenges affecting all natural ecosystems.[2] At present, concentration of CO_2 in the atmosphere is 350 ppm that will increase to 500-700 ppm in 2050.[3] These increased greenhouse gases which resulted in global warming. Increase of world temperature rise is thought to be ranged from 0.3 to 6.4°C at 2090-2099 relatively to 1980-1999.[4] Influences of changing climate are possibly severe to sensitive living organisms. Influences of changing climate are now seen worldwide to living organisms. Fishes and many aquatic organisms are vulnerable to climatic change. Climate change poses significant threats to fisheries on top of many other concurrent pressures such as overfishing, habitat degradation, pollution, introduction of new species and so on.[5] Climate change increased stress on ecology of the living world. Fisheries will be very much affected due to changing climate. Changing climate can alter abudandance as well as distribution of aquatic organisms. Climate change can cause extinction of species and their stock. Already fisheries sector is facing several challenges like overfishing, habitat loss and weak management. Climate change became another additional stress to fisheries sector. Direct effects of

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climate change act on physiology, behaviour, growth, reproduction, mortality and distribution and indirect effect alter the productivity, structure, and composition of the aquatic ecosystems on which fish depend for their food and shelter.[6] Climate change is affecting the seasonality of biological processes, altering marine and freshwater food webs, with unpredictable consequences of fish production.[7] Abnormal temperature may affect exchange of nutrients including gases across water. It can alter primary productivity which brings changes in food chain and food web of the ecosystem and alteration of species assemblages, shifts in the competitive and disease susceptibility. Changing environment will increase the risk for living world in future. Allison *et al.*, (2009) used indicator based approach to compare the vulnerabilities of 132 nations to potential climate change impacts on their capture fisheries.[8] Lakshmi and Ramaya, (2009) has reported that climate change is also expected to increase the number of extreme events such as tropical cyclones.[9] The solubility of the oxygen in water inversely related to temperature and salinity.[10] Fish being thermal conformers, are unable to regulate their temperature independently of the surrounding water,[11] so changes to water temperature potentially can affect migration routes and ultimately geographic distribution. Climate is one of the most important factors controlling the growth, abundance, survival and distribution of species as well as regulating natural ecosystems in a variety of ways.[12] Among meteorological parameters Rainfall is one of the important parameter. In recent years, it is observed that there are severe changes in patterns of rainfall in this region. There are dry and droughts and sometimes floods observed in the locality. Yeldari region of Parbhani district is rich of biodiversity. There is need for conservation of biodiversity of this area. In due course of time, drastic changes in climatic conditions and seasonal patterns are observed which affected life of many sensitive living organisms. Aquatics like fish are very sensitive to climate and get affected by minor changes. Hence there is requirement for investigation of influence of changing climate and meteorological trends of this region to protect and conserve the Ichthyofauna diversity of Yeldari reservoir.

MATERIALS AND METHODS

About Reservoir

Yeldari reservoir selected because of its unique meteorological and extreme climatic conditions. This reservoir is constructed on Purna river in Parbhani district of Maharashtra (India). Yeldari reservoir is located about 15 km due south west of Jintur town of Parbhani district. Geographically it is located between 19°-43'-00" N latitude-76°-45'-00" E longitude. Principle features of Yeldari reservoir tabulated as follows (Table 1).

Table 1: Principle features of Yeldari reservoir.

Name of Reservoir:	Yeldari
Year of start:	1958
Final completion:	1968
Purpose:	hydropower and storage
Location:	Latitude-19°-43'-00" N Longitude-76°-45'-00" E
Address:	Village- Yeldari camp, Subdistrict- Jintur, District-Parbhani
Type of dam:	Large sized
River:	Purna
Basin:	Godavari
Catchment Area:	7329. sq.km
Occupied area:	2472 ha
Maintained by:	State Irrigation Department and State Electricity Board Maharashtra state

Record and Collection of Meteorological Data

The present research was conducted on Yeldari reservoir during four consecutive years from January 2016 – December 2019 to evaluate magnitude of meteorological parameters of Yeldari reservoir for its suitability for fishery sector of this area. Meteorological parameters like Atmospheric temperature (°C) and Humidity (%) were recorded monthly at Yeldari reservoir using a centigrade mercury thermometer (0.0°C - 100°C) and Hygrometer (HTC-1) respectively. Meteorogical observations were carried out in the second week of every month. These parameters were recorded at the main site of reservoir in diurnal basis i.e. in the morning hours between 07.00-09.00 am and afternoon 12.00-02.00 pm. Reports of meteorological parameters like evaporation (mm) and rainfall (mm) were collected from Central Agrometeorological Observatory, AICRP on Agrometeorology, VNMKV, Parbhani and Office of the Executive Engineer, Purna Irrigation Project (Govt. of Maharashtra), Yeldari Camp, Jintur, Parbhani respectively and analysed to investigate, its impacts on Ichthyofauna diverstiy.[13]

RESULTS

Results of investigations are tabulated in the particular tables. The observation of investigation are provided monthly basis.

Atmospheric temperature (°C)

Temperature also affects the water chemistry which ultimately affects aquatic organisms. It varies according to time and season of year. Atmospheric temperature was recorded on diurnal basis. The values of atmospheric temperatures are given in Table 2. In the year 2016, the minimum atmospheric temperature (10.2°C) observed during December and maximum (42.0°C) observed during May. In 2017, the minimum atmospheric temperature (9.8°C) observed during December and maximum (41.0°C) observed during May. In 2018, the minimum atmospheric temperature (10.3°C) observed during December and maximum (42.0°C) observed during May. In 2019, the minimum atmospheric temperature (10.2°C) observed during January and maximum (42.5°C) observed during May.

Humidity (%)

Humidity is also known as relative humidity. It is the content of water vapours present in air. It fluctuates with change in temperature and pressure. The values of humidity are given in Table 3. In the year 2016, the Lowest Humidity (18%) was recorded during April and highest humidity (88%) during September. In year 2017, the lowest i Humidity (12%) observed during April and highest humidity (84%) during August. In year 2018, lowest Humidity (16%) observed during April and highest humidity (88%) during August. In year 2019, lowest Humidity (12%) observed during April and highest humidity (88%) during.

Evaporation (mm)

Evaporation is the phenomenon by which water from water bodies escapes into atmosphere. During this process water passes into vapour state into atmosphere. The values of evaporation are given in Table 4. Various meteorological and physical parameters affect the rate of evaporation. In the year 2016, minimum rate of evaporation (3.7 mm) observed during July and September and maximum rate of evaporation (16.6 mm) during May. During 2017, minimum rate of evaporation (4.1 mm) observed during December and maximum rate of evaporation (13.5 mm) was recorded in during May. During 2018, minimum rate of evaporation (3.2 mm) observed during July and maximum rate of evaporation (13.2 mm) during May. During 2019, minimum rate of evaporation (2.8 mm) observed during September and maximum rate of evaporation (13.8 mm) during May.

Table 2: Diurnal values of Atmospheric temperature (°C) from years 2016 – 2019.

Month / Year	2016		2017		2018		2019	
	Mn	Af	Mn	Af	Mn	Af	Mn	Af
Jan	11.0	30.2	11.1	30.0	10.4	30.3	10.2	29.5
Feb	16.4	34.6	12.8	32.6	14.1	33.2	12.6	32.7
Mar	21.0	38.8	17.5	35.8	18.2	36.7	18.3	36.8
Apr	23.4	41.8	22.6	40.6	20.8	40.8	21.8	41.2
May	26.4	42.0	25.8	41.0	26.3	42.0	26.2	42.5
Jun	24.1	35.6	23.2	33.4	21.8	32.8	23.8	37.6
Jul	23.6	31.2	24.0	32.4	22.5	31.2	22.6	32.8
Aug	22.2	32.1	23.2	30.5	20.8	29.4	20.6	32.3
Sep	20.7	30.3	21.8	26.5	21.4	27.5	20.8	31.6
Oct	19.4	30.8	20.1	33.0	15.8	33.6	19.6	29.8
Nov	12.2	31.4	14.2	30.4	13.7	32.0	15.6	29.7
Dec	10.2	30.0	9.8	29.2	10.3	29.1	12.5	29.2

(Mn-morning, Af-afternoon) (Standard deviation - +1°C)

Table 3: Diurnal values of Humidity (%) from years 2016 – 2019.

Month /Year	2016		2017		2018		2019	
	Mn	Af	Mn	Af	Mn	Af	Mn	Af
Jan	65	22	74	30	75	26	74	25
Feb	66	20	70	25	72	23	69	22
Mar	60	24	68	20	63	19	60	18
Apr	51	18	44	12	49	16	41	12
May	43	20	40	19	43	22	37	14
Jun	68	41	78	50	82	50	68	36
Jul	86	65	81	58	85	68	80	56
Aug	85	58	84	66	88	65	82	64
Sep	88	69	82	58	80	51	88	68
Oct	80	46	80	49	75	27	81	56
Nov	74	29	74	31	72	31	80	48
Dec	76	32	72	29	71	30	81	44

(Mn-morning, Af-afternoon)

Table 4: Mean monthly values of Evaporation (mm) from 2016 – 2019.

Month/Year	2016	2017	2018	2019
Jan	5.3	4.2	4.6	4.5
Feb	7.3	6.4	5.3	6.2
Mar	9.3	9.4	7.8	9.5
Apr	14.0	11.8	11.1	11.8
May	16.6	13.5	13.2	13.8
Jun	8.6	6.5	5.6	8.8
Jul	3.7	4.5	3.2	5.1
Aug	4.7	4.2	3.7	4.5
Sep	3.7	4.4	5.3	2.8
Oct	4.9	4.4	6.1	3.4
Nov	4.6	4.5	5.0	3.5
Dec	4.5	4.1	4.6	3.4

(Source: Central Agrometeorological Observatory, AICRP on Agrometeorology, VNMKV, Parbhani)

Table 5: Monthly and annual values of Rainfall (mm) from 2016 – 2019.

Month/Year	2016	2017	2018	2019
Jun	195	211	266	115
Jul	293	90	149	204
Aug	129	221.2	291	102
Sep	218	159.8	38	374
Oct	91	53	0	176
Annual	**926**	**735**	**744**	**971**

(Source: Office of the Executive Engineer, Purna Irrigation Project (Govt. of Maharashtra), Yeldari Camp, Jintur, Parbhani)

Rainfall (mm)

Values of Rainfall are given Table 5. Annual rainfall was recorded 926 mm in the year 2016. Maximum monthly rainfall (293 mm) observed during July while minimum (91 mm) observed during October of year 2016. Annual rainfall was recorded 735 mm in the year 2017. Maximum monthly rainfall (221.2 mm) observed during August and Minimum (53 mm) observed during October of year 2017. Annual rainfall was recorded 744 mm in the year 2018. Maximum monthly rainfall (291 mm) observed during August and Minimum (38 mm) observed during September of year 2018. Annual rainfall was recorded 971 mm in the year 2019. Maximum monthly rainfall (374 mm) observed during September while Minimum (102 mm) observed during August of year 2019.

It is observed that rainfall trend is not even throughout season. There were very less (July 2017, September 2018) and very high (September 2019) rainfall events recorded during the study period.

DISCUSSION

Climate change increases the risk of extinction of species that have a narrow geographic and climatic range.[14] Rising temperatures similarly reduce levels of dissolved oxygen and increase metabolic rates of fish, leading to increases in fish deaths, declines in production or increases in feed requirements while also increasing the risk and spread of disease.[15] Climate induced changes in distribution and phenology of fish larvae and their prey can also affect recruitment and production of fish stocks.[6] The distribution or productivity of marine and fresh water fish stocks might be affected owing to the processes such as ocean acidification, habitat damage, changes in oceanography, disruption to precipitation and freshwater availability.[16] Climate change has direct effects on physiology and behavior which hamper growth, reproduction capacity, mortality and distribution (Abbink *et al.*, 2012).[17]

Atmospheric temperature is important ecological parameter which influences life processes. Rise and fall in atmospheric temperature affects the physiological processes of living organisms. Temperature may have positive as well as negative impacts on living organisms. It increases the growth rate, thus it would increase the per unit area production but temperature above 30°C results in slow feeding and slow the growth rate.[18] If air temperature increases by about 1.7 degrees, as predicted for the next 80 years, there will be further increases in thermal stability and reductions in productivity.[19] IPCC (2001) report stated the mean global temperature likely to increase 1-7°C within the next hundred years.[20] Increasing temperature can alter the physiological functions (thermal tolerance, growth, metabolism, food consumption, reproductive success, etc.) of the fish body to maintain homeostasis with the environment.[21]

Atmospheric temperature was found to be in the range of 24.7°C to 38.2°C and it was minimum during December and maximum in the month of May.[22] The minimum air temperature was 22.1°C in January 2007 and 21.6°C in January 2008, and maximum was 29.02°C in May 2007 and 34.25°C in May 2008.[23] Air temperature ranges between 27.0°C to 35.0°C where minimum temperature was recorded in winter and maximum in summer from Nagapur near Parli Vaijanath, Beed district.[24] A season wise analysis showed that the high temperature was recorded during summer, slightly slowdown in monsoon and least in winter season.[25] Masood Ahmed and Krishnamurthy (1990) observed the maximum humidity during monsoon (75%) and minimum in summer (less 40%) and about 50% during winter.[26] Shaikh *et al.*, (1997) observed peak humidity during monsoon (92%), during winter (85%) and least during summer (65%).[27] Baig, (2004) recorded lowest humidity in the month of 23% during March and highest during f July and August during the years 2002-2004.[3] During the year 2015, the annual rainfall of Yeldari was 487 mm which was very less as compared to the years 2016-2019.[28] The threats to biodiversity of this region increased due to these extreme climatic events. Fishes are also affected due to loss of habitat, shelter, food and other facilities. Changing patterns of rainfall observed during investigation are very variable which may be the cause of loss of sensitive species and alteration in Ichthyofauna diversity of Yeldari reservoir. It may also cause of severe negative impact on fisheries of this area. Hence there is urgent need to indicate influence of changing climate for conservation and management of biodiversity to secure the life on this planet.

CONCLUSION AND SUMMARY

Aquatic ecosystems and biodiversity are highly sensitive to changing climate . Changing climate has potential which may disrupt fisheries.

Decrease in water amount as well as increase in temperature of fresh water bodies may cause migration or death of fishes.

Life of aquatic animals depends on patterns of rainfall, seasonal changes in rainfall patterns may disturb life cycle of these species. Due to anthropogenic activities there is increase in pollution which causes increase in global warming. Climate change could lead to structural and functional changes in fishes. Climate change can cause species extinction. Climate change needs to be controlled to minimise adverse effects on fishes. Government bodies and policy makers need to think about policies and management to control influences of climate change of Ichthyofauna diversity.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

IPCC: Intergovernmental Panel on Climate Change; **FAO:** Food and Agriculture Organization; **AICRP:** All India Coordinated Research Project on Agrometeorology; **Mn:** morning; **Af:** afternoon; **VNMKV:** Vasantrao Naik Marathwada Krishi Vidyapeeth; **Govt:** Government.

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