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IMPACT OF CLIMATE CHANGE ON FISH FAUNA OF JAMMU AND KASHMIR

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ABSTRACT

Climate change is a significant and lasting change in the statistical distribution of weather pattern over periods ranging from decades to millions of years. With increased global temperature, the spatial distribution of fish stock might change due to the migration of fish from one region to another in search of suitable conditions. Precipitation and run off, affect the inland fisheries, surface wind and carbon dioxide level etc. Climate profile document of Jammu and Kashmir said 'there is increase in an average temperature in J&K' adding Kashmir valley has shown rise of 1.45 degree Celsius and Jammu region has shown a rise of 2.34^{0}c over last two decades. The maximum temperature has increased by 0.5 ^{0}c per year in Kashmir valley and 0.8^{0}c per year in Jammu. Current model of climate change predict a rise in sea surface temperature of between 2^{0}C and 5^{0}C by the year 2100 (IPCC, 2001) it also predict various risk to aquatic system from climate change including loss of coastal wet land, coral bleaching, change in distribution and timing of fresh water flow etc. Intergovernmental Panel on Climate Change, average global temperature increased by 0.74±0.18°C during the last 100 years. The fishery is indisputably the most climate-sensitive sector, and affecting lives of millions people directly or indirectly. In recent years, possible impact of climate change on fisheries has been the most intensively debated, yet neglected topic. This paper explores the possible impact of climate change on fisheries and aquatic ecosystem, with special reference to Jammu and Kashmir.

Key words:climate change and fishes of Jammu and Kashmir.

I. INTRODUCTION

Climate change is the variation in the earth's global climate or in regional climates over time and it involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. The United Nations Framework Convention on Climate Change (UNFCCC) uses the term 'climate change' for human-caused change and 'climate variability' for other changes. In last 100 years, ending in 2005, the average global air temperature near the earth's surface has been estimated to increase at the rate of 0.74 +/- 0.18 °C (1.33 +/- 0.32 °F) (IPCC 2007). In recent usage, especially in the context of environmental policy, the term 'climate change' often refers to changes in the modern climate.There are both natural processes and anthropogenic activities affecting the earth'stemperature and the resultant climate change. The steep increases in the global anthropogenic greenhouse gas (GHG) emissions over the decades are major contributors tothe global warming. Sun is the primary source of energy on earth. Though the sun's output is nearly constant, small changes over an extended period of time can lead to climate change. The earth'sclimate changes are in response

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to many natural processes like orbital forcing (variations inits orbit around the Sun), volcanic eruptions, and atmospheric greenhouse gasconcentrations. Changes in atmospheric concentrations of greenhouse gases and aerosols, land-cover and solar radiation alter the energy balance of the climate system and causes warming or cooling of the earth's atmosphere. Volcanic eruptions emit many gases and one of the most important of these is sulfur dioxide (SO2) which forms sulfate aerosol (SO4) in the atmosphere. Although it is difficult to connect specific weather events to global warming, an increase in global temperatures may in turn cause broader changes, including glacial retreat, arctic shrinkage, and worldwide sea level rise. Changes in the amount and pattern of precipitation may result in flooding and drought. Other effects may include changes in agricultural yields, addition of new trade routes, reduced summer stream flows, species extinctions, and increases in the range of disease vectors (Understanding and responding to Climate Change. 2008: http://www.national-academies.org). Most models on Global climate change indicate that snow pack is likely to decline on many mountain ranges in the west, which would bring adverse impact on fish populations, hydropower, water recreation and water availability for agricultural, industrial and residential use. Partial loss of ice sheets on polar land could imply meters of sea level rise, major changes in coastlines and inundation of low-lying areas, with greatest effects in river deltas and low-lying islands. Such changes are projected to occur over millennial time scales, but more rapid sea level rise on century time scales cannot be excluded. Current models of climate change predict a rise in sea surface temperatures of between 2^0C and 5^0C by the year 2100 (IPCC Third Assessment Report, 2001: Done et al., 2003).Climate profile document of Jammu and Kashmir said 'there is increase in an average temperature in J&K' adding Kashmir valley has shown rise of 1.45 degree Celsius and Jammu region has shown a rise of 2.34^0c over last two decades. The maximum temperature has increased by 0.5 ^{0}c per year in Kashmir valley and 0.8^0c per year in Jammu.

II. HOW FISHERIES WILL BE AFFECTED?

In general, fishes cannot maintain a constant body temperature like mammals do. Their body is exactly the same temperature as the water they are living in. Surprisingly, fishes can live in very cold or very hot water, but each species has a range of temperatures that it prefers, and fish can't survive in temperatures too far (increase or decrease) out of this range. When fish encounter water that is too cold for them, their metabolism slows down and they become lethargic. Contrary, as the surrounding water warms up, their metabolism speeds up and they digest food more rapidly, grow more quickly, and eventually have more energy for reproduction. But fish need more food and more oxygen to support this higher metabolism. Warmer fish tend to mature more quickly, but the cost of this speedy lifestyle is often a smaller body size (Pottinger 1998). Ninety percent of aquatic animals raised in warm water end up smaller than their peers raised at cooler temperatures (Wedemeyer*et. al.*, 1999). For instance, Southern calamari grow more quickly at higher temperatures, but they also hatch much earlier, and reach sexual maturity earlier, so they can't catch up in size to Squid who have more time to grow in cool water(Beitinger*et al.*, 2000). Many fish will also have less offspring as temperatures rise, and some may not be able to reproduce at all and become permanently sterile.

III. IMPACTS OF CLIMATE CHANGE ON FISHERIES AND AQUACULTURE

Fish has been an important part of the human diet in almost all countries of the world. It is highly nutritious; it can provide vital nutrients absent in typical starchy staples which dominate poor people's diets (FAO, 2005a; FAO, 2007a). Fish provides about 20 % of animal protein intake (Thorpe et al., 2006) and is one of the cheapest sources of animal proteins as far as availability and affordability is concerned. While it serves as a health food for the affluent world owing to the fish oils rich in polyunsaturated fatty acids (PUFAs), for the people in the other extreme of the nutrition scale, fish is a health food owing to its proteins, oils, vitamins and minerals and the benefits associated with the consumption of small indigenous fishes (Mohanty et al., 2010a).

IV. POTENTIAL IMPACTS OF CLIMATE CHANGE ON FISHERIES

Climate change is projected to impact broadly across ecosystems, societies and economics, increasing pressure on all livelihoods and food supplies. The major chunk of earth is encompassed by water that harbors vast majority of marine and freshwater fishery resources and thus likely to be affected to a greater extent by vagaries of climate change. Capture fisheries has unique features of natural resource harvesting linked with globalecosystem processes and thus is more prone to such problems. Aquaculture complements and increasingly adds to the supply chain and has important links with capture fisheries and is likely to be affected when the capture fisheries is affected. The ecological systems which support fisheries are already known to be sensitive to climatevariability. For example, in 2007, the International Panel on Climate Change (IPCC) highlighted various risks to aquatic systems from climate change, including loss of coastal wetlands, coral bleaching and changes in the distribution and timing of fresh water flows, and acknowledged the uncertain effect of acidification of oceanic water which is predicted to have profound impacts on marine ecosystems (Orr et al., 2005..Fisheries and fisher folk may have the impact in a wide range of ways due to climate change. 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 (Daw et al., 2009). Climate change, in particular, rising temperatures, can have both direct and indirect effects on global fish production. With increased global temperature, the spatial distribution of fish stocks might change due to the migration of fishes from one region to another in search of suitable conditions.

V. IMPACT OF CLIMATE CHANGE ON THE PARASITES AND INFECTIOUS DISEASES OF AQUATIC ANIMALS

It was suggested that both the climate and human activities may have accelerated the global transport of species, bringing together of pathogens and previously unexposed populations (Harvell et al., 1999; De Silva and Sato, 2009). Climate changes could affect productivity of aquaculture systems and increase the vulnerability of cultured fish to diseases. All aquatic ecosystems, including freshwater lakes and rivers, coastal estuarine habitats and marine waters, are influenced by climate change (Parry et al., 2007; Scavia et al., 2002; Schindler, 2001). Relatively small temperature changes alter fish metabolism and physiology, with consequences for growth, fecundity, feeding behavior, distribution, migration and abundance (Marcogliese, 2008). The general effects of increased temperature on parasites include, rapid growth and maturation, earlier onset of spring

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maturation, increased parasite mortality, increased number of generations per year, increased rates of parasitism and disease, earlier and prolonged transmission, the possibility of continuous, year-round transmission (Marcogliese, 2001). Many diseases display greater virulence at higher temperatures that might be the result of increased transmission of the vectors.

VI. WATER BODIES OF KASHMIR

The Himalayan state of J&K has more than 1230 water bodies according to Department. of Environment and remote sensing. Out of 1230 water bodies, 150 water bodies are in Jammu province, 415 in Kashmir province and 665 in Ledakh.

Water resources of Kashmir

S.No.	Water body	Length/area
1.	River Jhelum	241 km
2.	Sind	95 km
3.	DachigamNala	150 km
4.	Lidder stream	50 km
5.	Bringi stream	50 km
6.	Erin stream	25
7.	River Kishanganga	150 km
8.	DoodhGanga	70 km
9.	Hiropora stream	12 km
10.	Rambiara stream	50 km
11.	Sukhnag stream	40 km
12.	Wular Lake	130 Sq. km
13.	Dal Lake	16.5 sq. km.
14.	Nageen Lake	8 Sq. km
15.	ManasbalLake	2.8 Sq. km

JEHLUM RIVER

DAL LAKE

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WULAR LAKE

NAGEEN LAKE

Major Water Bodies of Jammu Province

1. Chenab River
2. Tawi river
3. Anji river
4. Ravi river
5. Pahi
6. Neeladhab
7. Nudder
8. Dudder
9. Jhajjarkotli
10. Mansar lake
11. Surinsar lake
12. Poonch lake
13. Uj river
14. Basanter river
15. Behani

SURINSAR LAKE

MANSAR LAKE

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Fish species of Jammu & Kashmir

There are about 138 fish species in state, 93 fish species in Jammu province and 45 in Kashmir province. Many species are in both provinces like *Schizothoraxrichordsonii*, *Tor putitora*, *Glyptothorax*, *Nemachielus* etc.

Jammu Province(Commercially important species)	**Temp.range**
• *Tor Putitora*	17.5-30.2
• *Tor khudree*	17-31.4
• *Schizothoraxrichordsonii*	18-34.5
• *Schizothorax longipinnis*	-----
• *Schizothorax progastus*	-----
• *Wallago attu*	15-35
• *Bagarius bagarius*	22-34
• *Puntius sarhana*	----------
• *Puntius sophore*	----------
• *Puntius ticto*	---------
• *Labeo dero*	23.5- 35
• *Labeo bata*	--------
• *Channa marulius*	19-34.4
• *Channa orientalis*	--------

VII. FISHES OF JEHLUM RIVER WITH THEIR TEMPERATURE RANGE

S.No.	**Fish Species**	**Local Name**	**tempt. range**
1.	*Schizothoraxeocinus*	Schurgad	10-29
2.	*Schizothoraxplagiostomous*	Khont	-----
3.	*Schizothoraxniger*	Alegad	-------
4.	*Schizothoraxcurvifrons*	Sattergad	-------
5.	*Schizothoraxlabiatus*	Chush	------
6.	*Labeodero*	Ropet	15.5 -30
7.	*Banganadiplostomous*		-------
8.	*Crossochielusdiplochilus*	Tethar	---------
9.	*Tryplophysamermerata*		---------
10.	*Glyptothorax*	Annur	--------
11.	*Nemachielus*	Araguran	-------
12.	*Tor putitora*	Mahseer	17.5-29
13.	*Cyprinuscarpiospecularis*	Primgad	18-35
14.	*Cyprinuscarpiocommunis*	Punjaib gad	15-35

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Crossocheilus latius

Gambusia (mosquito fish)

Fig. 1.1 **Fig. 1.2**

'Nigeen Lake has turned eutrophic (Mysterious death of fish in Nigeen lake triggers panic)

Srinagar, Aug 5: Mysterious death of thousands of fish in the famous Nigeenlake here created panic among the people who thronged the spot on Sunday to witness the phenomenon. The Lakes and Waterways Development Authority (LAWDA) entrusted with conservation of Dal and Nigeen lakes however played down the matter saying the death of fish was caused by increase in temperature. However, experts call for a comprehensive scientific study to establish real cause behind the death of large of number of fish. Prof A R Youssef, a prominent fisheries biologist of the Valley said soaring temperature can be one of the causes for the fish mortality. "Continuous rise in temperature causes low level of oxygen and high decomposition of weeds and macrophytes in water bodies. Certain fish species particularly trash fish scientifically known as *Gambusia*, cannot thrive in such hostile conditions. The process in which large number of fish are killed is called summer kill," Dr Youssef told Greater Kashmir. Experts said in June and July, the average rainfall in the Valley used to at 95 mm, whereas in this season it has been just 46 mm affecting eco-system of water bodies and creating drought like situation. Srinagar, Aug 10: Setting all speculations about death of thousands of fish in Nigeen Lake to rest, the Fisheries and Limnological experts of Sher-e-Kashmir University of Agricultural Sciences (SKUAST) Kashmir said high mortality was mainly caused due to change in the physico-chemical parameters of Nigeen waters propelled by high pollutionlevels.Experts from SKUAST have been conducting various tests in the Nigeen since Sunday when the death of large number of fish came to fore. In their preliminarily studies, the experts have detected low dissolved oxygen levels in Nigeen due to eutrophication. After comprehensive scientific tests we have found that Nigeen Lake is almost euthrophic. It has high concentration of organic matter. At some places the dissolved oxygen level has dropped from normal to 1.8 milligrams per litre which proved fatal for some species of fish like *Crossocheilusdiplochilus* and *Gambusiaassinis*,"(fig 1.1and 1.2). Native fish*Schizothorax* was not affected by the process as it prefers to move around springs and cleanerparts of the lake.

Dr Feroz said that two years ago death of fish in large numbers was witnessed in Wullar Lake. "Same species of fish were affected there too. He said *Crossocheilusdiplochilus* and *Gambusia asinus* are mainly found in those parts of a water body which, like Nigeen Lake, have high concentration of mosquitoes as they feed on their larva. "We have gathered samples of the morbid fish and will conduct histopathological examination of vital

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parts including liver, kidney and gills for traces of toxification due to metals and other toxic elements present in the water body," he added.

"The orthophosphate level in the lake is 2.9 milligrams per litre, much higher that permissible one microgram. This signifies that Nigeen has turned eutrophic. The decomposition of organic matter caused hypoxic condition in the water system leading to increase in ammonical nitrogen which is highly toxic for fish.

The influx of sewage from Lal Bazar and adjoining areas contributes to pollution level in the lake," Dr Abubakar said. He said the summer deweeding can be another cause of depletion in dissolved oxygen because the aquatic plants produce oxygen in the process of photosynthesis.

"Root cause of high mortality of fish in Nigeen Lake cannot be only due to high temperature. Oxygen depletion coupled with high pollution levels cause heavy influx of macrophytes, algae which suck oxygen during night," Dr Balki said on Sunday when the fish died the weather was cloudy and hence no photosynthesis occurred in Nigeen Lake causing acute deficiency of dissolved oxygen and subsequent death of fish. Different theories have been floated about the cause of fish deaths. While the LAWDA maintains that the fish died due to high temperature, the Fisheries Department to ascertain cause of fish mortality in Nigeen.claims that low oxygen levels triggered by decomposition of obnoxious weeds led to high mortality of fish.

VIII. JAMMU, NOV 6

The average temperature in Jammu and Kashmir is increasing due to variation in climate characteristic over the years while as majority of glaciers have been showing degradation and the prevailing situation has the potential of posing biggest challenge for the State in the coming decades.This has been observed in the document of Department of Ecology, Environment and Remote Sensing prepared by GIZ (a German Firm) Consultants IRG Pvt Ltd in consultation with the stakeholders of the State."In the context of Jammu and Kashmir, which nestles in fragile Himalayan ecosystem, there are natural fluctuations in climate, human induced changes due to large scale urbanization that drives the warning trend", the document said, adding "the biodiversity loss and water stress owing to the climate change are the greatest challenge for the State over the coming Decades".Stating that climate change poses a serious threat to the species diversity, habitats, forests, wildlife, fisheries and the water resources in the region, the document said, "many wetlands in J&K that support 20% of the known range of biodiversity in the region are adversely affected".

Observing that climate profile of J&K indicates variation in climate characteristic over the years, the document said, "there is increase in an average temperature in Jammu and Kashmir", adding "Kashmir valley has shown rise of 1.45 degree Celsius and Jammu region has shown a rise of 2.32 degree Celsius over last two decades". The maximum temperature has increased by 0.5 degree Celsius per year in Kashmir valley and 0.08 degree Celsius per year in Jammu region. Moreover, amount of snowfall has reduced over the years, the document said while laying stress on in-depth exercise to study the climate change projections in Jammu and Kashmir.About the changes observed in glaciers in Jammu and Kashmir, the document said, "the studies conducted during last three decades by the National Institute of Hydrology, Roorkee, reveal that in Ladakh, Zanskar and the Great Himalayan ranges of Jammu and Kashmir are generally receding and the glacier volume changes range between 3.6% and 97% with the majority of glaciers showing a degradation of 17%–25%"."The 23-km long Drang-Drung glacier in the Zanskar valley is highly affected by western disturbances", the document said, adding "the

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Nubra valley of Jammu and Kashmir has 114 small-sized glaciers varying between less than 5 km and 10 km in length. The glaciers of the valley, however, do not show much change in their length and area during the period 1989–2001".“However, variable decline in the glacial area of the Siachin glacier has been observed with the area reducing from 994.99 km2 in 1969 to 932.90 km2 in 1989. However, small change in the area (932.90 km2 to 930 km2) has been noticed during the following decade (1989–2001)", the document said, adding “the impact of rising temperature and reducing snowfall on glacier mass require a sound long-term database for precise climate change assessment".

IX. CONCLUSION

Fisheries and aquaculture needs to be blended into national climate change adaptation strategies. Without careful planning, aquatic ecosystems, fisheries and aquaculture can potentially suffer as a result of adaptation measures applied by other sectors, such as increased use of dams and hydropower in catchments with high rainfall, construction of artificial coastal defenses or marine wind farms. Mitigation solutions are not at all well-known and require in innovative approaches such as the recent inclusion of mangrove conservation. The Ecosystem Approach to Aquaculture (EAA) aims to integrate aquaculture within the wider ecosystem as with any system approach to management; EAA encompasses a complete range of stakeholders, their influences, and other interlinked processes. In addition to the above improvements, it is imperative that the developed countries and the rapidly developing countries formulate strategies to curb greenhouse gas emissions. Developing countries like India should also look at adopting new energy-saving technologies and planting of more trees. The emphasis should also be laid on increasing the use of renewable energy sources like solar and wind. The above facts emphasize the need not only to study in detail the climate change vulnerability of fisheries &aquaculture but also the methods of improving the adaptive capacity of aquaculture to climate variability and extremes.

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