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Relationship between Inland Fishing and Rain fall pattern of West Bengal a statistical analysis

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Abstract:

Inland fishing is a primary economic activity. In West Bengal this type of activity varies heterogeneously from district to district. Though among all geographical characteristics, climatic factors are affecting the inland fishing primarily but relief and anthropogenic activities also intervention this activity. So, we tried to relate the fishing area i.e. sanctioned area with the rainfall pattern of this state to show how the rainfall pattern affect this type of activity directly or not. After co-relate these two variables by statistical techniques it is clear that there is no direct or positive relationship in between rainfall pattern and sanctioned area though in some districts of West Bengal, there are positive relation in these two variables. From the investigation, it can be said that there are some other physical and anthropogenic parameters which directly affect the inland fishing and in this field rainfall pattern is not only an important parameter.

Key words: Inland fishing, Sanctioned area, Aqua culture, Rainfall, Correlation

1.0 Introduction:

We know that, the earth is a waterary planet. But only 0.76% of total water is fresh water which is useable for mankind [1].The most of the surface water is used in aquaculture and agriculture. In tropics this type of water are mainly recharged by rainfall. Here the relationship between rainfall and aquaculture area of west Bengal is taken into consideration as it is situated on monsoon belt with topographically heterogeneous [2]. So the impounded area and water logging varies district to district. West Bengal is located in the northern hemisphere , stretches from 21°30' North latitude in the south to 27°10' North latitude in the north. In the eastern hemisphere, west Bengal stretches from 85°50' east longitude in the west to 89°53' east longitude in the east [3].Topographically west Bengal divided in three physiographic divisions such as northern Himalayan region (e.g. Darjeeling, Jalpaiguri), flood plain area mainly Hooghly river basin and extended part of Chotonagpur plateau(e.g. Purulia, Bankura etc.)[4].Climatogenetically this state of India is hot moist sub humid region [5]. Here Monsoon is dominant controlling factor. From June to September heavy rainfall occurs due to south west Monsoon. Northern part of west Bengal, distribution and intensity of rainfall is very high. Moderate to low rainfall occurs on Hooghly river basin and western part of west Bengal in this season. But rest of the time (October to May) scarcity of rainfall affects agriculture and aquaculture [6].These types of geographical environment are suitable for the inland fishing. Though there are many factors are responsible for the development of the inland fishing, in this paper, we tried to showonly how the inland fishing of West Bengal is dependent on the rainfall pattern.

Organization of the paper is as follows. In section 2.0 we give some definitions. In section 3.0 we discussed the material

and method used in our analysis and in section 4.0 numerical simulation is done. Finally some conclusion is done.

2.0 Some definitions:

Aquaculture area:

Aquaculture is the farming of aquatic organism, including fish, molluscs, crustaceans and aquatic plants [6]. An aquaculture area is a designated area of water selected for its suitability for a specific aquaculture sector. In the state the potential aquaculture area is 8.16 lakh ha. and area under culture is 3.45 lakh ha. [7].

Impound area:

Impound means to shut up or enclosed. The impounded areas are local enclosed water resources: such as ground water, rivers, lakes and atmospheric precipitation [8]. In West Bengal the total impounded fresh water is 331739.70 ha. [9].

Sanctioned area:

The sanctioned area we defined as granted aqua culture area, for cultivation aquatic organisms' particular fishing season. In West Bengal the total sanctioned area was 1644.43 ha.under Fish Farmer's Development Agency (FFDA) in 2008-09. It was gradually decreasing from 2008-09 to 2012-13. Now in 2012-13, the total sanctioned area was 921.96 ha. [8].

3.0 Materials and methods:

The materials used here are the rainfall data collected from Indian Meteorological Department (IMD)[8]and the sanctioned area is collected from the statistical handbook of fisheries[10].

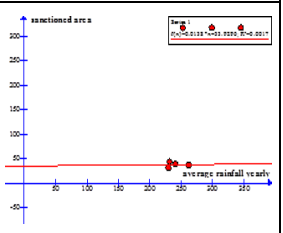
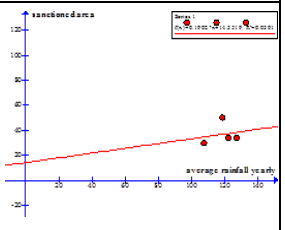
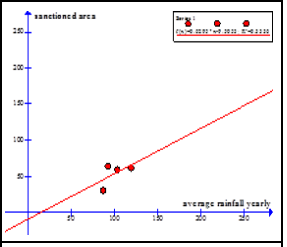
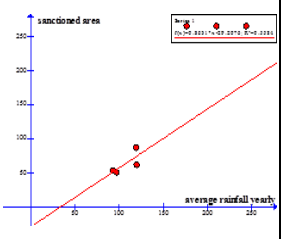
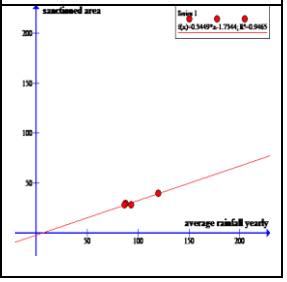
Let $x_1, x_2 \ldots\ldots x_n$ be the sample values. Now the mean is defined by $\overline{x} = \frac{x_1 + x_2 + \ldots\ldots + x_n}{n}$, some author use the symbol m

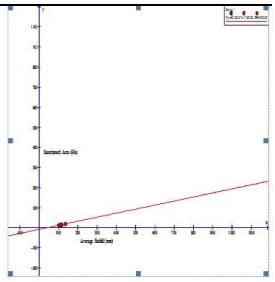
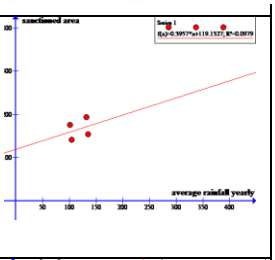
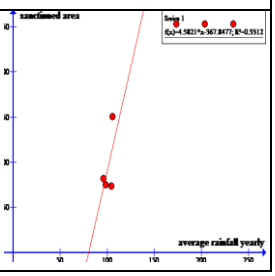
to denote mean. The standard deviation is defined by $<\sigma_x>=\sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2}$. The regression coefficient between two variables x and y is denoted by r and defined by $r=\frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sigma_x\sigma_y}$,where $\bar{x}$, $\bar{y}$ are the sample means of x and y respectively and σ_x and σ_y are the sample variances. The regression line of y on x is defined by $y=A+Bx$ where $B=\frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sum_{i=1}^{n}(x_i-\bar{x})^2}$ and $A=\bar{y}-B\bar{x}$ denotes the best fit line between the random variables x and y. The positive slope of the regression line indicates the variables are related positively i.e. if x increases then y increases and vice versa. On the other hand the negative slope of the regression line indicates the variables are related negatively i.e. if x increases then y decreases and vice versa. If the variables x and y is positively related then $r>0$, otherwise $r<0$. r=0 indicates no relation. If $|r|>0.8$ then x and y are highly related and if $|r|<0.5$ we called no relation and otherwise moderate relation [8].

4.0 Result and Discussion

The average rain fall and sanctioned area is shown in the following tables, the corresponding regression coefficient and regression line is also inserted in the table district wise

Table 1: The District having positive relation between Rainfall and Sanctioned area

District	Year	Rainfall (mm)	Sanctioned Area (ha)	r-value	The Regression line
a. Coochbihar	2009-10	240.5	38.53	0.04144 1	
	2010-11	231.2833	42.837		
	2011-12	261.8083	36.7		
	2012-13	229.1167	30.89		
b. Dakhsin Dinajpur	2009-10	118.6333	50.4	0.17363 2	
	2010-11	122.1083	33.78		
	2011-12	127.3833	33.85		
	2012-13	107.6417	29.86		
c. Malda	2009-10	119.5083	61.29	0.57758 3	
	2010-11	103.125	59.27		
	2011-12	92.25833	63.97		
	2012-13	86.925	30.4		
d. Murshidabad	2009-10	119.0083	87	0.74728 8	
	2010-11	119.7667	61.582		
	2011-12	92.85	53.68		
	2012-13	96.71667	50.62		
e. Nadia	2009-10	119.7583	39.89	0.97288 2	
	2010-11	93.08333	28.57		
	2011-12	87.39167	29.65		
	2012-13	86.53333	28.34		

f. Purulia	2009-10	101.825	12.92	0.99	
	2010-11	116.375	15.1		
	2011-12	112.5667	14.83		
	2012-13	136.2917	19.8		
g.East Midnapore	2009-10	101.05	174.97	0.31291	
	2010-11	135.0833	154.39		
	2011-12	103.9083	141.02		
	2012-13	132.3083	193.05		
h. Hooghly	2009-10	105.5583	150.82	0.57549	
	2010-11	98.20833	75.23		
	2011-12	104.525	73.58		
	2012-13	96.06667	81.78		

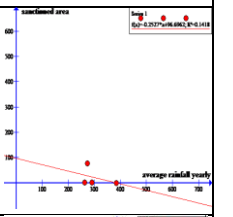
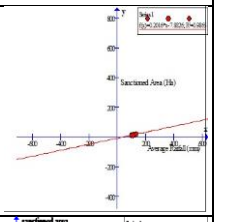
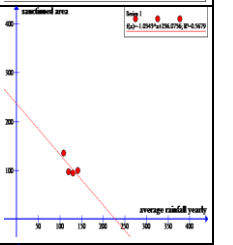
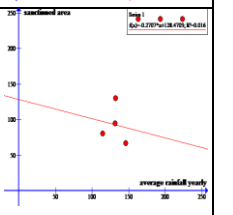
a. **Coochbihar:** In this district correlation coefficient (r) between average rainfall (mm) and sanctioned area (ha) is positive (0.0414). This weakly positive relation shows rainfall affects sanctioned area. The topographical characteristic demands heavy water logging. But excessive rainfall in the year 2011-12 made flood condition. This is why the sanctioned area decreased in the year 2011-12 and 2012-13.

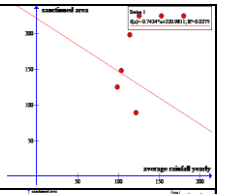
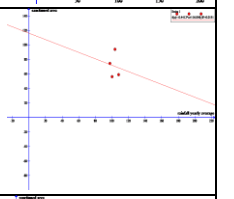
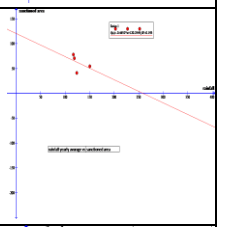
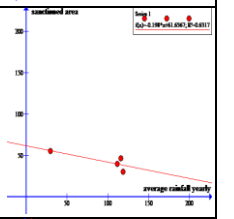
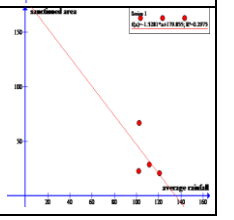
b. **Dakshin Dinajpur:** In this table-1 the correlation between both variables is positive and low (r=0.173632). The significance of this relation is that the sanctioned area dependent on annual average rainfall. But very low relation indicates other parameters also affect the system. The parameters may be topographic characteristics, and lack of interest in fishery.

c. **Malda:** Due to flood plain land situated on the basin of the river "GANGA", most water bodies filled up in rainy season. So average rainfall directly affects the sanctioned area for aqua culture. In this connection it is clear that the correlation between two variables is moderately positive.
d. **Murshidabad:** Here the highly positive correlation indicates the sanctioned area are directly affected by annual average rainfall. Due to many flood plain lakes are self-capable for water logging and a huge part of population is interested to inland fishing. The demand is high, and it is valuable for employment generation as well as development of rural economy.
e. **Nadia:** Geographically Nadia is situated on flood plain area. This district has different kind of water bodies and soil character is fine-loamy. So water logging capacity is very high. In this connection the district water bodies (i.e. ponds, tanks, Beel, Baor, river, canals etc.) are recharged by rainfall, mainly in rain season. This is why the correlation between the sanctioned area and average annual rainfall is very highly positive.
f. **Purulia**: The most western part of the state, Purulia district is located on the Chotonagpur plateau fringe. Undulating topography with west to east ward slopping, rocky structure and poor drainage system are the main characteristic of this district. For that reason maximum impounded areas are recharged in monsoon period. So the correlation between the two variables is very highly positive.
g. **East Midnapore:** In East Midnapore district the correlation between the two variables is low positive. This district situated on the coastal region of Bay of Bengal. As a result sanctioned area not only dependent on rainfall but also depend on saline water. Here some water bodies are used as cage fishing throughout the year by saline water.

h. Hooghly: Topographically Hooghly district is flat land. Many water bodies are capable of water logging. Population density is not so high and pollution is also under control. For that reason average annual rainfall affect the sanctioned area directly. So both variables are correlated with moderately positive.

Table 2: The District having negative relation between Rainfall and Sanctioned area

District	Year	Rainfall (mm)	Sanctioned Area (ha)	r-value	The Regression line
a.Darjeeling	2009-10	385.2833	0	-0.37659	
	2010-11	291.6083	2		
	2011-12	274.025	76		
	2012-13	263.4917	1.94		
b.Jalpaiguri	2009-10	299.95	23.85	-0.11326	
	2010-11	300.375	13.94		
	2011-12	292.6417	19.74		
	2012-13	284.55	19.58		
c.North 24 Parganas	2009-10	107.95	136.028	-0.7536	
	2010-11	119.95	98.04		
	2011-12	141.2167	100.014		
	2012-13	129.5667	94.44		
d.South 24 Parganas	2009-10	132.0083	130.34	-0.12659	
	2010-11	131.1667	94.55		
	2011-12	114.45	80.33		
	2012-13	145.6083	67		

e.Burdwan	2009-10	113.5083	198.34	-0.1658	
	2010-11	103.475	147.67		
	2011-12	98.275	124.76		
	2012-13	121.1333	89.19		
f.Birbhum	2009-10	118.4417	70.67	-0.11	
	2010-11	123.725	41.05		
	2011-12	116.6917	77.86		
	2012-13	150.1917	54.65		
g.Bankura	2009-10	118.4417	70.67	-0.43	
	2010-11	123.725	41.05		
	2011-12	116.6917	77.86		
	2012-13	150.1917	54.65		
h.West Midnapore	2009-10	29.90833	55.46	-0.79481	
	2010-11	115.7833	46.57		
	2011-12	111.2667	39.96		
	2012-13	118.35	30.26		
i.Howrah	2009-10	102.225	66.89	-0.54521	
	2010-11	120.5917	20.73		
	2011-12	111.6417	29.04		
	2012-13	102.0167	23		

a. **Darjeeling:** The relationship between two variables is negative. The correlation analysis of average annual rainfall and sanctioned area reveals substantial to strong negative correlation, because this area is rugged topography. For that reason the water logging capacity is very poor and in winter season snow fall freezes the water bodies.

b. **Jalpaiguri:** The Himalayan foot hill district is topographically downwards to the north to south direction. The rocky nature of soil is not capable for huge water

logging. As a result the sanctioned area and average rainfall is weakly negative correlation.

c. **North 24 Parganas:** The correlation between sanctioned area and average rainfall of North 24 parganas district is highly negative. This district is highly populated and urbanized. Many part of the district like Sandeshkhali, Hingalgaunge etc are practiced fish farming by cage and pen culture using saline water. As a result sanctioned area is not directly dependent on rainfall.

d. **South 24 Parganas:** Due to tidal feeding drainage system, maximum water bodies are dependent on saline water. So rainfall does not affect throughout the year. There is low negative correlation between sanctioned area and average annual rainfall of the district South 24 Parganas.

e. **Burdwan**: This district geographically divided broadly into two segments. The western part is rocky and eastern part is situated on the Hooghly river basin, sloping is downward from west to east. Clearly water logging is poor. Correlation coefficient (r) between average rainfall(mm) and sanctioned area(ha) is -0.1658. This also agrees with the explanation.

f. **Birbhum:** In the Birbhum district the data shows negative relation. Here rainfall has minimum effect on the sanctioned area. Due to Lateritic soil character and east ward sloping the water logging capacity of this district is very poor. For that reason the correlation between average rainfall(mm) and sanctioned area(ha) is negative and the r value (-0.11) shows very weak relation.

g. **Bankura:** From the table and graph it is clear that the relationship between average rainfall (mm) and sanctioned area (ha) of inland aqua culture is negative that means sanctioned area is not dependent on rainfall. It seems that other parameters like anthropogenic activities affect the sanctioned area. Here the value of correlation coefficient is -0.43, this "r" value shows the relation between two variables is low or weak relation.

h. **West Midnapore**: The correlation between sanctioned area and average annual rainfall of West Midnapore district is highly negative. This district is situated on south west part of West Bengal. Here low population density, dense forest and lack of interest causes the negative relation between the two variables
i. **Howrah:** On the basis of above data the correlation between sanctioned area and annual average rainfall is moderately negative. This district situated on the bank of Hoogly River and highly populated. Here industrial growth is very high. As a result many water bodies are polluted and useless for fishing activities.

From the table-1 it is cleared that among the positively related (i.e. having positive correlation co-efficient between rainfall in mm and sanctioned area in ha) districts, East Midnapur is highly inland fishing district though rainfall is moderate. This shows that, to increase the inland fishing rainfall is necessary but not a sufficient criterion. The Coochbihar district has high rainfall but sanctioned area of inland fishing is very low which indicates either topological characteristic or consciousness of inland fishing or there are some other conditions which are affecting the inland fishing of the district. The inland fishing in this district is not increasing for the above mentioned problems. In Hoogly district rainfall is moderate and sanctioned area also moderate among these positively related districts. This district has high probability of development of inland fishing if some proper steps are taken into consideration. The Purulia district has moderate rainfall but poor sanctioned area (maximum 19.4ha) indicates this district has some other problems.If it is undulating topography then there is low possibility to increase sanctioned area unless new water logging method is developed. Nadia, Maldia, Dakshin Dinajpur and Murshidabad has average rainfall but sanctioned area is poor compared to East Midnapoor but physical features here alluvial plain like, So

there is high probability of increasing the sanctioned area with proper action plan.

The negative value of correlation coefficient among the districts in table-2 indicates in those districts rainfall does not affect the inland fishing. North 24parganas, South 24Parganas has moderate rainfall but sanctioned area is comparatively high indicates some other criteria affects the increasing of inland fishing. It may be effect of tidal fed river, anthropogenic activities etc. Burdwan district is an interesting district because here rainfall is moderate but sanctioned area is high due to large area of eastern part is river centric and highly water logging capacity. Darjeeling and Jalpiguri have heavy rainfall but very low sanctioned area indicates rainfall does not affect the fishing activities because slope is steep, water logging capacity is very low and development of inland fishing is quite harder here. The western part of west Bengal, Birbhum, Bankura, Howrah and West Midnapoor in table-2 has moderate rainfall but sanctioned area is comparatively poor indicates there are high possibility of development of inland fishing using rainfall water.

5.0 Conclusion:

From the above discussion it is cleared that in maximum district of West Bengal rainfall does not affect the inland fishing. The coastal districts or the districts in the river basin is highly probable for inland fishing but the district having complex topographical features has low probability of inland fishing. Thus we can conclude topographical features affect inland fishing because inland fishing is an artificial primary economic activities developed by human intervention.

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