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Impact of Climatic Variability on Salt Production in Sambhar Lake, a Ramsar Wetland of Rajasthan, India

[1]A.H. Bhat, [1]K.C. Sharma and [2]U.J. Banday

[1]Department of Environmental Science, Central University of Rajasthan, India
[2]Department of Economics, Central University of Haryana, India

Abstract: Climate and weather conditions affect almost every industry in nearly every country. Over the coming decades climate change could potentially have impacts on many industries. For example, salt production, particularly in developing regions of the world is likely to be hard hit by climate change over the coming decades. Sambhar Lake has a wealth that supports diverse and unique habitats of ecosystem. In this context, the importance of temperature and rainfall for salt production is highlighted in this paper.This paper briefly describes Indices such as frequencies of daily minimum and maximum temperature, monthly rainfall, number of rainy days in each month, annual rainfall and total number of rainy days in a year. The analysis of the data revealed that the rainfall pattern has changed slightly during the years of study. The monthly number of rainy days has increased during the monsoon season for the period from 2010 to 2013.The analysis shows that the change in temperature and rainfall patterns of climatic shift which may affect the salt production.It was observed from data that during the years in which annual rainfall was less the salt production was recorded high, while as during the years in which annual rainfall was higher the salt production was low.

Key words: Wetland · Rainfall · Temperature · Salt

INTRODUCTION

Wetlands are amongst the most productive ecosystems of the Earth [1]. India is the third largest Salt producing Country in the World after China and USA with Global annual production being about 230 million tones. The total production of salt in 2012 was 282 million tons whereas it was 261 million tons in 2011 [2]. The growth and achievement of Salt Industry over the last 60 years has been spectacular. When India attained Independence in 1947, salt was being imported from the United Kingdom &Adens to meet its domestic requirement. But today it has not only achieved self-sufficiency in production of salt to meet its domestic requirement but also in a position of exporting surplus salt to foreign countries [3]. The production of salt during 1947 was 1.9 million tones which have increased tenfold to record 22.18 million tons during 2011-12. India exported salt to the tune of about 35 Lakh tones during the year 2011-2012 [4]. The demand for salt is increasing especially in developing countries due to the large chemical manufacturing market. Salt production declined by 2.1% in 2012 versus the previous year due to lower US and Canadian volumes. Winter in North America was mild which caused decline in production. Several countries also supplied less salt to the world market in 2012, while there was no significant increase in output of any particular country or region. The global salt demand is predicted to increase by almost 3% each year from 2013 to 2016, boosting prices for the product across many regions [5]. In 2016, the global salt production volume is likely to go beyond 310 million tones [6]. Over the years natural resources exploitation has increased. In India salt is extracted from two major Lakes Sambhar Lake in Rajasthan and Chilka on the east coast. Sambhar Lake is the principal source of lake salt.

Study Area and Back Ground: The Sambhar Lake was chosen because it is the largest inland saline Lake popular for salt manufacturing since ancient times and independent India. The saline Lake has been designated as Ramsar site (Wetland of international importance No. 464 March 1990) and Important Bird and Biodiversity area (IBA site No. IN-RJ-1) because of wintering area for tens

Corresponding Author: Umar Banday, Department of Economics, Central University of Haryana, India.

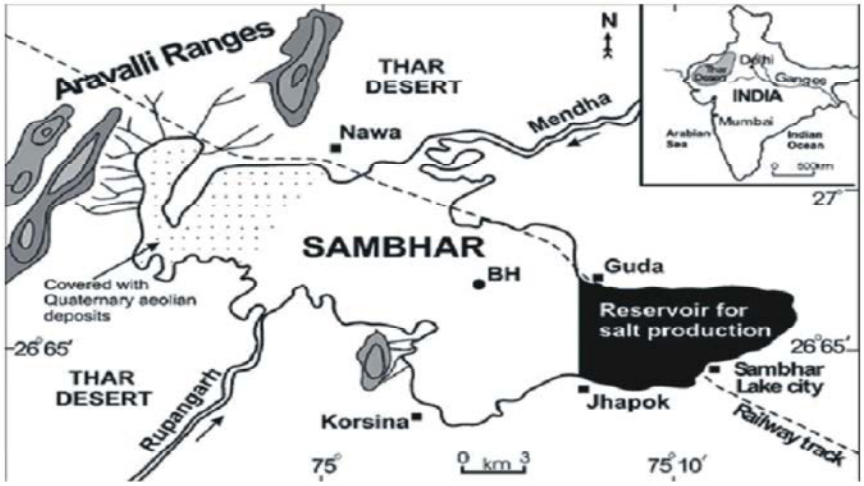

Fig. 1: Location map of Sambhar Lakein the Thar Desert of Rajasthan

of thousands of flamingos (endangered species) and other birds migrated from northern Asia. It is a shallow centripetal Lake situated at 26°52′–27°2′ N, 74°53′–75°a13′E. Salt is produced by evaporation process of brine and is mostly managed by Shambar Salts Ltd.(SSL), a joint venture of the Hindustan Salts Ltd. and the government of Rajasthan. Brine from vast western side of dam is pumped via sluice gates, canals and pumps after a particular density (considered optimal for crystallization) to eastern side of dam, which serves as reservoir for salt extraction. Salt extraction from Sambhar Lake in India started in the 6th Century A.D. Sambhar Salt Lake in Rajasthan is well known for salt manufacturing since long including periods of Scindhias, Rajputs, Marathas, Moghuls, rulers of Jaipur and Jodhpur (joint owners) leased it to British in 1870. Britishers laid down rail trolley system (presently replaced by mini diesel locomotives) across the dam to various far flung locations of Lake. The share of Rajasthan in the total production of salt in India is about 8 percent. Sambhar Salts Limited (SSL) contributes only 3 per cent to the total production in India. But it is high on demand because of presence of sodium chloride in its brine about 2 lakh MT is being extracted annually by Sambhar salts Limited from surface water of Lake and by sub-soil brine by making bore wells. Almost more than 8,000 hectors ofarea of the Lake has been appropriately given to saltpans. Average depth of Lake during monsoon period is about 0.6m. The area experiences semi-arid to arid climatic conditions with annual average rainfall of 550mm, average annual temperature of 23°C and maximum temperature of 45°C. The salt Lake is fed by present drainage systems of Mendha, Roopnagar, Kharian and Khandel. MendhaRiver, the largest feeder stream (catchment area 3600 Sq. Km) originated in the north east of the Lake (Sikar district), flows southwestward and enters the Lake towards north. RupangarhRiver originating in the south near Ajmer city has northeasterly flow and joins the Lake from south after draining about 625 Km^2 hilly areas. Total catchment area of the Lake is about 7500 Km^2.

Sambharlake is fed by the river Mendha from north east (NE) and the river Rupangarh from the south west (SW). The easternmost part of the lake is used for salt production by sambhar salts Ltd. (SSL).

Sambhar Lake is divided by a five kms long stone dam (Jhapok to Guda) into two unequal parts. The eastern divide of the Lake is a brine reservoir covering an area of 76.8 Sq.km. This area comprises number of salt pans (Kyars) for the manufacture of salt through natural evaporation method, by Sambhar salt limited.

Methodology: The study was based on meteorological data and production data collected from Sambhar Salts Limited which is located near Lake Boundary. The existing data and reports were also reviewed and then data were analyzed. Field surveys and extensive consultations were done with stakeholders in the vicinity of the Lake and villages in the catchment area. The analysis of data was made through both descriptive and inferential statistics. In Descriptive analysis data was presented through maps, flow charts, tables and figures. Statistical analysis was made through some appropriate statistical tools as per the requirement of the research like percentages and averages etc. Multiple Regression and t test has been used to analyze the impact of climate change on salt production of Sambhar Salts Limited.

Fig. 2: (A)Showing Lake separated into two different parts (B) Salt transportation (C) Packing

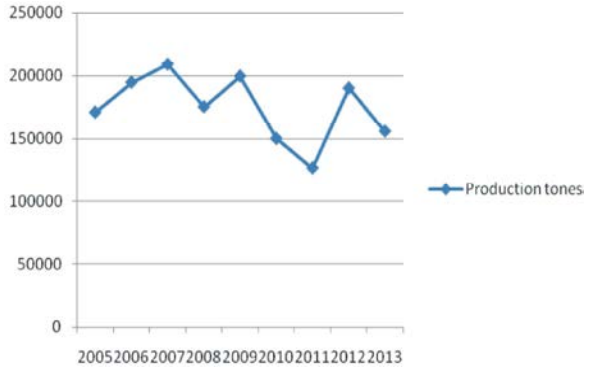

Fig. 3: Salt production per year (tones)

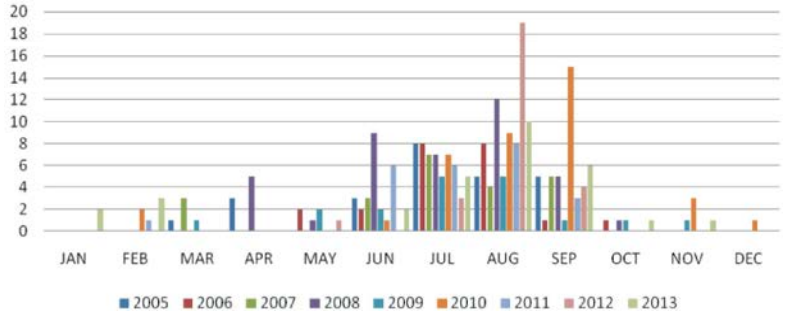

Fig. 4: Number of rainy days per month during the period 2005 to2013

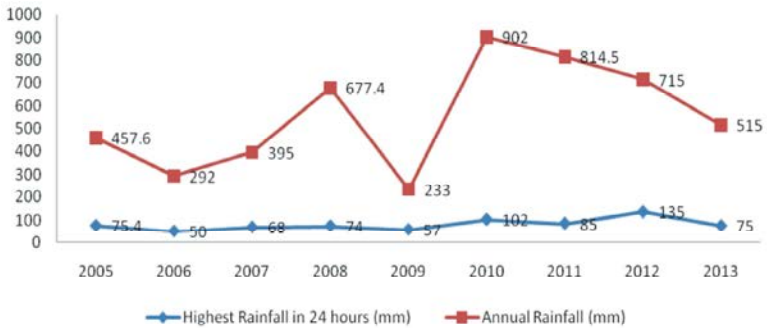

Fig. 5: Annual rainfall of year's 2005 to2013 and highest rainfall in 24 hours

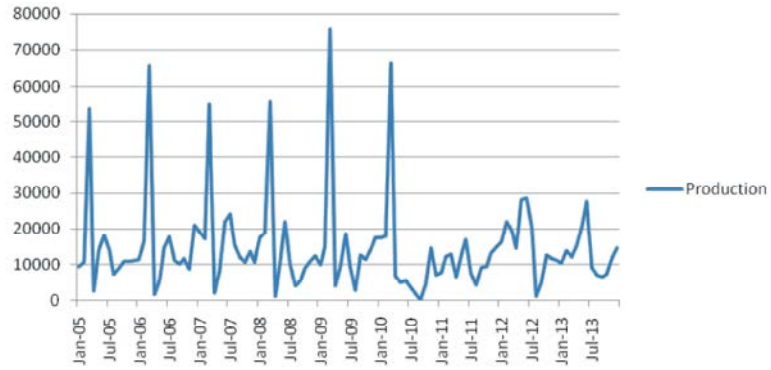

Fig. 6: Monthly Salt production

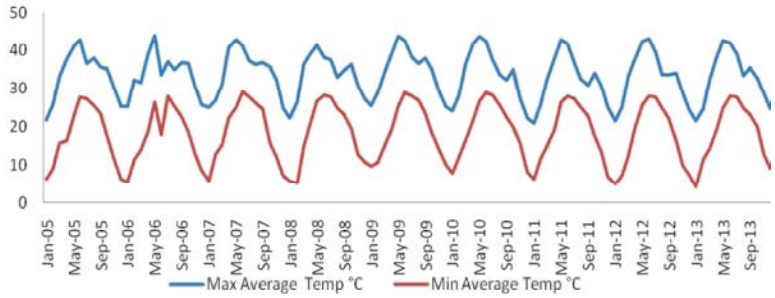

Fig. 7: Monthly Average Max and Min Temperature of period of 2005 to 2013

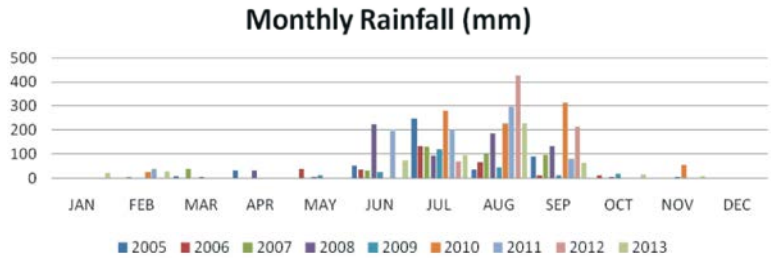

Fig. 8: Monthly rainfall (mm)

Relationship Between Salt Production and Climate Change: The relationship between climatic conditions and salt production is very critical. The different graphs below show the relationship between salt production and temperature and salt production and rainfall.

So we can say: **Salt Production**=*f* (Temp and Rainfall) (1)

Higher the Rainfall higher will be the production and more the temperature more will be the salt production. This means the entire phenomena is based on climatic conditions. On the other hand higher will be the production it will generate higher economic value in the form of employment, income and development of the area.

The above results show us that the salt production is dependent on the climatic conditions of that area. It is being seen that Rajasthan has a climatic hot conditions which is favorable for the salt production but on the other side the rainfall is very less, which affects the salt production that means by climatic variations is going to affect the economy of that area and also the adjoining areas.

RESULT AND CONCLUSION

The Following Model is build:-
Model-1

$$Y_t = \alpha_o + \beta_1 X_1 + \beta_2 X_{2t} + \mu_t$$

Table 1: Impact of Rainfall and Temperature on Salt Production

Salt Prod	Coef	Std.Er	p value	t-value	R^2	Obs
Rainfall	-.0787696	.035336	0.067	-2.23	0.53	9
Temp	1.363941	4.48808	0.77	0.30	.52	-
Cons	172.3914	160.889	0.325	1.07	-	-

Y= Salt production
X1 =Variation in temperature
X_2=Average Annual rainfall
μ = Disturbance term

Table 1 shows the results of Multi regression between Rainfall, Temperature and salt production of The Sambhar salts Limited from the year 2005-2013 in which salt production is regressed on temperature and rainfall. It is assumed that the climate variation measure in term of variation in rainfall and temperature have an impact on salt production over the period of time. The result of model reveals that the climate change (increase in Temp and Decrease in Rainfall) has an impact on salt production. The model shows a significant impact of temperature on the salt production if there is an increase in 1ºC temperature 1.363 tons of salt production is increased. On the other hand the rainfall too have significant impact on salt production, the results of model show if there is 1mm increase in rainfall will lead -.078 ton decrease in salt production. The decrease in salt production is a clearer evidence of climatic change in Rajasthan.

CONCLUSION

This study revealed that the climatic variation as occurrence of drought have significant impact on the salt production. The reduction impact of salt production is very high due to decrease in rainfall due to climate change on the other the increase in temperature which is good for salt production but the salt is a bye product of water more the water or rainfall more will be the salt production.

It was observed from data that during the years in which annual rainfall was less the Salt production was high i.e. during years 2007, 2009 and 2006 there was 209326,199826 and 194911 MT(Metric ton) of salt were the annual rainfall was 395,233 and 292mm respectively while as during the years in which annual rainfall was higher the salt production was low i.e. during the years 2011, 2010 and 2013 there was 126409,149833 and 155740 MT of salt were the annual rainfall was 814,902 and 515 mm respectively. It may be because the salt production process is monsoon-dependent. The lake taps water from seasonal rivers Mendha, Rupangarh, Kharian and Khandel and numerous streams and rivulets. This water reacts with the Lake sediments and becomes brine. When there is less rainfall the brine concentration is strong this may be corroborated with more concentration of salt in brine because of dilution. The amount of water content in brine is directly related with temperature, high temperature results in higher rates of evaporation under such conditions the extraction of salt from the brine is more per unit time.The results of this paper pose importance to those factors by which we can control climate change and how to address these issues.

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