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Investigate the effect of drought conditions on potential rate of corrosion and deposition on the Bahmanshir River

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Abstract: Effects of drought damage had been so much in water resources, agriculture, manufacturing, health care in recent years. One of the drought is hydrological drought Hydrological drought which means Lack of water flow by comparing to the normal value that is a natural event and reproducible in any climate. In this study, precipitation data from synoptic stations of Abadan during 2004-2013 has been used for the analysis. Therefore using SPI drought index to evaluate the severity of the drought were investigated and after that to investigate the potential for corrosion and deposition of river water quality data have taken from 11 station of Bahmanshir in Abadan then The annual average index for calculation of corrosion and deposition parameters (Ryzener and Larsen) were used. Finlay the water corrosively potential association with the extent of drought in both years were analyzed. The results showed that the corrosion potential and sedimentation of water has a direct relationship. With periods of drought meanwhile as the drought is much more severe on other hand Corrosion and deposition potential will increases too. The most severe drought period had happened in years (2009-2008). The amounts of corrosion and deposition parameters show the maximum amount. Also the results indicate that the quality parameters of river by comparing to the reducing in amount of water flow is vulnerable In periods of drought Therefore it is recommended that Water resources planning and management activities to reduce the devastating effects of drought on Bahmanshir River and its water supply must be done as soon as possible.

Key words: *Corrosion index; Drought; River Bahmanshir index; Precipitation; Drought*

1. Introduction

Corrosion and deposition is one of the most important indicators in assessing water quality (Crittenden et al., 2005). Occurrence of corrosion and deposition phenomena are disrupted, economy, industry, transmission and distribution, and in some cases of water treatment Corrosion products cause adverse health problems and reduced life into drinking water pipes and fittings (Seyed Razi, 1997; Sawyer et al., 1994). Sedimentation also reduces the flow of pipes and in addition will reduce the performance of valves and fittings (American Water Works Association, 1990; Edwards, 2004) the corrosion of water distribution networks will occur on the effect of electrochemical, chemical, physical reasons and some factors such as alkalinity, hardness, dissolved gases, temperature, and pH, are the main factors which are effective (Brogers and Appendix, 2002; HDR Engineering, 2001).

Many variable factors such as the features and the type of metal that have used in pipes structures, the surface in contact with water, oxygen, sulfate ions, increased release of carbon dioxide, temperature and the presence of microorganisms, the extent of corrosion are controlling in a water supply system **(**Pishnamazi, 1998). The successive droughts, Water harvesting and increasing consumption on the other, And finally sources of pollutants discharged into rivers The successive droughts, Water harvesting and increasing consumption on the other, And finally sources of pollutants discharged into rivers have been caused Increasing salinity and severely degrade the water quality of the river is its unique source of drinking water supply for various uses including agriculture needs. Preserving and protecting the quality of water resources and drought weather conditions, harvesting and consumption increasing environmental pollution and also extensive invasion is a mission that are facing to us as a national priority. This research is trying to explore the impact of drought conditions on the corrosion potential Bahmanshir River and analyzing the river's water by comparing sedimentation and deposition of corrosion indicators. Also very worrying prediction of the future continuation of the current situation in the drought conditions has analyzed.

2. Materials and Methods

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2.1. The area of studying

Bahmanshir River with approximately 70 kilometers Length has been located in south of Khuzestan province that has been split from Karoon River in a pace which has named HEFAR in KHORAMSHAHAR and after passing through the Abadan and CHUEBDEH cities is connected to the Persian Gulf. This river is affected by tides of Persian Gulf. The resulting wave of this phenomena will continue to move to the farthest point on the Bahmanshir River. In this phenomenon salty water of the sea and river's water meet and mixing takes place. Some of the used water in Abadan is providing from station 11 which has located beside Bahmanshir River. The coordinates of the mentioned station are 88 degrees, 49 minutes and 50 seconds is the length and 30 degrees, 22 minutes and 40 seconds width. The satellite images of Project's location and the location of 11th station has shown in Fig.1.

Fig.1: Location The studied area (station 11 in Abadan)

Therefore using SPI drought index to evaluate the severity of the drought were investigated and after that to investigate the potential for corrosion and deposition of river water quality data have taken from 11 station of Bahmanshir in Abadan then The annual average index for calculation of corrosion and deposition parameters (Ryzener and Larsen) were used. As following the standard SPI drought index for drought study is presented.

3. Standardized Precipitation Index (SPI)

This method developed by McKee et al (1993) due to the lack of differential effects of precipitation on groundwater, reservoirs and surface water resources, soil moisture and stream flow are presented. This index is a powerful tool in the analysis of rainfall data. The purpose of SPI is assign a numerical value to the rainfall that can be compared with areas with different weather. The advantage of this index that can be pointed out is its simplicity and versatility. The index is normally distributed and has flexibility over different spatial and temporal scales.

This index is calculated by the following equation.

$$SP = \frac{P_i - \overline{P}}{SD} \qquad (1)$$

Where SPI is Standard Precipitation Index

P_i: rainfall amounts

$\overline{P}$: Average long-term average rainfall

And SD is standard deviation.

McKee et al (1993) with regard to the value of the index and the index properties and the occurrence periods were classified Intensity of dry periods in

Table 2.n this classification, a period of drought occurs when SPI index consistently is negative and reaches 1 - and lower and ends when the SPI index is positive.

Table 1: Classes extremely dry periods based on SPI amounts

Extreme dry periods	Severe dry period	The average dry period	Dry periods of poor	Normal	Class
Smaller or equal-*2*	of *-1/5* up to *-1/99*	of *-1* up to-*1/49*	Of *0* up to*0/99* -	Under	Amount SPI

In order to evaluate the corrosion and deposition of Bahmanshir River, water chemical parameters of station 11 in Abadan has used. Statistics of this station was received from Khuzestan Water and Power Authority. The taken Statistics relating to the years 2004-2013 These data is including: Temperature, pH, calcium concentration, bicarbonate concentration, total dissolved solids (TDS) and electrical conductivity (EC).

4. Methods of corrosion and fouling

There are different methods to predict water fouling or corrosion tendency. It should be noted that these methods are usually based on chemical equilibrium and can only determine what will happen, but it would not check the dynamics.

The easiest way to explore this issue is determining tendency to sedimentation or erosion of water the by Using indicators Relations corrosion.

$$pH_s = (9.3 + A + B) - (C + D) \qquad (2)$$

$$A = (\mathrm{Log}_{10}(\mathrm{TDS}) - 1)/10$$

$$B = -13.12 Log_{10}(^{0}\mathrm{C} + 273) + 34.5$$

$$C = Log_{10}(\mathrm{Ca}^{+2} \text{ as } \mathrm{CaCO_3}) - 0.4$$

$$D = Log_{10}(\text{Total Alkalinity as } \mathrm{CaCO_3})/10$$

To calculate the Ryzener index relationship (3) has used.

$$RI = 2pH_s - pH \qquad (3)$$

To calculate the Larsen (LR) index equation (4) has used.

$$LR = \frac{(\sum Cl^{-} + \sum SO_4^{-2})}{(\sum HCO_3^{-} + \sum CO_3^{-2})} \quad (4)$$

Table 2: Detailed index Ryzener (Pishnamazi, 1998)

Detailed Mode	RI Index
Water has a high deposition	$RI \leq 4$
Precipitation is relatively little water and is corrosive	$5 \leq RI \leq 6$
It is neither corrosive nor deposition	$6 \leq RI \leq 6.5$
Wateriscorrosivedepositionislow	$6.5 \leq RI \leq 7$
Severe corrosive of water	$RI \geq 8$

Table 3: Detailed index Larsen (Pishnamazi, 1998)

Detailed Mode	LR **Amount**
Severe corrosive of water	$LR \succ 1.2$
The water is corrosive	$0.8 \prec LR \prec 1.2$
Sedimentation The property of water are	$0.8 \succ LR$

Table 4: Calculation of water corrosively index Bhmnshyr at Station 11

LR Larsen		RI Ryzener		Index / Year
Interpretation	Amount	Interpretation	Amount	
The water is corrosive	8/12	The water sedimentation	7/64	**2004**
The water is corrosive	7/43	The water sedimentation	7/18	**2005**
The water is corrosive	7/22	The water sedimentation	7/06	**2006**
The water is corrosive	7/09	The water sedimentation	7/06	**2007**
The water is corrosive	7/079	The water sedimentation	7/11	**2008**
The water is corrosive	7/39	The water sedimentation	7/21	**2009**
The water is corrosive	7/32	The water sedimentation	7/37	**2010**
The water is corrosive	7/19	The water Corrosive	7/62	**2011**
The water is corrosive	7/11	The water Corrosive	7/53	**2012**
The water is corrosive	7/03	The water sedimentation	7/31	**2013**

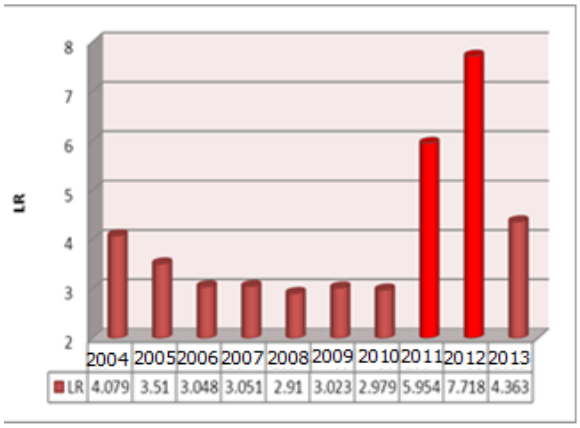

Fig.2: Larsen index indifferent

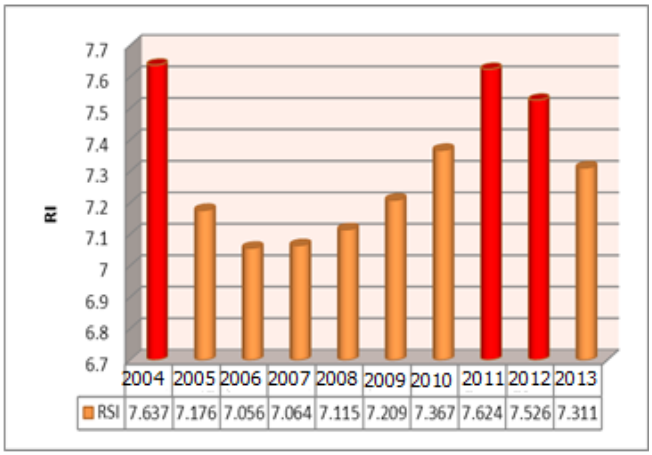

Fig.3: Index levels in different Ryzener

Table 5: Calculation of drought monitoring indicators based on SPI

SPI		Water year
The droughtconditions	Index value	
Normal	0.63	2004-2005
Droughtpoor	-0.77	2005-2006
Normal	0.65	2006-2007
Droughtpoor	-0.16	2007-2008
Normal	0.73	2008-2009
Normal	0.14	2009-2010
Averageof drought	-1.27	2010-2011
The severe drought	-1.99	2011-2012
Droughtpoor	-0.46	2012-2013

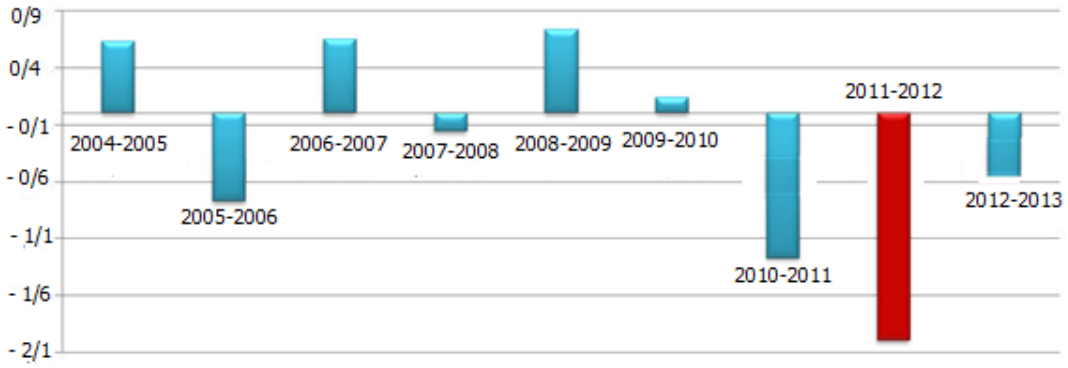

Fig.4: View of the annual SPI synoptic stations of Abadan

5. Results and Discussion

Reproducibility of this phenomenon is due to drought in the coming years is inevitable. According to the standard SPI drought index varying degrees of drought categories (Table 4) has been studied as follows.

5.1. The monitoring of standard drought index SPI:

1 Moderate drought event, 2 event of severe drought 3 and 4 is showing normal situation year's Poor Event drought .

The worst drought is the drought of years (2011-2012). Results of water quality parameters and corrosively index have been shown in Table 7 and 1 and 2 charts. Which shows that both Index and Larsen Ryzener years (2011-2012) that the most severe drought occurred are introduced the water in Corrosive and sediment conditions. On the base of Fig.1 and Table 7

Ryzener index in (2004-2013) indicates the status of the water sedimentation and since (2011-2012) that the most severe drought conditions occurred shows Water conditions with high corrosion potential. Which indicated that severe droughts and water resources corrosion potential of water have been increased. Larsen index for all years (2004-2013) as corrosive water situation shows that this index has increased with increasing Intensity of droughts. What is the overall outcome of this study is that on the river Bahmanshir are tended to corrosion and deposition especially in periods of severe drought. Corrosive water also will create problems for consumers and farmers. Corrosive waters in different cases causing cost. that the most important ones are: Reduce the efficiency of the heating system and interfere with their work Corrosion and damage to the residential plumbing system and water supply, Create a bitter taste similar to water due to the relatively large amounts of metal components, creating water color, increases water loss and the possibility of poisoning due to the use of waters containing toxic metals such as lead and copper values. In addition to the above, the corrosive effects of water would adversely affect the aesthetic of the water. Since the control corrosion and deposition targets, including public health, improve water quality, increase the lifespan of water supply facilities and also provide national standards for water quality. It is therefore reasonable and practical actions in this regard will also be economical. However, due to the warm weather conditions in Abadan, which accelerate chemical reactions associated with corrosion ,therefore it is possible to dissolve some compounds, heavy metals and other undesirable compounds in water is not unexpected.

Hence, attention to water corrosion control, corrosion and deposition of continuous monitoring of water status is recommended.

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