

FLUCTUATIONS IN HYDROGEN ION ONCENTRATION IN PUNJAB SATLUJ FLOODPLAIN (INDIA): SPATIAL- TEMPORAL ANALYSIS FROM 1970 TO 2011

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Abstract

Hydrogen ion concentration in water decides its basic and alkaline property. Water beyond normal range of pH value adversely affects the nutritional balance due to increased toxicity. It affects nutrients solubility and availability in water. Mean pH value of underground water for Punjab Satluj floodplain is 7.64 during 1970 which has been increased to 8.33 in 2000 and again reduced to 7.6 in 2011. Standard Deviation is 0.14 in 1970 and 0.29 in 2011. Prominently underground water of this area is basic in character.

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Introduction

Hydrogen ion concentration depicts on pH scale. It indicates the acidic, basic and alkaline property of water. pH value less than 7 is considered acidic, 7 value shows the neutral character, more than 7 means water is basic and above 8.5 depicts water is alkaline (Todd and Mays, 2011). Water having above 8.5 pH value is bitter in taste (Khattak et al., 2012). Its value is altered from the addition of carbon dioxide from plant respiration process and decomposition of organic material as it releases carbon dioxide, and through run off from land (Sheila, 2007). This process worked tremendously in that area as cropped land was expanded over 46404.47 hectares (100.56 percent) positively from 1971 to 2011 (Gill, 2015). According to World Health Organization (2011) permissible limit of pH value ranged 6.5 to 9.2 and values above this affect the potability of water.

Methodology

Data had been collected for identified fifty wells located in Punjab Satluj floodplain from the Department of Soil and Conservation, Punjab and Central Groundwater Board, India for 1970 to 2011. Spatial plotting of identified wells had been done in Geographic Information System. Spline interpolation technique has been applied for preparing isolines.

Discussion and Analysis

Hydrogen ion concentration in underground water of Punjab Satluj floodplain varied with time depending upon the extensive agricultural expansion and its allied activities that add adulterants in water. Movement of groundwater also affects the spatial variation of pH. Mean pH value of water was 7.64 in 1970 with 0.14 standard deviation that was increased to 8.33 mean pH for 2000 with 0.26 standard deviation and again decreased to 7.6 mean pH in 2011 with 0.29 standard deviation (table 1).

During **1970**, pH value for Satluj floodplain ranged between 7.35 and 7.8. This has been categorized into three classes. Distribution pattern of these three classes separates the study area in three parts i.e. eastern, central and western part (figure 1 (a)). In *eastern part* gradient of high to low pH value was observed from north-east to south-westward. Eastern part of study area was characterized with high pH value that ranged 7.6 to 7.8 and comprises eastern Balachaur Block

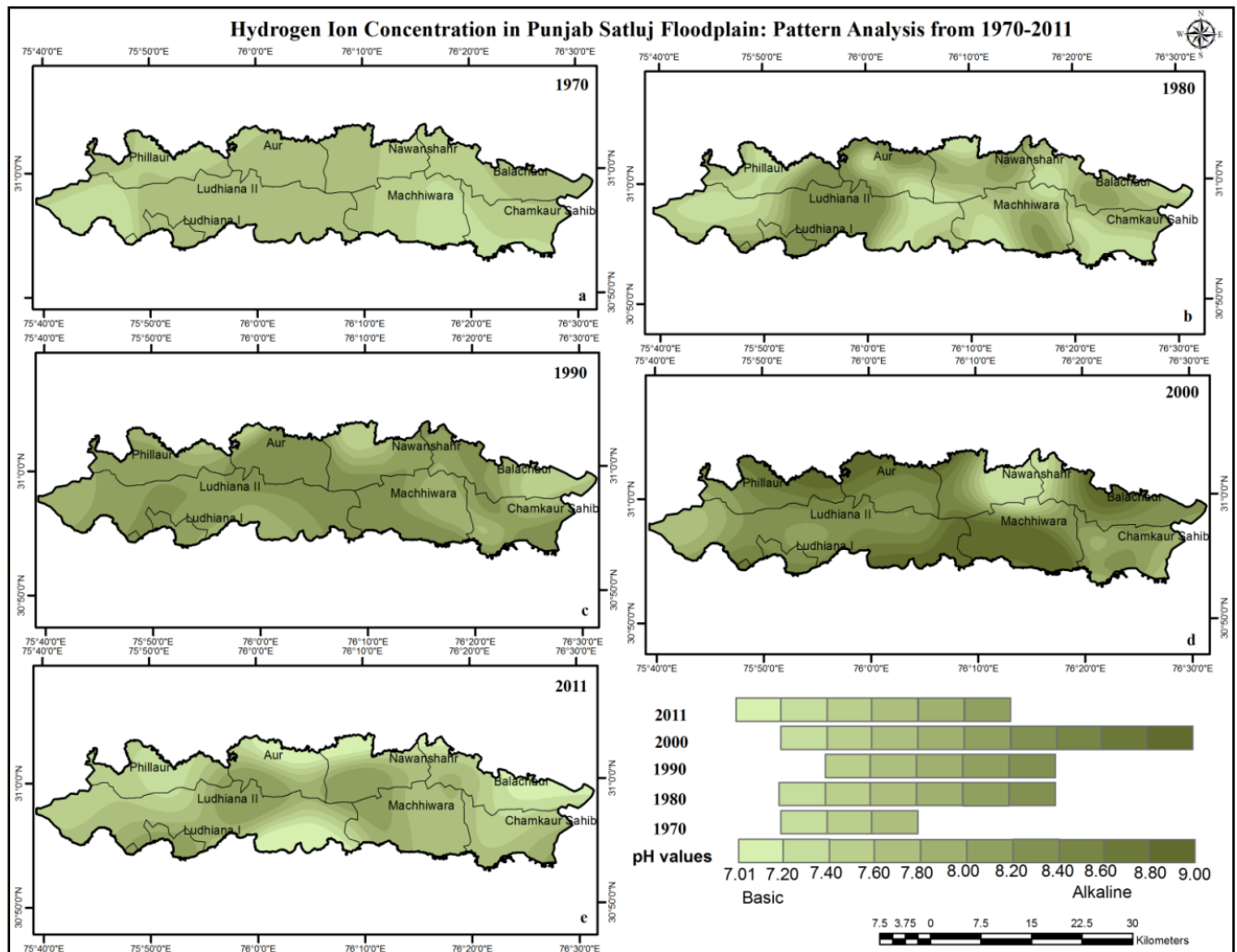
(Shahid Bhagat Singh Nagar District) and upper part of Chamkaur Sahib Block (Rupnagar District). South of this curved belt ranged between 7.4 to 7.6 pH value, which was distributed in the area comprising the central part of Chamkaur Sahib Block (Rupnagar District), western Balachaur Block (Shahid Bhagat Singh Nagar District) and eastern and central part of Nawanshahr Block (Shahid Bhagat Singh Nagar District) and Machhiwara Block (Ludhiana District) respectively. Groundwater of southern part had 7.6 to 7.8 pH value and it included southern Chamkaur Sahib Block (Rupnagar District) and eastern Machhiwara Block (Ludhiana District).

Table 1: Hydrogen ion Concentration in Punjab Satluj Floodplain: Variability Analysis from 1970 to 2011

Parameters	Maximum Permissible Limit for Consumption (WHO, 2011)	1970	1980	1990	2000	2011
pH (Range Variability)	6.5 - 9.2	7.35-7.8	7.2-8.25	7.55-8.25	7.35-9	7.01-8.19
Mean		7.64	7.71	8.02	8.33	7.6
Standard Deviation		0.14	0.26	0.21	0.39	0.29

Source: Central Groundwater Board, India

For *central part*, groundwater with 7.6 to 7.8 pH value was found. It incorporates western part of Nawanshahr Block (Shahid Bhagat Singh Nagar District) and Machhiwara Block (Ludhiana District), central part of Aur (Shahid Bhagat Singh Nagar District) and Ludhiana II Block (Ludhiana District), whole of Ludhiana I Block of Ludhiana District. In *eastern part*, pH distribution can be seen with respect to river bluff. Along the river bluff pH value was low and it increases towards the centre. pH value with 7.4 to 7.8 was found in western and central part of Phillaur Block (Jalandhar District) and south western part of Ludhiana II Block of Ludhiana District.



Source: Interpreted from data provided by Central Groundwater Board, India

Figure 1: Hydrogen Ion Concentration in Punjab Satluj Floodplain: Pattern Analysis (1970-2011)

For 1980, range of groundwater pH increased as compared to previous year. During this time it varies between 7.2 and 8.25, which was categorized into six parts for analysis. Spatial distribution of these classes clearly shows that areas earlier categorized under 7.6 to 7.8 pH value becomes intense with increased pH value i.e. 8.2 to 8.4. Distribution pattern of pH value reflected from figure 1 (b) shows that for the eastern part of Satluj floodplain towards the bluff pH value decreases. For western part high pH value increases towards the central part of

Ludhiana District. Four major areas of high pH value were found in the study area. A broad stream of high pH value flowing north to south was observed, which covered western part of Aur Block (Shahid Bhagat Singh Nagar District), eastern part of Phillaur Block (Jalandhar District) and central part of Ludhiana District. Patch of high pH value was also seen in centre of Balachaur Block eastern Nawanshahr Block of Shahid Bhagat Singh Nagar District. South eastern part of Machhiwara Block of Ludhiana District was also characterized by high pH value. During **1990**, lowest value of pH scale increased and ranged between 7.55 to 8.25. Maximum area was covered under the 8 to 8.4 pH category (figure 1 (c)). High pH value area covered the central part of Satluj floodplain, whereas near the edges groundwater with low pH was observed. For **2000**, lower limit of the groundwater pH was reduced and upper limit was significantly increased and extended upto alkaline level. It actually ranged from 7.35 to 9 (figure 1 (d)). Groundwater with high ranged value was found in a form of linear segments and spread east to west. One of them was found in southern part of study area consisting of Machhiwara Block and south eastern Ludhiana II Block of Ludhiana District. Other comprising upper portion of Aur Block (Shahid Bhagat Singh Nagar District) and Phillaur Block of Jalandhar District and upper part of Balachaur Block (Shahid Bhagat Singh Nagar District). Groundwater with low pH concentration was observed in eastern Nawanshahr Block of Shahid Bhagat Singh Nagar District.

For **2011**, lower and upper limit of pH value was reduced. It ranged between 7.01 to 8.19 (figure 1 (e)). Groundwater with high pH concentration was found in the central portion of the study area and less pH concentrated groundwater was found at the bluff part. Eastern part of the study area experienced north-east to south-west distribution of low to high pH concentrated groundwater. Whereas for western part low to high pH concentrated groundwater was distributed from north-west to south-east i.e. high towards the Ludhiana I Block of Ludhiana District.

Conclusion

Underground water of Punjab Satluj floodplain has been basic in character. Variation in the spatial pattern of pH value has been observed due to the adulteration by surface use and movement of groundwater in south westward direction. Alkanity has been noticed during 2000, which has been normalized to basic in 2011.

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