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Seasonal variation of physico chemical properties of ground water in rainfed agricultural area of Shivalik foot hills at pandoga sub watershed, Una district of Himachal Pradesh

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***Abstract*:** *Water is a critical and basic resource for human survival, economic development and ecological balance in nature. Rainfall in India, the primary source of sweet water, is characterized as erratic in quantum, intensity and distribution. India shares about 16% of the global population but it has only 4% of the total water resources. The hydrological challenge is to relocate four months rainwater in time to year round for multifaceted uses: drinking, domestic consumption and life saving irrigation (food security) in rainfed areas. Watershed management is recognized as an efficient way of intervention for integrated natural resource management in rainfed systems. Intervention changed cropping pattern and utilization of water for irrigation which may changed the quality of water by leaching of different metals and ions. Physico chemical parameters of water [temperature, pH, TDS, EC, dissolved oxygen, biological oxygen demand(BOD) and chemical oxygen demand(COD)] shows that parameters fluctuated with the seasons and sites. Season wise result shows that maximum mean of all parameters was higher in pre monsoon season as compared to post monsoon season and mean values of all parameters were within permissible limits in both seasons as compared to WHO standard.*

Key words: *Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, Sub watershed, Sustainable development, Swan River*

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I. Introduction

Water is a vital and versatile gift of nature and accounts for 50-97% of the weight of all plants and animals and about 70% of human body. Life could not survive without water on earth (Kumar and Tripati, 2000). Main source for drinking water are the surface and ground water sources. Groundwater, act as the primary buffer against drought for both human requirements and plant production (Siebert S. et al., 2010). In India, there are over 20 million private wells in addition to the government tube wells (Datta, 2005). Groundwater naturally contains mineral ions dissolved from soil particles, sediments and rocks as water travels along mineral surfaces of the aquifer (Harter T., 2003). Water quality refers to physical, chemical and biological characteristics of water body which determine how well it support ecosystem processes. Ground water quality parameters changed with the factors likes climate, slope, drainage conditions and residence time of groundwater (Pandey and Tiwari, 2009). There are various other ways for ground water contamination such as use of fertilizer in farming (Altman and Parizek, 1995), seepage from effluent bearing water body (Adekunle, 2009). Water supply for drinking purpose in present study area is through public department work (PDW) but that supply was too from ground water through pipelines. Implementation of pandoga sub watershed in pandoga village changed scenario in catchment area changed farming, cropping pattern and irrigation facility with recharged ground water. Recharged water increased bore wells which improved water facility for drinking and for agriculture purpose particularly in summer season. Water availability enhanced agro farming practices which increased utilization of fertilizers and pesticides coupled with new construction of buildings for commercialization and industrialization. Therefore it is of utmost concern to evaluate physico chemical characteristics of groundwater with the season at present study site to judge sustainability of water for drinking.

II. Materials And Methods

2.1 Description of the study area

The Swan River (tributary of Sutlej), known as sorrow of Una district (Himachal Pradesh), India, flow from north to west. Swan river integrated watershed management project (SRIWMP) was launched in this area as to convert a flooded and hazards area into natural gift. Pandoga sub watershed is one of the 22 sub watersheds implemented in swan river catchment area. The Pandoga sub watershed was located at 31^0 30’25.30”N and 76^0 82’ 02.24” E at 350 to 600 meters above mean sea level. Topography of the area is gentle to moderate. Mean annual rainfall is approximately 1155mm with extreme variation in rainy and post rainy season. Temperatures also vary from extreme high in summer season to low in winter season. Agro climatic zone is Shivalik foot hills of Western Himalayan zone. The structure of soil is poor (due to intensive cultivation), low clay, and organic content.

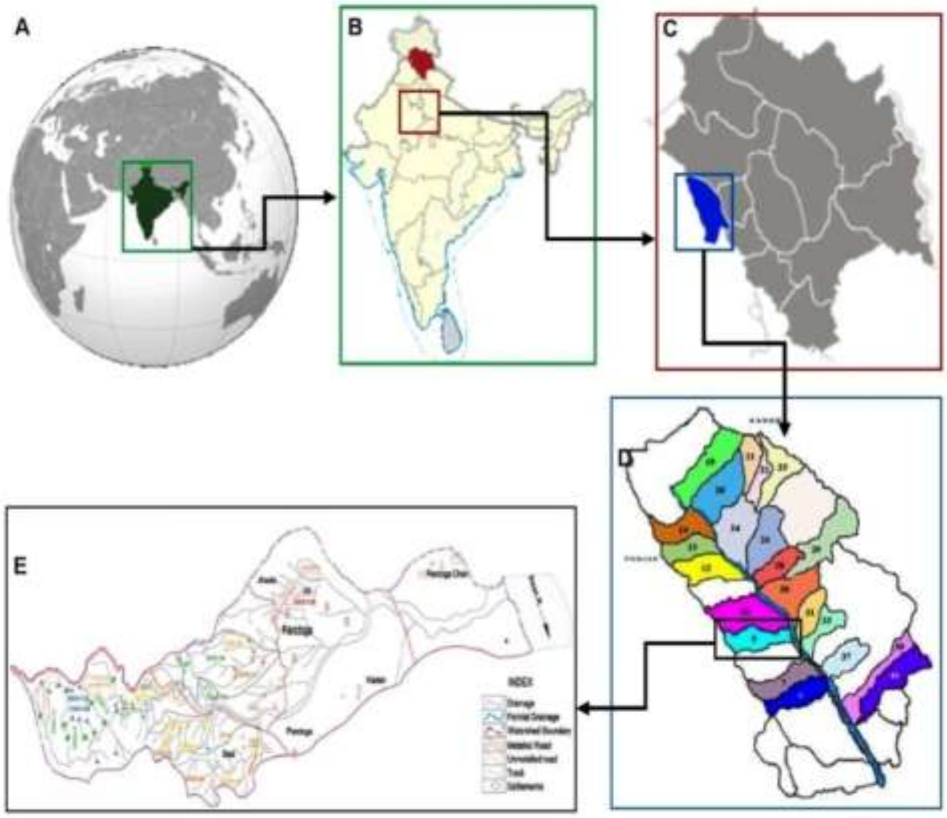

Figure 2.1: Location map A. India in world; B. Himachal Pradesh in India; C. Distt. Una in Himachal Pradesh; D. Swan River watershed project area; E. Pandoga sub-watershed

2.2Methodology

2.2.1Sampling Design and Water Sample Collection

Three–stage systematic sampling design was followed where watershed's catchment area was divided into three sites; second one was further division of each site into three wards (Table2.2.1). There was three sampling points per ward, thus total of twenty seven samples of water were collected in pre-cleaned one liter polythene bottles from the sampling site for two seasons i.e., post monsoon season and pre monsoon season of 2014 to 2015 to assess groundwater quality. Water was collected in such a manner so that no air bubbles could form. Water samples were preserved by adding 1.5ml of Conc.HNO_3 to each sample. Preserved water was assessed by standard methods (Table2.2.2). Results of physico chemical analysis was subjected to mean and standard error mean method through graph pad prism5.

Table 2.2.1: Sampling locations and general description of Pandoga sub watershed catchment area

Site	*Wards*	*Longitude*	*Latitude*	*Height*	*Specification*
Site1	8	31 503241^0 N	76.147426^0 E	420	Beneficiary to watershed project
	9	31.51 20 96^0 N	76.15 21 29^0 E	411	
	11	31.51 0108^0 N	76.172239^0 E	376	
Site2	1	31.514135^0 N	76.152506^0 E	422	Marginal beneficiary to project
	2	31.51 55 38^0 N	76.16 2864^0 E	398	
	10	31 .51 3024^0 N	76.15 8763^0 E	391	
Site3	3	31.522056^0 N	76.164652^0 E	384	Non beneficiary of project but in same catchment
	4	31.522393^0 N	76.16 9156^0 E	380	
	7	31 .51 27 93^0 N	76.15 86 75^0 E	391	

Table 2.2.2: Physico chemical parameters of water studied and methods

Parameters	***Method***
Temperature	Thermometer/Water analysis kit(VSI-07)
pH	pH meter /water analysis kit (VSI-07)
TDS	TDS meter
Electrical conductivity	Electrical conductivity meter
Dissolved Oxygen	Water analysis kit(VSI-07)
Biological Oxygen Demand	American public health association (APHA)
Chemical Oxygen Demand	American public health association (APHA)

III. Results And Discussion

3.1 ***Water Temperature***: Maximum mean temperature (27°C) in ward 3 of site 3 and minimum mean (22°C) in ward 9 of site1 was observed in pre monsoon while maximum mean temperature (15.33°C) was in ward 3 of site 3 and minimum mean temperature (12°C) in ward 1 of site 2 in post monsoon season. Seasons had impact upon the temperature. (Fig.3.1). The water temperature recorded lower during post monsoon season that might be due to cold weather and low atmospheric temperature as well as scarce rainfall whereas in summer higher temperature could be due to longer photoperiod, bright sunshine, dry wind and other weather conditions. The present findings are in confirmation with the findings of (Salve and Hiware, 2008). The temperatures of present study remain within the range recommended by WHO (30°C).

3.2

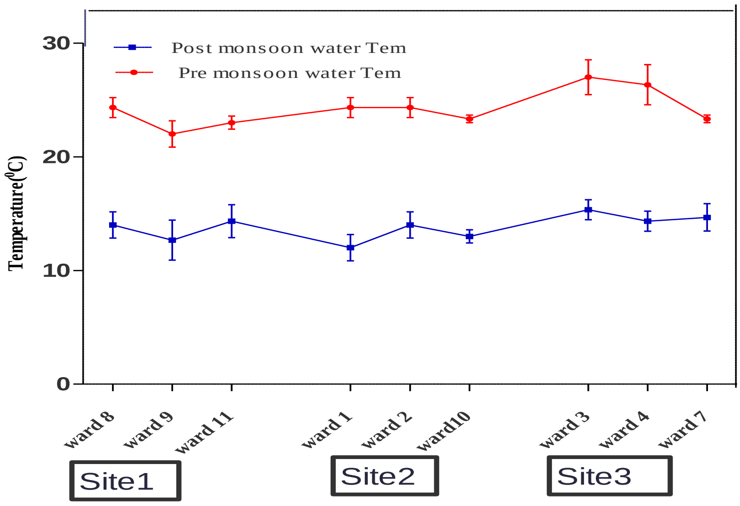

Fig.3.1: Variation in temperature of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

3.2 ***Water pH***

During pre monsoon season maximum mean pH (7.10) was in ward 3 of site 3 and minimum (6.13) in ward 2 of site 2. Post monsoon results shows that maximum mean pH (6.76) was in ward 3 of site 3 and minimum mean pH (6.16) in ward 1 of site 2(Fig.3.2). Results indicate pH of samples ranged in neutral to slightly alkaline. Herojeet *et al*. (2013) suggested that alkaline water was suitable for domestic purpose. pH was higher in pre monsoon and decreased in post monsoon season. According to Sharma and Capoor (2010) higher pH in pre monsoon could be due to decreased volume of water by evaporation and minimum in winter due to decreased evaporation due to short day length. High pH value in site 3 may be due to more anthropogenic activities such as use of organic manure and decomposition of crop and fodder waste and microbial decomposition. pH varied with concentration of organic and inorganic solutes present in water bodies (Kumar *et al*., 2015). All water samples analyzed had pH concentration within safe limit of 6.5-8.5 standard set by the WHO.

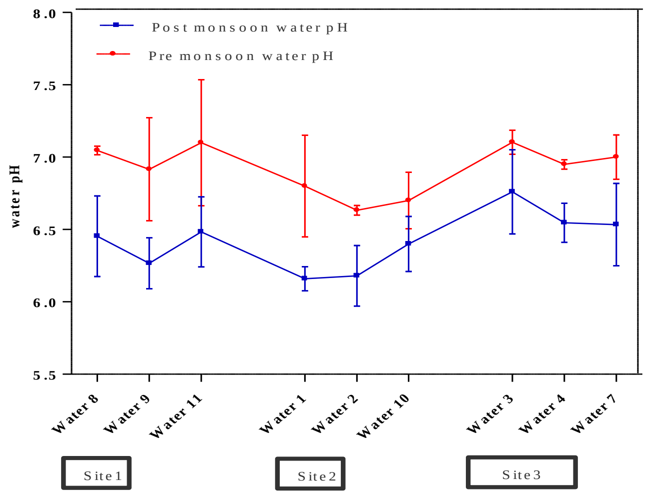

Fig. 3.2: Variation in water pH of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

3.3 *Electrical conductivity*

Electrical conductivity was a good measure of dissolved solids (Singare *et al*., 2011). In the present study, maximum mean electrical conductivity (725.33 µ mhos/cm) in ward 7 of site 3, while minimum mean (431.66 µ mhos/cm) in ward 8 of site 1 was in pre monsoon season. In post monsoon season maximum mean electrical conductivity (622.33 µmhos/cm) was in ward 7 of site 3 and minimum mean (417.66µmhos/cm) in ward 2 of site 2 (Fig.3.3). All the samples in both seasons belonged to moderately saline condition (250-750 µ mhos /cm). High electrical conductivity in site 3 might be due to pollution load by domestic disposed off, agricultural waste runoff, agrochemical runoff or leaching to ground water. These results are in conformity with the Ibraheem *et al*. (2015) who stated that electrical conductivity increased with total dissolved solids.

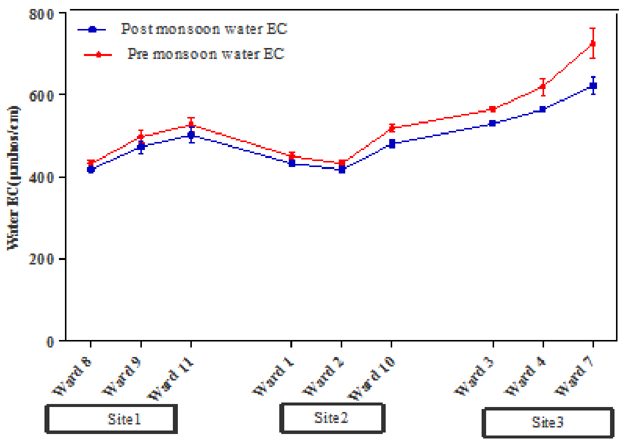

Fig. 3.3: Variation in Electrical conductivity of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

3.4 *Total dissolved solids*

In the present study, a TDS value of groundwater show maximum mean TDS (723.33mg/l) in ward 7 of site 3 and minimum mean (286.6mg/l) in ward 1 of site 2 in pre monsoon season. However in post monsoon season maximum mean TDS (706.6mg/l) was in ward 7 of site 3 and minimum mean (280mg/l) in ward 8 of site 1 (Fig.3.4). This pattern of fluctuation in TDS was in conformity with the results of Kumar *et al*. (2015). In pre monsoon season higher concentration of total dissolved solids might be due to evaporation of water in higher temperature (Tripathi and Pandey, 2009). The elevated amount of dissolved solids in ward 2 and 10 in site 2 in post monsoon water indicates that there are anthropogenic actions or pollution load from agricultural activities (Hossain *et al*., 2013). All samples of present study ranged within the range of WHO standards (1000 mg/l for drinking water).

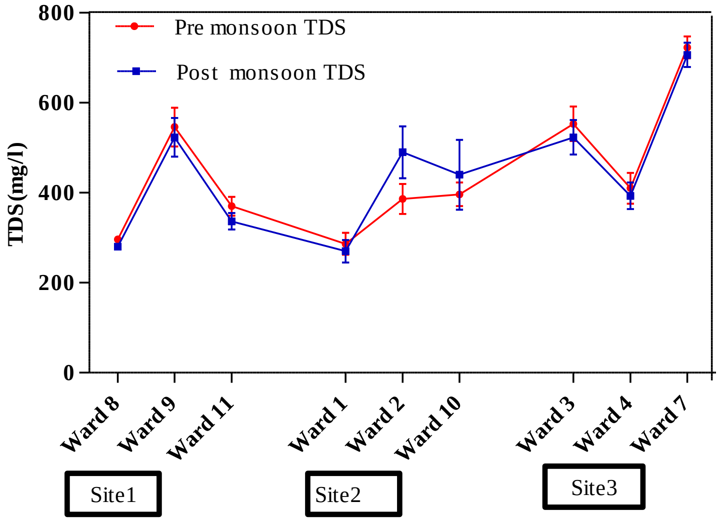

Fig. 3.4: Variation in TDS of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

3.5 *Dissolved oxygen*

Dissolved oxygen (DO) was one of the parameter which gives its direct and indirect correlation with bacterial activity, photosynthetic availability of nutrients, stratification (Vikal, 2009). In the present study, maximum mean dissolved oxygen was (8.00mg/l) in ward 9 and 11 of site 1and minimum mean dissolved oxygen(4.80mg/l) in ward 8 of site1 in pre monsoon season. In post monsoon season maximum mean dissolved oxygen was (6.16mg/l) in ward 7 of site3 and minimum (4.66mg/l) in ward 2 of site 2(Fig.3.5). The maximum mean value was recorded in the pre monsoon as compared to post monsoon. The high dissolved oxygen in summer was due to increase in temperature and duration of bright sunlight that had influence on the percentage of soluble gases (oxygen and carbon dioxide). The long days and intense sunlight during summer seem to accelerate photosynthesis by phytoplankton, utilizing carbon dioxide and giving off oxygen. This possibly accounts for the greater qualities of oxygen recorded during summer (Manjare *et al*., 2010).

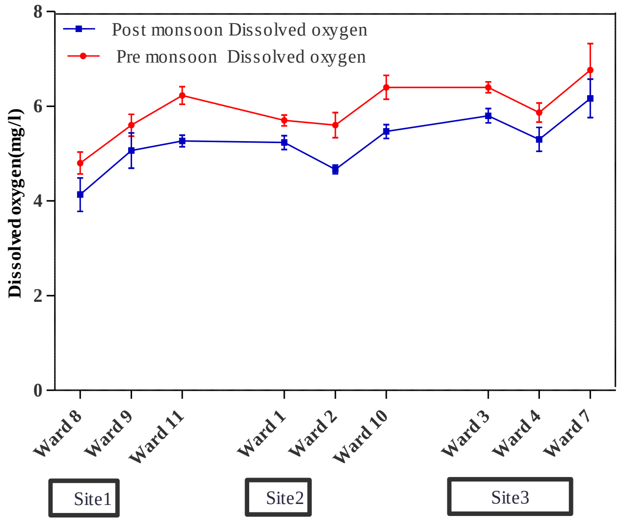

Fig. 3.5: Variation in dissolved oxygen of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

3.6 *Biological oxygen demand*

BOD was a measure of organic carbon loading in the water system that exerts a high level of biological oxygen demand to the system (Sullivan *et al*., 2010). In the present study, maximum mean BOD value of groundwater was (2.80mg/l) in ward 4 of site 3 and minimum mean (0.56mg/l) in ward 8 of site1 in pre monsoon season. In post monsoon season maximum mean Biological oxygen demand was (2.03mg/l) in ward 7 of site 3 and minimum mean (0.33mg/l) in ward 8 of site 1(Fig.3.6). It was observed that BOD varied with the season but highest variation was observed in ward 4 of site 3. High value of BOD in site 3 may be due to increase in total nutrient in water body such as fertilizer, animal farm, construction effluent as was reported in the study of (AL Sabahi, 2007). Present findings consistent with the study of Prasana and Ranjan (2010) who also reported decrease in Biological oxygen demand BOD during post monsoon season which might may be due to higher solubility of oxygen at lower temperature. When the BOD was high, the dissolved oxygen become low and hence greater the BOD, greater was pollution.

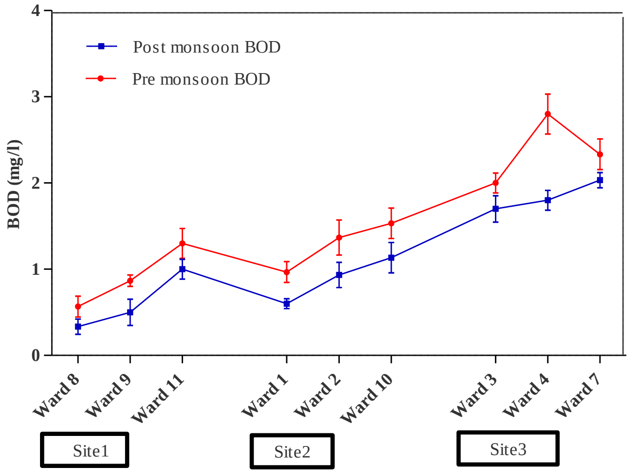

Fig. 3.6: Variation in biological oxygen demand of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

3.7 ***Chemical oxygen demand***

Chemical oxygen demand determine quality of oxygen required to oxidize the organic matter in water compounds which are disposed domestically, institutionally or industrially under specific conditions of oxidizing agent, temperature and time. In the present study, maximum mean of Chemical oxygen demand value of groundwater was (20.00mg/l) in ward 7 of site 3 and minimum mean (6.00mg/l) in ward 8 of site1 in pre monsoon season. However for post monsoon season maximum mean of COD was (18.46mg/l) in ward 7 of site3 and minimum mean was (5.33mg/l) in ward 8 of site 1.The maximum COD was recorded in site 3 in both seasons (Fig.3.7). Direct discharge of domestic waste and agricultural input like pesticides and fertilizers may be reason for higher values than the other sites. Maximum COD of ground water were recorded during pre monsoon season. Similarly, Kaushik and Saksena (1999) reported heavy load of organic and inorganic pollution that requires more oxygen to oxidize under increased thermal conditions. COD in unpolluted surface water range from 20 mg/l or less to greater than 200 mg/l in waters receiving effluents (Agbaire *et al*., 2009; Garg *et al*., 2010).

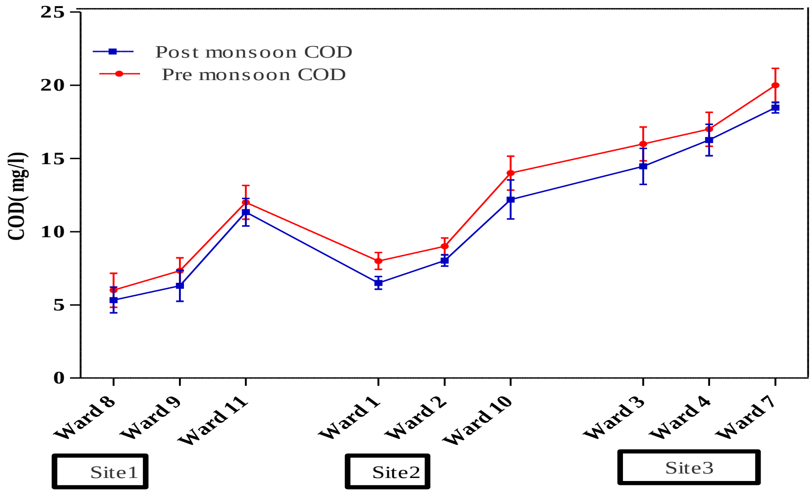

Fig. 3.7: Variation in COD of Pandoga sub watershed catchment area at three study sites during two seasons. Values are mean ±standard error. n=3

IV. Conclusions

Physico chemical parameters of water such as temperature, pH, TDS, EC, dissolved oxygen, biological oxygen demand(BOD) and chemical oxygen demand(COD) shows that parameters fluctuated with the seasons and sites. All parameters were within permissible limits as compared to WHO till now but changed agro farming scenario in watershed catchment area might affect suitability and sustainability of water for drinking purpose. Proper action should be enforced to educate the society for utilization of fertilizers and pesticides at control rate so that soil and water might save from contamination in future.

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