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COMPARATIVE STUDIES ON WATER QUALITY OF BORE WELL AND RAIN WATER HARVESTING WELL

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Abstract

Quality and quantity of water has been the most discussed issues in the world as its availability and aesthetic quality is related to the health of people. Recent water scarcity in part of Maharastra has once again drawn attention of state administration to pay attention and give topmost priority to In-Situ and Ex-Situ measures of rainwater harvesting. Water transported from far distances to scarcity area pose monitory burden on government. In -situ Water harvesting gaining importance to conserve water in the country. Ground water of Chandrapur city is in association with coal and calcium bearing rocks which may elevate hardness and other constituents at level may pose trouble in normal functioning of the body. Research studies on water quality in pre-monsoon and during monsoon shows variation in water quality parameters. Concentration of the physical and chemical constituents, namely, pH, TDS, TSS, acidity, alkalinity, hardness, fluoride, chloride, and nitrate beyond tolerable limit in drinking water could awaken people to adopt and implement rainwater harvesting in houses, open places and agriculture field.

Key words- Rainwater harvesting, TDS, TSS, Acidity, Hardness, fluoride

Introduction

Water is a precious gift of nature (1). Water sources distributed in country, state, region and local area have an influence on productivity of people, economy, agriculture and industrial manufacturing (2). Quantity of rainwater received in any region can be correlated with climatic factors. Recently the most discussed phenomenon, i.e. El-Nino and La-Nina is also changing the weather pattern which affects rainfall in certain regions (1). Decades ago with less population had fulfilled the requirements of people even scanty rainfall, but the situation in the present era is different, the unplanned urban infrastructure development in developing countries creates a notorious situation both with less and high rainfall (3). Urban area fails to manage the situation in the event of scanty and heavy rainfall (4). People are forced to pump ground water when rainfall is below average oppositely high rainfall arrest normal drainage of water through storm water pipeline may be due to ill planned and under designed pipeline network thus flooding and contaminating urban water resources. Rainwater harvesting has the potential to comply acute situation of shortage of water.

Chandrapur city is well known for coal and recently land of the tiger. Being dominated by coal and calcium bearing rock strata, groundwater is dominated by calcium and other minerals. Studies on deteriorating ground water quality and quantity broaden the thinking of administrators, policy makers and planners to conserve water through rainwater harvesting for future generation of urban area.

Study area-Chandrapur city (M.S.) with populated Tukum area identified for water quality assessment of bore well and rainwater harvesting well.

Materials and Methods

Survey program had undertaken to identify rainwater harvesting structure in Tukum area of Chandrapur city. A residential house having both bore well and rainwater harvesting structure was decided for studies on water quality assessment. After discussion with houseowner, details of construction of the rainwater harvesting structure had gathered.House owner adopted self-invented method of construction of water harvesting pit. PVC drum (200 **litres** x 2) with holes was inserted in previously dug pit (7 feet) filled with stones, pebbles, gravels, coarse sand, red brick pieces and fine sand on top. The purpose of using PVC drum was to arrest the flow of rainwater, provide opportunity for filtration and equal distribution of water on all sides of the pit. Water sample of borewell and dug well was collected prior and during monsoon from May 2019 to September 2019 by adopting the procedure of APHA manual (5).

Result and Discussion

Water quality is an indication of its use for drinking and other purpose. Changes in the quality of water can be assessed by routine analysis (1). Construction of rainwater harvesting system and use of water from it by people is a need for the future availability of water in urban areas. Water from harvesting pit have more advantages over borewell water, which can be seen by detailed investigation of water. Water analysis report of borewell and rainwater harvesting well before and during the rainy season from May to September 2019 is depicted in Table1.

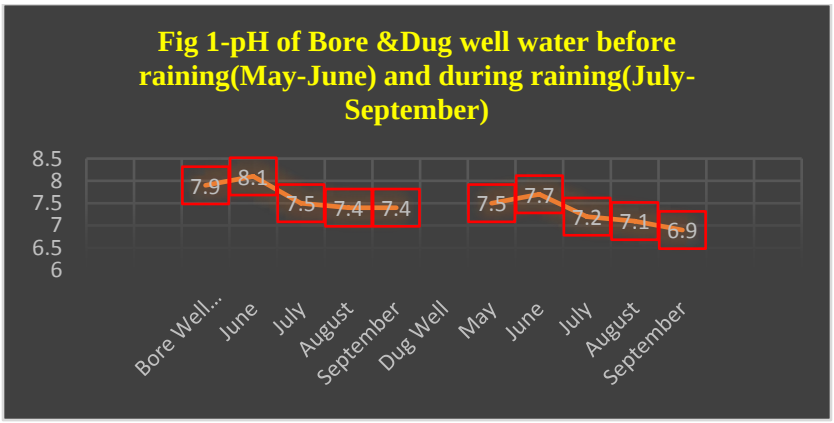
Table1.Physical and Chemical analysis report of borewell and rainwater harvesting well

Month &Year (2019)	**Water Quality Parameters (Borewell)**								
	Before Rainy Season								
	pH*	TSS	TDS	Total Acidity	Total Alkalinity	Total Hardness	Chloride	Fluoride	Nitrate
May	7.9	BDL	380	8	320	428	158	0.9	8
June	8.1	BDL	410	12	346	446	174	0.9	10
During Rainy season									
July	7.5	BDL	312	10	238	326	144	0.9	8
August	7.4	BDL	308	8	212	314	138	0.8	5
September	7.4	BDL	290	6	205	304	126	0.8	5
Water Quality Parameters (Dug well), Before Rainy season									
May	7.5	50	250	5	230	248	75	0.8	2.0
June	7.7	65	274	5	240	256	86	0.8	2.2
During Rainy season									
July	7.2	100	140	8	96	108	46	0.7	1.4
August	7.1	123	122	16	90	102	38	0.6	1.0
September	6.9	132	114	16	80	92	30	0.6	1.0
Maximum	8.1	132	410	12	80	428	158	0.9	10
Minimum	6.9	50	114	5	346	92	30	0.6	1.0
Range	1.2	82	296	7	266	336	128	0.3	9
Mean	7.47	94	260	7.75	205.7	262.4	101.5	0.78	4.36
SD	0.34	31.93	98.92	2.27	87.64	121.82	50.35	0.10	3.17

*****All values are in mg/l except pH, BDL-Below detectable limit

pH

Determination of pH is helpful in accessing information of acidity and alkalinity (6). Geology and soils of a place where bore well is dug may have influence on acidic or basic nature of water. Chandrapur city's ground surface is dominated by limestone, so in summer water requirement increases tremendously which would lower ground water. Water in contact with deep strata limestone contributes to high pH (8.1, Table 1). During rainy season, dilution and saturation of ground water table reverse pH, concentration from 8.1 to 7.4. Dug Well water also shows alkaline pH, which is within permissible limit (6.5-8.5), (7), well water enriched with harvested rain from July to September during study indicate maximum mixing of rain water which contain carbonic acid due to contact with atmospheric carbon dioxide result in slightly acidic pH (8). Borewell and rain harvested well water before and during rainy season does not indicate abnormal changes in pH values (Fig 1).



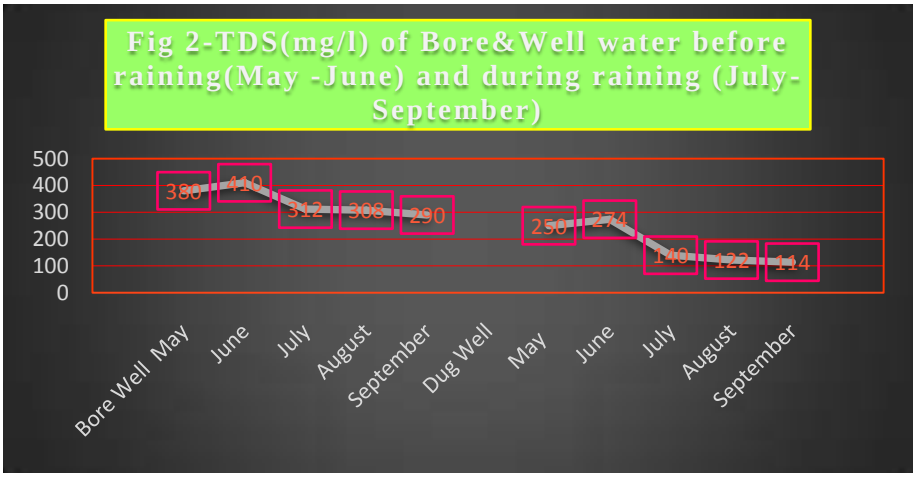
Total Suspended Solids

Total suspended solids (TSS) is a measure of suspended particles in known amount of water which include silt, clay, microscopic flora and other particulate matter (9). Bore well water is a closed system which is not in contact with the atmosphere so TSS content in it not noticed in analysis of water samples.Dug-Well is normally open to the sky, organic debris, leaves, microscopic organisms contribute TSS (100 to 132 mg/l, Table 1) higher than Bore well. Study shows incremental suspended solids during rainwater harvesting. Rainwater collected from roof top or open places normally carries a considerable amount of TSS in rain harvested pit.Rain water harvesting pit is unable to remove TSS to that extend which could make the water crystal clear. Water from rain harvested pit prior to use for drinking required to be treated with disinfectant, filtration, advance UV or RO technology.

Total Dissolved Solids (TDS)

TDS consists of the total amount of inorganic and organic substances in water (10). It consists of cations and anions. Bore well water during its journey from top to ground water table dissolve a variety of inorganic salts which increases TDS (380-410 mg/l) load depending upon depth of the water table. TDS of bore well water before rainy season is higher due to excessive pumping of water in summer. During Rainy season, dilution and saturation of ground water lead to reduction in TDS (312-290 mg/l, Table 1) concentration.

Dug-Well water before rainy season shows slightly higher TDS (250-274 mg/l) but less than bore well water sample as depth of dug well is less. TDS (140-114mg/l) level decreases considerably by rain water harvesting, rainwater without contact with the ground helps to reduce concentration (Fig 2).



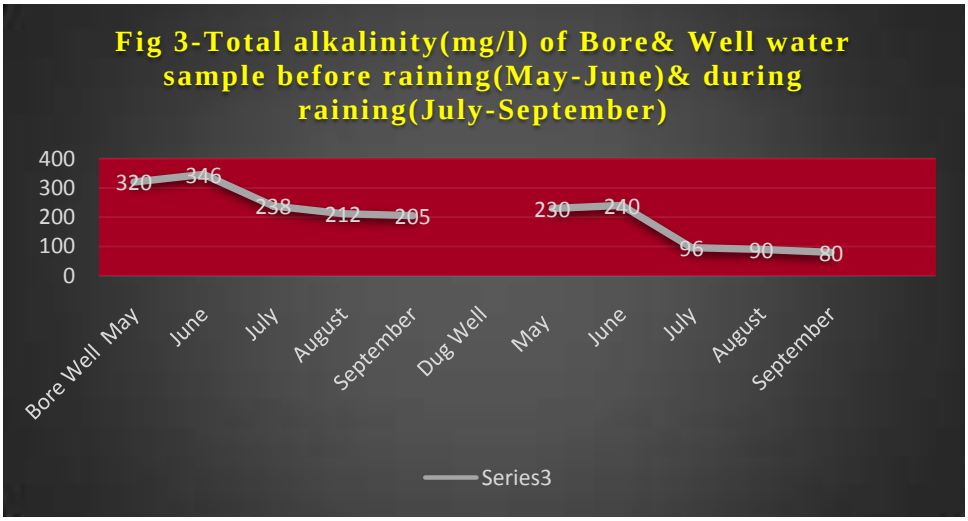
Total Acidity

Total Acidity is the capacity of water to neutralise base. Dissolved carbon dioxide is the principle source of acidity in natural water (11). Concentration of acidity is insignificant in bore well, except in dug well because of mixing of carbon dioxide-carbonic acid water with dug well water during harvesting of rainwater, elevating total acidity (8-16 mg/l, Table1) not that much higher to deteriorate the quality of water.

Total Alkalinity

Total Alkalinity aids in measurement of carbonate, bicarbonate and hydroxide in water (9). These constituents help to neutralize acids. Bore well water shows considerable amount of alkaline constituents derived from rocky stratum. Total alkalinity of bore well water before rainy season indicates dissolved alkaline constituents higher (320-346 mg/l,) with a depth of water table. During rainy season total alkalinity decreases considerably with percolation of water in the ground (238-205 mg/l, Table 1).

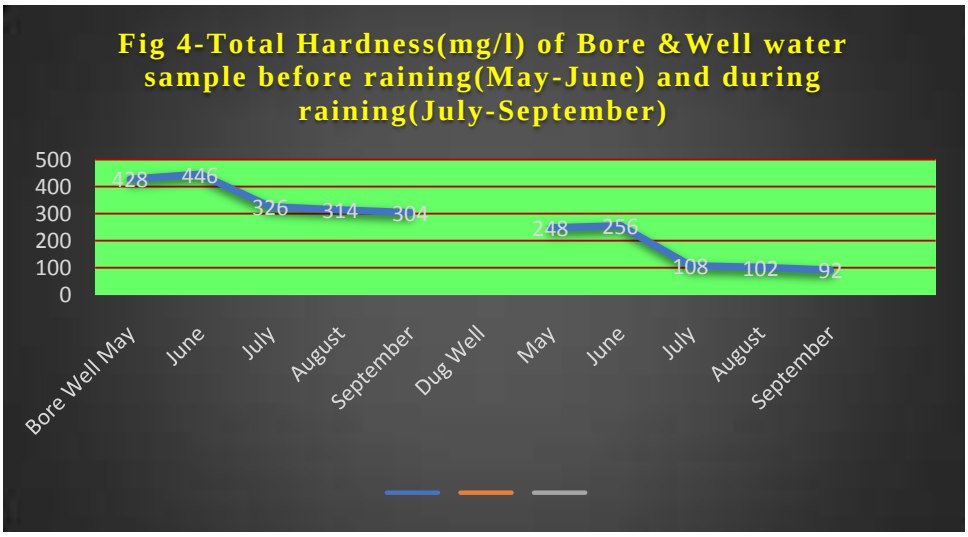
Total alkalinity values in dug well water sample shows slightly higher values before raining but goes on decreasing during rainy season. Rainwater harvested in dug well water shows less alkalinity (96-80 mg/l), these concentrations again increase after rainy season thus keeping acid -alkaline balance of water (Fig 3).



Total Hardness

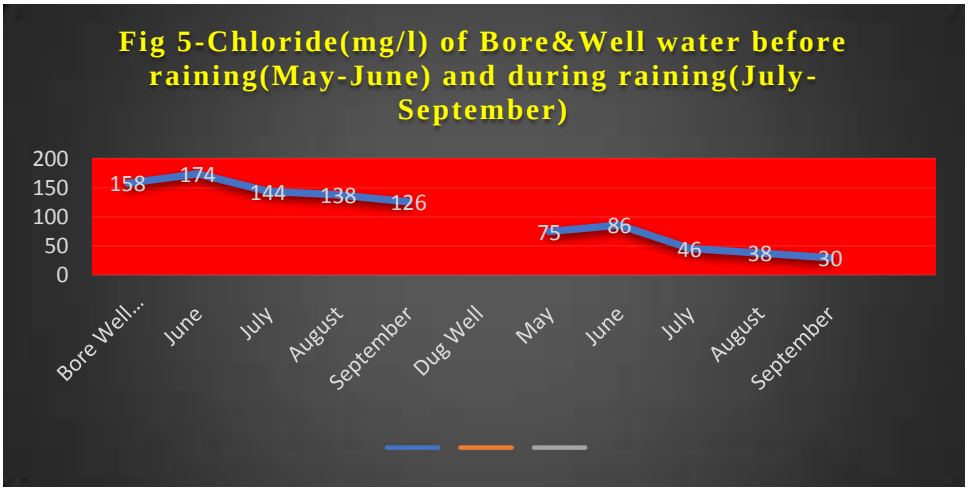
Total Hardness in water is due to the presence of bicarbonates and divalent cations principally calcium and magnesium (1). Bore well water sample indicating the highest total hardness (428-446 mg/l) is a sign of calcium bearing rocks in the ground; water deep in the ground probably not utilized previously and with ageing initiated concentration of cations in water. Water of this kind interferes with digestion of food. During rainy season, the situation improves with dilution of water.

Rain water harvesting in dug well minimizes higher concentration of hardness and makes water suitable for drinking and other purposes. Total hardness concentration (92-108 mg/l, Table 1) of dug well water during the raining indicates the advantages of use of harvested water for drinking in urban areas (Fig 4).



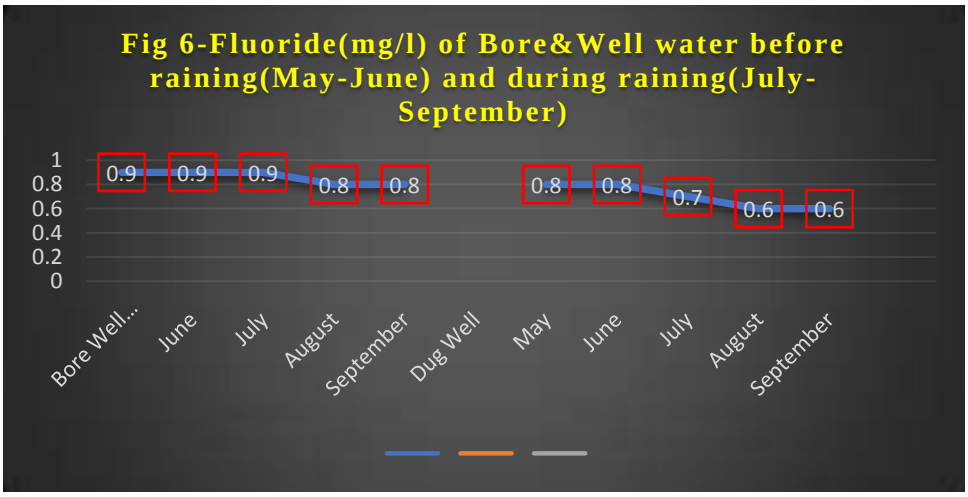
Chloride

Chloride concentration above 250 mg/l affects taste of water (12). Study shows normal chloride concentration in bore well (126-174 mg/l) and dug well (30-75 mg/l, Table 1) water sample. Rainwater harvesting is also effective to reduce chloride concentration and improving the taste of water (Fig 5).



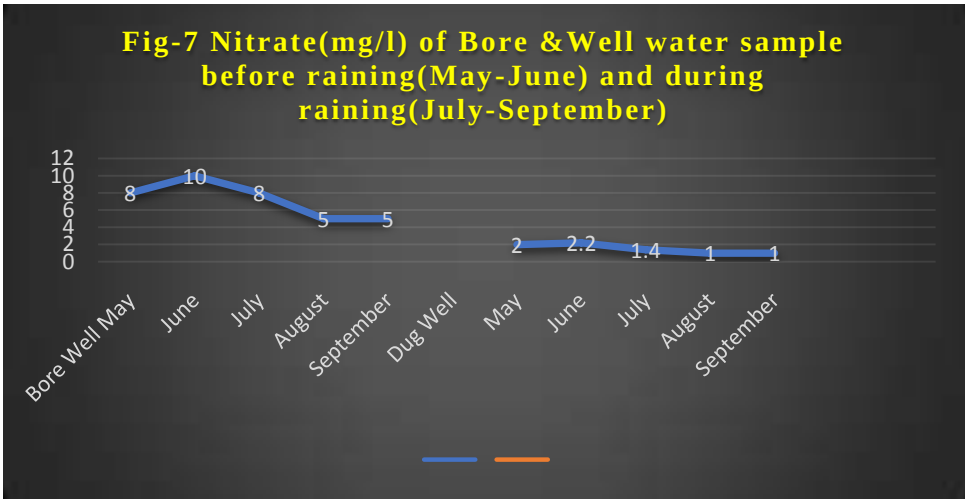
Fluoride

Fluoride concentration between (0.7-1.2 mg/l) is most acceptable for prevention of dental caries and dental fluorosis (13). Bore well water sample (0.8-0.9 mg/l) and dug well water sample (0.6-0.8, mg/l, Table 1) does not show variation in fluoride concentration in this study. Rain water harvesting is effective to minimize issues related to the effects of fluoride concentration in water (Fig 6).



Nitrate

Conversion of nitrogen compounds into nitrate in soil and water constitute sources of nitrates in nature (14). Human activities also contribute nitrate in soil and water by adding fertilisers. Possibility of nitrate concentration in residential bore well and dug well above acceptable level is less as compared to agricultural field. Nitrate concentration beyond 45 mg/l has not been found in bore well (5-10 mg/l, Table 1) as well as dug well (1-2 mg/l, Table 1) water sample (Fig 7).



Conclusion

Water quality investigation of bore well and dug well along with rainwater harvesting in dug well clearly indicates benefits of rainwater harvesting for improving quality as well as quantity of water for drinking purposes. Rain water harvesting well shows noticeable reduction in water quality indicator parameters, proving its qualitative and quantitative value for drinking purpose. Bore well water has to be treated with most popular RO technology and rain water harvested water is also needed to disinfect prior to use.

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