

Linear Correlation and study of ground water quality of Pedapadu Mandal , West Godavari district, AP, India.

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Abstract

Fresh water is one of the most important resources crucial for the survival of all the living beings. It is even more important for the human being as they depend upon it for food production, industrial and waste disposal, as well as cultural requirement. Water plays an essential role in human life. Although statistics, the WHO reports that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water. Human and ecological use of ground water depends upon ambient water quality. India's declining ground water resources both in quality and quantity is a product of many driving factors. Though groundwater contamination is due to natural and anthropogenic activities, ground water pollution is mostly due to knowingly or unknowingly human activities. In order to understand water quality, it is very useful to display data in a visual manner. Because environmental data is also inherently spatial in nature (i.e. it varies geographically and due to environmental conditions), viewing the data in a way which displays this geographical variation is of particular use. For example, seeing where different water quality parameters are higher in concentrations can help explain causes and sources of contaminants. It is in this context, the ground water quality is determined in this mandal. In Physico-chemical analysis, various quality parameters are measured including pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), content of calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), sulphate (SO_4^{2-}), Iron (Fe), DO, BOD, COD, Total alkalinity (TA) and Nitrate (NO_3^{2-}) concentration present in ground water. Also all parameters were compared with ICMR standards of water quality. In the present research paper water samples of Pedapadu mandal was classified on the basis of Total hardness.

Key words: Contamination, water quality, ground water, Physico- chemical parameters

Introduction:

Ground water is considered as one of the purest forms of water available in nature and meets the overall demand of rural as well as urban population. Ground water plays a vital role in human life. Increase in urbanization, industrialization, agriculture activity and various human activities increase the pollution of surface water & ground water. Once the groundwater is contaminated,

its quality cannot be restored back easily and we need to device ways and means to protect it (Maniyar, 1990). Consequently number of cases of water borne diseases has been seen which cause health hazards [Elizabeth and Naik, 2005; Aremu et al., 2011). An understanding of water chemistry is the bases of the knowledge of the multidimensional aspect of aquatic environmental chemistry which involves the source, composition, reactions and transportation of water. The quality of water is of vital concern for the mankind since it is directly linked with human welfare. Therefore, monitoring the quality of water is one of the essential issues of drinking water management (Shama et al., 2011). Considering the above aspects of groundwater contamination, the present study was undertaken to investigate the impact of the groundwater quality water samples at Pedapadu mandal of West Godavari district, A.P, India. To communicate information on the quality of water to the concerned citizens and policy makers, analysis of water is utmost important. It is thus, becomes an important factor for the assessment and management of ground water. Thus, in this research work an attempt has been made to assess the physical and chemical parameters of ground water. As the safe & potable drinking water is needed various treatment methods are adopted to raise the quality of drinking water. Water should be free from the various contaminations viz. Organic and Inorganic pollutants, Heavy metals, Pesticides etc. as well as all its parameter like pH, Electrical Conductivity, Calcium, Magnesium, Total Hardness, Carbonate, Bicarbonate, Chloride, Total Dissolved Solid, Alkalinity, Sodium, Potassium, Nitrate, DO should be within a permissible limit. During last decade, this is observed that ground water get polluted drastically because of increased human activities. Consequently number of cases of water borne diseases has been seen which a cause of health hazards.

Study area:

“Eluru” is the headquarters of the West Godavari district, one of the nine coastal districts of Andhra Pradesh State. Agriculture is the main stay of population in the district. The district is having both surface and ground water resource potential. The delta area is mainly served by surface irrigation, whereas in the upland areas of the district the irrigation is chiefly by ground water. Physiographically the district is divided into 2 natural regions. viz., Alluvial plain and upland areas. The different type of soils encountered in the district are red soils, black cotton soils, deltaic alluvial soils and coastal sands. In general, the ground water is suitable for drinking and irrigation purposes in crystallines, sedimentaries while that occurring in alluvium the water is not suitable for drinking purpose and irrigation purpose under ordinary conditions.

Water pollution is one of the major and most critical issues in India, as almost 70 per cent of the surface water resources and various groundwater reserves are contaminated by biological, toxic, organic and inorganic pollutants. Deep tube wells, hand pumps and private bore wells are the main sources for extraction of groundwater in the Pedapadu mandal to cater the water demand of the population. It is in this context, the ground water quality is determined in this mandal. In Physico-chemical analysis, various quality parameter are measured including pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), content of calcium

(Ca²⁺),magnesium (Mg²⁺),chloride(Cl⁻), sulphate (SO₄²⁻), Iron (Fe), DO, BOD, COD, Total alkalinity (TA) and Nitrate (NO₃²⁻) concentration present in ground water. Also all parameters were compared with ICMR standards of water quality. In the present research paper water samples of Pedapadu mandal was classified on the basis of Total hardness.

Water Sampling:

In present investigation water samples were collected in polythene bottles which were cleaned with acid water, followed by rinsing twice with distilled water. The water samples are chemically analyzed. The analysis of water was done using procedure of standard methods.

Methodology:

- The pH and Turbidity was measured by using nephelometrically using Systronics.
- EC was measured by using Elico.
- TDS was measured by using EUTECH(digital).
- Total hardness, calcium and magnesium were measured by EDTA Complexometric titration.
- Chloride was measured volumetrically by silver nitrate(precipitation) titrimetric method.
- Iron, Fluoride, Sulphate, phosphate, Nitrite was measured by using Systronics Spectrophotometer.
- Total alkalinity is determined by Acid Base titration.
- DO is measured by using Winkler's method.
- BOD is measured by using dilution method.
- COD by using Redox titration.

GPS Values and Soil Nature of the villages of Pedapadu Mandal are shown in Table – 1. The results of the 19 physico-chemical parameters of water samples for 22 different villages in different seasons i.e., Pre monsoon and Post monsoon are represented in Table 2A & 2B respectively and compared with IS and WHO standards. Correlations among 11 different water quality parameters were represented in table 3A and 3B for pre and post monsoon 2016 respectively. Based on Total hardness the water samples are classified and shown in Table 4. WQI Values are represented in Table 5.

Table – 1 Location GPS values and Soil types of Pedapadu Mandal

S. No	Name of the Village	GPS Values		Source Details		Geology / Soil type	Health	Landmark	Command Population
		Latitude & Longitude(Degrees)	Elevation(Ft)	Bore Depth(Ft)	Water Table(Ft)				
1.	Buragudem	16.6845,81.09215	69	500	82	Black Cotton Soil	Good	Near Anganwadi	3000
2.	Edulakunta	16.64208,81.08668	49	-----	86	Black Cotton soil	Good	Near church	2500
3.	Epuru	16.6465,80.97506	89	300	106	Black Cotton Soil	Good	Near substation	2500
4.	Gogunta	16.584,81.008	36	-----	104	Alluvial soil	Good	Near co-operative	5000
5.	Kalaparru	16.66918,81.00985	75	300	89	Black Cotton Soil	Good	Near church	3500
6.	Kokkirapadu	16.68555,81.00631	69	250	99	Black Cotton Soil	Good	Near temple	4000

7.	Koniki	16.5809,81.05614	89	-----	94	Alluvial Soil	Good	Near Ro plant	4500
8.	Kothuru	16.68388,81.08371	89	550	92	Black Cotton Soil	Good	Near Panchayathi	6000
9.	Mupparru	16.66346,81.08333	56	550	98	Black Cotton Soil	Good	Near school	4000
10.	Nandikeswarapura m	16.63491,81.01341	72	300	105	Alluvial Soil	Good	Near church	2500
11.	Pedapadu-I	16.626,81.02595	72	300	102	Alluvial Soil	Good	Near church	5000
12.	Pedapadu-II	16.63788,81.03428	82	300	107	Alluvial Soil	Good	Near Panchayathi	4500
13.	Punukollu-I	16.63325,81.01083	66	350	82	Black Cotton Soil	Good	Near temple	2000
14.	Punukollu-II	16.64981,81.01905	72	350	83	Black Cotton Soil	Good	Near temple	2500
15.	Rajupeta	16.62171,81.02415	66	300	84	Black Cotton Soil	Good	Near school	4000
16.	Sakalakotheppalle	16.59467,81.03682	66	-----	86	Alluvial Soil	Good	Near Panchayathi	2500
17.	Satyavole	16.64888,81.03065	66	-----	84	Black Cotton Soil	Good	Near Panchayathi	4000
18.	Tallagudem	16.66943,81.08583	59	500	95	Black Cotton Soil	Good	Outside of the village	3000
19.	Vasanthavada-I	16.62266,80.99936	66	-----	92	Alluvial Soil	Good	Near hospital	4500
20.	Vasanthavada-II	16.62158,80.99963	66	-----	98	Alluvial Soil	Good	Near school	4500
21.	Vatluru	16.70203,81.05476	13	300	93	Black Cotton Soil	Good	Near Panchayathi	6000
22.	Vempadu	16.69758,81.00486	62	350	91	Redloomy soil	Good	Near temple	3500

Table 2A

Physico-chemical parameters of water samples of Pedapadu mandal in Premonsoon season 2016

S.No	Name of village	pH	E.C	TDS	Turbidity	Alkalinity	Hardness	Na	K	Ca	Mg	Fe	Cl-	F-	NO ₂	SO ₄ ⁻²	PO ₄ ⁻³	DO	COD	BOD
			µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01	Buragudem	7	2780	1860	0	578	264	43	5.2	53.7	31.6	0	475	0.38	0	69	0	8.4	0	6
02	Edulakunta	8	950	630	0	242	118	65	11.8	25.6	13.1	0	153	0.25	0	16.6	0	8.4	0	5.6
03	Epuru	7.4	1550	1040	0	322	234	42	9.1	56.1	22.9	0	262	0.19	0	21.8	1.21	8.4	0	5.6
04	Gogunta	7.5	850	560	2	272	128	71.8	17	29.6	13.1	0	102	0.45	0	9.5	0	9.2	0	6
05	Kalaparru	7.4	2210	1480	0	398	260	35	7	62.5	25.3	0	397	0.09	0	51.7	0	8	0	5.2
06	Kokkirapadu	6.9	2490	1670	0	404	266	34	5.8	64.9	25.3	0	493	0.81	0	47.4	0	9.2	4.8	6.4
07	Koniki	7.6	2360	1580	2	310	200	69.2	12	31.2	29.7	0	482	0.95	0	49.5	0	6.4	0	4.4
08	Kothuru	7.1	2560	1710	0	530	272	49	8	58.5	30.6	0	451	0.89	0	60.6	0	8.8	0	6.4
09	Mupparru	7.6	3490	2340	1	448	306	57	7	60.1	35.5	0	749	1.1	0	92	0	8	6.4	4.8
10	Nandikeswarapuram	6.9	3490	2340	1	456	364	43	6	72.1	44.8	0	752	1	0	93.2	0.24	8.8	0	6.8
11	Pedapadu-I	7.7	660	440	0	230	96	61	7.2	20	11.2	0	85	0.52	0	6.1	0	8.8	6.4	8
12	Pedapadu-II	7.6	340	230	1	132	68	65	9	16	8.7	0	35	0.66	0.44	6.9	0.85	8.8	4.8	5.6
13	Punukollu-I	7.1	2540	1700	0	454	260	59	5.8	52.1	31.6	0	439	0.97	0	18	0.39	9.2	0	6
14	Punukollu-II	7.7	370	250	0	140	62	69	9	11.2	8.2	0	50	0.33	0	6.3	0.55	9.2	0	6
15	Rajupeta	7.6	580	390	1	214	84	71	10	19.2	8.7	0	65	0.52	0	7	0.2	8	0	5.2
16	Sakalakotheppalle	7.6	770	520	3	140	96	45	10	20	11.2	0	119	0.94	0	34.5	0.13	9.6	0	6
17	Satyavole	7.5	720	480	1	160	80	69.6	9	16	9.7	0	102	0.84	0	31.5	0.62	8.4	1.6	5.6
18	Tallagudem	7.6	3580	2400	0	424	290	53	7	61.7	33.1	0	773	1.03	0	93.7	0	9.2	0	6.4
19.	Vasanthavada-I	7.8	640	430	0	140	80	43	5.2	14.4	10.7	0	120	0.78	0	12.9	0	8.8	0	6.8
20.	Vasanthavada-II	7.6	640	430	0	130	80	41	5	15.2	10.2	0	120	0.76	0	12.5	0	5.2	0	2
21.	Vatluru	7.3	1380	920	0	294	184	35	5	38.4	21.4	0	234	0.84	0	23.1	0	9.2	0	6
22.	Vempadu	7.5	2380	1600	1	400	334	39.5	5	60.9	44.3	0	475	1.01	0.85	34.5	0	9.2	4.8	8.4

Table – 2B

Physico-chemical parameters of water samples of Pedapadu mandal in Postmonsoon season 2016

S.No	Name of village	pH	E.C	TDS	Turbidity	Alkalinity	Hardness	Na	K	Ca	Mg	Fe	Cl ⁻	F ⁻	NO ₂	SO ₄ ⁻²	PO ₄ ⁻³	DO	COD	BOD	
			µS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
01	Buragudem	7.1	2800	1870	1	570	260	42	6	55.3	29.7	0	460	0.4	0	72	0	8	0	6.4	
02	Eduvakunta	8.2	970	650	0	260	126	68	12	27.2	14.1	0	155	0.28	0	16	0	8	0	5.2	
03	Epuru	7.6	1570	1050	0	330	242	44	9.3	56.9	24.3	0	270	0.21	0	20	0	8.4	0	5.6	
04	Gogunta	7.5	910	610	3	280	134	73	19	28.8	15.1	0	110	0.52	0	11	0.98	9.6	0	6.4	
05	Kalaparru	7.3	2320	1550	0	400	264	38	6	60.9	27.2	0	400	0.1	0	52	0	8.4	0	5.6	
06	Kokkirapadu	7	2510	1680	0	410	272	36	5	64.1	27.2	0	510	0.82	0	50	0	9.6	5.2	6	
07	Koniki	7.7	2370	1590	2	320	210	72	14	30.4	32.6	0	480	0.96	0	52	0	6	0	4.8	
08	Kothuru	7.2	2650	1770	0	540	280	52	10	59.3	32.1	0	465	0.92	0	62	0	8.4	0	6.8	
09	Mupparru	7.7	3480	2330	1	450	310	59	9	60.9	38.4	0	760	1.14	0	94	0	8.4	6.8	5.2	
10	Nandikeswarapuram	7	650	430	1	450	372	45	7	73.7	45.8	0	765	1.04	0	95	0.26	8.8	0	6.4	
11	Pedapadu-I	7.8	350	230	0	220	110	64	7.4	22.4	13.1	0	95	0.56	0	6.4	0	8.4	6.8	8.4	
12	Pedapadu-II	7.5	2560	1710	1	142	80	68	10	14.4	10.7	0	40	0.68	0.46	7.2	0.9	8.8	5.2	6	
13	Punukollu-I	7	380	250	0	472	270	61	6	53.7	33.1	0	444	1.01	0	18.4	0.4	9.6	0	6.4	
14	Punukollu-II	7.8	600	400	0	170	68	72	10	12.8	8.7	0	60	0.38	0	8	0.43	9.2	0	5.6	
15	Rajupeta	7.8	780	520	1	210	90	73	12	20.8	9.2	0	70	0.55	0	7.4	0.18	8.4	0	4.8	
16	Sakalakothapalle	7.9	790	530	4	150	110	48	12	21.6	13.6	0	124	0.96	0	36	0.09	9.2	0	6.4	
17	Satyavole	7.4	750	500	1	164	92	66	13	19.2	10.7	0	108	0.82	0	32	0.64	8	2	5.2	
18	Tallagudem	7.7	3610	2420	1	432	310	55	10	63.3	37	0	780	1	0	93	0	9.2	2	6	
19.	Vasanthavada-I	7.9	680	450	0	160	90	40	5	15.2	12.6	0	125	0.76	0	12	0	8.8	0	6.4	
20.	Vasanthavada-II	7.7	670	450	0	126	94	40	7	17.6	12.1	0	126	0.7	0	14	0	5.6	2	2.4	
21.	Vatluru	7.4	1400	940	0	300	196	38	7	39.2	23.8	0	244	0.84	0	22	0	9.6	0	6.4	
22.	Vempadu	7.6	2410	1610	2	410	340	40	7.2	62.5	44.8	0	480	1	0.9	32	0	9.2	4.4	8.8	

Table 3.A

Correlation matrix for water quality parameters for Pedapadu Mandal – Pre monsoon 2016

	pH	EC	TDS	Alkalinity	Total Hardness	Sodium	Potassium	Calcium	Magnesium	Chloride	Fluoride	Sulphate	DO	COD	BOD
pH	1														
EC	-0.57702	1													
TDS	-0.57659	0.99988	1												
Alkalinity	-0.69892	0.894825	0.893695	1											
TotalHardness	-0.64303	0.946142	0.946282	0.905977	1										
Sodium	0.473696	-0.36153	-0.36284	-0.35854	-0.48961	1									
Potassium	0.379781	-0.35269	-0.35481	-0.30552	-0.3813	0.696384	1								
Calcium	-0.683	0.906395	0.906363	0.900463	0.97482	-0.54103	-0.35894	1							
Magnesium	-0.57939	0.931175	0.93151	0.861398	0.972204	-0.41507	-0.38678	0.896823	1						
Chloride	-0.51124	0.990035	0.990378	0.828985	0.923317	-0.35119	-0.36073	0.874102	0.918282	1					
Fluoride	-0.21132	0.43434	0.435573	0.1818	0.335592	-0.09193	-0.31409	0.211009	0.443124	0.486818	1				
Sulphate	-0.45056	0.900346	0.900616	0.728482	0.787208	-0.31778	-0.28206	0.752733	0.771265	0.916761	0.432677	1			
DO	-0.19642	0.065045	0.064919	0.158597	0.15199	-0.04965	0.016501	0.203017	0.099452	0.035843	0.051973	0.020723	1		
COD	0.057489	0.070473	0.071859	0.023466	0.10262	0.019342	-0.20708	0.090567	0.102651	0.103155	0.237852	0.040772	0.130355	1	
BOD	-0.15668	0.149282	0.14947	0.249059	0.274398	-0.10535	-0.13685	0.262084	0.285024	0.130305	0.097729	0.057629	0.80943	0.317584	1

Table 3B

Correlation matrix for water quality parameters for Pedapadu Mandal – Post Monsoon 2016

	pH	EC	TDS	Alkalinity	Total Hardness	Sodium	Potassium	Calcium	Magnesium	Chloride	Fluoride	Sulphate	DO	COD	BOD
pH	1														
EC	-0.19648	1													
TDS	-0.19483	0.999992	1												
Alkalinity	-0.63643	0.577878	0.576662	1											
TotalHardness	-0.57339	0.570665	0.569853	0.895707	1										
Sodium	0.364163	-0.20325	-0.20259	-0.31685	-0.45482	1									
Potassium	0.363636	-0.09993	-0.09807	-0.30292	-0.35947	0.72957	1								
Calcium	-0.61591	0.557265	0.556348	0.900955	0.975823	-0.50215	-0.3873	1							
Magnesium	-0.4992	0.554706	0.554045	0.843634	0.973221	-0.38061	-0.31076	0.899454	1						
Chloride	-0.45817	0.634621	0.63432	0.824094	0.929517	-0.32523	-0.29735	0.880517	0.932378	1					
Fluoride	-0.2005	0.201599	0.201944	0.208742	0.372334	-0.06208	-0.05639	0.238199	0.493845	0.501951	1				
Sulphate	-0.39221	0.651896	0.651672	0.715527	0.778284	-0.29	-0.17119	0.746837	0.770692	0.908432	0.435491	1			
DO	-0.24805	-0.00565	-0.00652	0.192893	0.194663	-0.08254	-0.09367	0.260056	0.116181	0.075904	0.09824	-0.01965	1		
COD	0.034933	0.335265	0.334726	-0.03088	0.08334	0.01186	-0.21474	0.069323	0.093376	0.141058	0.284763	0.083908	0.050341	1	
BOD	-0.17457	0.067429	0.065582	0.317544	0.313063	-0.12371	-0.17105	0.290666	0.32089	0.136726	0.159511	0.029322	0.637931	0.242448	1

Table – 4

PEDAPADU MANDAL

DESCRIPTION	HARDNESS	PRE MONSOON	MONSOON	POST MONSOON
Soft	0-75	1	2	2
Moderately Hard	75-150	10	8	8
Hard	150-300	9	8	9
Very Hard	>300	2	4	3

Table- 5

Se No	Nameof the village	WQI Value	Status of water quality
1	Buragagudem	312.3	Unsuitable
2	Edulakunta	141.7	Poor
3	Epuru	198.2	Poor
4	Gogunta	121.4	Poor
5	Kalaparru	371	Unsuitable
6	Kokkirapadu	279.7	Very Poor
7	Koniki	212.8	Poor
8	Kothuru	263.2	Very Poor
9	Mupparru	177.5	Poor
10	Nandikeswarapuram	363.4	Unsuitable
11	Pedapadu-I	114.5	Poor
12	Pedapadu-II	121.4	Poor
13	Punukollu-I	278.3	Very Poor
14	Punukollu-II	99.83	Good
15	Rajupeta	117.9	Poor
16	Sakalakotheppalle	150.2	Poor
17	Satyavole	116.9	Poor
18	Tallagudem	379.5	Unsuitable
19	Vasanthavada-I	325.8	Unsuitable
20	Vasanthavada-II	121.3	Poor
21	Vatluru	237	Very Poor
22	Vempadu	284.7	Very Poor

WQI Values of Pedapadu mandal**Results and Discussion:**

The water from the study area has no colour. Taste of the water of the water sample in most of the locations is pleasant in taste. The pH of water shows variation in its ranges. It indicates that they are in range of water quality parameter permissible limits. The EC of water samples shows wide variation in all the samples. TA within the limits. Chloride content in water is low, the fluoride content in water is low due to this no dental and Skelton problem arises in the study area. The value of DO, BOD, COD were in limits. Turbidity was higher of all the observed parameters of almost all the samples . The Ca^{2+} was showed wide variation in all the accepted limits. Mg^{2+} values were within the limits. Sulphate data was low. Total hardness shows that maximum samples contain higher values of hardness. TDS were in permissible limits except few samples where it is high.

By using linear correlation matrix, negative and positive relation between any two water quality parameters can be determined. Alkalinity shows significant correlation with calcium and magnesium indicating that the alkaline nature of ground water is mainly due to calcium and magnesium salts. Calcium shows good correlation with chlorides indicating that calcium is associated with chlorides in water of the study area. Conductivity shows significant correlation with calcium and chlorides which reveals that conductance of water samples is mainly due to calcium and chlorides in the ground water of the study area. It has been found that there was a stronger positive correlation between EC and TDS in both the seasons. While the negatively correlated values were found between EC & pH and TDS & pH and Chloride and pH. DO and BOD are important organic pollutants which showed negative correlation with other parameters.

Conclusion:

pH is a measure of the amount of acidity in the stream. A low pH indicates more acidity. Turbidity is a cloudiness or haziness of water caused by individual particles that are too small to be seen without magnification. Turbidity is increased in urban areas, as well as in areas that have activities that increase the amount of particles in water, such as agricultural activity.

Conductance or conductivity is defined as the amount of ionic material (i.e. salts) dissolved in the water. In addition, conductivity of a water body can be influenced by the conductivity of rain water. Total hardness is a primary function of carbonate and bicarbonate content in water.

Calcium is found naturally in certain types of rocks, as well as in landfill leachate and wastewater effluent. Burning of fossil fuels can contribute to calcium in water bodies. It is also found in road salts, and as such may be higher in urban areas or near highways. Magnesium is found in landfill leachate, as well as road salts. Higher value of TDS is due to the Calcium and Magnesium.

Hence, consistent monitoring measures are very important to assess the impact of the percolation of the wastewater, causing contamination of the groundwater in the study area, and a preventive mechanism coupled with remedial measures is necessary for the benefit of mankind. It is also recommended that water analysis should be carried out from time to time to monitor the rate and kind of contamination. It is need of human to expand awareness among the people to maintain the cleanness of water at their highest quality and purity levels to achieve a healthy life

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