

ANNUAL DRINKING WATER QUALITY SURVEILLANCE REPORT 2021

Royal Center for Disease Control, MINISTRY OF HEALTH

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1. Introduction

According to the United Nation, every individual must have access to safe, sufficient and affordable water, sanitation and hygiene facilities as it is recognized as Human rights, reflecting the fundamental nature of these basics in every person's life. The lack of these basic rights has devastating effects on the health, dignity, and prosperity of billions of people and has significant consequences for the realization of other human rights

Sustainable Development Goal 6.1 aims to achieve safe and affordable water for all universally by 2030. The goal also targets improving the quality of drinking water by reducing pollution by eliminating and minimizing the dumping of waste such as human excreta and hazardous chemical waste into the water.

As per the World Health Organization, in 2017, 71% of the people used the improved quality, easily accessible and affordable drinking water services and about 90% of the population got at least access to safe drinking water. While 785 million people still lack basic drinking-water service.

In Bhutan, 97.7% of the population has access to safe drinking water from which, 58.8% of the water was piped into a compound, 24% piped into a dwelling, 7.8% public tap, and 5.9% to the neighbor respectively. (**National Health Survey 2012,pg38**)

The Ministry of Health is responsible for looking after the quality of drinking water as per the Water Act of Bhutan, 2011 page 9C. National Water Reference Laboratory (NWRL) under Royal Centre for Disease Control (RCDC) is the lead institution for Drinking Water Quality Surveillance in Bhutan under the Ministry of Health. (**BDWQS2016**)

2. Methodology:

There are two water supply system; the urban water supply system and rural water supply system.

The urban health centres collect and do the monitoring of the quality of drinking water once every month and the rural health centres do the monitoring biannually.

2.1. The general parameters currently monitored by Urban Health centres are:

Sl.no	Parameters in BDWQS 2016(Urban)	Parameters tested
1	Color (TCU)	Thermo tolerant Coliform
2	Conductivity	Turbidity
3	Odor	pH
4	pH	Free Residual Chlorine
5	Taste	Conductivity/TDS
6	Turbidity	E.Coli
7	Calcium	
8	Free Residual Chlorine	
9	Iron	
10	Manganese	
11	Sulphate	
12	Fluoride(applicable to ground and spring Water only)	
13	Nitrate	
14	Arsenic(applicable to ground water only)	
15	E.COLI	

2.2. The parameters for rural health centres are:

SL.NO	Parameters in BDWQS 2016(rural)	Existing Parameter
1	Conductivity	E.coli
2	Odour	Conductivity
3	Appearance	Turbidity
4	pH	pH
5	Taste	Odour
6	Turbidity	Colour
7	E.Coli	

3. Bacteriology(Thermo tolerant coliform):

Thermo tolerant coliform are bacteria of the coliform groups which are most commonly found in the feces of warm blooded animals. These bacteria are heat resistant and can live up to 44 °C. Presence of thermotolerant Bacteria indicates that the water is contaminated and there may be harmful pathogenic bacteria. Generally, these coliforms act as indicator bacteria to assess the quality of drinking water. As per Bhutan Drinking Water Quality Standard 2016, there should not be any colony-forming unit (CFU) in 100mL of water sample after the incubation for 18-24 hours.

Methodology

3.1. Media preparation: MFC broth media;

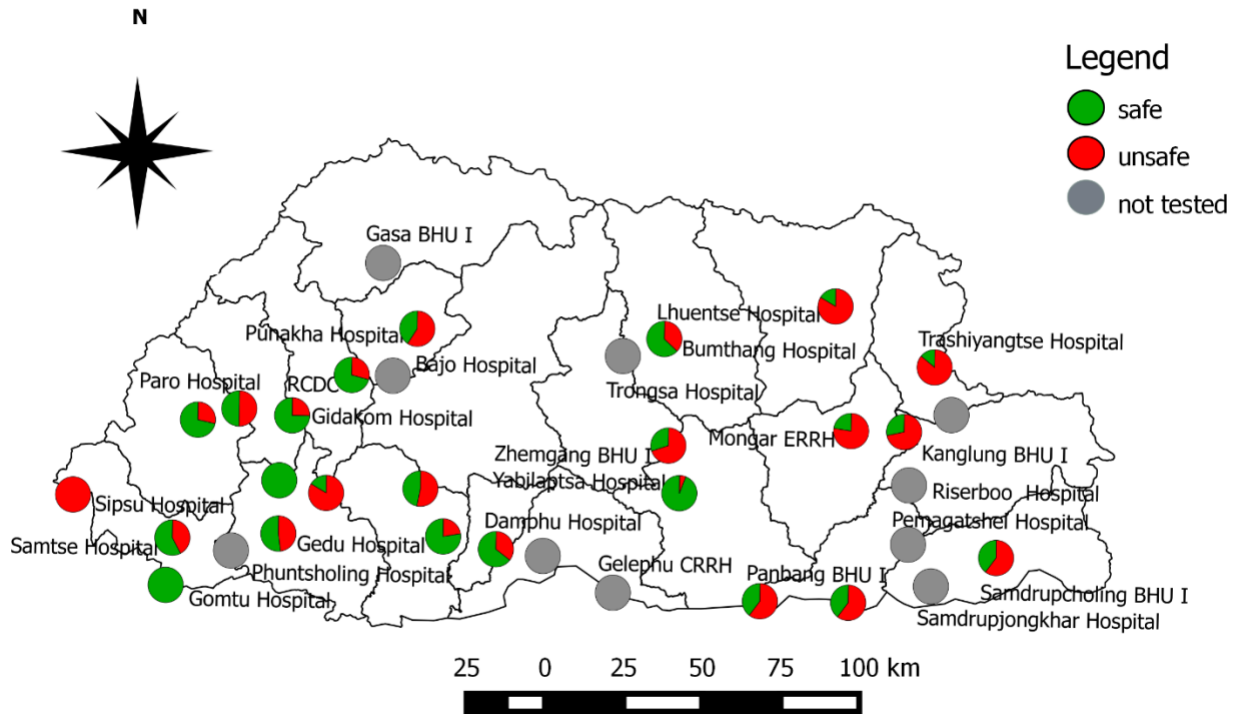
- 3.1.1. Suspend 37.1 grams in 1000 ml distilled water containing 10 ml 1% Rosolic Acid (FD058). Heat to boiling to dissolve the medium completely. **DO NOT AUTOCLAVE**. Cool to 45°C and add 2 ml of M-FC Broth on sterile absorbent pad placed in a sterile Petri plate.

3.2. Testing procedure: the standard method of membrane filtration technique is used.

100mL of sample is filtered through a membrane filter paper and is plated on the culture plate with the media. Temperature of 37°C is maintained and colony is counted after 24 hours of incubation. In order to validate the test result, known positive and known negative water sample is used as a control every time the test is conducted.

4. Results and Discussion:

4.1. Urban bacteriology report:



Map 1: Bacteriology test report of 34 hospitals/BHU-1 in urban area

Out of 2940 samples total of 901 samples were tested for thermo tolerant coliform by 34 urban health centres. Out of 901 samples tested, 48.1% of the samples were found to be safe for consumption and 51.9% were found unfit for the consumption. Comparing the result with the last year's annual report the health center, not reporting has increased from 6 health centres to 10 health centres. **See: map1**

Table1: Consistency in reporting

Reporting Center	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	%
Bumthang Hospital	NR	NR	R	R	R	R	R	R	R	R	NR	R	75
Chhukha BHU I	NR	NR	NR	R	NR	NR	R	NR	NR	NR	R	R	33.3
Gedu Hospital	NR	NR	NR	R	NR	NR	NR	NR	NR	NR	R	R	25
Phuentsholing Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Tsimalakha Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	R	R	25
Dagana BHU I	NR	NR	NR	NR	NR	NR	R	R	NR	NR	R	R	33.3
Dagapela Hospital	NR	NR	NR	NR	NR	NR	NR	R	R	R	R	R	41.7
Lhamoyzingkha BHU I	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Gasa BHU I	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Haa Hospital	R	R	R	R	R	R	R	R	R	R	R	R	100
Lhuentse Hospital	R	R	R	R	R	R	R	R	R	R	R	R	100
Monggar ERRH	NR	NR	R	R	R	R	R	R	R	R	R	NR	75
Paro Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	R	25
Nganglam BHU I	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	R	16.7
Pemagatshel Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	NR	8.33
Punakha Hospital	R	R	R	R	R	R	NR	R	R	NR	R	NR	75
Samdrup Jongkhar Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Samdrupchholing BHU I	NR	NR	NR	NR	NR	NR	NR	R	NR	NR	R	R	25

Gomtu Hospital	NR	NR	NR	NR	NR	NR	NR	R	R	R	R	0	33.3
Samtse Hospital	R	R	R	NR	NR	R	R	R	R	NR	R	R	75
Sibsoo BHU I	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	8.33
Gelephu CRRH	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Sarpang Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Gidakom Hospital	NR	NR	R	NR	NR	NR	NR	NR	NR	NR	NR	R	16.7
Bartsham BHU I	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Kanglung BHU I	NR	NR	NR	NR	NR	R	R	R	R	NR	R	R	66.7
Riserboo Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	R	16.7
Trashigang Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Trashi Yangtse Hospital	NR	NR	NR	NR	R	NR	NR	NR	R	NR	R	R	33.3
Trongsa Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	8.33
Tsirang Hospital	R	NR	R	R	NR	R	NR	R	R	R	R	R	75
Wangduephodrang Hospital	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Panbang BHU I	NR	NR	NR	NR	NR	NR	R	NR	R	NR	R	R	33.3
Yebilaptsa Hospital	R	R	R	R	NR	R	R	NR	NR	NR	R	NR	58.3
Zhemgang BHU I	R	NR	R	R	R	R	NR	NR	R	NR	R	R	66.7
Khatoekha BHU I	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0
Royal Centre for Disease Control	NR	R	R	NR	NR	R	NR	R	NR	R	R	R	58.3

Note:R=Reported

NR=Not reported

5. Physio-Chemical Report

5.1 Turbidity

Turbidity is a measure of the cloudiness of the water caused by suspended particles or colloidal matter. It indicates the effectiveness of the treatment plants. Although turbidity may not have a direct health effect it may have a negative impact on consumer acceptability.

A total of 770 samples were monitored for turbidity from 34 urban health centers for routine water quality surveillance. Out of which, 83.9% of the samples were found within the acceptable limit (<5NTU).

The figure indicates the maximum number of turbid samples were observed in May, June, July, November, and December.

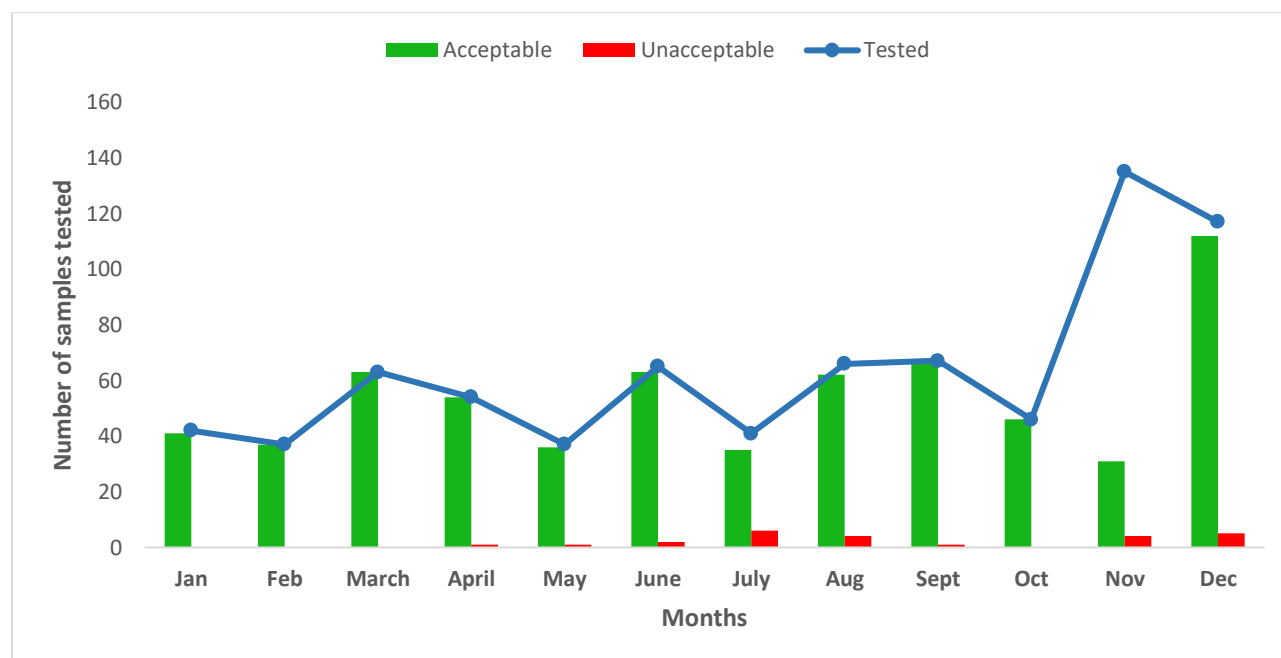


Figure1: Seasonal variation of turbidity from 34 health centers

Table2: Turbidity Compliance

Reporting centre	Compliant	Non Compliant
Bumthang Hospital	56	0
Chhukha BHU I	11	5
Gedu Hospital	22	0
Phuentsholing Hospital	0	0
Tsimalakha Hospital	15	0
Dagana BHU I	23	0
Dagapela Hospital	0	0
Gasa BHU I	0	0
Haa Hospital	52	7
Lhuentse Hospital	10	1
Monggar ERRH	49	3
Paro Hospital	26	0
Nganglam BHU I	4	0
Pemagatshel Hospital	8	0
Punakha Hospital	55	0
Samdrup Jongkhar Hospital	0	0
Samdrupchholing BHU I	13	1
Gomtu Hospital	23	0
Samtse Hospital	80	0
Sibsoo BHU I	5	0
Gelephu CRRH	0	0
Sarpang Hospital	0	0
Gidakom Hospital	5	2
Royal Centre for Disease Control	74	1
Kanglung BHU I	48	0
Riserboo Hospital	1	0
Trashigang Hospital	0	0
Trashy Yangtse Hospital	24	3
Trongsa Hospital	7	0
Tsirang Hospital	52	1
Bajo Hospital	0	0
Panbang BHU I	14	0
Yebilaptsa Hospital	34	0
Zhemgang BHU I	32	0

5.2 pH

The allowable range for pH is 6.5 to 8.5 as per BDWQS. Out of 844 samples tested only 0.6% of the samples were found non-compliant. The highest pH tested was found to be 8.2 and the lowest value was tested 0.1.

5.3 Chlorine:

Out of 34 urban reporting centres, only six health centers (Bajo, Bumthang, Gelephu, Phuntsholing, Thimphu and Samtse) monitor chlorine level in drinking water as there are no treatment facilities or non-functional treatment facilities. A total of 275 treated water samples were tested for Residual Chlorine and only 78.2% were inadequately (0.2-0.5ppm free residual chlorine) chlorinated.

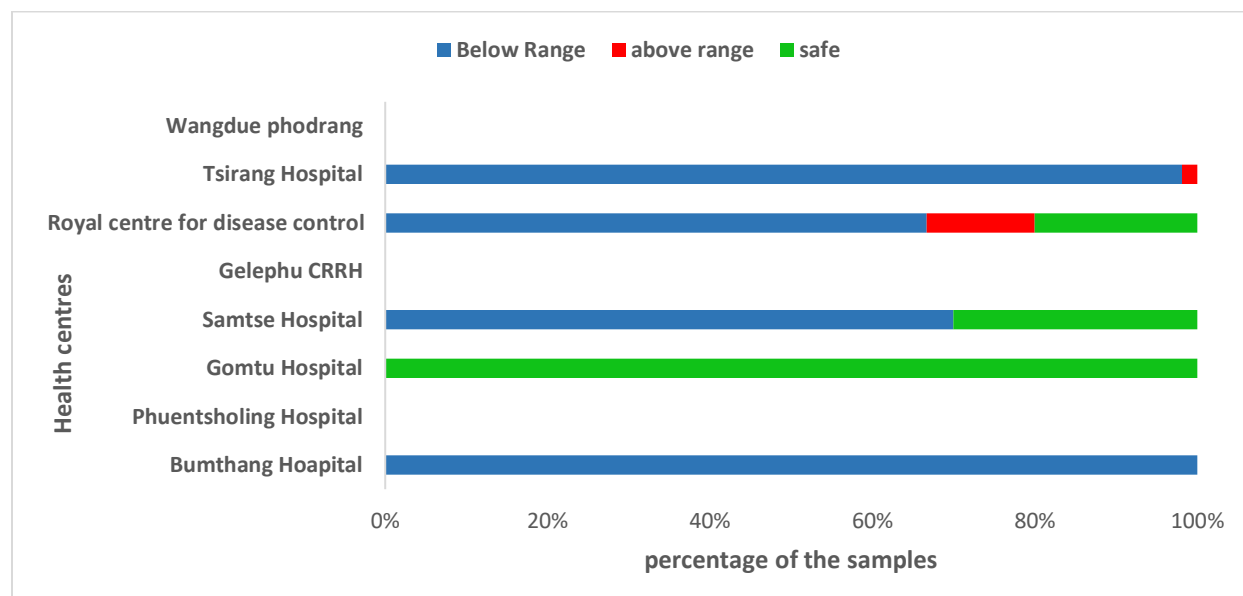
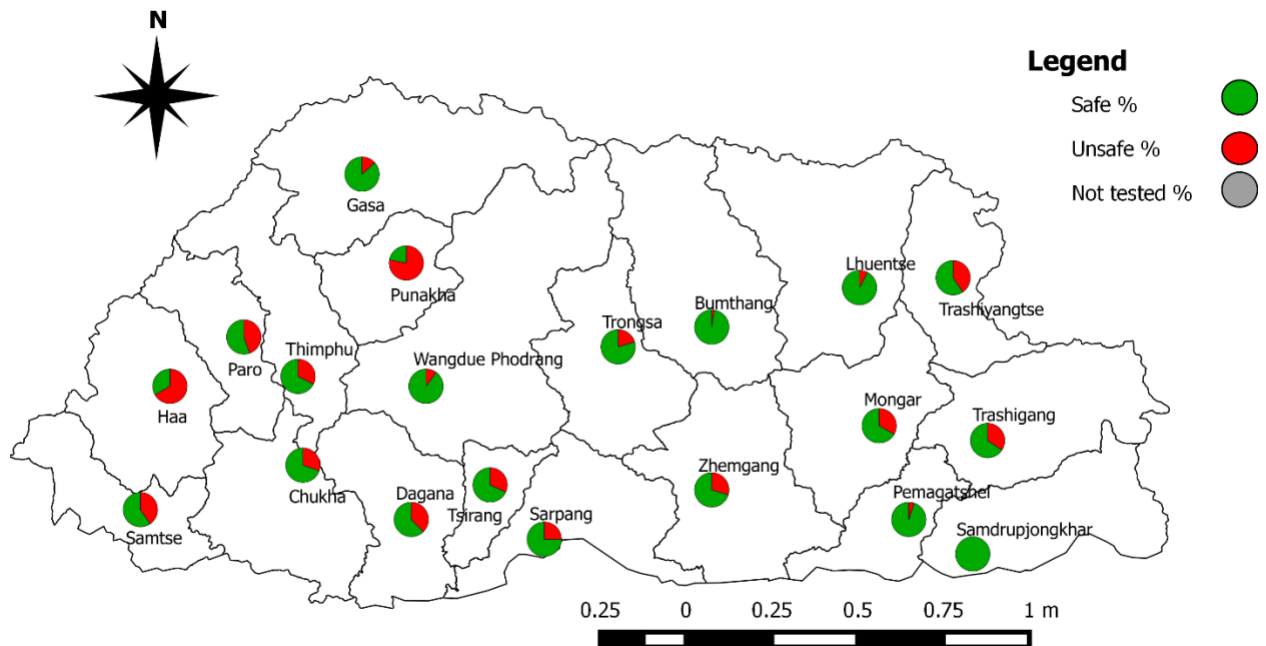


Figure 2: Residual Chlorine maintained at different urban drinking water treatment facilities

5.4 Rural Drinking Water Quality Monitoring (RDWQM)



Map2: Rural bacteriology report

Total of 1803 out of 3894 samples were tested for E.Coli out of which 73.8% were found fit for consumption and the rest was found to be unfit for consumption.

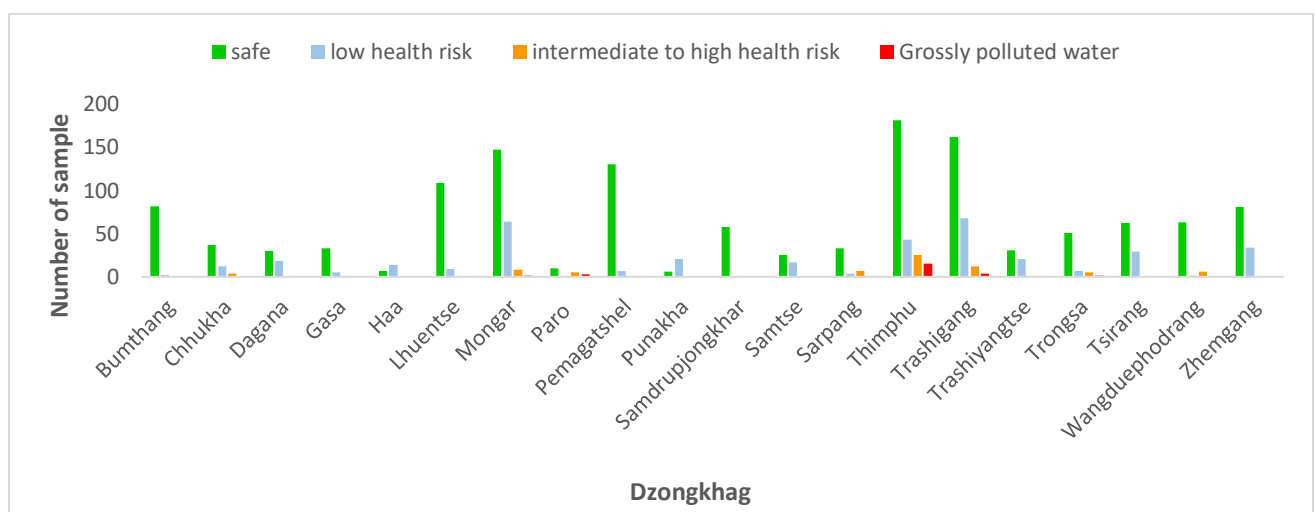


Figure3: Health risk category of the water quality results from different dzongkhags

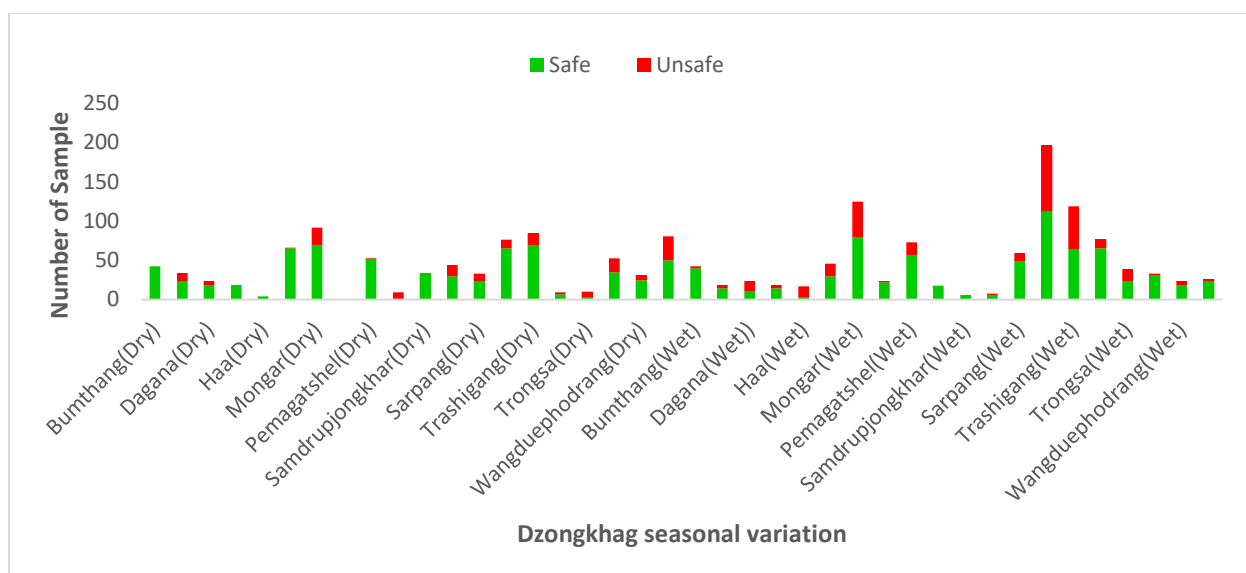


Figure4: Seasonal variation of rural drinking water quality

Table5: Seasonal variation of water quality in rural area

Sl.No	Dzongkhag	Safe	Unsafe
1	Bumthang(Dry)	42	0
2	Chhukha(Dry)	23	11
3	Dagana(Dry)	19	5
4	Gasa(Dry)	19	0
5	Haa(Dry)	4	0
6	Lhuentse(Dry)	65	1
7	Mongar(Dry)	69	23
8	Paro(Dry)	0	0
9	Pemagatshel(Dry)	51	2
10	Punakha(Dry)	1	8
11	Samdrupjongkhar(Dry)	34	0
12	Samtse(Dry)	30	14
13	Sarpang(Dry)	23	10
14	Thimphu(Dry)	65	11
15	Trashigang(Dry)	70	15
16	Trashiyangtse(Dry)	7	2
17	Trongsa(Dry)	3	7
18	Tsirang(Dry)	35	18
19	Wangduephodrang(Dry)	25	6
20	zhemgang(Dry)	50	31

21	Bumthang(Wet)	40	2
22	Chhukha(Wet))	14	5
23	Dagana(Wet))	11	13
24	Gasa(Wet))	14	5
25	Haa(Wet)	3	14
26	Lhuentse(Wet)	30	16
27	Mongar(Wet)	80	45
28	Paro(Wet))	22	2
29	Pemagatshel(Wet)	57	16
30	Punakha(Wet)	18	0
31	Samdrupjongkhar(Wet)	6	0
32	Samtse(Wet)	5	3
33	Sarpang(Wet)	49	10
34	Thimphu(Wet)	112	85
35	Trashigang(Wet)	64	55
36	Trashiyangtse(Wet)	65	12
37	Trongsa(Wet)	24	15
38	Tsirang(Wet)	31	2
39	Wangduephodrang(Wet)	18	6
40	zhemgang(Wet)	23	3

6. Conclusion:

A total of 2704 samples, 901 from urban and 1803 from rural were tested for E.Coli(rural) and Thermotolerant coliform (Urban) in the year 2021. 48.1% of the 901 samples from urban and 78.3% of 1803 samples from rural is found to be safe for consumption. Health centres like Gasa, Sarpang, Trashigang, Phuentsholing, lhamozhingkha, Samdrupjongkhar, Sarpang, Gelephu and Wangduephodrang have not submitted a single test result. However, Lhuentse and Haa have 100% test results.

275 treated water samples were tested for free residual chlorine by the six urban health centres and more than 50% (78.2%) were inadequately (0.2-0.5ppm free residual chlorine) chlorinated. The rest of the 34 urban health centres and rural health centres do not monitor free residual chlorine level in the drinking water. The reasons could be due to no treatment facilities or non-functional treatment facilities.

A total of 770 samples were monitored for turbidity from 34 urban health centers for routine water quality surveillance. And it is found that 83.9% of the water was within the acceptable range.

7. References:

- <https://www.unwater.org/water-facts/human-rights/>
- **National Health Survey 2012,pg38**
- **Bhutan drinking water surveillance 2016**
- **Annual drinking water surveillance report 2019 and 2020**
- **Water Act of Bhutan, 2011**
- (<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/coliform-bacterium>)

