



ANALYSIS OF THE MAIN DRINKING WATER QUALITY INDICATORS OF CENTRALIZED WATER SUPPLY SYSTEMS IN THE FERGANA REGION

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Abstract

This article presents a sanitary and hygienic analysis of the main drinking water quality indicators in centralized water supply systems of the Fergana Region, Republic of Uzbekistan. The study is based on a comparative assessment of published regional laboratory monitoring results, sanitary regulations, and scientific literature. Particular attention is given to the influence of hydrogeological conditions, anthropogenic pressures, and the operation of water distribution infrastructure on drinking water quality. Chemical and bacteriological monitoring data for Fergana city and the Fergana Region in 2012 and 2021 were compared. According to the published results, the proportion of water samples failing to meet chemical quality requirements in the region decreased from 6.9% to 4.6%, while the proportion failing to meet bacteriological requirements changed from 2.7% to 2.6%. The analysis indicates territorial variations in water quality related to water sources, distribution network conditions, and environmental factors. These findings substantiate the need to strengthen operational and public-health surveillance, prevent secondary water contamination, and implement differentiated sanitary and hygienic risk assessment to protect the population. The reported measurements were taken from published monitoring data and do not represent new laboratory testing by the present author.

Keywords: drinking water; Fergana Region; centralized water supply; hygienic assessment; water hardness; mineralization; chemical parameters; bacteriological safety; public health.



INTRODUCTION

Providing the population with safe and high-quality drinking water is one of the principal tasks of environmental hygiene, sanitary and epidemiological surveillance, and preventive medicine. Drinking water is indispensable for human life. It contributes to the regulation of fluid and electrolyte balance, the maintenance of physiological homeostasis, the transport of nutrients, and the elimination of metabolic waste products [9].

The sanitary and hygienic importance of drinking water depends not only on its availability but also on whether its chemical composition, organoleptic properties, and microbiological characteristics meet established safety standards. Poor drinking water quality can contribute to the spread of waterborne infectious diseases and increase the population's exposure to potentially harmful chemical substances during prolonged consumption [9].

The problem of ensuring an adequate drinking water supply is particularly relevant to regions characterized by high population density, intensive agricultural production, and extensive industrial infrastructure. The Fergana Region of the Republic of Uzbekistan is one such territory.

The Fergana Region is located in the eastern part of Uzbekistan within the Fergana Valley. It comprises urbanized areas, agricultural districts, and industrial centers. Its climatic and hydrogeological conditions contribute to spatial differences in surface-water and groundwater characteristics and thus affect the quality of resources used for domestic and drinking water supply.

In different settlements, drinking water quality may depend on the mineralogical composition of aquifers, water exchange dynamics, the technical condition and operation of abstraction facilities, distribution infrastructure, and potential sources of pollution. A published investigation by F. T. Abduvalieva and F. L. Azizova indicated increased concentrations of dissolved mineral salts in some districts of the Fergana Region, both in raw water sources and in supplied drinking water. By contrast, the underground source serving Fergana city met the chemical composition requirements of O'z DSt 951:2011 assessed by those authors [2].



These findings support the need for territorially differentiated sanitary and hygienic assessment across the region, including Fergana, Kokand, Margilan, Kuva, Rishtan, Altyaryk, Bagdad, Yazyavan, and other districts and settlements. Priority parameters include color, turbidity, odor, pH, total hardness, dissolved solids, nitrogen compounds, iron, chlorides, sulfates, and microbiological indicators.

A comprehensive evaluation of these parameters makes it possible to assess compliance with sanitary requirements, identify priority areas for surveillance, and design preventive measures to limit the potential adverse effects of drinking water quality on public health.

STUDY AIM

To conduct a comparative sanitary and hygienic assessment of the principal drinking water quality indicators in centralized water supply systems of the Fergana Region using published laboratory monitoring results, and to identify the main remaining problems in ensuring the chemical and microbiological safety of drinking water.

MATERIALS AND METHODS

The object of analysis was drinking water supplied through centralized domestic and drinking water systems in the Fergana Region, including Fergana city. This work was designed as a retrospective, comparative analytical review of previously published sanitary and hygienic monitoring results; no original water samples were collected or analyzed for this article.

The primary empirical source was the study by F. T. Abduvalieva and F. L. Azizova, published in the Bulletin of the Tashkent Medical Academy in 2022, together with other available scientific publications on drinking water quality in the Fergana Region [2–5].

For interpretation of the indicators, the published requirements of SanPiN of the Republic of Uzbekistan No. 0211-06, “Hygienic Criteria and Quality Control of Water in Centralized Domestic and Drinking Water Supply Systems of the Population of Uzbekistan,” were considered [6]. The current legal status of this



regulation and any subsequent amendments or replacements must be checked before journal submission.

The comparison covered organoleptic characteristics, physicochemical parameters, compliance with chemical quality requirements, and bacteriological safety. Descriptive and comparative analytical methods were applied. The dynamics of non-compliant samples were estimated by comparing their reported percentages in 2012 and 2021, with changes expressed in percentage points. Differences in sample size, sampling geography, seasonality, and analytical coverage were considered important limitations of the interpretation.

RESULTS AND DISCUSSION

The published results reveal spatial variation in the quality of drinking water supplied through centralized networks in the Fergana Region. Between 2012 and 2021, Fergana city showed improvement in both chemical and bacteriological monitoring outcomes. Across the region as a whole, improvements were smaller, indicating persistent difficulties in maintaining standard-compliant drinking water in particular localities [2].

Chemical quality indicators

Table 1. Results of chemical quality monitoring of drinking water in Fergana city and the Fergana Region

Indicator	2012	2021
Water samples examined, Fergana city (n)	410	3,120
Water samples examined, Fergana Region (n)	2,813	2,195
Non-compliant samples, Fergana city (%)	2.4	0.8
Non-compliant samples, Fergana Region (%)	6.9	4.6

Source: Abduvalieva and Azizova (2022) [2]; values reproduce the published monitoring table. “Fergana Region” denotes the regional series reported by the source.

The proportion of samples failing to meet chemical quality standards in Fergana city decreased from 2.4% in 2012 to 0.8% in 2021, a reduction of 1.6 percentage



points. The corresponding regional proportion declined from 6.9% to 4.6%, representing a reduction of 2.3 percentage points.

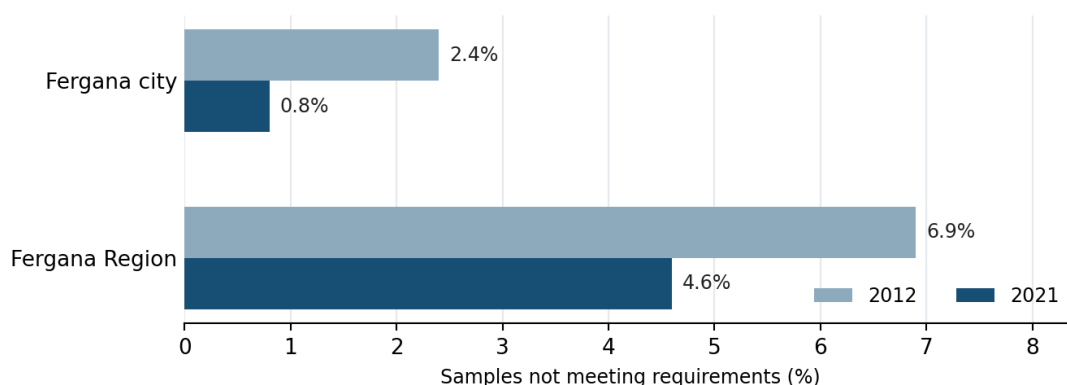


Figure 1. Proportion of drinking water samples failing to meet chemical quality requirements in 2012 and 2021.

Source: visualized from the published monitoring figures of Abduvalieva and Azizova [2].

Despite this improvement, the regional percentage of chemically non-compliant samples remained 5.75 times the corresponding proportion for Fergana city in 2021 (4.6% versus 0.8%). This contrast illustrates the heterogeneity of conditions across centralized water supply systems. However, the number of analyzed samples differed across the two years, and the monitoring results cannot independently establish the causes of the observed changes. Detailed interpretation would require information on the location, season, source type, and precise chemical composition of each sample.

Bacteriological quality indicators

Table 2. Results of bacteriological monitoring of drinking water in Fergana city and the Fergana Region

Indicator	2012	2021
Water samples examined, Fergana city (n)	1,286	929
Water samples examined, Fergana Region (n)	8,590	5,108
Non-compliant samples, Fergana city (%)	3.2	0.7
Non-compliant samples, Fergana Region (%)	2.7	2.6

Source: Abduvalieva and Azizova (2022) [2].

An improvement in bacteriological quality was observed in Fergana city, where the proportion of samples failing to meet sanitary requirements decreased from 3.2% in 2012 to 0.7% in 2021, a reduction of 2.5 percentage points. For the Fergana Region as a whole, the change was minimal: from 2.7% to 2.6%.

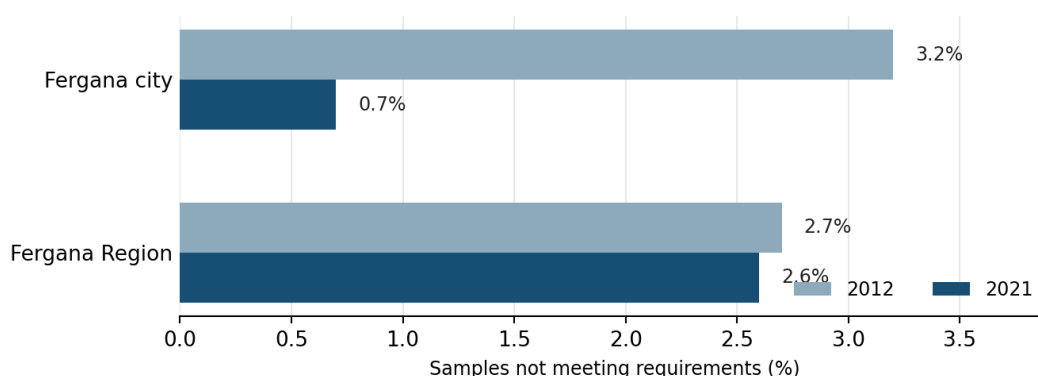


Figure 2. Proportion of drinking water samples failing to meet bacteriological requirements in 2012 and 2021.

Source: visualized from the published monitoring figures of Abduvalieva and Azizova [2].

These findings suggest the persistence of factors that may facilitate microbial contamination in some regional systems. Potential mechanisms include inadequate pipeline integrity, insufficiently maintained distribution facilities, intermittent service, reduced pressure, and limitations in the effectiveness of preventive disinfection. Such mechanisms are plausible explanations rather than established causes in the absence of site-specific engineering and sanitary investigations.

The monitoring results support maintaining continuous microbiological surveillance from the water intake and treatment stages to the final points of consumption. Distribution segments with unstable hydraulic conditions, aging infrastructure, or greater potential for secondary contamination require particular attention.

Organoleptic and physicochemical characteristics

The organoleptic properties of drinking water have practical significance for consumer acceptability and can provide early indications of changes caused by natural processes, water treatment, or contamination within the distribution



network. Color, turbidity, odor, and taste are therefore important components of hygienic evaluation. The hydrogen ion concentration (pH) characterizes acid–base conditions and may influence corrosion, the solubility of chemical substances, and the efficiency of disinfection.

Total water hardness is determined mainly by dissolved calcium and magnesium compounds. Greater hardness promotes scale formation and may reduce the acceptability and operational suitability of water. When assessing possible health effects, individual susceptibility, overall water composition, and dietary factors must be considered. Elevated hardness alone does not establish a causal relationship with urolithiasis or cardiovascular disease.

Total dissolved solids (dry residue) reflect the overall mineral content of water. A marked increase may affect taste and indicate the geochemical characteristics of the source. Nitrogen compounds are relevant as potential indicators of pollution, while high nitrate exposure is especially hazardous to young infants because of the risk of methemoglobinemia. Elevated iron concentrations may produce discoloration, sediment, and a metallic taste [9].

Table 3. Principal parameters recommended for the hygienic assessment of centralized drinking water supply in the Fergana Region

Parameter	Unit	Published limit under SanPiN No. 0211-06
Odor	points	≤ 2
Taste	points	≤ 2
Turbidity	mg/L	1.5
pH	pH units	6.0–9.0
Total hardness	mg-eq/L	7.0
Dry residue (total dissolved solids)	mg/L	1,000
Nitrates	mg/L	45
Nitrites	mg/L	3.0
Total iron	mg/L	0.3
Chlorides	mg/L	250
Sulfates	mg/L	400



Note: These are the values reported for the cited historical regulation [6]; some parameters may have conditional permissible values. They are regulatory reference values, not measured concentrations from Fergana Region samples. Legal currency and any applicable exceptions should be verified before publication.

Unlike the regional proportions of non-compliant samples, the published monitoring material used in this review does not provide a complete set of regional mean concentrations for every physicochemical parameter in Table 3. Accordingly, no quantitative claims about the magnitude of exceedance for individual chemical substances can be made without additional laboratory datasets.

Given the previously reported elevated mineralization in certain districts [2], targeted analysis should prioritize total dissolved solids, total hardness, calcium, magnesium, chlorides, and sulfates. Nevertheless, mineralization alone does not demonstrate that each of these components exceeds its respective limit; reliable conclusions require direct chemical measurement.

Public health implications

Drinking water quality is a major determinant of sanitary and epidemiological well-being. In assessing the water-related burden of disease, chemical, microbiological, and operational aspects of safety must be evaluated together. Microbiological contamination can create immediate epidemiological hazards by enabling the transmission of enteric pathogens. Risks may increase where distribution systems are damaged, disinfectant protection is inadequate, or water becomes contaminated during transport and storage [9].

Chemical characteristics are often most relevant to long-term exposure. Nitrates, fluoride, arsenic, and certain metals require substance-specific toxicological assessment that accounts for exposure duration and the susceptibility of different population groups. For the Fergana Region, water hardness and mineralization deserve particular study. Research published in 2026 examined the relationship between drinking water hardness and the composition of urinary calculi in the



region [4]. Its findings should be interpreted in the context of the study design and potential confounders.

Laboratory measurements of drinking water quality cannot, by themselves, demonstrate increased disease incidence in a population. Epidemiological studies evaluating age, sex, diet, socioeconomic circumstances, comorbidities, and other factors are necessary to assess potential associations between water composition and health outcomes.

Priority areas for improving sanitary surveillance

The present analysis supports a comprehensive approach to drinking water safety in the Fergana Region. Regular laboratory monitoring should be conducted at abstraction sites, after water treatment, and at representative locations throughout the distribution network. Particular priority should be given to communities where chemical or bacteriological non-compliance has been recorded in previous monitoring rounds.

Seasonal variation should be considered, including hydrogeological changes, fluctuations in consumption, and potential agricultural influences. Enhanced analytical capacity would allow more detailed measurement of major ions, nitrogen compounds, metals, and other sanitary and toxicological indicators.

At the same time, the effectiveness of disinfection, the physical condition of water supply infrastructure, and the prevention of secondary microbial contamination should remain central operational priorities. A geographically differentiated monitoring strategy would help identify locations with repeated non-compliance and direct preventive investments to the areas of greatest need.

CONCLUSION

The comparative analysis of published monitoring results demonstrates geographical heterogeneity in the quality of drinking water supplied through centralized systems in the Fergana Region.

Between 2012 and 2021, Fergana city exhibited a marked improvement in the proportion of samples meeting chemical and bacteriological requirements.



Chemical non-compliance declined from 2.4% to 0.8%, while bacteriological non-compliance declined from 3.2% to 0.7%.

At the regional level, improvements were less pronounced. The proportion of chemically non-compliant samples decreased from 6.9% to 4.6%, whereas bacteriological non-compliance changed from 2.7% to 2.6%. Thus, despite favorable trends in some localities, further improvement of drinking water quality control remains necessary across parts of the region.

Published studies also describe elevated mineralization in some local water sources. This observation justifies more detailed study of the chemical composition of supplied water, particularly hardness, calcium, magnesium, chlorides, sulfates, and nitrogen compounds. Stronger sanitary and hygienic monitoring, upgraded water distribution infrastructure, improved treatment processes, and timely preventive interventions are important measures for protecting public health in the Fergana Region.

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