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STUDY ON THE SALT INTRUSION IN SOME RIVER WATER SOURCES SERVING FOR DOMESTIC WATER SUPPLY IN COASTAL AREAS OF VIETNAM

Pham Thanh Dat[a], Dang Thi Thanh Huyen[b,*]

[a]*Center for Water and Environmental Training, College of Urban Works Construction, No. 48, Phu Dong commune, Hanoi, Vietnam*
[b]*Faculty of International Education, Hanoi University of Civil Engineering, 55 Giai Phong road, Bach Mai ward, Hanoi, Vietnam*

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Abstract

Saline intrusion in Vietnam's coastal areas has been significantly increased by climate change and anthropogenic activities, particularly water resource exploitation. This paper presents a comprehensive assessment of salinity levels within river systems supplying domestic water, with a focus on the Mekong Delta, Central Coast, and Northern regions. The findings indicate that saline intrusion fronts have penetrated inland distances ranging from tens to hundreds of kilometers. This penetration results in pronounced seasonal and diurnal (hourly) variations in river water salinity. Measured concentrations range from several hundred to tens of thousands of mg/L (quantified as Total Dissolved Solids, TDS), or up to several tens of parts per thousand (‰). River systems exhibiting high average salinity (> 1 ‰) include the Re, Cam, and Ninh Co rivers (North); the Yen, Cai, and Ma rivers (Central); and the Cua Tieu, Cua Dai, and Co Chien rivers (Mekong Delta). A critical associated issue is the elevated concentration of bromide ions (Br-) in saline-affected waters. This presence significantly increases the formation potential of carcinogenic disinfection byproducts (DBPs) during the chlorination process. Consequently, this study proposes technical solutions designed to mitigate and adapt to these adverse impacts on domestic water supplies.

Keywords: coastal area; river water; salinity; bromine ion; proposed solutions.

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1. Introduction

The coastal strip of Vietnam is a place of vibrant economic development and high population density. In the interaction between the continent and the ocean, human activities in both the basin and on the spot have caused great impacts on the surface water environment [1]. In addition, climate change also has important impacts on the quality of river and lake water in coastal provinces and cities. These impacts have led to a number of prominent coastal environmental problems such as saltwater intrusion.

Currently, river basins in coastal provinces have been and are under strong pressure from population growth, urbanization and industrialization [1]. Urban areas, residential areas and concentrated industrial zones have been formed and strongly developed along river basins. Among the sources of waste, domestic wastewater and industrial wastewater contribute a large proportion with a very high total amount of pollutants. Most of the domestic wastewater from urban areas is largely untreated, directly discharged into canals and flows directly into rivers, causing surface water pollution. In addition, the coastal plains have formed industrial centers, mainly distributed in provinces and cities such

*Corresponding author. *E-mail address:* huyendtt@huce.edu.vn (Huyen, D. T. T.)

as Hai Phong [2], Quang Ninh [3], Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, etc. However, up to now, there is still a situation where some industrial parks and large factories (about 8 %) discharge improperly-treated wastewater into the surrounding river and lake systems, potentially causing water pollution, especially organic matter in many river sections in the basin [4].

In addition, according to tidal pressure, saline intrusion has penetrated deep into the rivers of coastal areas, for example, saline intrusion has penetrated 30-40 km on the Red River system and 60-70 km on the Mekong River system [5]. The irregular saline intrusion process of surface water sources in coastal areas will affect the exploitation and use of domestic water supply. For example, in Hai Phong city, located in the northern coastal region of Vietnam, there are two notable surface water sources that are currently used as water supply sources, the Re River and the Da Do River, both of which are saline and have a fairly high organic content [2, 6]. The organic content measured by $CODKMnO_4$ in the surface water of these rivers fluctuates between 7 and 17 mg/L, especially high in the dry season. In addition, these rivers are saline, at times the salinity is more than 300 mg/L, exceeding the allowable threshold (250 mg/l). For river basins in the Central coastal region, the coastal seawater environmental monitoring report at 34 points in 7 provinces and cities (Quang Binh, Quang Tri, Thua Thien - Hue, Da Nang, Quang Nam, Quang Ngai and Binh Dinh) at the end of 2022 showed that only 22.2 % had good water quality for domestic water supply purposes due to pollution of organic matter and other impurities including salinity [7, 8]. In addition, coastal areas in the Central region such as Quang Ngai, Binh Dinh, and the Northern region such as Thai Binh, Nam Dinh are also recording increasingly serious salinity, greatly affecting the quality of domestic water sources and local agriculture [9]. Another concern is the presence of bromide ions in saltwater, which can react with chlorine during the disinfection process to create by-products such as bromodichloromethane (BDCM) - a substance that is potentially carcinogenic.

Therefore, this paper aims to provide an overview and assessment of the salinity and Bromine ion concentration of coastal river water in Vietnam, from which solutions can be proposed to cope with the conditions of river water with high salinity and Bromine ion concentration.

2. Methodology

The paper synthesized data on the quality of coastal rivers in the North, Central and Mekong Delta, specifically on salinity and TDS.

The main research methods are (i) synthesizing secondary documents from specialized reports (General Department of Water Resources, National Center for Hydrometeorological Forecasting), and scientific articles published in the period 2015–2024; (ii) Analyzing measurement data (Cl^-, TDS, salinity) and (iii) Applying descriptive statistical probability method to analyze the surface water quality by month/year to assess water quality changes. Specifically, the results are shown on Box and Whisker plot.

It should be noted that data acquisition was conducted over a four-year period (2018–2021), focusing on strategic monitoring locations near estuarine zones during the dry season [10]. As these river systems are tidally influenced and regulated by salinity control barriers, monitoring stations were established upstream of these structures at incremental distances from the river mouth (e.g., 10 km, 20 km, and 40 km). This spatial configuration enables the modeling of real-time salinity dynamics, providing a critical baseline for early warning systems. The selected watercourses serve as primary raw water sources for municipal supply in the adjacent provinces.

While the comprehensive dataset spans the entire dry season (December to May), this study specifically isolates and evaluates the peak salinity events—typically occurring in January—to assess maximum salt intrusion levels across the 2018–2021 timeframe.

3. Results and Discussions

3.1. Salinity assessment in coastal rivers

a. In Mekong Delta region

During the 2019–2020 and 2023–2024 dry seasons, saline intrusion in the Mekong Delta occurred strongly, exceeding the historical level of 2016. In the Mekong Delta, saline intrusion tends to increase in both scope and intensity.

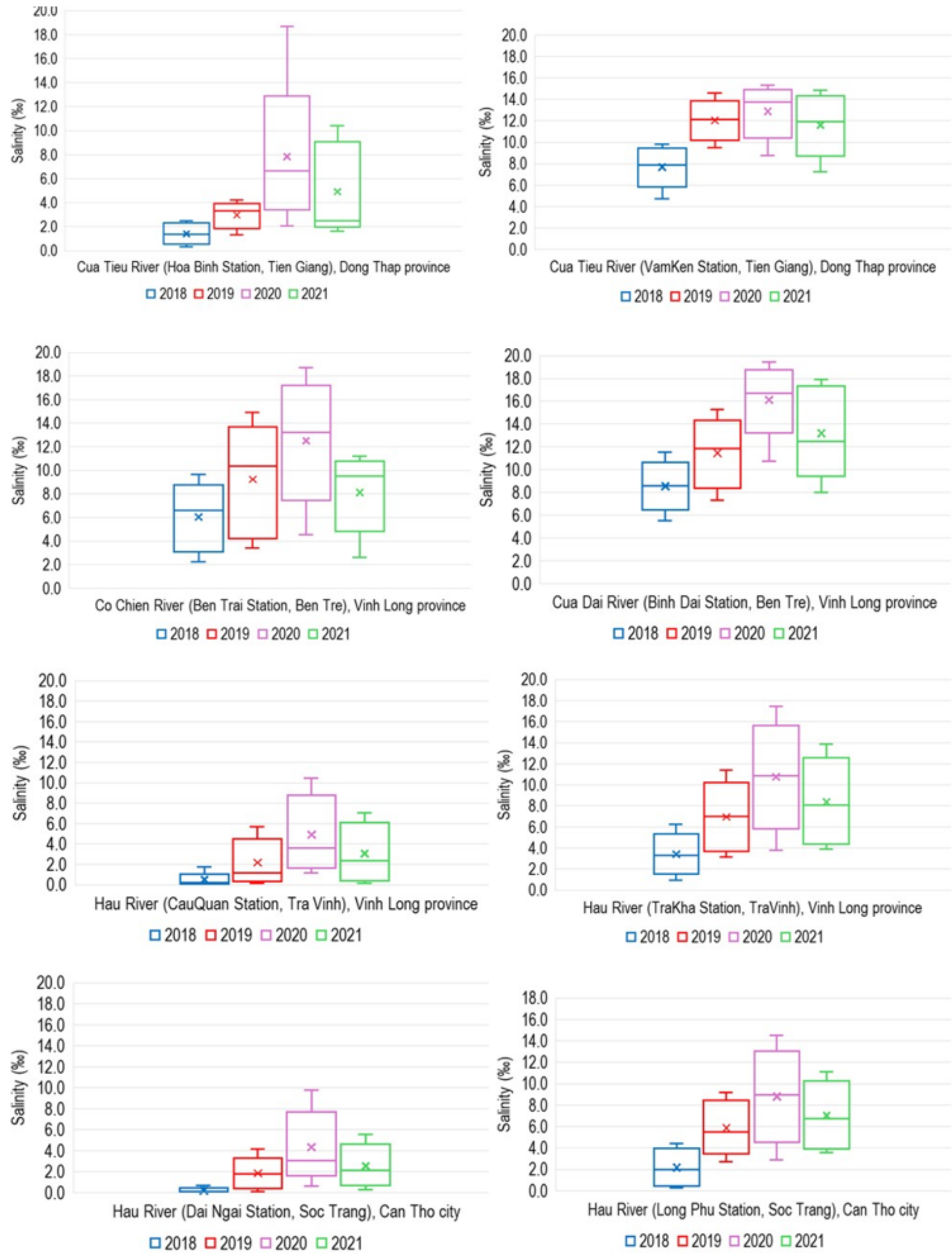

Figure 1. Box & Whisker plot presenting Salinity (‰) in some rivers in Mekong delta coastal region during dry season

According to the General Department of Irrigation (2020), during the 2019–2020 dry season, salinity penetrated 50 to more than 110 km into major rivers such as Cua Tieu, Cua Dai, Ham Luong and Hau rivers [10]. Specifically, salinity beyond 0.5 ‰ (domestic water threshold) penetrated deeply, for instance:

- Vam Co Dong River: salinity intrusion up to 110 km;
- Cua Tieu and Cua Dai Rivers: salinity intrusion up to 85 km;
- Ham Luong River: salinity intrusion up to 90 km;
- Hau River: salinity intrusion over 60 km.

It can be seen from Fig. 1 that salinity in many rivers in Mekong delta coastal region was higher than the allowable value for water supply source (0.5 ‰). Specifically, the coastal stations on the Cua Tieu, Cua Dai, and Co Chien rivers were highly vulnerable to saltwater intrusion, while the Hau River stations were less. The possible explanation lies in the fact that the estuaries of the Tien River system (Cua Tieu, Cua Dai, and Co Chien) are located in the East of the Mekong Delta (bordering the East Sea), where the semi-diurnal tidal regime has a large and strong amplitude. This condition facilitates deep and easy saltwater intrusion into the mainland. Conversely, although the Hau River also borders the East Sea, the large flow volume from the upper reaches creates a strong pushing force, significantly reducing the role of the tide in driving saltwater deep into the mainland, a clear difference compared to the Tien River system. For the Hau River stations, the 75th percentile (the top of the box) was often below 0.5 ‰, meaning more than 75 % of their measurements were below this threshold. While data from Cua Tieu, Cua Dai, and Co Chien rivers had their 25th percentile at or above 0.5 ‰ in many years, indicating that 75 % of all measurements taken during that period were 0.5 ‰ or higher. The entire region was subject to major year-to-year fluctuations, with the 2020 dry season representing a period of severe salinity intrusion. In 2021, salinity levels receded from the 2020 peak but did not fully return to previous levels. At the high-salinity stations (Vam Ken, Ben Trai, Binh Dai), the 2021 levels were still significantly higher than in 2018.

TDS levels measured at stations ranged from 800 mg/L to more than 12,000 mg/L at peak salinity. Especially at coastal stations such as Giao Hoa (Ben Tre), salinity reached 23 ‰, exceeding the threshold for domestic use according to QCVN 01-1:2025/BYT, making it almost impossible to get enough surface water for domestic use. The explanation for very high salinity in Ben Tre province may be due to some reasons including: (i) the freshwater pushing force (hydraulic barrier) is insufficient to counter the seawater due the to construction and operation of hydropower dams on the upper main stream of the Mekong River and the dispersion of the main river into many separate estuaries; (ii) The Ben Tre's terrain is very low and flat, standing only about 0.5 m to 1.5 m above sea level. Approximately 94.2 % of the province's area is affected by tidal activity and (iii) The province is subject to a semi-diurnal tidal regime (two high tides and two low tides per day) with a large and strong amplitudes, which easily push high-salinity seawater (23 ‰ to 25 ‰) deep into the estuaries, especially during peak high tide periods in the dry season.

b. In Central coastal region

The salinity intrusion situation in each region has different variations, which depends largely on the topographical characteristics, hydrogeology and the current status of groundwater exploitation in those areas. Short and steep rivers in the Central region are susceptible to salinity due to rapid changes in hydrology and low water volume in the dry season [10]. For instance:

- Vu Gia - Thu Bon River (Quang Nam): salinity intrusion up to 35 km;
- Tra Khuc River (Quang Ngai): salinity intrusion from 15–25 km;
- Cau River (Phu Yen): salinity recorded from 2–6 ‰ in April.

From Fig. 2, it depicted that this region showed a different pattern. Salinity at all four stations decreased from 2018 to 2019. Following the 2020 spike, the Yen and Ma rivers interestingly showed even higher median salinity in 2021, a trend not seen in the Mekong Delta. Data in Cai River (Vinh Ngoc Station) showed this is the most saline station by a large margin. Its 25th percentile was above 15 ‰ in all four years, indicating it is in a constant state of high salinity during the dry season.

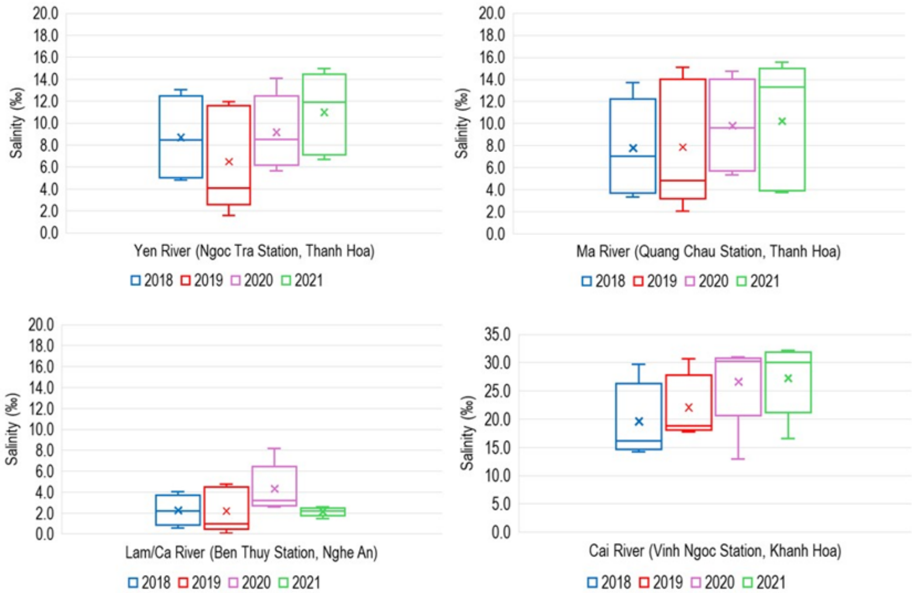

Figure 2. Box & Whisker plot presenting Salinity (‰) in some rivers in Central coastal region during dry season

Survey results in Da Nang city, a coastal province in the Central region, show that the river system in the Da Nang area has been mostly affected by salinity, specifically the entire Han River section is affected by salinity. The salinity of the Co Co River has decreased due to the construction of a sluice gate to prevent salinity, and the salinity at the section passing through Quan Am Pagoda in Hoa Hai ward is almost negligible. The Do Toa River is affected by salinity throughout the entire Da Nang area. The Cam Le River section is affected by salinity throughout. The Cau Do River section is affected by salinity throughout, but only during high tide. The Tuy Loan River is affected by salinity up to Tuy Loan bridge. The Yen River is affected by salinity about 3 km deep from the Cau Do - Tuy Loan - Yen River junction. The Cu De River is almost completely affected by salinity, reaching deep into the middle of Hoa Bac commune. Closed reservoirs that are not connected to the river have not been affected by salinity. Canals connected to the sea are affected by salinity according to the tidal water level [11].

In the Ma - Ca River basin, the phenomenon of salinity intrusion tends to increase in the areas of Thanh Hoa, Ha Tinh, especially in Nghe An. Some areas are in the salty water area but TDS content still tends to increase over time such as: Sam Son, Thanh Hoa increased at a rate of 11.67 mg/L.year; Nga Son, Thanh Hoa increased 409.16 mg/L.year; Quynh Luu, Nghe An increased 167.52 mg/L.year; Nghi Loc, increased 258.16 mg/L.year [7].

c. In Northern coastal region

Although the Northern coastal region has a large river network such as the Red River, Thai Binh River, Luoc River, Van Uc River and Da Bac River, during the dry season, especially in years with little rain such as 2019–2020 and 2023–2024, salinity intrusion also occurs significantly due to a sharp decrease in water flow downstream.

According to data from the General Department of Hydraulics [10], salinity of 1 ‰ has been recorded 20–30 km from the river mouth, exceeding the recommended threshold for domestic water in many places such as:

- Van Uc River (Hai Phong): salinity intrusion up to 25 km, salinity 1.2 ‰;
- Luoc River (Thai Binh – Hai Duong): salinity 0.7–1.1 ‰ in March;
- Day River (Nam Dinh): average salinity 1.3 ‰, peaking at 3 ‰ in the My Loc – Nghia Hung area.

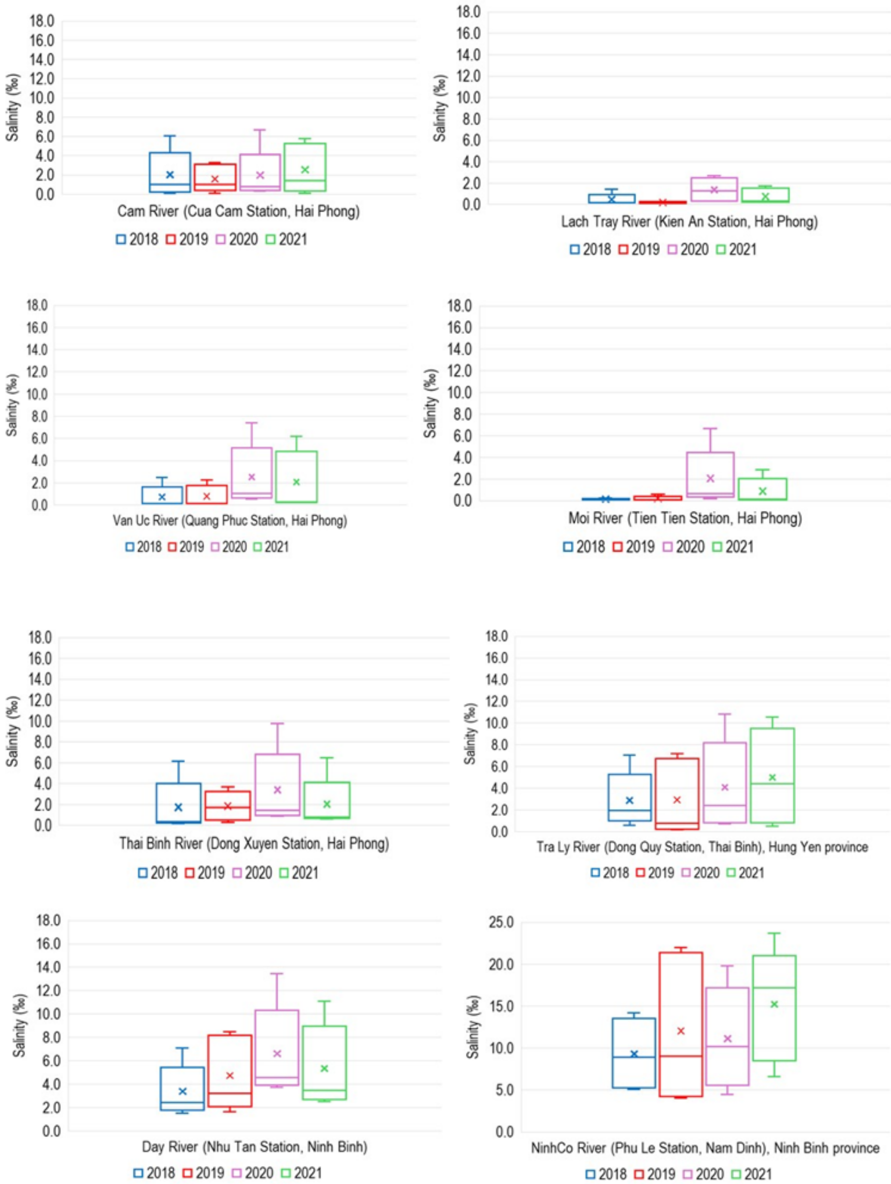

Figure 3. Box & Whisker plot presenting Salinity (‰) in some rivers in Northern coastal region during dry season

Fig. 3 revealed that the Ninh Co River at Phu Le is consistently the most saline station, with mean salinity often above 10 ‰. The Lach Tray River (Kien An) and Moi River (Tien Tien) are the least saline, indicating they are further upstream. However, they both clearly reflect the 2020 event, with mean salinity jumping significantly from near-fresh levels in 2018-2019 to noticeable levels in 2020-2021. The most striking feature is the spike in 2020. This is clearly visible in the Thai Binh, Tra Ly, Day, Cam, Van Uc, Lach Tray, and Moi rivers. The long upper whiskers for 2020 in these charts show that maximum salinity levels reached values far higher than in any other year, indicating that saltwater penetrated much further upstream. While salinity levels receded in 2021 from their 2020 peaks, they remained significantly elevated compared to the 2018 baseline in almost all locations. This suggests that the overall vulnerability of these river basins to salinity intrusion is increasing.

The results of salinity monitoring by the General Department of Hydrometeorology for coastal rivers and rivers at risk of saltwater intrusion (for example, December 2022), with monitoring points about 15 - 200 km away, show that most rivers near the sea (less than 30 km away) are affected by saltwater intrusion, the most severely affected are the Red River (Nam Dinh, 0.85 %), Tra Ly River (Thai Binh, 0.41 %), Ninh Co River (Nam Dinh, 1.31 %), Ma River (Thanh Hoa, 0.96 %), Cai River (Khanh Hoa, 2.7 %). The remaining rivers are also affected by saltwater intrusion but at a lighter level [10]. In addition, the TDS content at the measuring points ranges from 300-1,500 mg/L, and during the peak of the drought, it can exceed the limit according to QCVN 01-1:2025/BYT for domestic water. The results of a survey of a number of water supply plants through direct interviews with water plant operators on the issue of saline water sources show that the Hai Hau area, Nam Dinh province, is often affected by saline water sources from November of this year to March of the following year. Response measures when the water source is affected by salinity are (1) stopping the water supply, (2) using an alternative water source (groundwater) temporarily, or (3) adding a sedimentation profile to use this water source in emergency conditions (affected by salinity). In Thanh Hoa, the Len River water source is not often affected by salinity, although the salinity is usually below 0.3 %. When the salinity exceeds the standard, the response of water supply units is to stop exploitation. In Hai Duong, the water source from the Thai Binh River is also sometimes affected by salinity, reaching a depth of about 10 - 15 km. Through the interview of water treatment plants' operators in Hai Duong province (now belongs to Hai Phong city) on raw water quality, the raw water was often affected by salinity sometimes a few hours a day and a few days per month during the dry season. Rural water supply stations exploiting river water near estuaries are more severely affected. When water sources are infrequently contaminated with salt, water supply units often respond by (1) temporarily stopping water supply, or (2) using alternative water sources (groundwater). Obviously, these solutions are all temporary and not thorough. Research on the impact of salinity on the efficiency of organic matter treatment has not been conducted much in Vietnam. However, studies around the world have demonstrated the impact on the coagulation process [12], and of course, the taste of the water after treatment.

3.2. Assessment of Bromine concentration in coastal rivers supplying domestic water

A factor that is less noticed when assessing the quality of coastal river water is the Br- content, because this indicator is not included in the requirements for monitoring surface water quality frequently [13]. Therefore, when reviewing reports on the assessment of coastal river water quality, there have been no data on Bromine concentration. Nevertheless, it should be noted that the concentration of Br- is usually less than 1 mg/L in freshwater and increases to 80 mg/L in seawater [14], the Br- content in brackish water can therefore fluctuate within that range depending on the degree of salinity intrusion. High Br- content in the seawater is owing to some reasons. Firstly, this compound is released into the atmosphere via volcanic eruptions and associated outgassing and then deposited into the oceans and seawater. Once in the ocean, bromide ions are highly stable and chemically unreactive under normal marine conditions. Secondly, Br- is also cycled through the deep ocean at hydrothermal vents. Seawater circulates through hot rocks in the oceanic crust, and while the ratio of some element's changes, bromide is often slightly enriched or conserved during this high-temperature interaction before being released back into the water column [15].

Specifically, the overview of research by Winid on the characteristics of Br- in water sources shows that the average bromine concentration in seawater is about 65 mg/L, in the Baltic Sea it is 23 mg/L. The average Br- contents were reported to be 2.03 mg/L, 11.84 mg/L and 7.74 mg/L in saline groundwater, saline stream water and in saline river water, respectively [16]. For rivers connected to the sea, the possibility of saline intrusion is high if the dam does not work well and the Br- concentration is higher. The Br- content in brackish water generally ranges from 1 – 20 mg/L [17]. The interest in understanding Br- presence in river water has increased in recent years due to the formation of carcinogenic by-products Br-THMs such as bromodichloromethane (BDCM), dibromochloromethane (DBCM), which have been demonstrated in many studies [18–22].

In Vietnam, the periodic monitoring data of the Ministry of Agriculture and Environment for rivers do not have Br- monitoring as stated above. This indicator is only measured when necessary as required. Recent research found that Br- in the estuary area in Thanh Hoa province was about 10-13 mg/L [23], corresponding to TDS of about 1200-1500 mg/L. The presence of bromide ions (Br-) in river water, which is typically rich in natural organic matter (NOM), is a critical concern for water treatment. During the chlorination process, Br- and NOM act as precursors, reacting with chlorine to create a high formation potential for carcinogenic disinfection byproducts (DBPs). This reaction specifically favors the generation of brominated trihalomethanes (Br-THMs), such as bromodichloromethane (BDCM) and dibromochloromethane (DBCM), at concentrations that could exceed permissible regulatory limits [23]. In the coming time, there will be a need for more surveys and assessments of coastal water sources in terms of Bromine concentration to have timely preventive solutions.

3.3. Water treatment technology solutions towards ensuring safe water supply

Existing surface water treatment technologies at water plants have been showing insufficient to meet requisite effluent quality standards [24]. This inadequacy is driven by escalating challenges, including persistent source water degradation and the impacts of climate change, particularly saline intrusion. In response, recent studies have evaluated advanced technologies that can be integrated into existing treatment process trains. The objective of this integration is to ensure that the final treated water consistently complies with national quality standards and regulations [25].

- Addition of Reverse Osmosis (RO) technology

RO uses a semi-permeable membrane to separate salt and dissolved substances from water. High pressure is used to force water through the membrane, retaining salt ions, heavy metals, microorganisms... The treatment efficiency can reduce TDS by 95–99 %, suitable for slightly salty water to seawater (Fig. 4(a)).

- Addition of Electrodialysis technology (ED)

Under the effect of an electric field, ions such as Na^+ and Cl^- move through selective ion exchange membranes, are separated from the water stream and create two streams: fresh water and salt water. Good treatment efficiency with brackish water (TDS < 5,000 mg/L), less energy consuming than RO if the salt concentration is low (Fig. 4(b)).

- Addition of Nanofiltration technology (Nanofiltration - NF)

Nanofiltration uses a membrane with a pore size smaller than microfiltration but larger than RO, can remove part of ions, organics, microorganisms without requiring too high pressure (Fig. 4(c)).

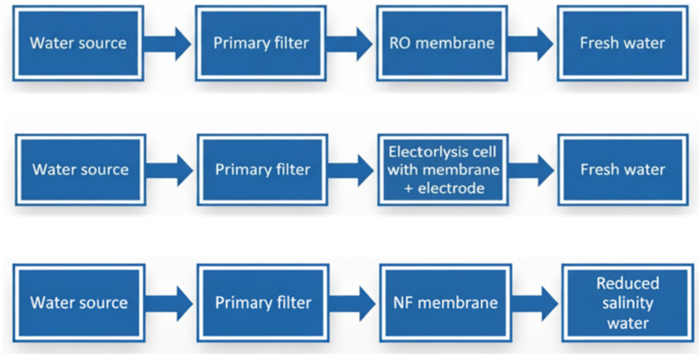

Figure 4. Enhanced treatment after conventional water treatment process

This technology can help reduce TDS by 50–80 %, suitable for treating slightly saline water.

In addition to using additional technologies to treat saline water after traditional filtration tanks, the following specific preventive measures can be applied (Fig. 5).

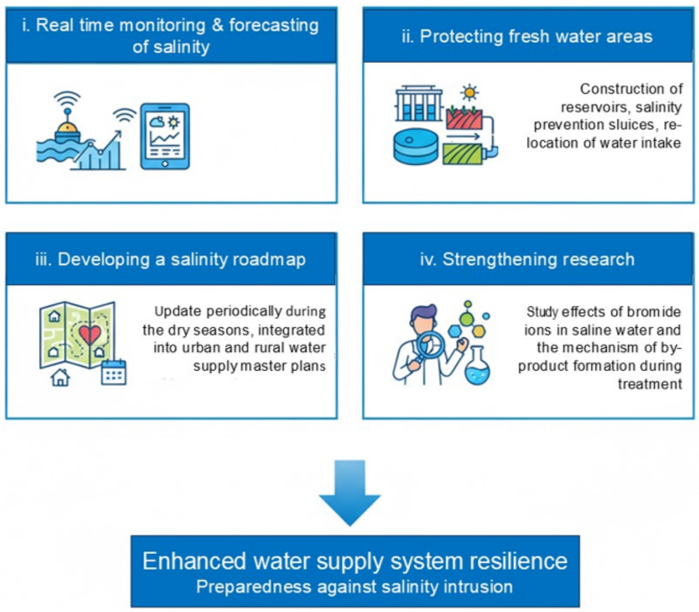

Figure 5. Preventive solutions for salinity control in water supply sources

- Real-time monitoring and forecasting of salinity

It is necessary to invest in an automatic monitoring system and a real-time forecasting model of salinity intrusion to support the management of water intake and operation of the water supply system.

- Protecting freshwater areas and planning safe water intake

Strengthening the construction of reservoirs, salinity prevention sluices, changing crop seasons and water intake locations from less saline areas.

- Developing a salinity risk map to serve domestic water supply planning

The map needs to be updated periodically according to the dry seasons, integrated into the master plan for urban and rural water supply.

- Strengthening research on the effects of bromide ions in saline water sources and the mechanism of by-product formation during treatment:

This is an issue that has not been studied much in Vietnam and needs investment to ensure public health safety.

4. Conclusions

Research has shown that salinity intrusion in rivers supplying domestic water in Vietnam is becoming increasingly serious, especially in the dry seasons in recent years (from 2018 - 2021). Specifically:

- In the Mekong Delta, the 4 ‰ salinity line penetrates from 60 to over 100 km deep at many large river mouths such as Tien, Hau, and Vam Co, seriously affecting the centralized water supply system.

- In the Central coastal region, short rivers such as Vu Gia, Thu Bon, and Tra Khuc are clearly affected with salinity lines reaching up to 25–35 km due to low dry season flow.

- Northern coastal areas such as Nam Dinh, Thai Binh, and Hai Phong also recorded salinity levels exceeding the allowable threshold for domestic water (> 0.5 ‰) at many times, especially when the Red River flow decreases.

Notably, the presence of bromide ions was noted in saline water samples, which increases the risk of forming carcinogenic byproducts when treating water with chlorine.

References

[1] Ministry of Natural Resources and Environment (2021). *Report on the State of the National Marine and Island Environment for the period 2016–2020*.

[2] Nguyen, T. V. (2020). Solutions to maintain raw water resources in Hai Phong. *Online Journal of Environmental Industry*.

[3] Bui, T. D. (2014). *Assessment of surface water quality and proposed solutions to manage and reduce water pollution in Quang Ninh province*. Master's thesis in Environmental Science, Vietnam National University, Hanoi.

[4] General Statistic Office of Vietnam (2024). *Data on society, environment and territory*.

[5] Tran, D. H., Nguyen, X. N., Tran, D. M. H. (2022). Prevention of formation and removal of toxic by-products when disinfecting water with chlorine. *Online Journal of Water Supply and Drainage*.

[6] Le, T. H. V., Le, T. H., Nguyen, T. K. N., Trinh, T. T. T. (2022). Assessment of surface water quality in Hai Phong City in 2021 using the method of calculating water quality index. *Environment Magazine*. No. IV/2022.

[7] General Department of Hydrometeorology (2022). *Report on monitoring results of rivers in coastal areas of Vietnam*.

[8] People's Committee of Quang Binh province (2017). *Report on management of main wastewater sources in river basins in Quang Binh province*. Quang Binh.

[9] Nguyen, V. H., Tran, T. M. (2020). Impact of saline intrusion on domestic water resources in the coastal areas of the Central and Northern regions. *Journal of Geographical Sciences*, 58(1):34–40.

[10] General Department of Irrigation (2020). *Report on the current status of saline intrusion in the Mekong Delta in the dry season of 2019–2020*. Ministry of Agriculture and Rural Development.

[11] Nguyen, N. T., Truong, V. T., Nguyen, V. T., Nguyen, T. L. (2017). Current status and vulnerability to saline intrusion in the context of climate change in Da Nang city. *VNU Science Magazine: Earth and Environmental Sciences*, 33(2):90–107.

[12] Megersa, M., Gach, W., Beyene, A., Ambelu, A., Triest, L. (2019). Effect of salt solutions on coagulation performance of *Moringa stenopetala* and *Maerua subcordata* for turbid water treatment. *Separation and Purification Technology*, 221:319–324.

[13] QCVN 08:2023/BTNMT (2023). *National Technical Regulation on Surface water quality*.

[14] Vengosh, A. (2014). Salinization and Saline Environments. In *Treatise on Geochemistry*, 325–378.

[15] Winid, B. (2015). Bromine and water quality – Selected aspects and future perspectives. *Applied Geochemistry*. S0883292715300603.

[16] Mills, J. F. (2002). Bromine. In *Ullmann's Encyclopedia of Chemical Technology*, Weinheim: Wiley-VCH Verlag.

[17] Chowdhury, S., Champagne, P., McLellan, P. J. (2010). Investigating effects of bromide ions on trihalomethanes and developing model for predicting bromodichloromethane in drinking water. *Water Research*, 44(7):2350–2359.

[18] Müller, E., von Gunten, U., Bouchet, S., Droz, B., Winkel, L. H. E. (2021). Reaction of DMS and HOBr as a Sink for Marine DMS and an Inhibitor of Bromoform Formation. *Environmental Science & Technology*, 55(8):5547–5558.

[19] Parveen, N., Goel, S. (2022). Effect of Seawater Intrusion on the Formation of Chlorinated and Brominated Trihalomethanes in Coastal Groundwater. *Water*, 14(21):3579.

[20] Nguyen, T. K. O., Le, V. P., Pham, T. H. H. (2021). Assessment of the Risk of By-Product Formation During the Chlorination of Saltwater Disinfection. *Journal of Water Science and Technology*, 65(2): 45–52.

[21] Zhang, X., Chen, Z., Shen, J., Zhao, S., Kang, J., Chu, W., Zhou, Y., Wang, B. (2020). Formation and interdependence of disinfection byproducts during chlorination of natural organic matter in a conventional drinking water treatment plant. *Chemosphere*, 242:125227.

[22] Zhang, Y., Zhao, X., Zhang, X., Peng, S. (2015). A review of different drinking water treatments for natural organic matter removal. *Water Science and Technology: Water Supply*, 15(3):442–455.

[23] Pham, T. D., Dang, T. T. H. (2024). Study on the impact of salinity on the efficiency of coastal surface water treatment using membrane filtration technology for domestic water supply. *Construction Journal*, 7:114–118.

[24] Nguyen, H. T. (2018). Clean water supply in the Mekong Delta under the impact of climate change – Challenges and solutions. *Online Journal of Water Supply and Drainage*. June 2018.

[25] Tran, T. H. H., Nguyen, V. A., Dang, T. T. H., Dao, A. D., Dinh, V. C. (2022). *Research on water treatment technology for domestic and drinking water supply for schools and residential areas in coastal areas*. Research Project of the Ministry of Education and Training (Code: CT.2020.04.XDA.07).