Escuela Superior Politécnica del Litoral

PARES & NONES
Un break científico

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Assessment of the Performance of a Water Treatment Plant in a Rural Community. Paute, Azuay - Ecuador case of study

PROBLEM

Access to drinking water remains a global challenge, only 38.2% of the rural population having access to drinking water. San Cristóbal, located in the Austro-Ecuador zone, is a rural community facing the challenge of inadequate water quality as the local treatment plant (WTP) struggles to provide drinking water.

CHALLENGES OF THE LOCAL WTP IN SAN CRISTÓBAL

Lack of water quality instruments | **Non-trained operators** | **Inadequate dose of treatment chemicals**

OBJECTIVE

This research aimed to evaluate the performance of the conventional water treatment plant called ‘El Descanso’ to identify issues during treatment processes and propose research-based improvements.

METHODOLOGY

(1) Field inspection.

- Water sampling
- Water quality measurement
- Survey of operation and maintenance practices

Fig. 1. Schematic diagram of the water treatment train

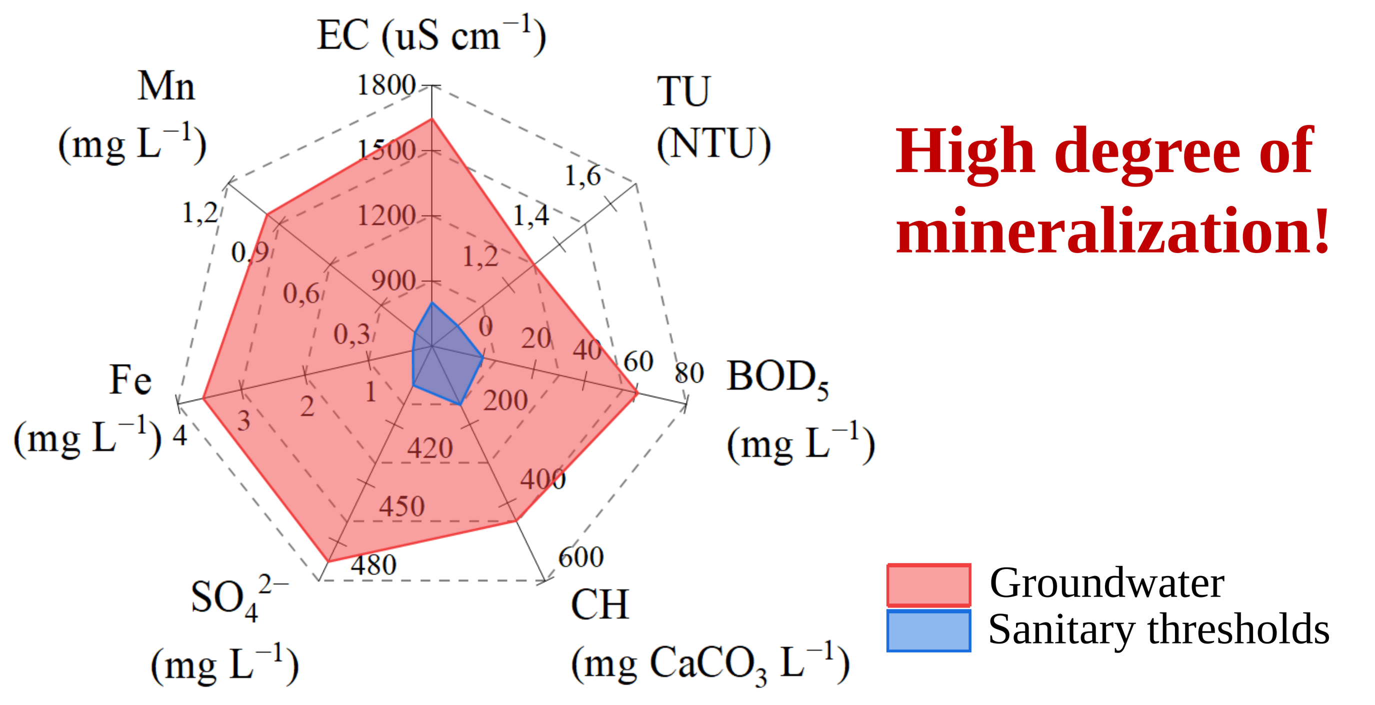
SCAN ME

(2) Analysis of groundwater quality and the performance of the treatment units.

(3) Improvement proposal for the water treatment units.

RESULTS

Problematic parameters in groundwater quality



High degree of mineralization!

Fig. 2. Physicochemical water quality characterization of groundwater source. Measurements of turbidity (TU), biochemical oxygen demand (BOD_5), calcium hardness (CH), SO_4^{2-}, total Fe, manganese, and electrical conductivity (EC).

Assessment of the conventional water treatment units:

- **Slat trays aerators:**

Unit efficiency:
32.6% Fe^{2+} removal.

Observation:
Corroded trays

Problem:
Turbidity increase from 1.3 to 10.6 NTU

It is highly recommended to **conduct regular maintenance on the slat trays aerators** to prevent the release of colloidal iron in the water flow.

- **Coagulation and floc sedimentation:**

Unit efficiency:
88.7% turbidity removal.

Observation:
Coagulum formations on water surface (foams)

Problem:
Alum Overdose of 92.8 mg L^{-1} $Al_2(SO_4)_3$

Experimentally, an **optimal dose of 20 mg L^{-1} $Al_2(SO_4)_3$ reduce 79% of colloidal suspension**, and minimized the use of the chemical additives.

- **Filtration units (granular and water softener):**

Unit efficiency	Issue
96.3% turbidity reduction	**The hardness concentration increased** from 210 to 358 mg L^{-1} $CaCO_3$ (70.5%).

Coagulation-flocculation ponds can be used to perform simultaneous lime precipitation and alum coagulation to reduce water hardness and maintain turbidity below 1 NTU. However, high dose of lime must be used, e.g., ~700 mg L^{-1}.

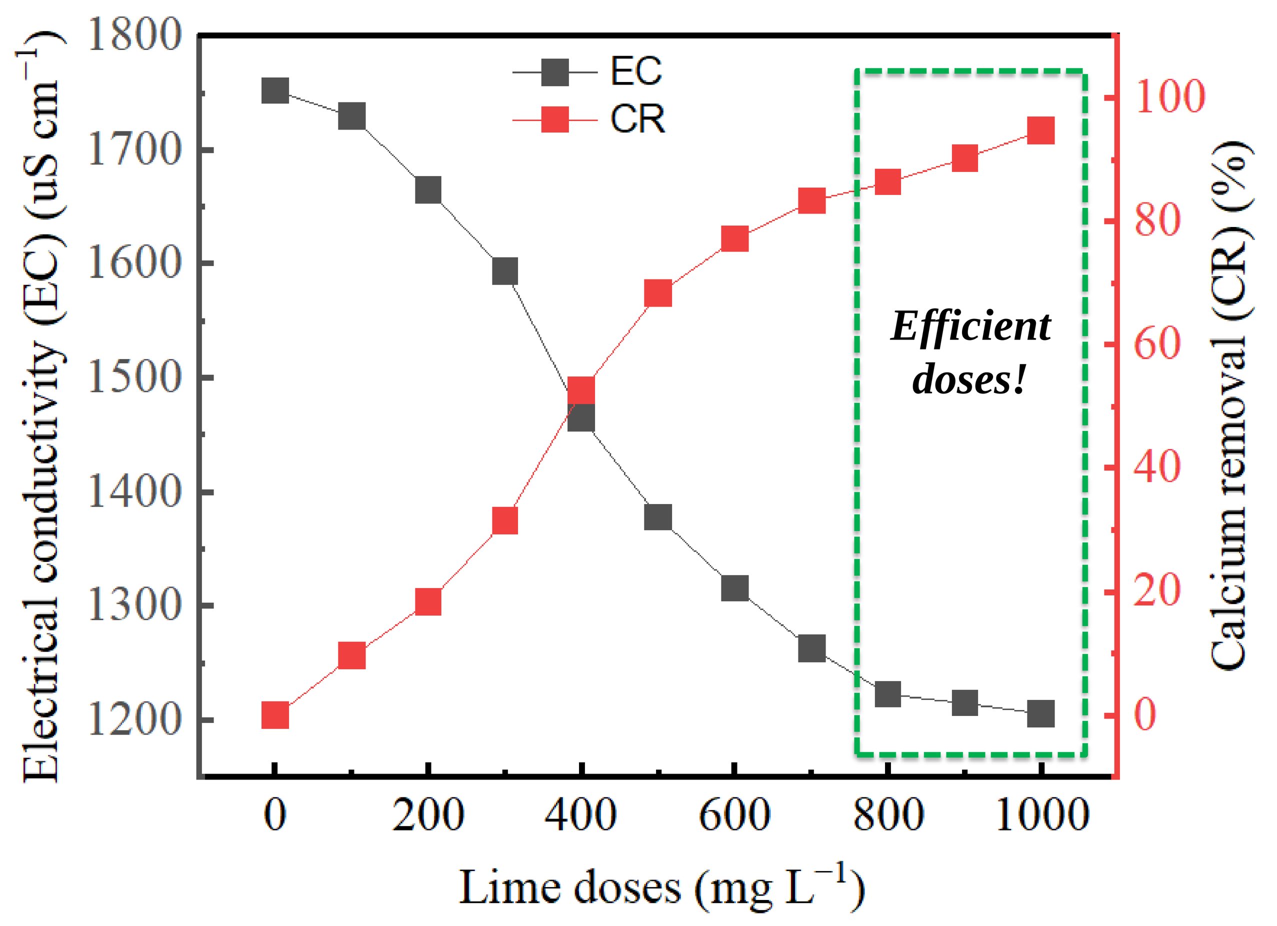


Fig. 3. Simultaneous chemical precipitation using a fixed alum dose of 20 mg L^{-1} $Al_2(SO_4)_3$ and various doses of lime to reduce hardness.

- **Disinfection unit:**

Issue	Observation
0.01 - 0.19 mg L^{-1} Cl_2 **Low concentration of free Cl_2 at plant outlet!**	Absence of trihalomethanes

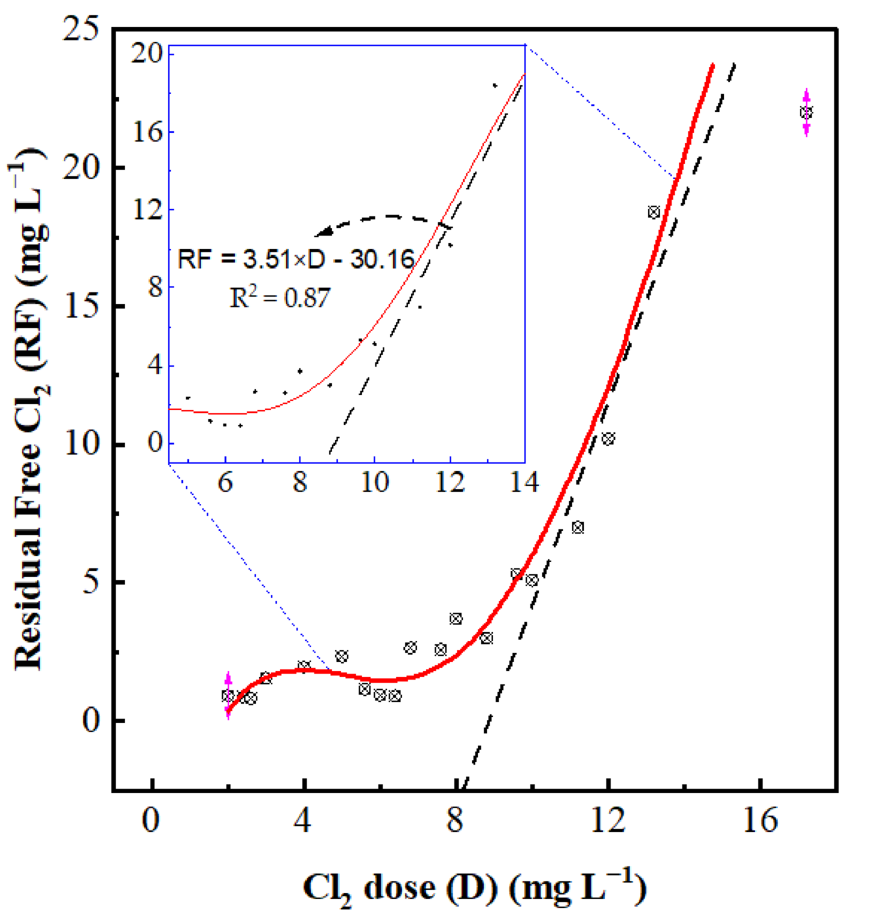


Fig. 4 Breakpoint curve to estimate the optimal dose of Cl_2.

Experimentally, the optimal chlorine dose was **8,6 mg L^{-1} Cl_2** as seen in Fig. 4.

CONCLUSIONS

- ❑ Although the slat trays aerators remove 32.6% of the ferrous iron, the lack of maintenance of the unit lead to an increase in turbidity.
- ❑ The high concentration of alum coagulant (92.8 mg L^{-1}) in the water increases the sulfate concentration and promotes the formation of thick lumps on the water surface. To effectively remove hardness and turbidity, the optimal dose of alum should be 20 mg L^{-1} accompanied by 700 mg L^{-1} of lime.
- ❑ The chlorine dose must meet 8.6 mg L^{-1} to produce a residual effect of free chlorine to inactivate pathogens.