Faculty of Medicine and Pharmacy, Marrakech, Morrocco
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Oral communication

Detection and Quantification of Antibiotics in Hospital Wastewater of the Mohamed VI Hospital Center in Marrakech

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Plan

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2. Background
3. Current State and Published Studies
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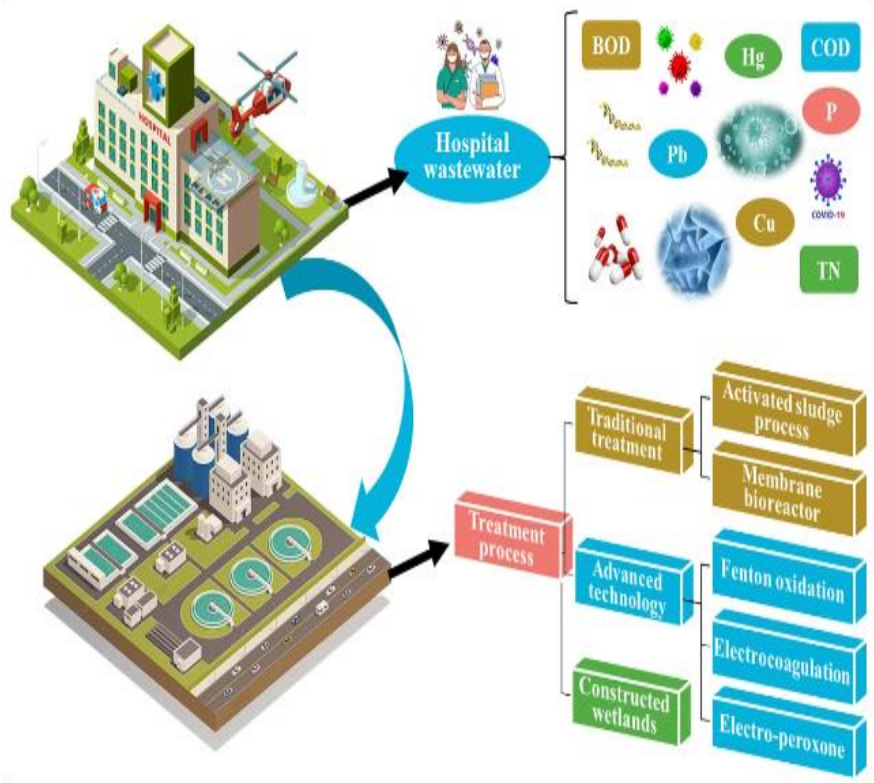


1 Introduction

🌍 The dissemination of emerging pollutants in the environment is a growing global issue.

💊 Among them, antibiotics pose a major risk due to their persistence and their ability to select for resistant strains.

🛡 Hospital effluents represent a direct and concentrated source of contamination, with a wide variety of antibiotics detected.

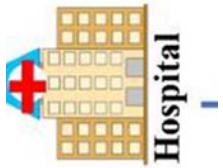
☣ Their presence leads to Eco toxicological risks and contributes to the spread of antibiotic resistance.

• Cycle of Antibiotics in the Environment

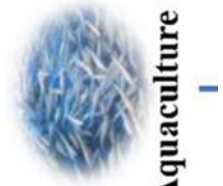
Livestock farms

Pharmaceutical factories

Hospitals



Aquaculture



Domestic use

WWTP / STEP
(Incomplete treatment)

Surface waters

Groundwaters

Soils & sediments

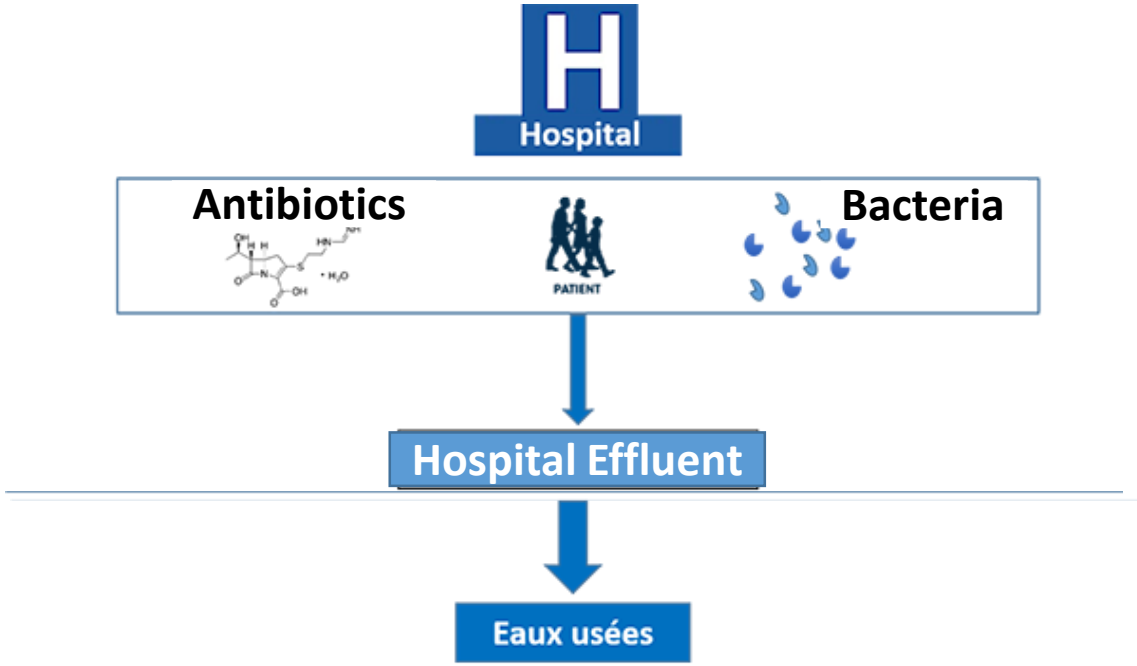
Impacts:

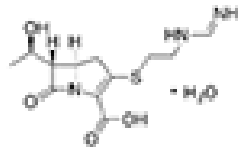
- impacts

Resistances (ARGs)
Ecological disturbances
Human health risks

Background

1. Intensive Use of Antibiotics
2. Risk of Bacterial Resistance
3. Environmental Impacts
4. Surveillance and Analysis





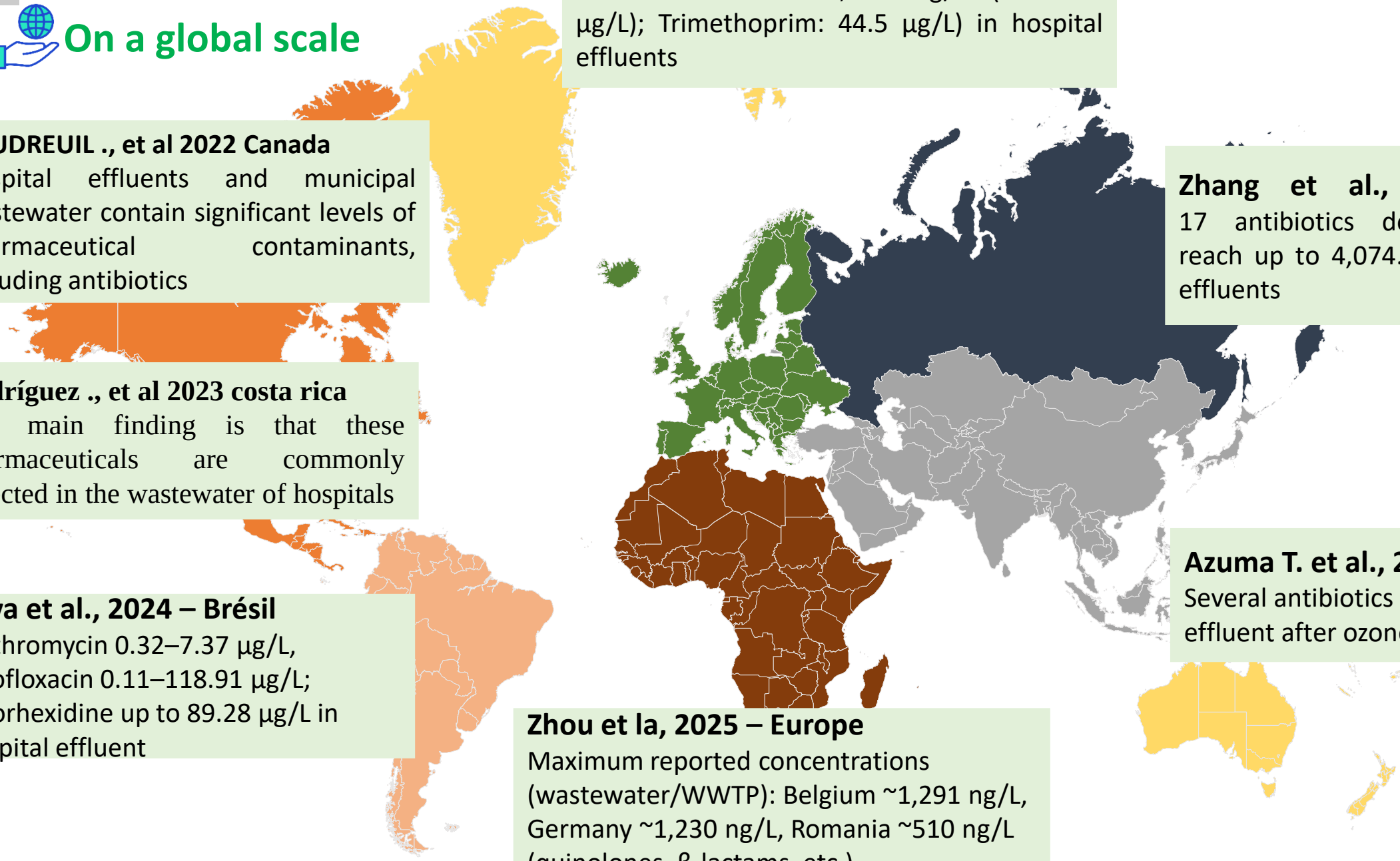
Ecotoxicological Risk

Published Studies

On a global scale

Byrnes N.A. et al., 2025 – UK
Sulfamethoxazole: 28,031 ng/L (≈ 0.724 µg/L); Trimethoprim: 44.5 µg/L) in hospital effluents

VAUDREUIL ., et al 2022 Canada
Hospital effluents and municipal wastewater contain significant levels of pharmaceutical contaminants, including antibiotics



Zhang et al., 2024 - Chine
17 antibiotics detected; β-lactams reach up to 4,074.08 ng/L in hospital effluents

Rodríguez ., et al 2023 costa rica
The main finding is that these pharmaceuticals are commonly detected in the wastewater of hospitals

Azuma T. et al., 2025 – Japan
Several antibiotics detected in hospital effluent after ozone treatment + UV

Silva et al., 2024 – Brésil
Azithromycin 0.32–7.37 µg/L, levofloxacin 0.11–118.91 µg/L; chlorhexidine up to 89.28 µg/L in hospital effluent

Zhou et la, 2025 – Europe
Maximum reported concentrations (wastewater/WWTP): Belgium ~1,291 ng/L, Germany ~1,230 ng/L, Romania ~510 ng/L (quinolones, β-lactams, etc.)

Studies in Africa

Tunisia

Ben Saad I. et al., 2025 - 6 antibiotics detected along the chain (HWW → WWTP → sea); amoxicillin up to 739.1 ng/L in hospital effluent.

South Africa

Deedat F.Z. et al., 2025—Correlation between hospital use of antibiotics and residues measured in effluent (SMX, cefazolin in particular); levels in the order of tens of µg/L.

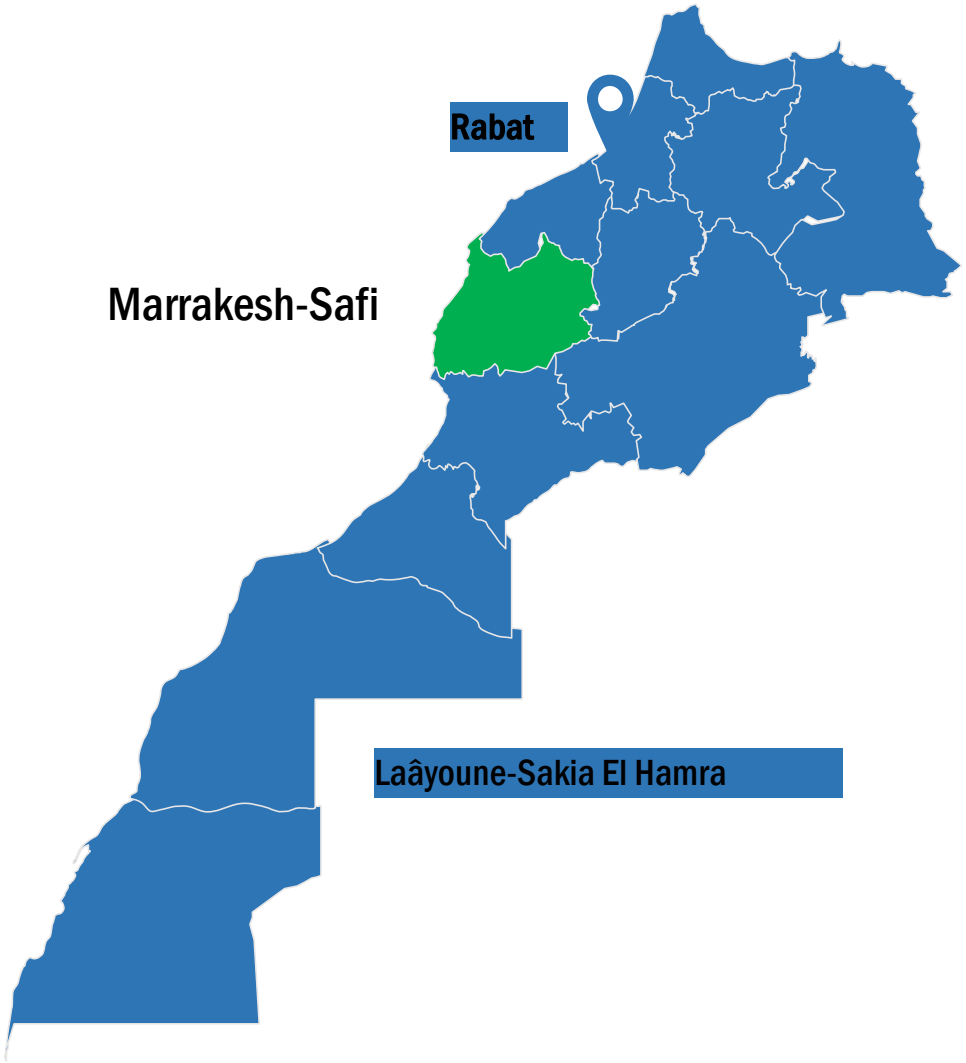
Mali

Coulibaly M., et al., 2025 - Four major hospitals' effluents contained **22 antibiotics (9 classes)** with concentrations ranging from **~0.1 to ~38.9 µg/L** (maxima near **38.9 µg/L**), at hospital exits and Niger River discharge points.

Kenya

Ngigi A.N., et al., 2020 – antibiotic residues detected in hospital effluents (up to 20.6 µg/L for sulfamethoxazole) and much higher than in surface water.

Focus on Morrocco



- **Current Research Focus:**

- Physico-Chemical Characterization:

Parameters such as pH, COD, BOD.

Studies of the organic and inorganic properties of effluents.

- Microbiological Characterization:

Analysis of bacterial load and pathogens.

Lack of Specific Analyses: e.g., antibiotic residues

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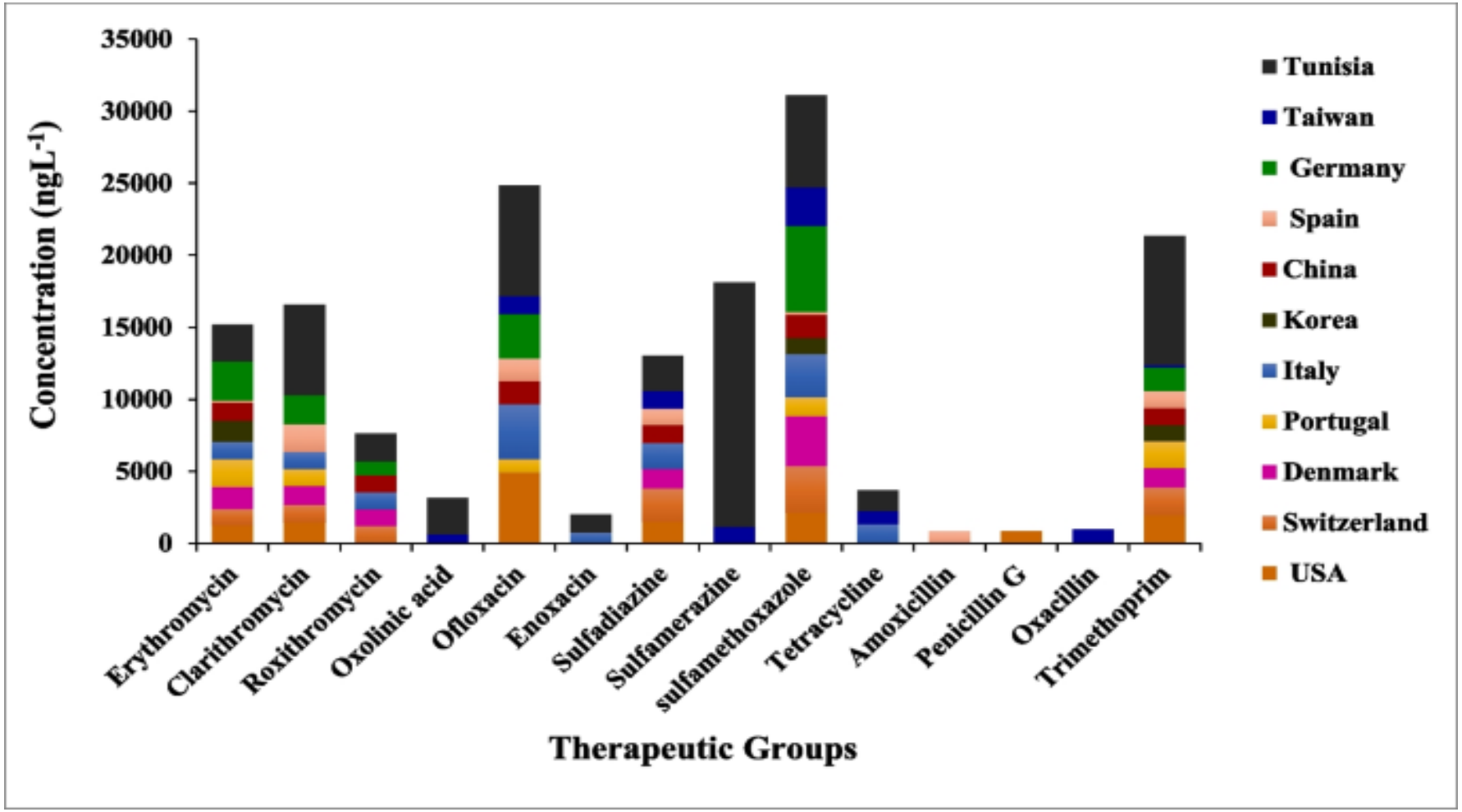
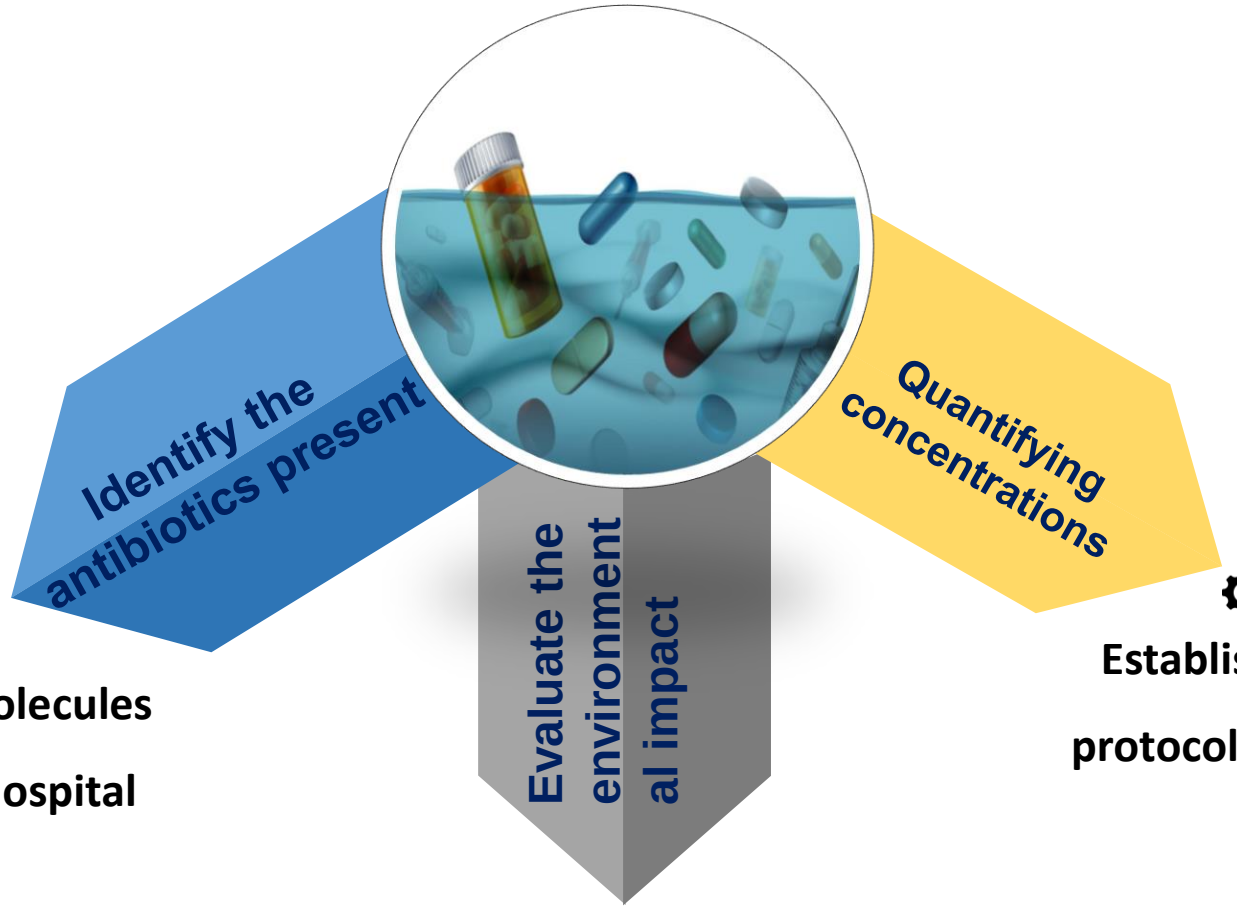
Current State



Presence of antibiotics in hospital effluents worldwide *(Nasri et al., 2024)*

Objectives of the Study

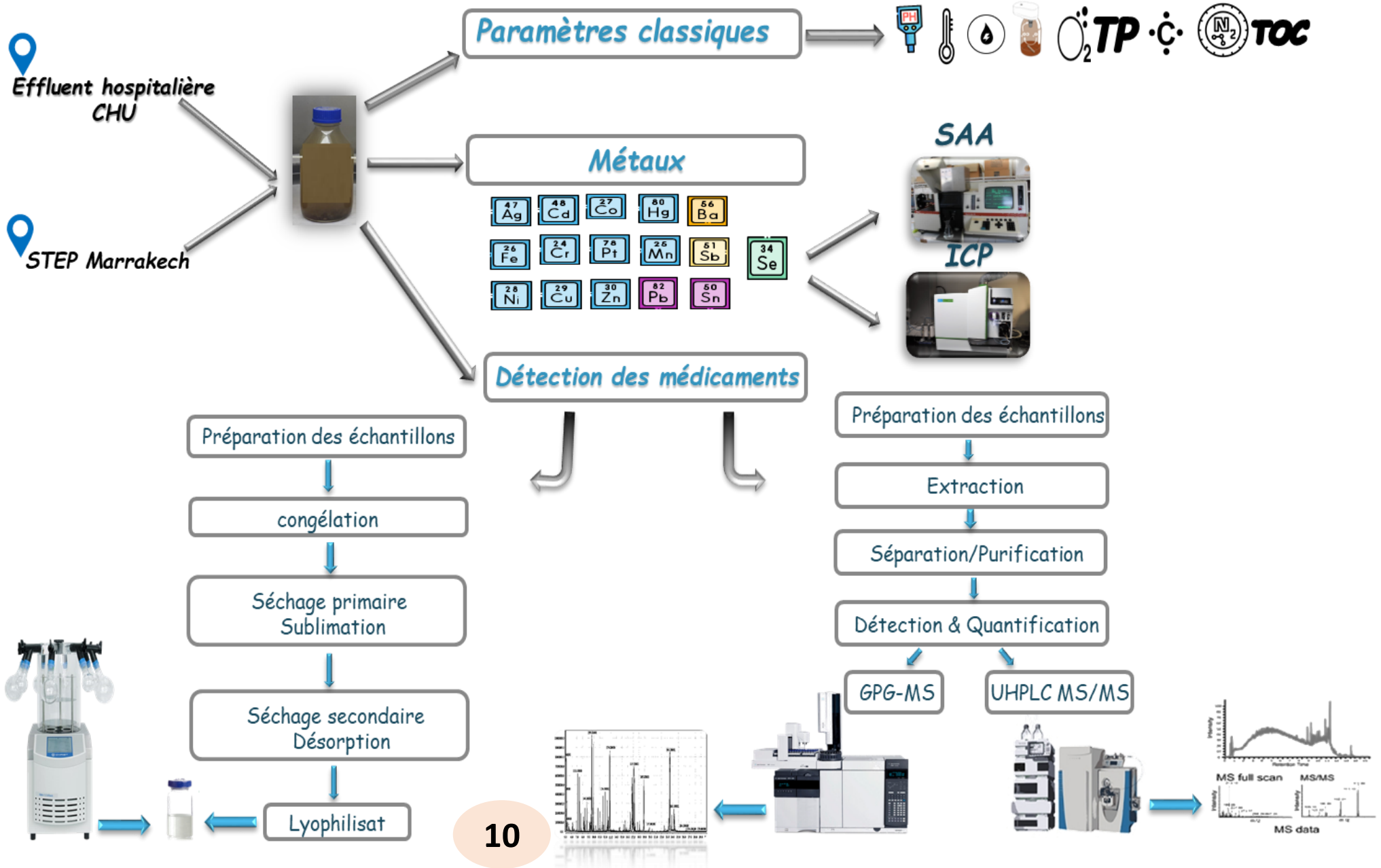


Determine the antibiotic molecules most commonly found in hospital wastewater

Establish precise measurement protocols to assess contamination levels.

Better understand the risks of these residues in the aquatic environment.

- **Wastewater Analysis: Procedure and Methods**



Methodology

1

Sampling

Sampling of wastewater at different points in the hospital network.

2

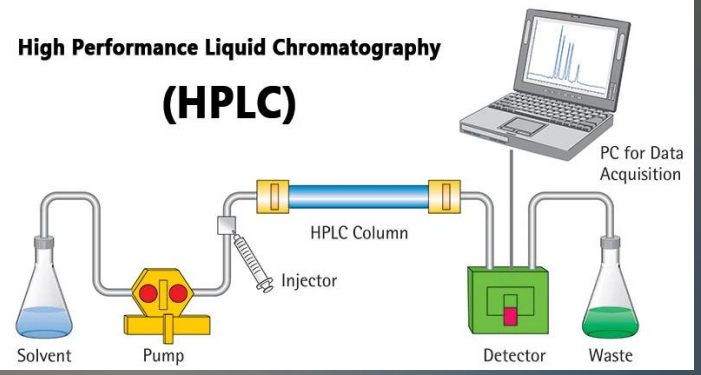
Pre-treatment

Filtration and Preservation.

3

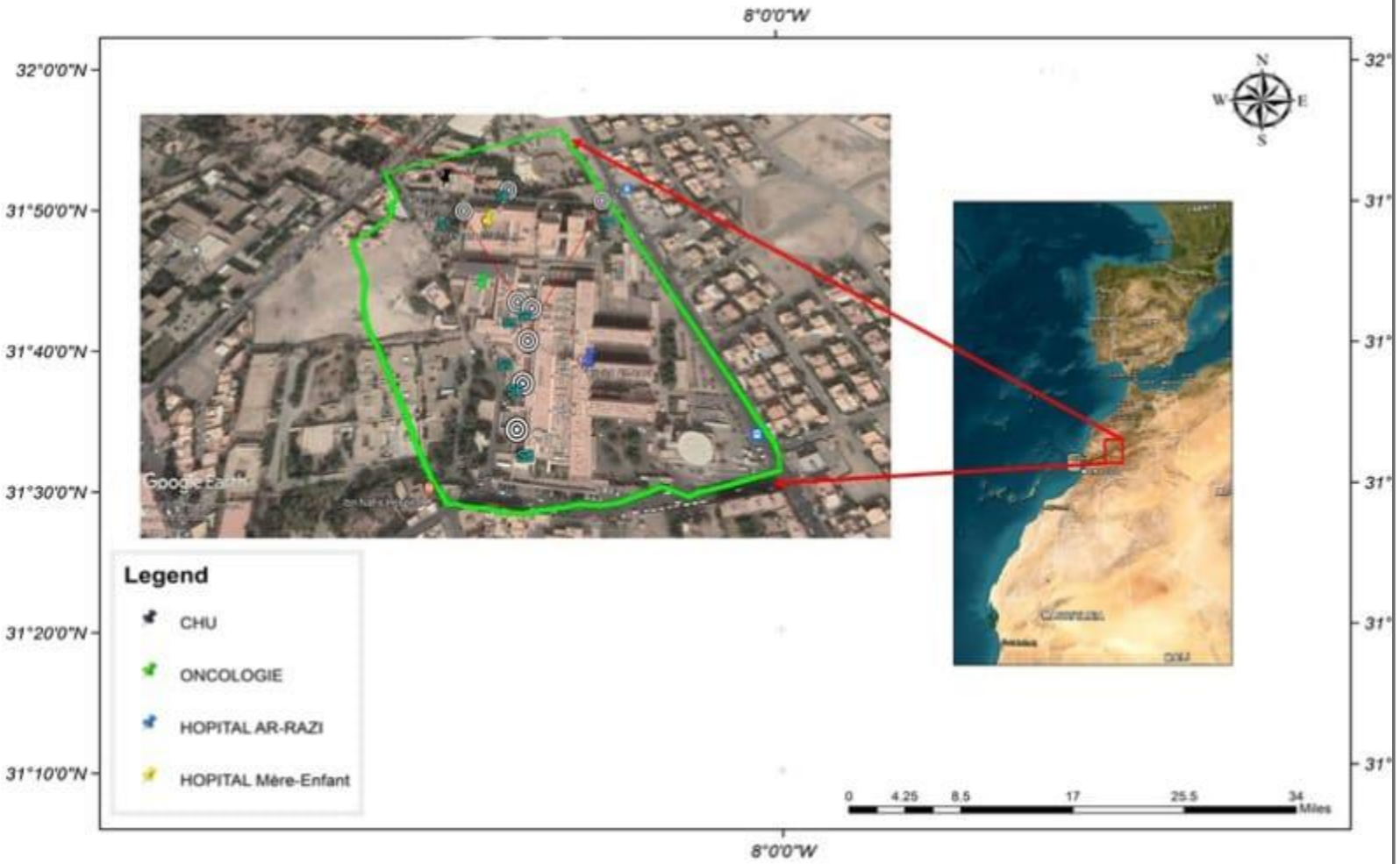
Analysis

Identification and quantification of antibiotics using analytical techniques



1.Sampling

a. Sampling Site (CHU) :



1. Mother and Child Hospital
2. Oncology center
3. Morgue, Central pharmacy, ARRAZI hospital equipment sterilization, Operating theatre, Radiology
4. Main collector for 3 hospitals (Mother and Child Hospital, Oncology center, hematology)
5. Mohamed VI University Hospital main kitchen
6. Hematology center
7. ARRAZI Hospital medical and pathological anatomy laboratories
8. Gastrology

b. Methodology

Sampling of wastewater
(500 ml for each sample)

Sterile glass vials
of analytical quality.

Filtration and Preservation :

- **Temperature :** -20°C

c. Sampling Fréquence

Month		Hours					
January		07:00	09:00	11:00	13:00	15:00	17:00
1	Sunday						
2	Monday	■		■		■	
3	Tuesday						
4	Wednesday		■		■		■
5	Thursday						
6	Friday						
7	Saturday						
8	Sunday						
9	Monday						
10	Tuesday		■		■		■
11	Wednesday						
12	Thursday	■		■		■	
13	Friday						
14	Saturday						
15	Sunday						
16	Monday	■	■	■			
17	Tuesday						
18	Wednesday						
19	Thursday				■	■	■
20	Friday						
21	Saturday						
22	Sunday						
23	Monday						
24	Tuesday						
25	Wednesday	■		■		■	
26	Thursday						
27	Friday		■		■		■
28	Saturday						
29	Sunday						
30	Monday						
31	Tuesday	■		■		■	

d. Extraction of Antibiotics

Addition of ethyl acetate to the wastewater sample (500 ml), with a visual of the phase in a shaking incubator.

Phase separation after 30 minutes of incubation.

Evaporation nearly to drybess at 70 °C in a rotary evaporator.

Redissolution in methanol and filtration using sterile syringes and 0,45 µm filters.

Injection into the HPLC vial for analysis.

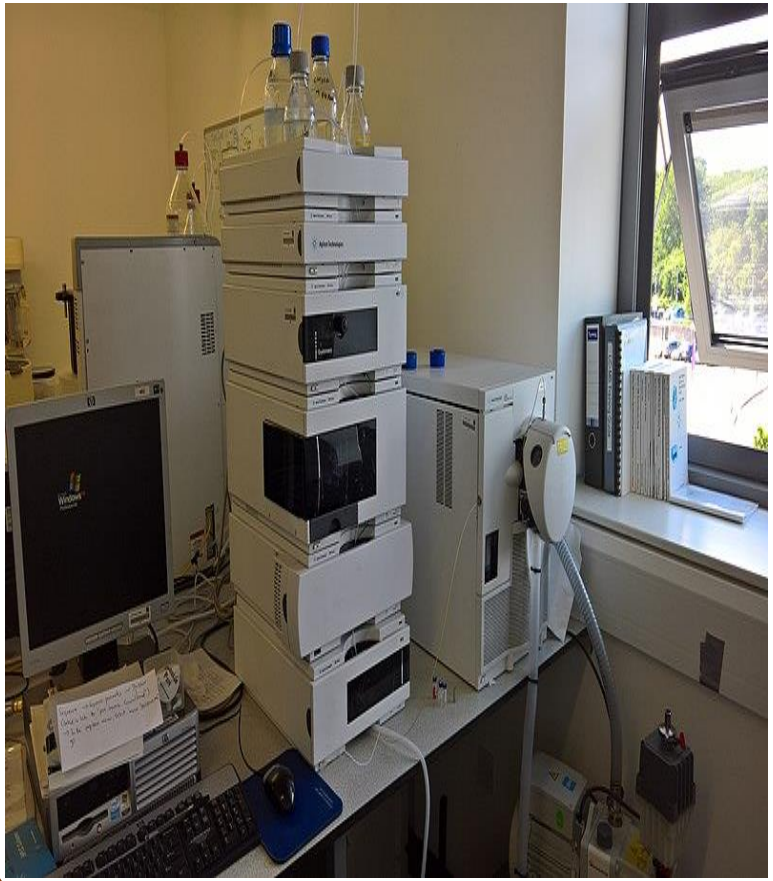
2. Chromatographic Analysis

a. HPLC

High-Performance Liquid Chromatography for the separation of compounds.

b. LC-MS/MS

Tandem Mass Spectrometry coupled with Liquid Chromatography.



c. Method Validation

- **Linearity**

Study of the system response as a function of concentration.

- **Efficiency**

Evaluation of analyte recovery after pre-treatment

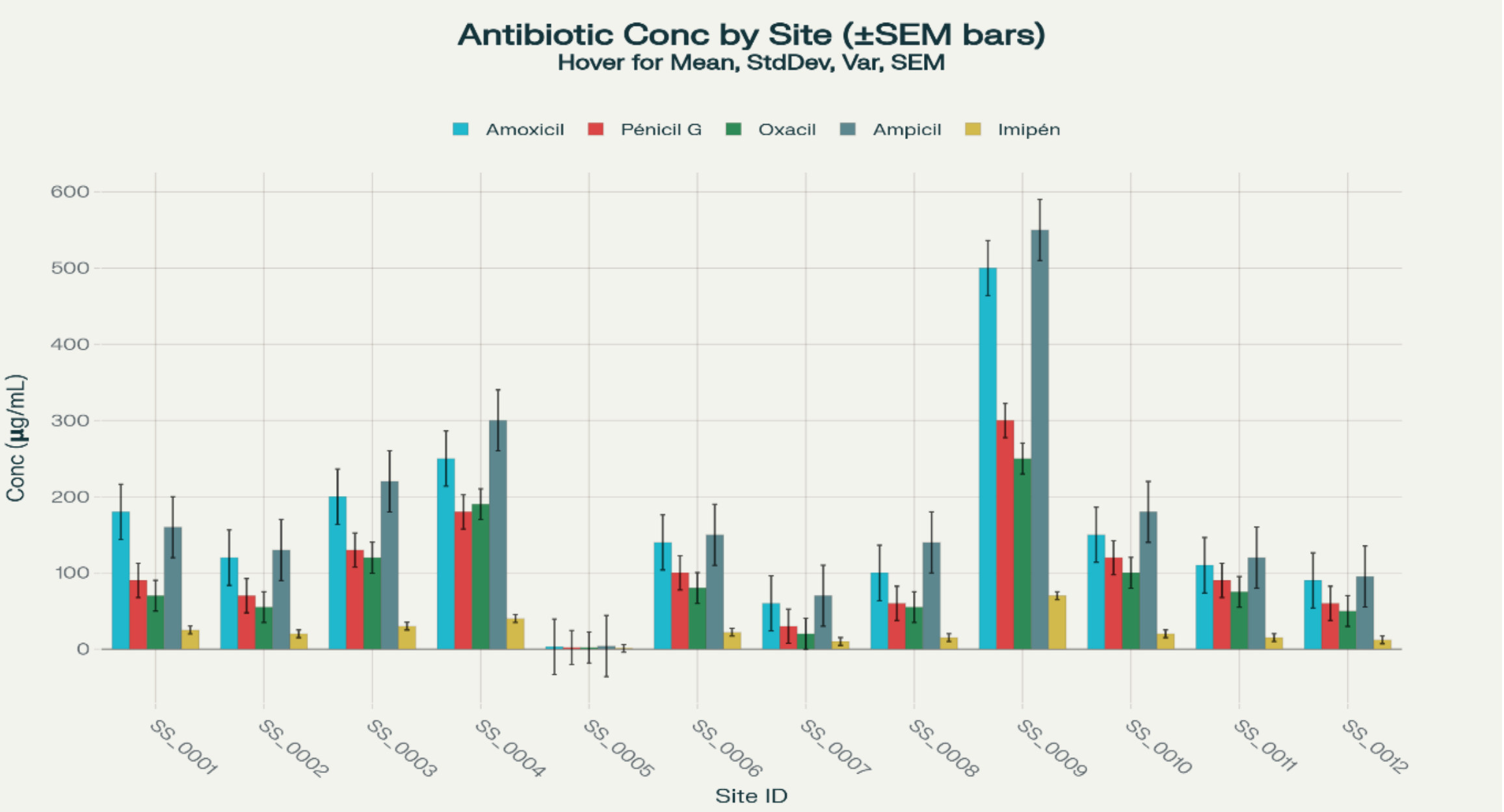
- **Limit of Detection**

Minimum Quantifiable Concentration with Reliability.

- **Precision**

Repeatability and Reproducibility of Measurements.

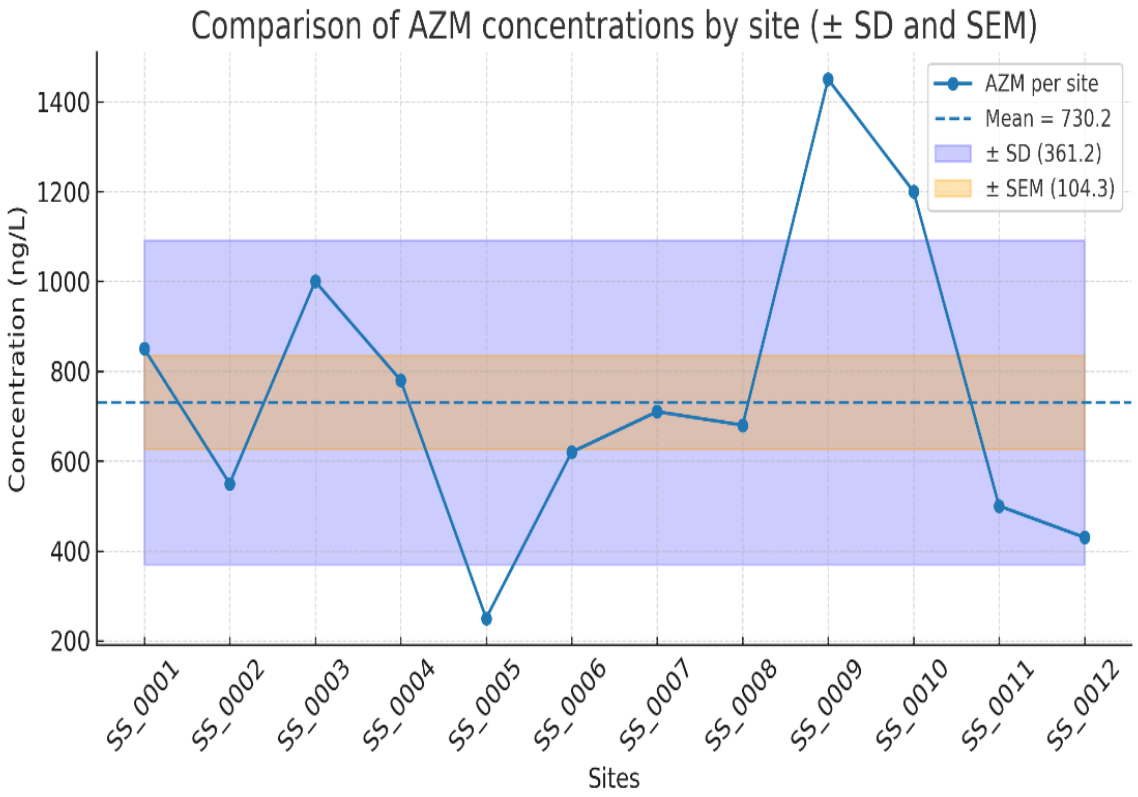
Results


Antibiotic Conc by Site (±SEM bars)
Hover for Mean, StdDev, Var, SEM
Amoxicil
Pénicil G
Oxacil
Ampicil
Imipén
Conc (µg/mL)
600
500
400
300
200
100
0
SS_0001
SS_0002
SS_0003
SS_0004
SS_0005
SS_0006
SS_0007
SS_0008
SS_0009
SS_0010
SS_0011
SS_0012
Site ID

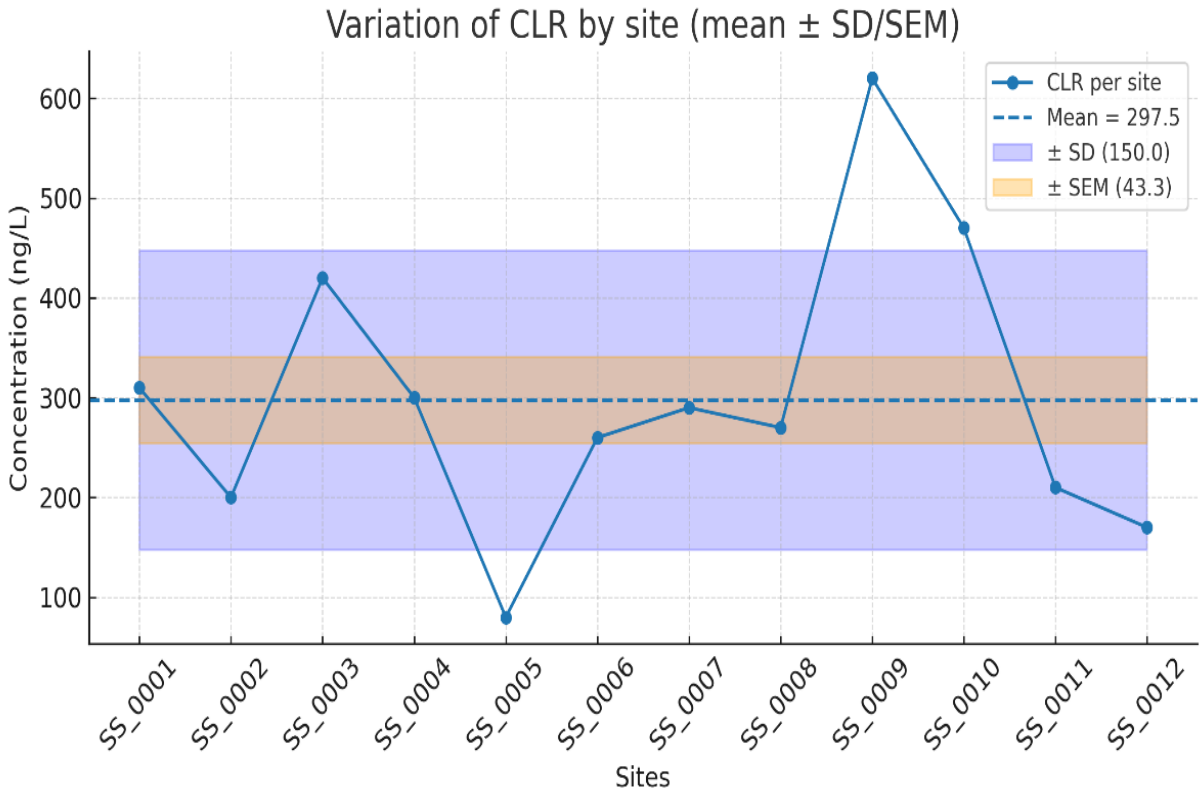
Results

- Specific graphs for each antibiotic

Figure 3. Variation in AZM by site with mean ± SD and ± SEM



- Figure 4. Variation in CLR by site with mean ± SD and ± SEM.



Results

Figure 6. Variation in SPI by site with mean ± SD and ± SEM.

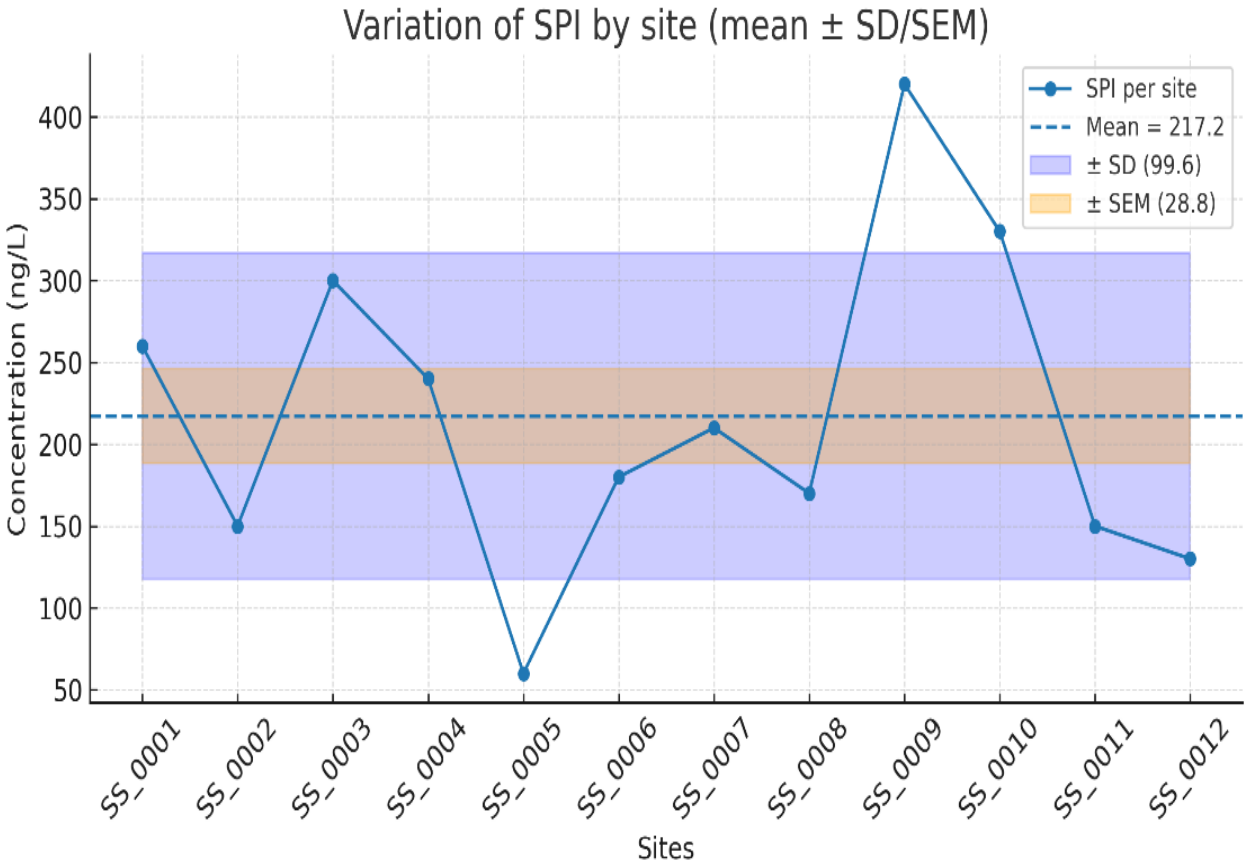
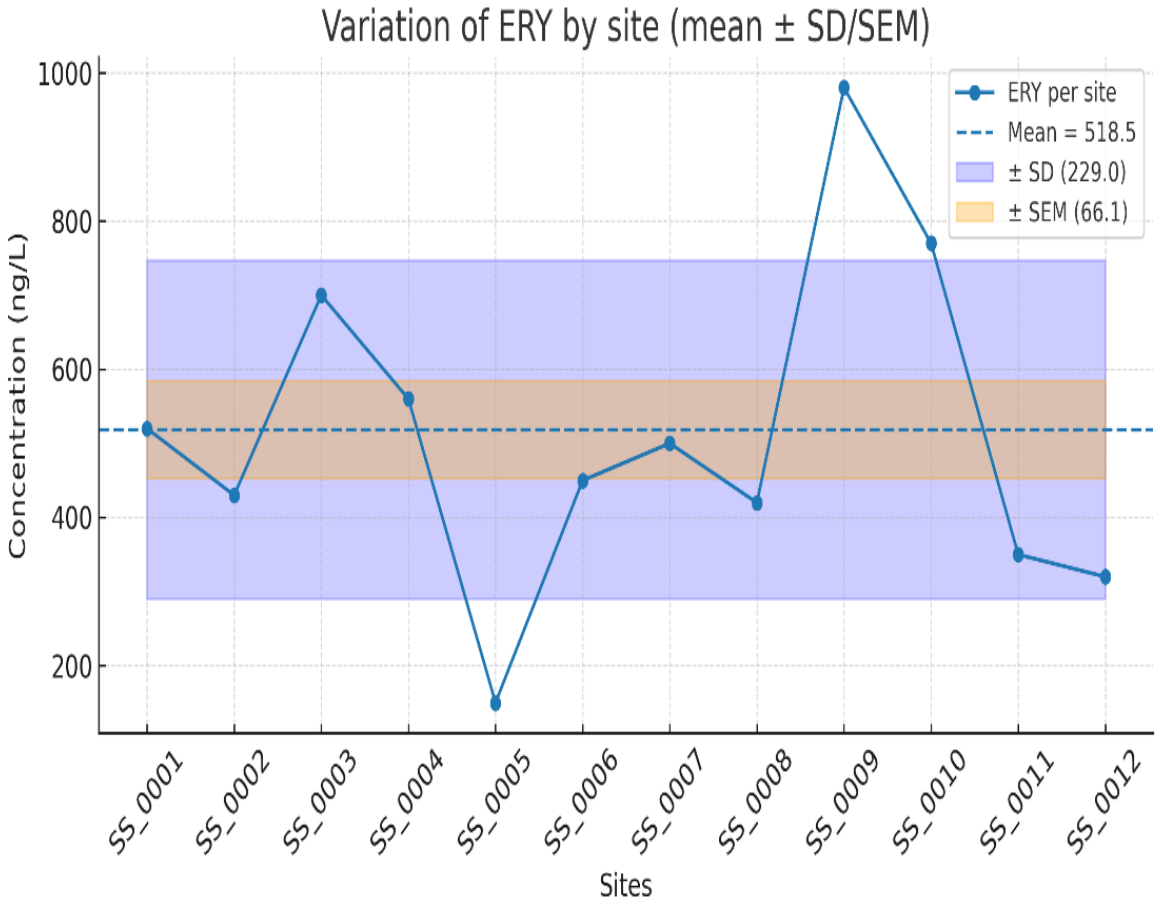
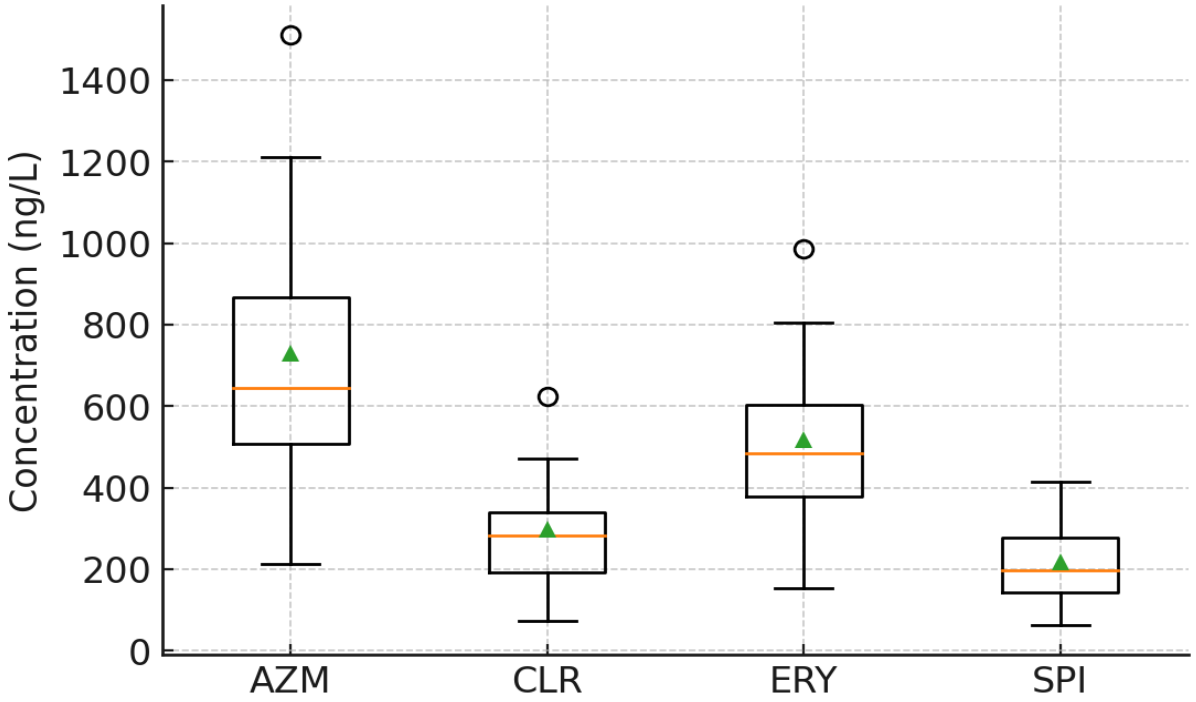


Figure 6. Variation in SPI by site with mean ± SD and ± SEM.

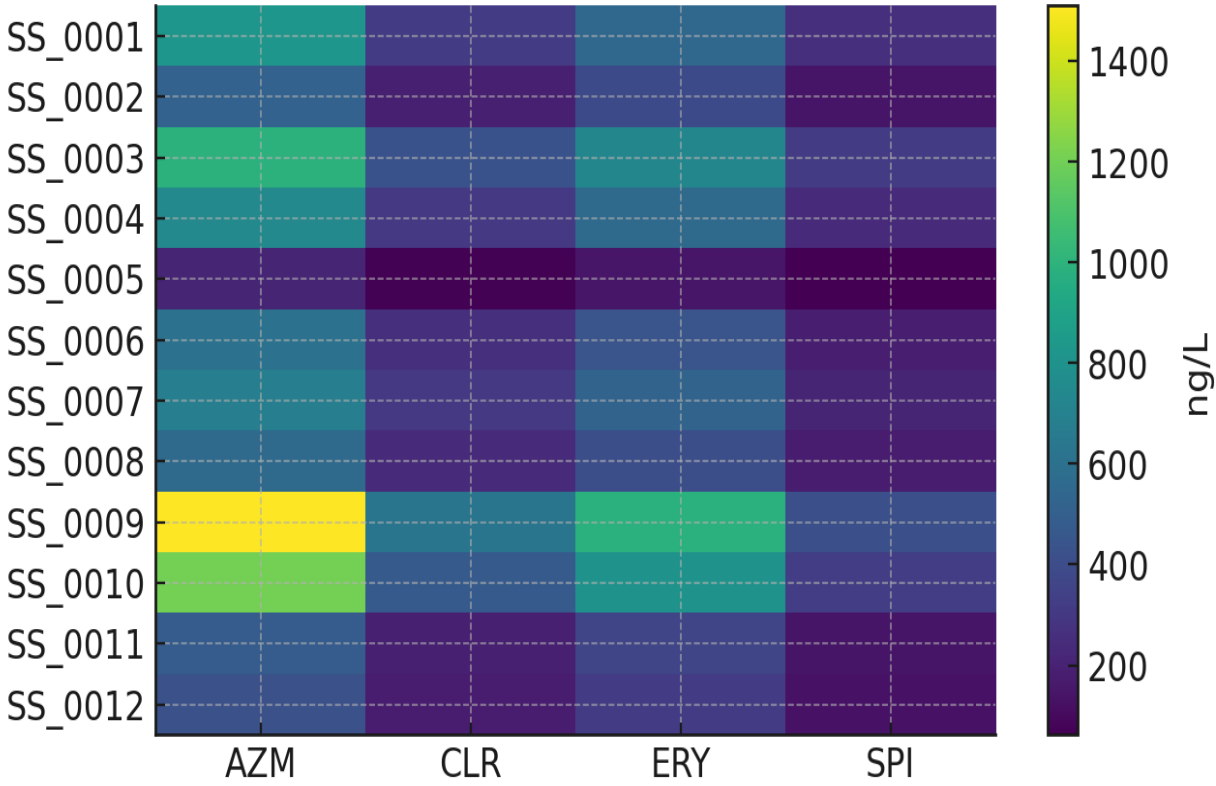


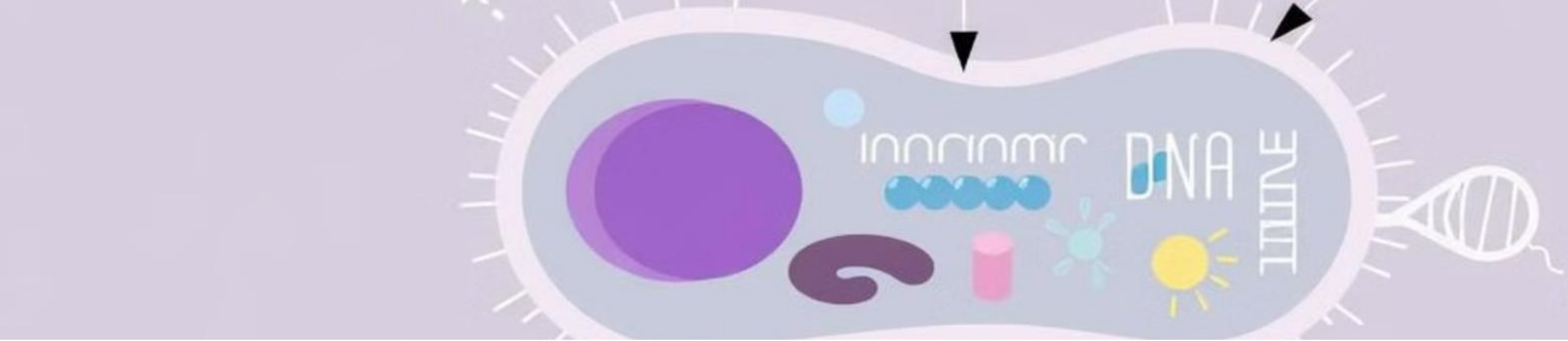
Results

- **Statistical comparison between antibiotics**



- **Correlations**





- Ongoing research

- **Detection and Monitoring of Antibiotic Residues in Hospital Effluents**
- **Studies on Bacterial Resistance Induced by Antibiotics in the Environment**
- **Ecotoxicological Impact of Beta-Lactams on Aquatic Ecosystems**

Conclusion and Perspectives

01

Continuous Improvement of Wastewater Treatment

02

Extended monitoring through the implementation of stricter standards intends to limit the concentration of antibiotic residues present in wastewater

03

Assessment of Risks to the Environment and Public Health

Thank you for your attention