



Ask the Experts - 11 November 2021

Occurrence of Heavy Metals in Drinking Water, Biogeochemical Cycles and Health Risk for Consumers

Dr Stéphane J. CLAON



Presentation Outline

- Introduction
- Arsenic in water and effects on health
- Iron and manganese in water and effects on health
- Case of exposure to iron, manganese and arsenic in Côte d'Ivoire
- Challenges of water decontamination
- Conclusion

Introduction

- A growing interest to make potable water more accessible through international programs



1981-1990-DIEPA
INTERNATIONAL DRINKING WATER SUPPLY AND SANITATION DECADE

2000-2015 MDG

MILLENNIUM GOAL FOR DEVELOPMENT



2015-2030 - SDG

- **SUSTAINABLE DEVELOPMENT GOAL**



- A growing interest to introduce and implement drinking water quality guidelines

Definition of potable water

Relate to health

clean, potable water **does not pose any known danger to the health** of a person who consumes it throughout their lifetime, taking into consideration the difference in potential susceptibility according to the different stages in life.(WHO,2017)

Relate to acceptability

Clean potable water must also taste pleasant as long as circumstances allow for it: importance of organoleptic factors (turbidity, colour, taste...)

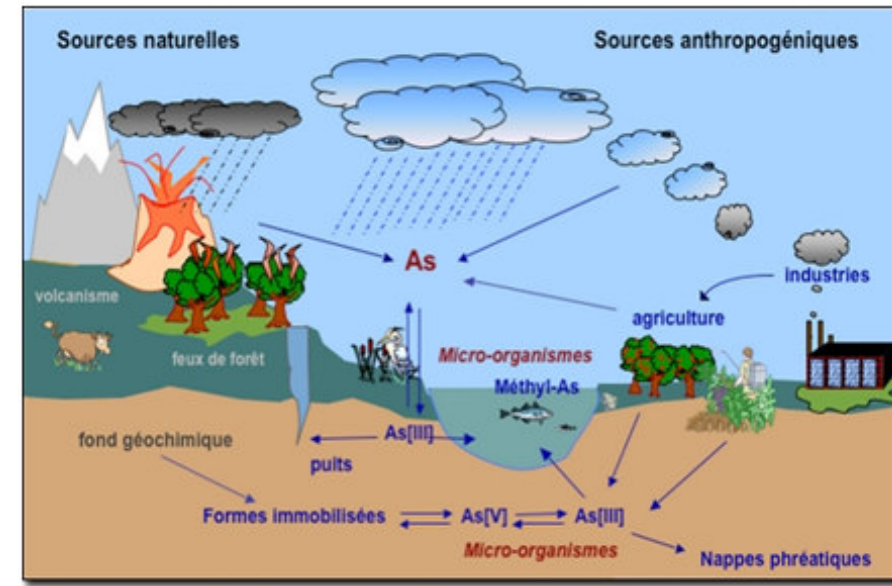
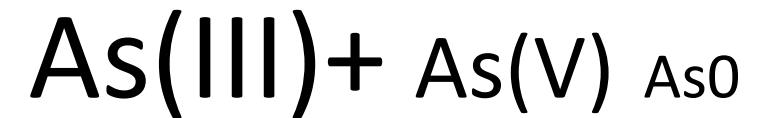
Change in the directives on the quality of potable water

GDWQ Edition	Publication date	Addenda publication dates
1 st Edition	1984	No addenda published
2 nd Edition	1993	1998, 2002
3 rd Edition	2004	2006, 2008
4 th Edition	2011	2017

Arsenic in drinking water

Origin and Exposure

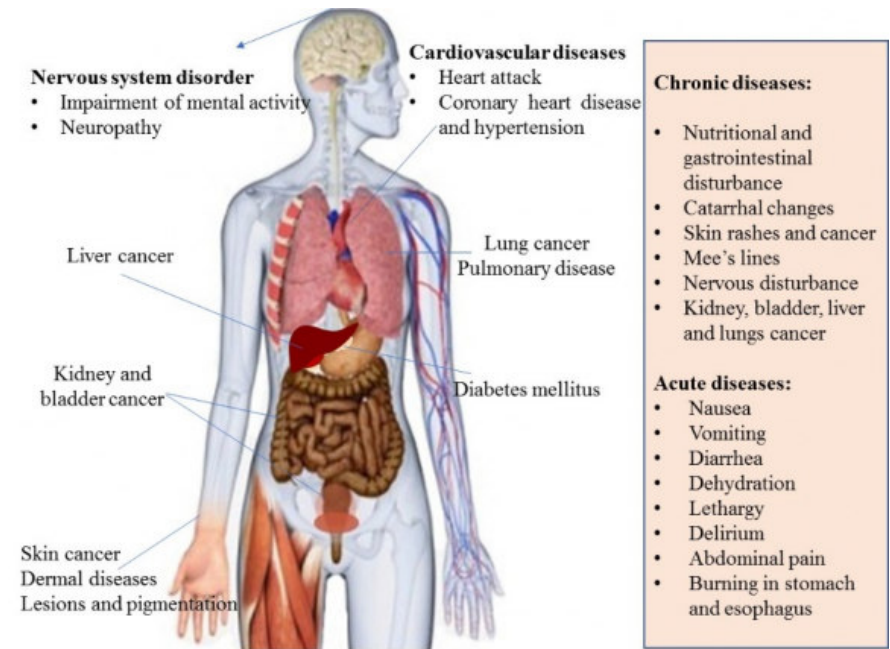
- Arsenic: Group VA of the metalloids family
- In inorganic state with four oxidation levels –III, 0, +III, +V (arsenites, arsenates...)
- In organic state (arsenobetaine, arsenocholine)
- Elements of the earth's crust present in the soil, air and water+++ due to natural erosion of soil, volcanic activity...
- Anthropogenic sources, especially abundant in gold, silver, copper ores (10 times more concentrated)
- Groundwater and foodstuffs irrigated from these water sources are the main way of exposure to the population



Cycle biogéochimique de l'arsenic
http://www.nbrienviis.nic.in/Database/Arsenic_2035.aspx

Effects on health

- Arsenic and its inorganic compounds have been classified as proven carcinogens to humans by the IARC (group 1) since 1980
- Toxicity varies according to the level of oxidation, As (III) > As (V) > As (organic) > As(0) types
- Bioaccumulation in the food chain (Bangladesh)
- Mechanisms interfering in phosphorylation in the ATP cycle and the replacement of Thiol groups to inhibit protein functions,
- Long term exposure is the cause for the impact on health
- Hyperpigmentation; skin, lung, liver, kidney cancer with peripheral arteriosclerosis and neurotoxic damage especially in case of in-utero exposure



Acute and chronic toxicity of arsenic (Shahid, 2018)

Values guide 0,1 µg/l



Effects on health

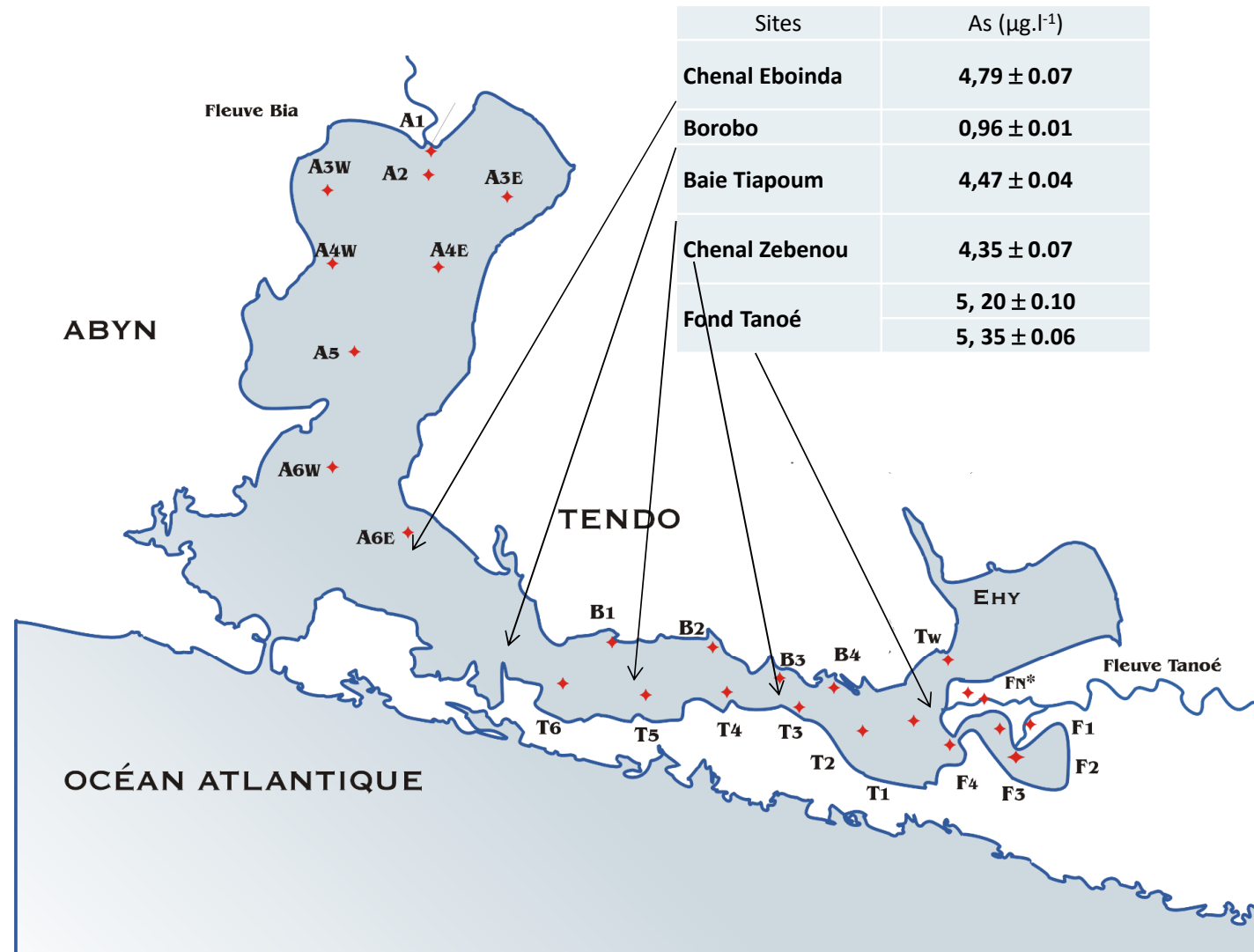


Arsenic in water in Côte d'Ivoire

Could be find in both inorganic and organic states of oxidation though poorly bioavailable

and available in small quantities in groundwater sources used for potable water

Arsenic in the Aby-Tendo lagoon



Iron and Manganese in Drinking Water

Origin and Source

- Elements of the earth's crust available in the soil, air and water+++ due to natural soil erosion, volcanic activity...
- Abundant in mineral sources
- Available in groundwater
- Industrial waste
- Corrosion of water pipes, acidic water
- Application of iron salts as a coagulation agent in water treatment

Effects on health

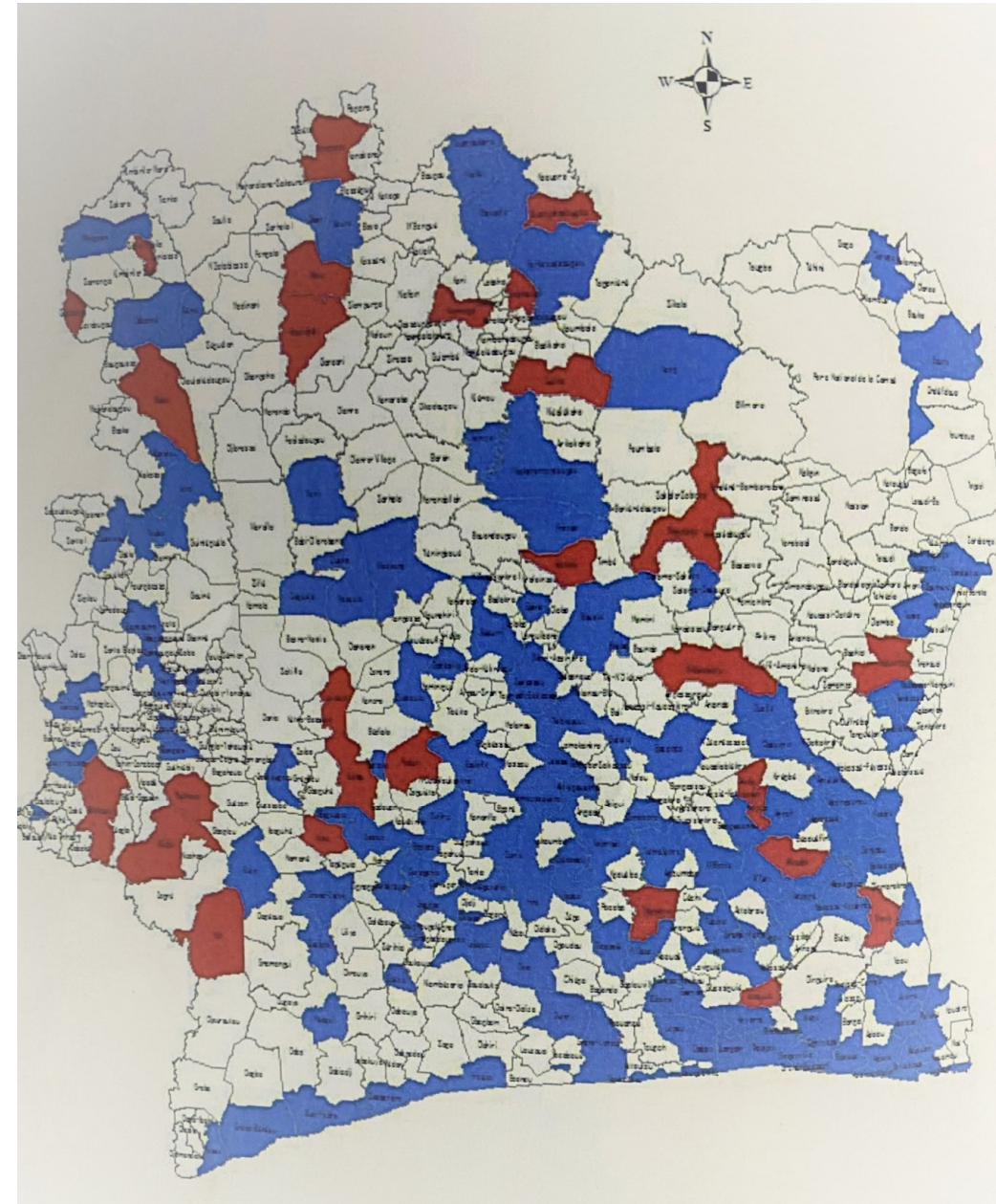
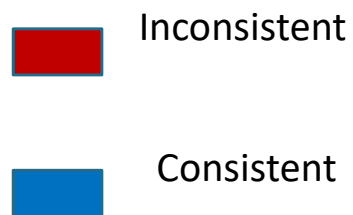
- Insomnia and headaches
- Neurological disorders
- Shivering

Other effects

- Coloration of rusty to brown water and cephalalgia
- Metallic taste
- Staining laundry and plumbing system

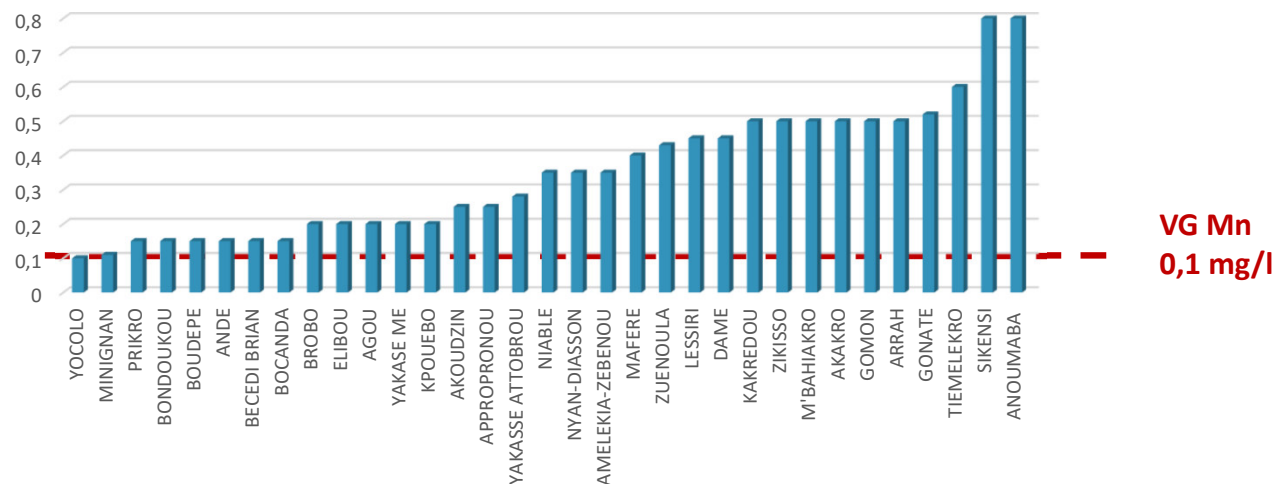
Iron and Manganese in water in Côte d'Ivoire

Abundance and distribution throughout Côte d'Ivoire

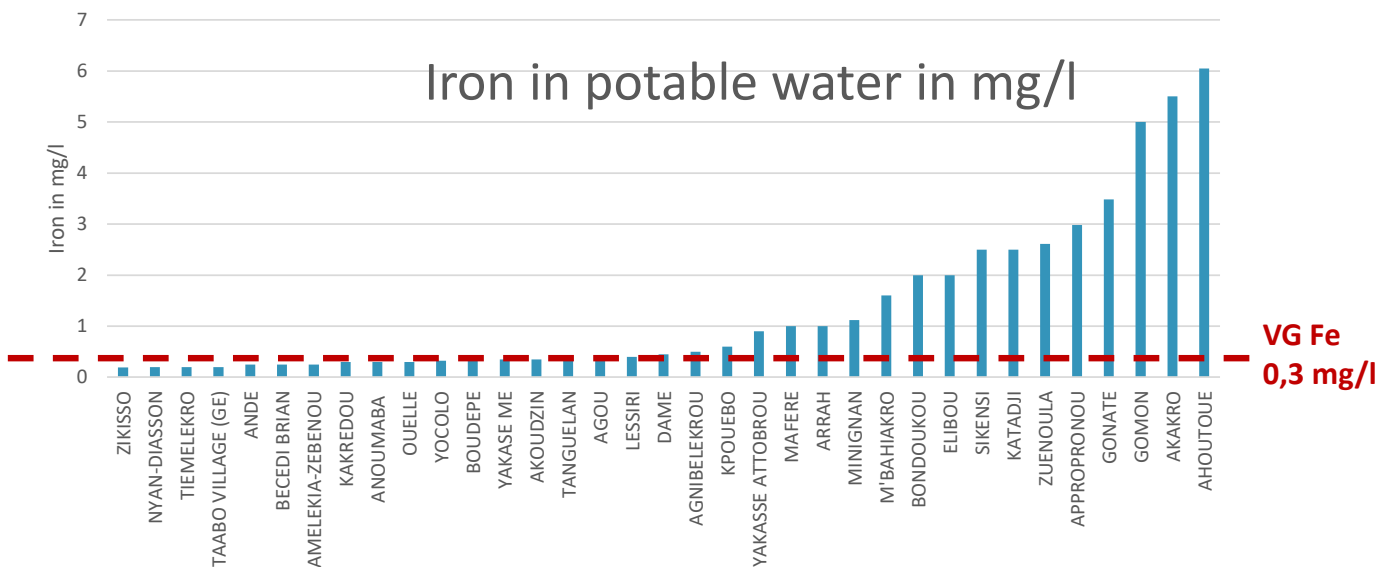


Iron and Manganese in water in Côte d'Ivoire

Manganese in water in mg/l



Iron in potable water in mg/l



Challenges with decontamination

As^{3+}

Analysis

- Methods
- As species formation
- Equipment

+

Mn^{2+}

Resources

- Financial
- Human
- Maintenance

+

Fe^{2+}

Decontamination

- Accessibility
- Durability
- Cost/benefit ratio



Conclusion

Rising issue with a growing mining industry concern
Risk Assessment and risk management challenges
Integrated management of catchment area
Sustainable and accessible decontamination system
Innovation and technology accessible to the population



Thank you

Danke

Merci