

Le Léman: du témoin des plus grands changements climatiques à la bactérie qui résiste aux antibiotiques



Club de plongée de Plan les
Ouates, 29 janvier 2018



Tabula Peutingeriana « Romans
world »(Talbert, 2010).

John Poté et
Walter Wildi



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l'environnement et de l'eau
Université de Genève

1. Le Léman c'est



Photo: Anh Dao Le Thi

1. Le Léman c'est

Le plus grand réservoir d'eau douce en Europe Centrale



Sport et détente



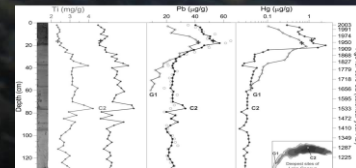
Un haut-lieu du tourisme



La nature pure



Le meilleur indicateur environnemental et la mémoire de son histoire

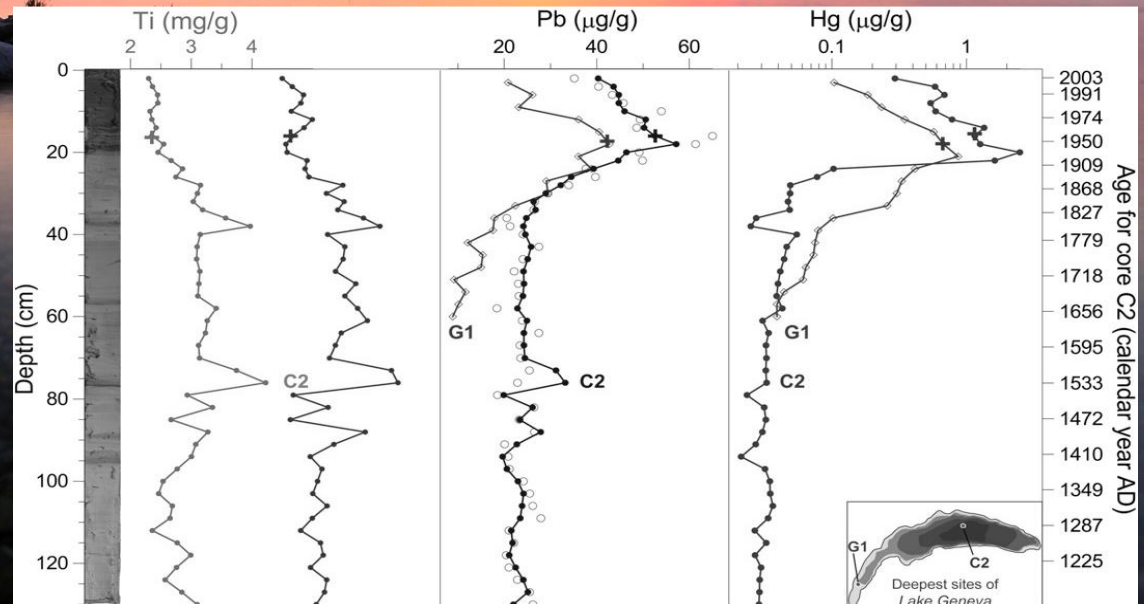


1. Le Léman c'est

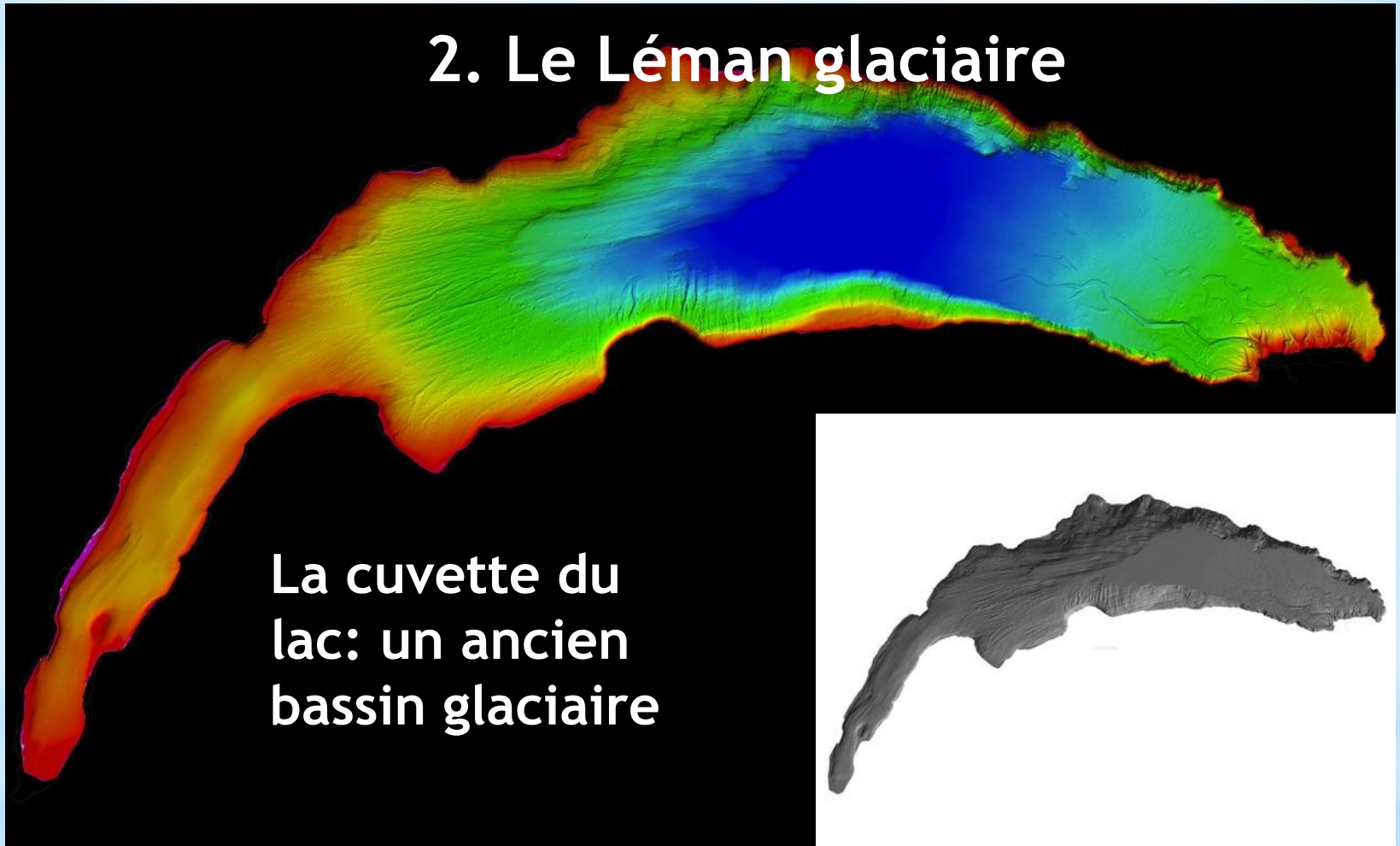
Rejets d'eaux usées,
empreinte
sédimentaire

Mercure et Plomb dans les
sédiments du Léman

Le meilleur
indicateur
environnemental
et la mémoire de
son histoire



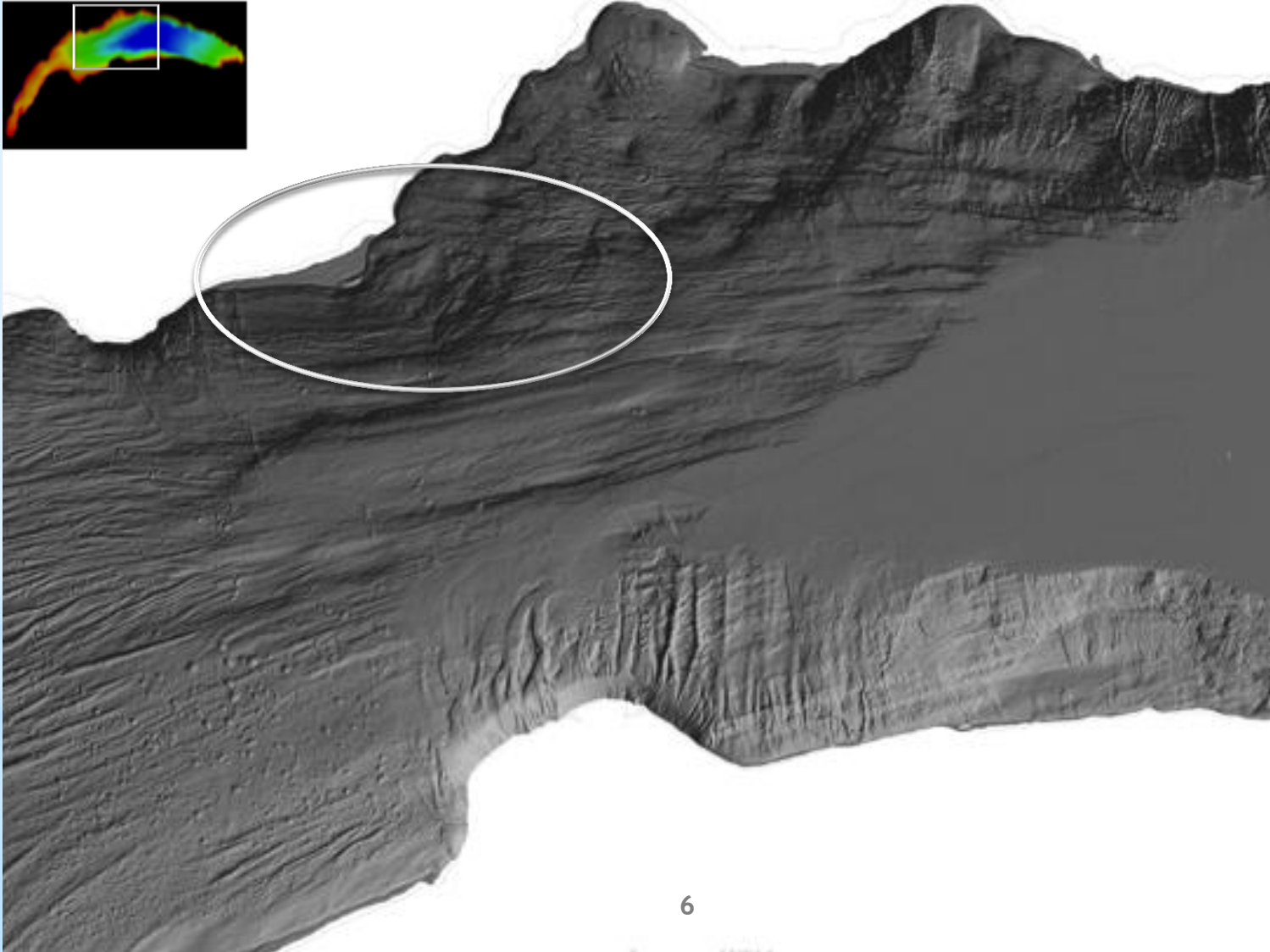
2. Le Léman glaciaire



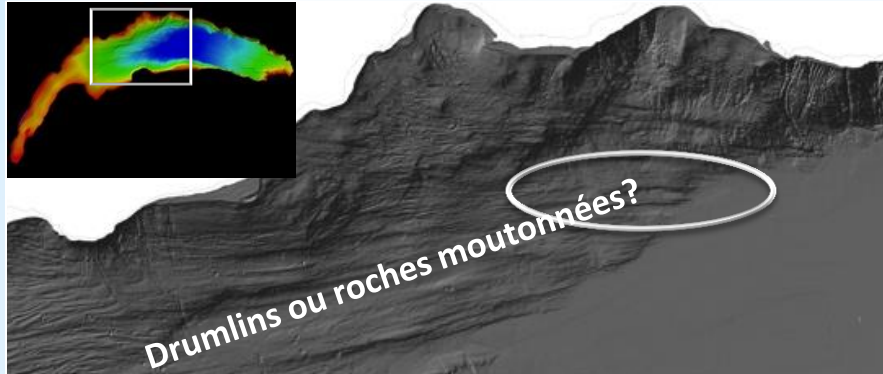
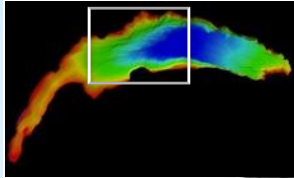
**La cuvette du
lac: un ancien
bassin glaciaire**

Carte bathymétrique par sonar multifaisceaux (Institut F.A. Forel, UNIGE et Institut de Géologie, UNIBE 2013-2014, Dép. Général de l'environnement, Etat de Vaud).

2. Le Léman glaciaire



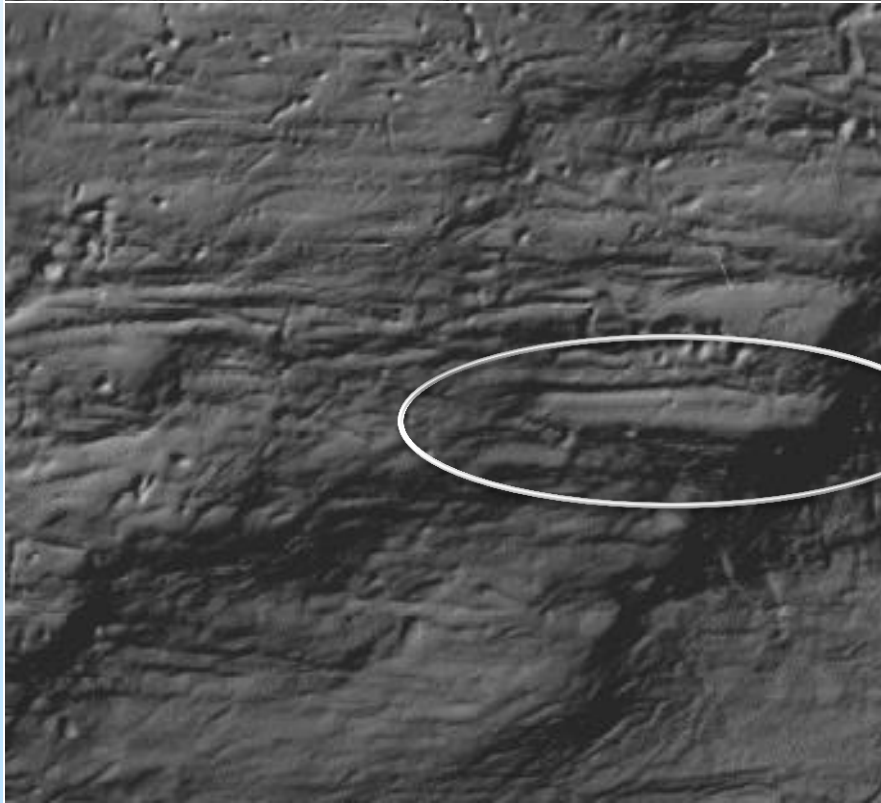
2. Le Léman glaciaire



Drumlins ou roches moutonnées?



Roche moutonnées
au Mont Miné



2. Le Léman glaciaire



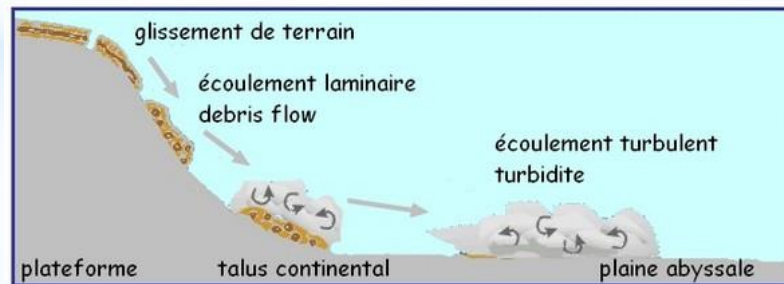
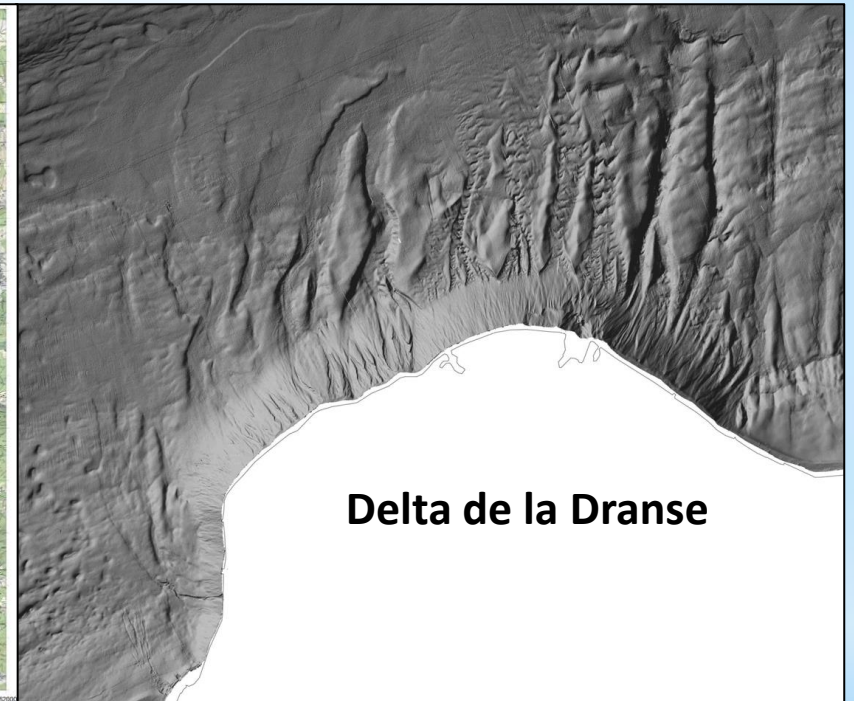
La Suisse au dernier âge glaciaire (swisstopo)

3. Le Léman physique



3. Le Léman physique

Sédimentation et érosion

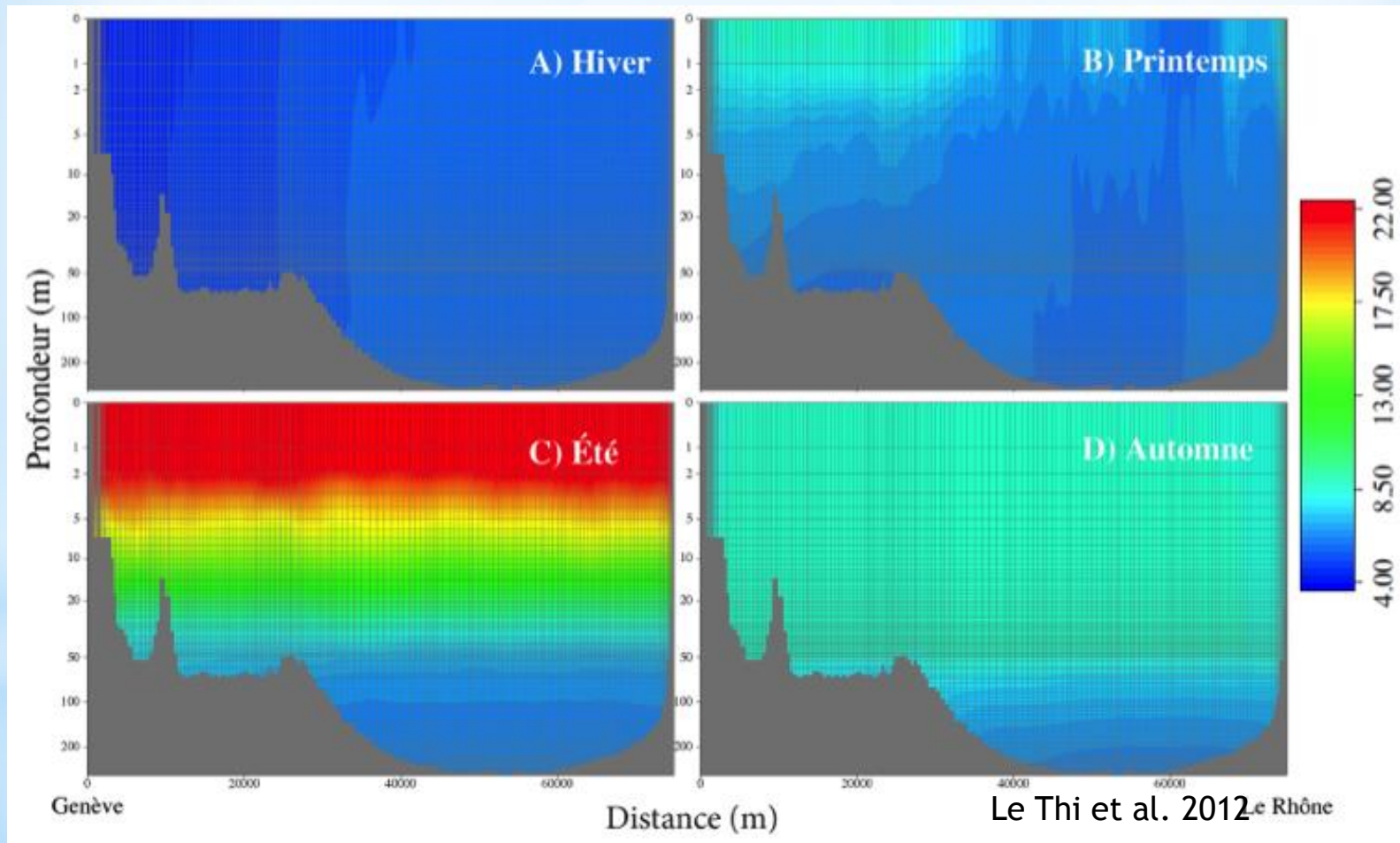


Formation des turbidites

3. Le Léman physique

Régime thermique saisonnier (« monomicte »)

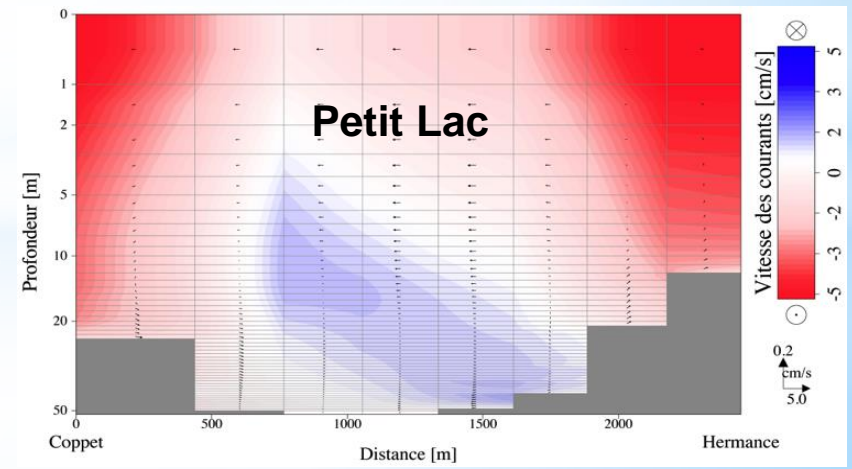
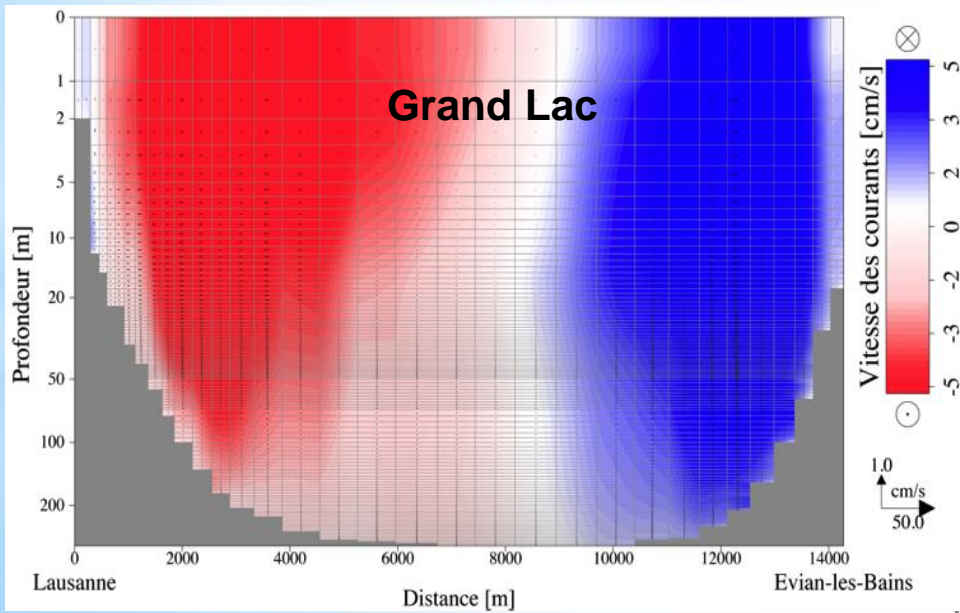
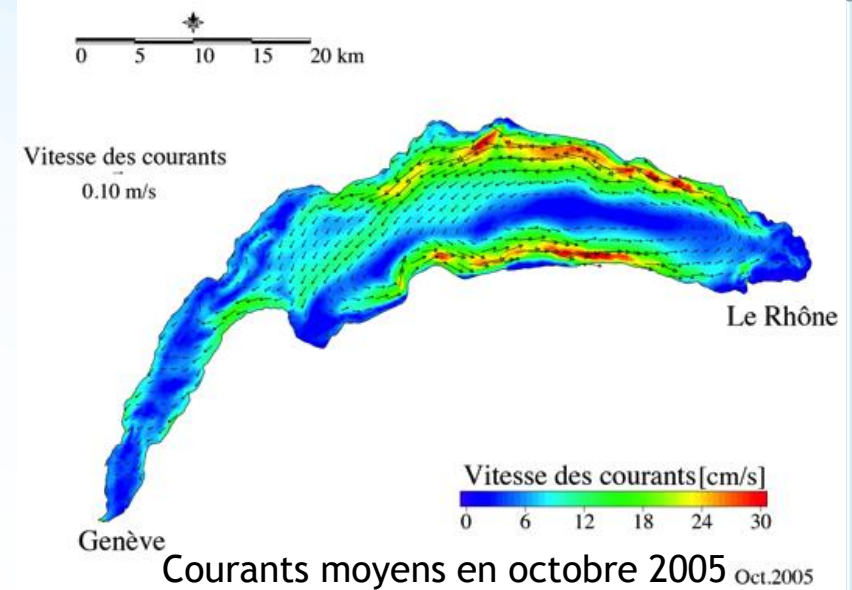
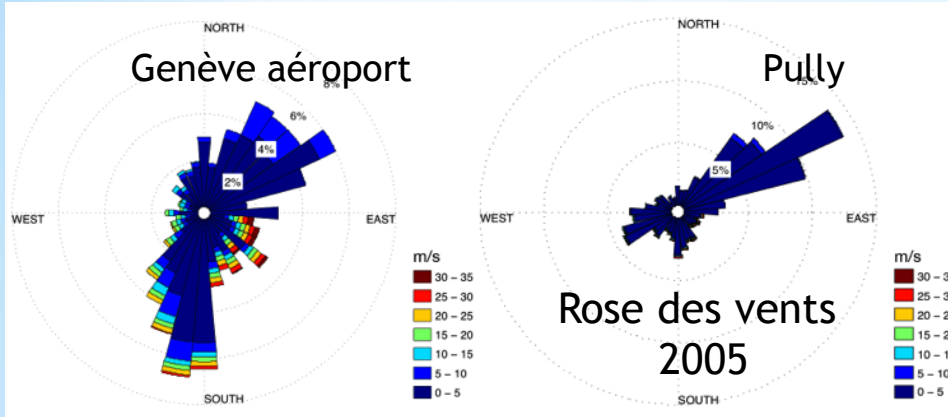
Petit Lac - Grand Lac



Répartition des températures (° C) sur une section longitudinale du Léman année 2005

3. Le Léman physique

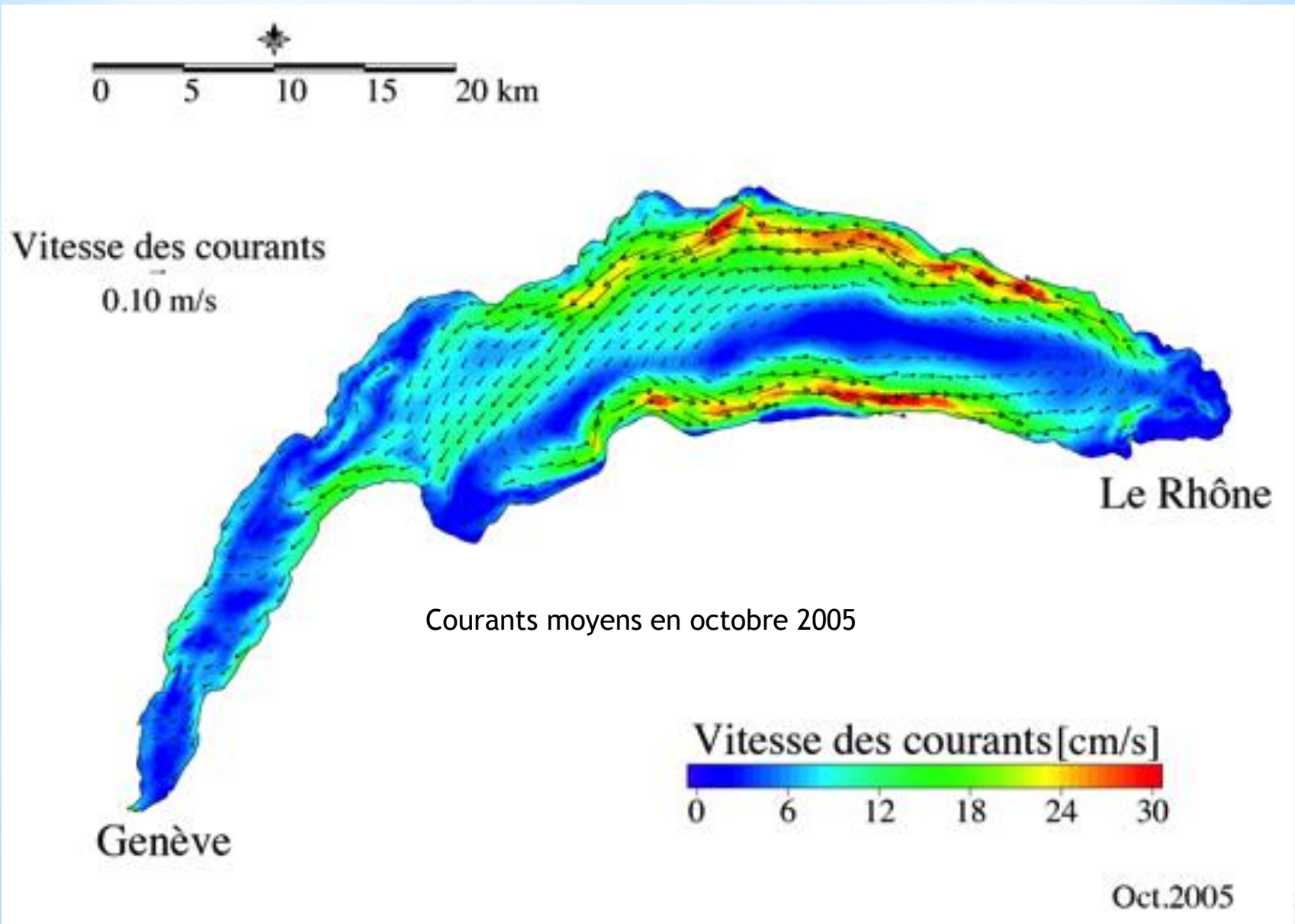
Régime des courants animés par les vents



Courants moyens 2005, transect B, Grand-Lac et transect B, Petit-Lac (Le Thi et al. 2012)

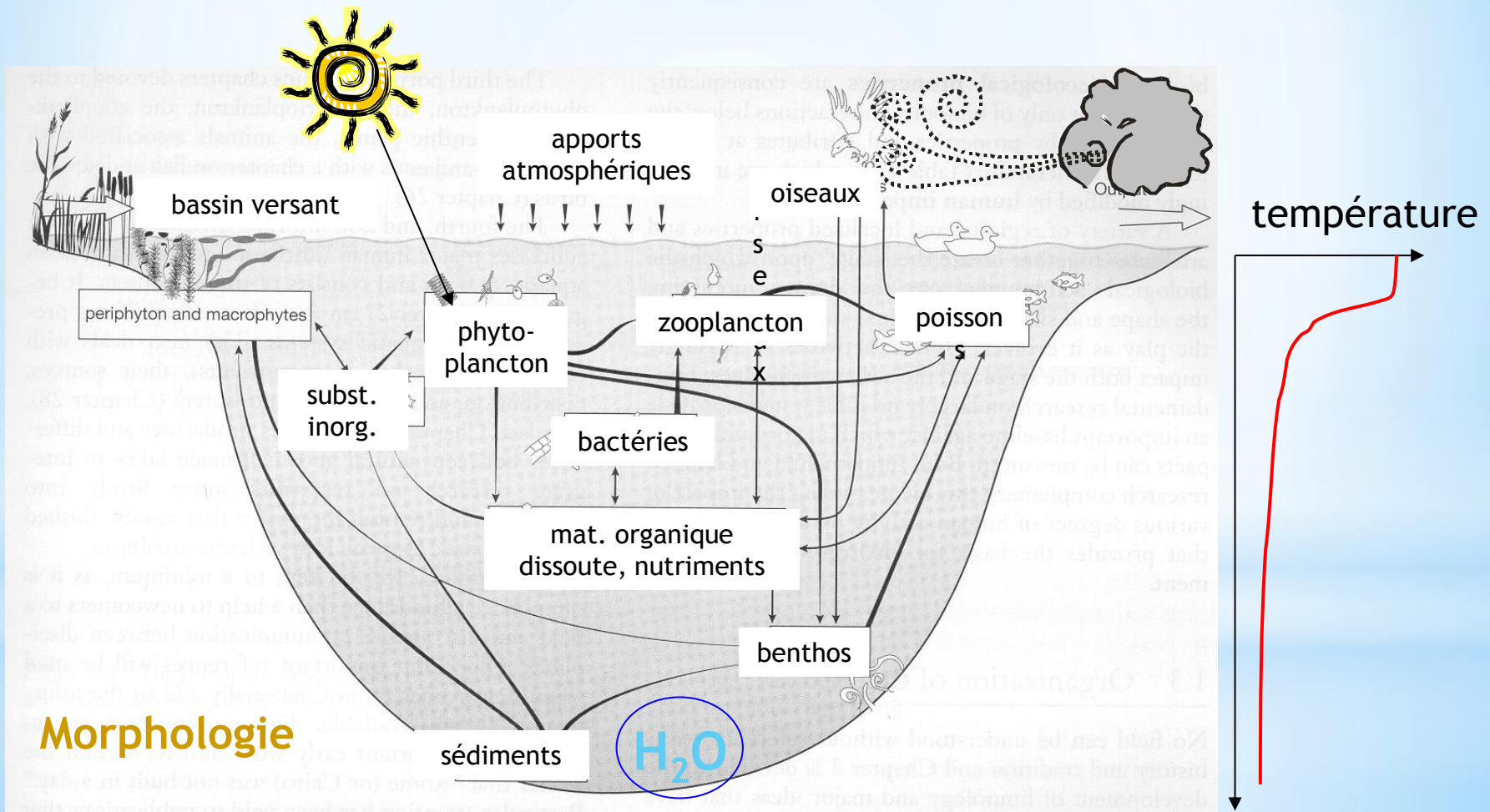
3. Le Léman physique

Régime des courants animés par les vents



4. Le Léman vivant

Structure et fonctionnement des écosystèmes aquatiques



5. Dissémination des antibiotiques, bactéries et leurs gènes de résistances aux antibiotiques dans le Léman



Objectif de la présentation:

- Les voies de dissémination des antibiotiques en milieu aquatique
- La relation entre antibiotiques et bactéries résistantes
- Comment une bactérie devient-elle résistante et transfère des gènes de résistance entre les bactéries
- L'impact des bactéries résistantes sur la faune et la flore aquatique, comme celle du lac Léman
- Eventuelles solutions pour éviter cette dissémination

Beaucoup de diapos en Anglais

5.1. Antibiotiques et résistances aux antibiotiques

Antibiotic

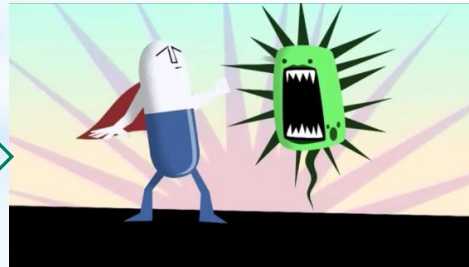
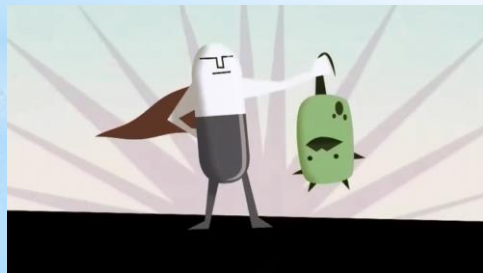


Resistance

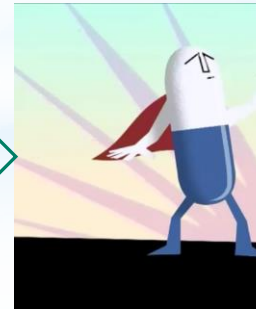
Médicament pour traiter les infections causées par les bactéries: la tuberculoses, les pneumonies, bronchites, otites, méningites, infections urinaires, septicémies, maladies sexuellement transmissibles,.....

What is antibiotic resistance or/and multi resistance?

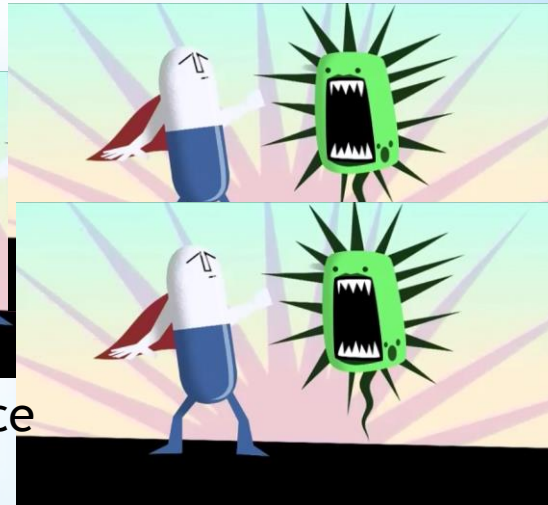
Antibiotic resistance occurs when bacteria develop the ability to survive exposure to antibiotic/s that is/were designed to kill them or stop their growth



Resistance
ARB & ARGs

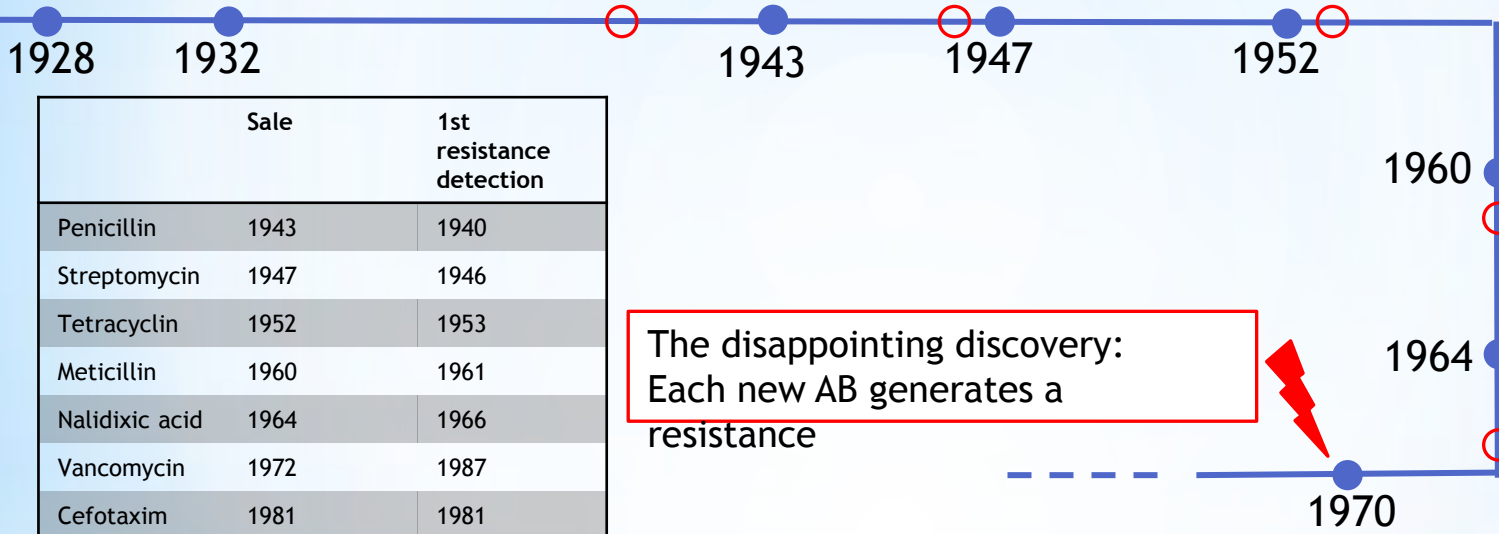


multiresistance



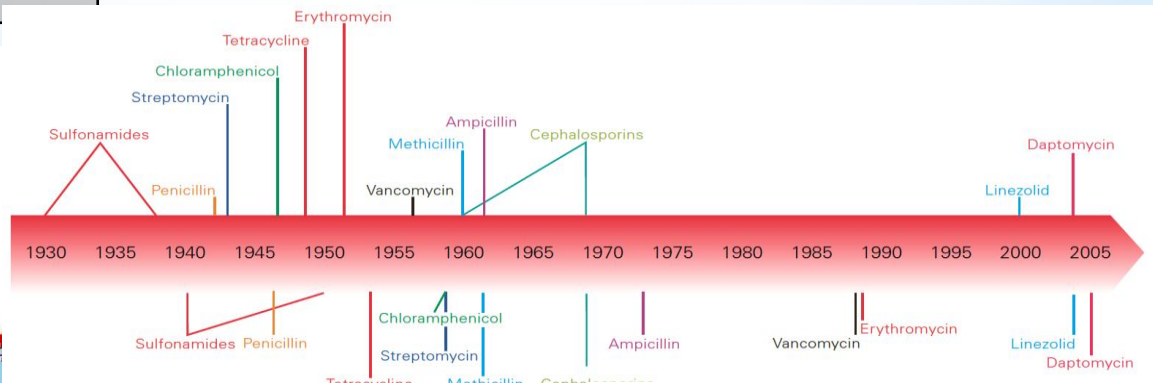
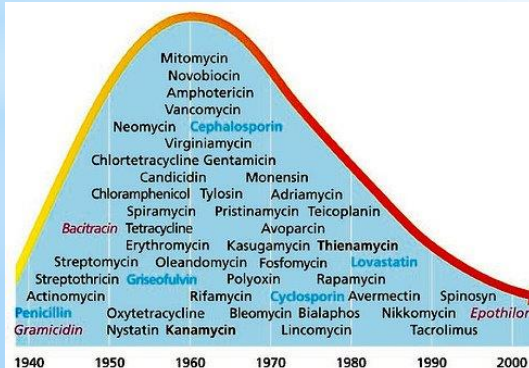
5.2. Quand et comment la bactérie devient-elle résistante

Penicillin
A. Flemming



	Sale	1st resistance detection
Penicillin	1943	1940
Streptomycin	1947	1946
Tetracyclin	1952	1953
Meticillin	1960	1961
Nalidixic acid	1964	1966
Vancomycin	1972	1987
Cefotaxim	1981	1981
Linezolid	2000	1999
Streptomycin	2003	1991

The disappointing discovery:
Each new AB generates a
resistance



Clatworthy et al. (2007); Nature Chemical Biology, Vol. 3].

Actually → Cephalosporin et Carbapenem: ESBL (BLSE) et CRE (ERC)

Bacteria become resistance by several ways including

- It is important to note that several antibiotics are produced by environmental microorganisms.
- In the recent years the proliferation of multi-resistant pathogens to conventional antibiotics and new antibiotic molecules such the last generation of beta lactamase, carbapenem-resistant and their resistance genes such as (*bla*_{TEM}, *bla*_{SHV}, *bla*_{CTX-M}, *bla*_{NDM}, Bla_{VIM}, Bla_{KPC}, Bla_{OXA} and *aadA*). **This can be explained by therapeutic application of antibiotic in medicine and veterinary.**
- **There is the correlation between environmental ATB concentration and bacterial resistance**
- **Aquatic environment is considered to be of special reservoir of resistance genes since it's recipient of bacteria from different sources.**

Horizontal Gene Transfer (HGT)



Mécanismes de transfert de gènes de résistance. [D'après «Horizontal gene transfer», Frolich (2006), Cours Microbiology, Community College of Rhode Island, modifié]

La prise d'antibiotique/utilisation excessive/abusive/sous-dosage d'antibiotique occasionnant la mutation ou acquisition de gènes résistance

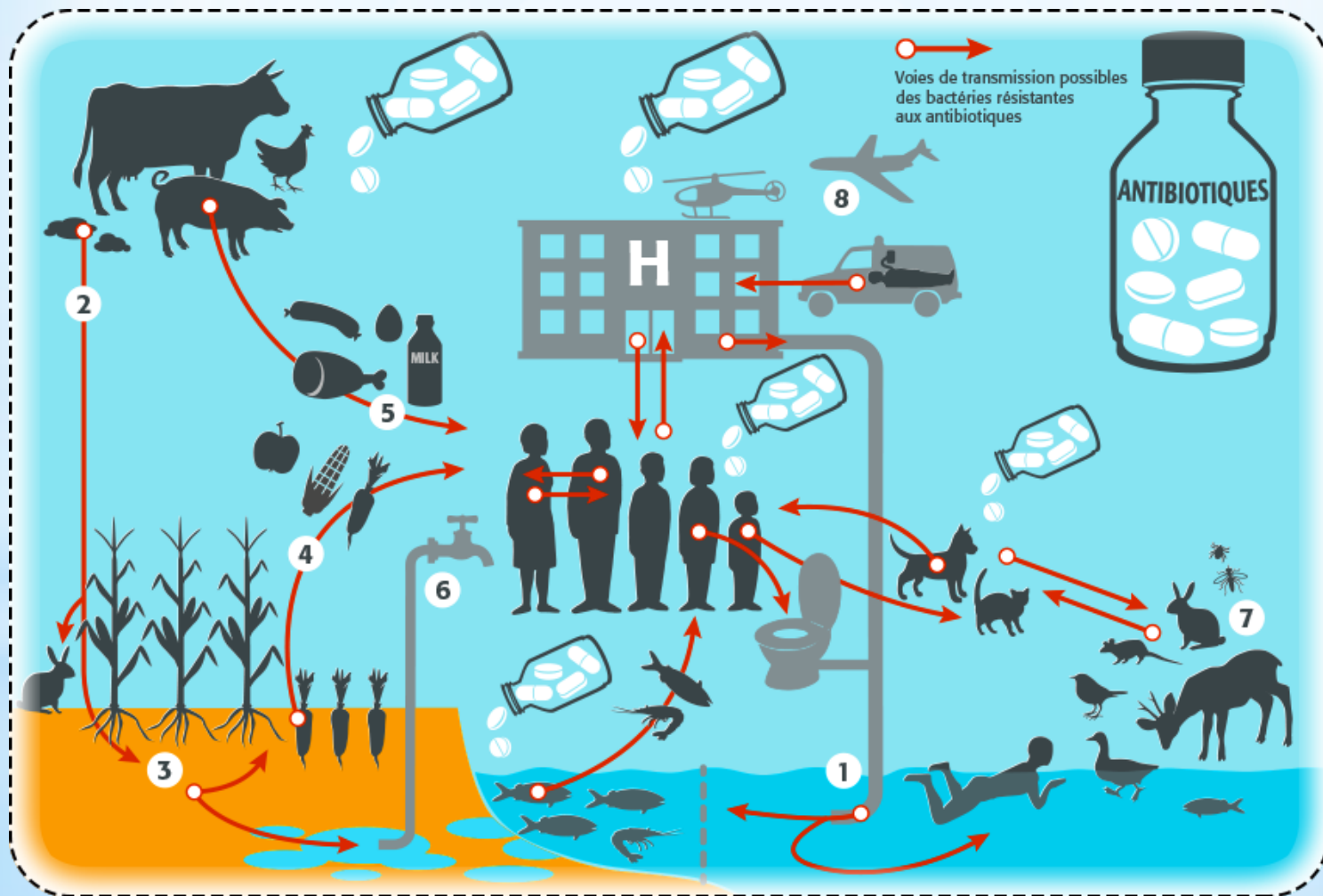
Les bactéries multirésistantes les plus inquiétantes sont les entérobactéries multirésistantes – les entérobactéries comme *Escherichia coli* et *Klebsiella pneumoniae* sont des bactéries du tube digestif responsables d'un très grand nombre d'infections; *les staphylocoques dorés résistants à la méthicilline, les bacilles tuberculeux multirésistants, ou encore le bacille pyocyanique et les Acinetobacter baumannii* qui sont, des bactéries infectant les poumons de personnes atteintes de mucoviscidose et qui sont responsables d'infections nosocomiales (acquises en milieu de soin de santé, en particulier les hôpitaux et les cliniques).

La résistance aux antibiotiques ne concerne pas seulement les bactéries pathogènes. Toutes bactérie à l'état de compétence peut acquérir les gènes de résistances. De plus, les bactéries résistantes et les gènes de résistance peuvent se transmettre entre l'homme, les animaux et l'environnement. Ainsi, l'utilisation d'antibiotiques en médecine, vétérinaire et le rejet d'antibiotiques dans l'environnement contribuent à l'apparition de nouvelles souches bactériennes multirésistantes.



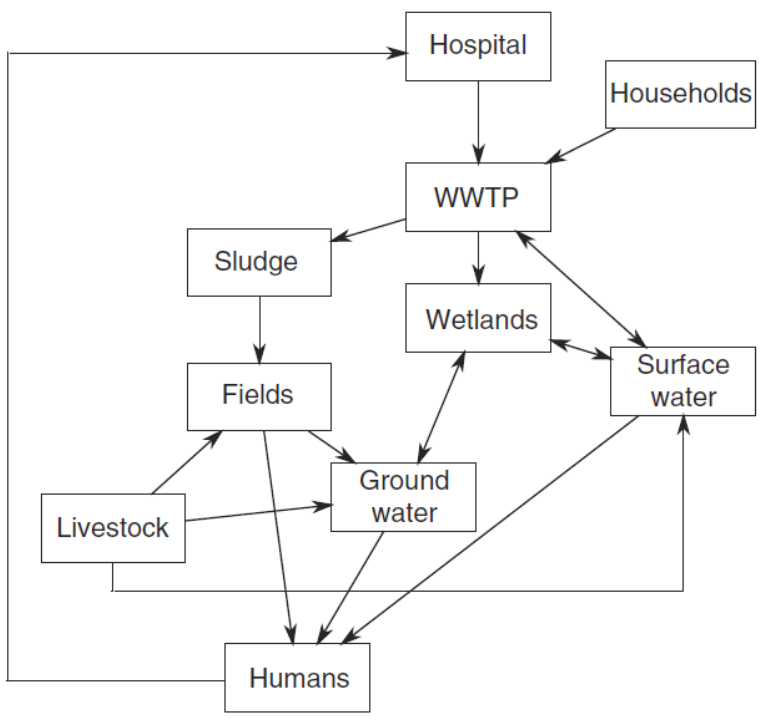
5.3. Dissémination des bactéries et gènes de résistance en milieux aquatique

The cause of transmission and the environmental proliferation of antibiotics and multi-resistant microbes are multiples and depend to the degree of the development of countries



➤ In developed countries

The technology of Waste Water Treatment Plant (WWTP) which receives the mixture of **effluent from hospitals** (urine and faeces from patients), **communities** (wastewater treatment system via people taking antibiotics from home), **animal farming and agricultural run-off**. The efficacy of WWTP can be considered a major point for antibiotics, antibiotic resistant bacteria (ARBs) and their genes (ARGs) for the aquatic environment



➤ In developing countries

The problem of ATB, ARB and ARG proliferation in non-clinical environment is considered as alarming for many reasons:

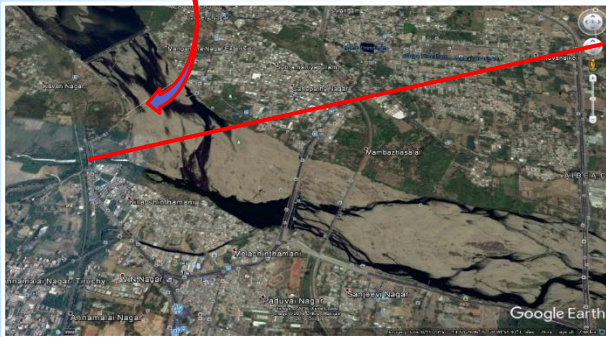
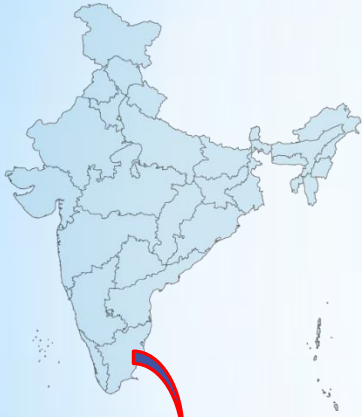
- No wastewater treatment
- The hospital effluents are discharged in receiving system without any previous treatment
- Open defecation
- No regulation of the prescription and use of antibiotics in human medicine and veterinary
- Use of contaminated water for irrigation and fresh produces

Congo DR



South of India

Impact of urban sewages in river receiving system : Trichy and Madurai (South India)



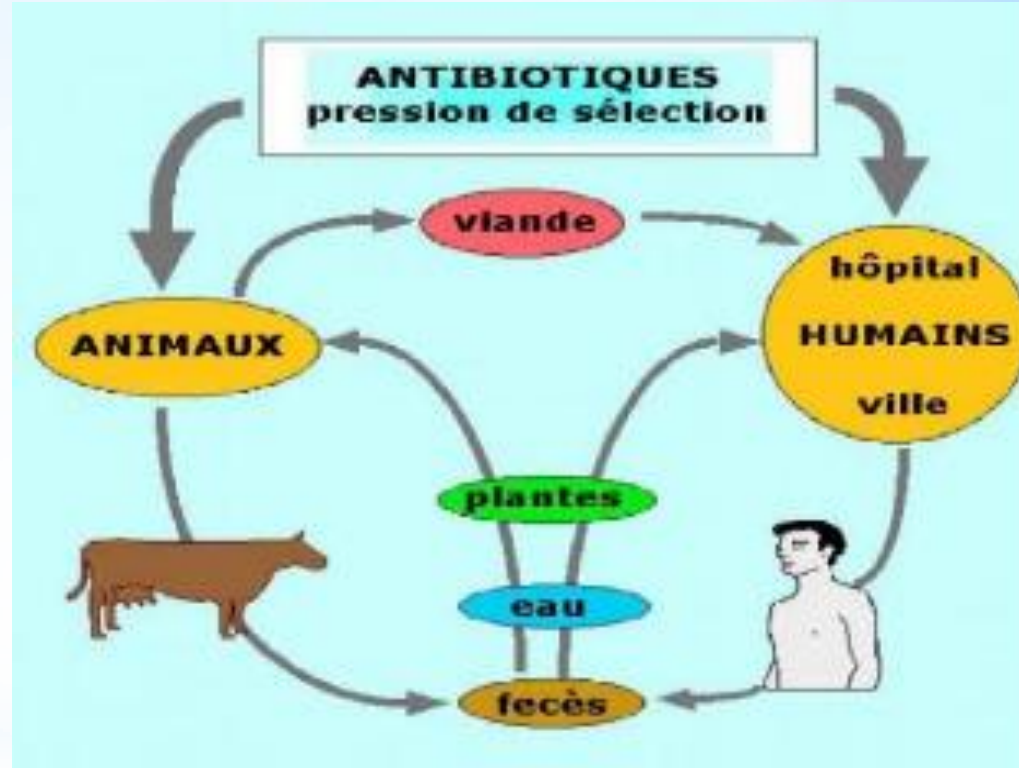
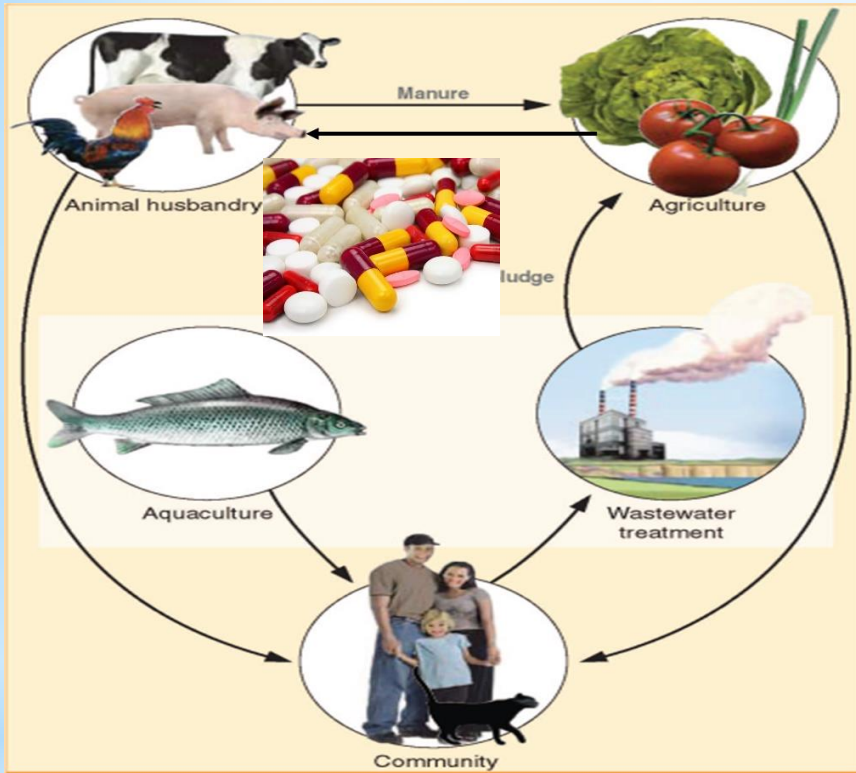
**Taking antibiotics
for colds and flu?**



There's no point.

*bla*_{NDM}

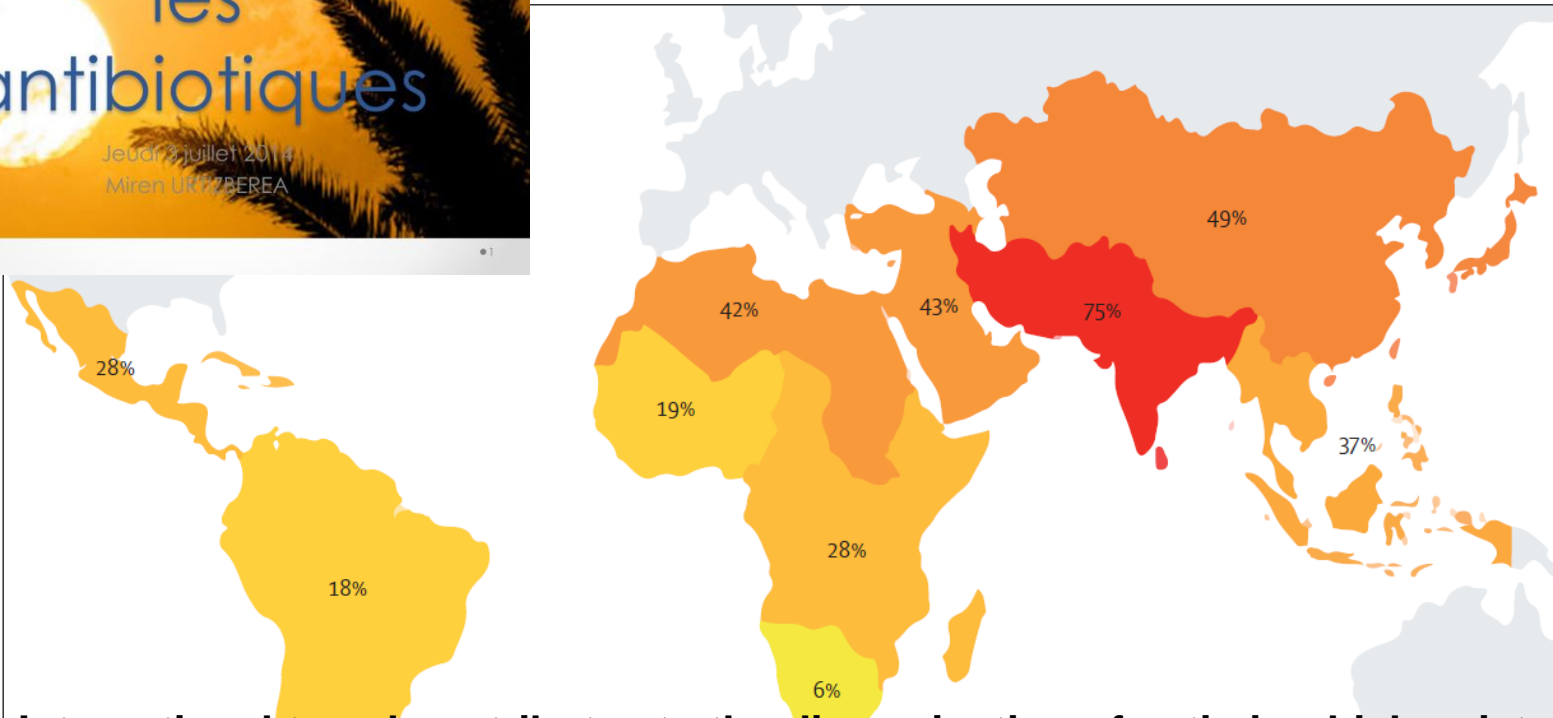
➤ Dissemination by contaminated and food habit



➤ Dissemination by travelers



Maris S Arcilla et al. Lancet Infect Dis 2017; 17: 78–85

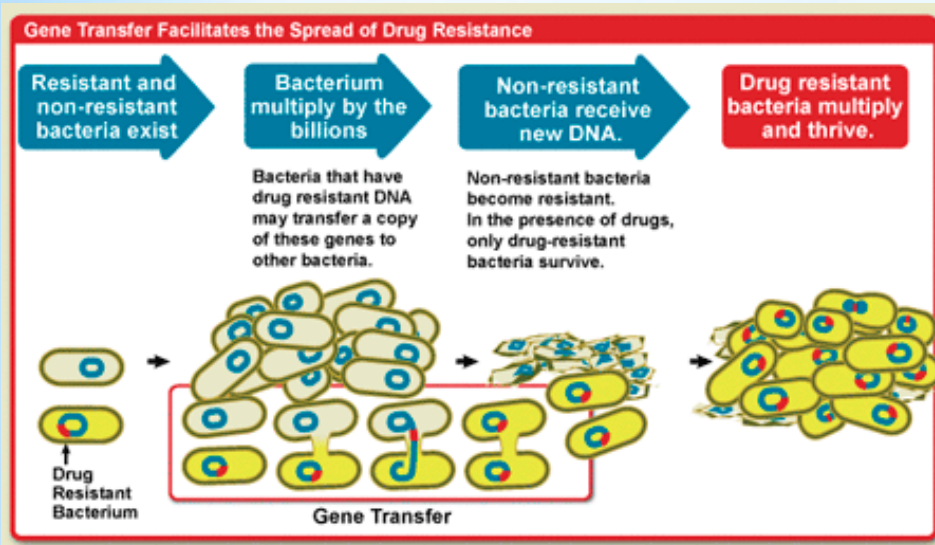


International travel contributes to the dissemination of antimicrobial resistance. Investigation of the acquisition of extended-spectrum β -lactamase-producing Enterobacteriaceae (ESBL-E) during international travel, with a focus on predictive factors for acquisition, duration of colonisation, and probability of onward transmission

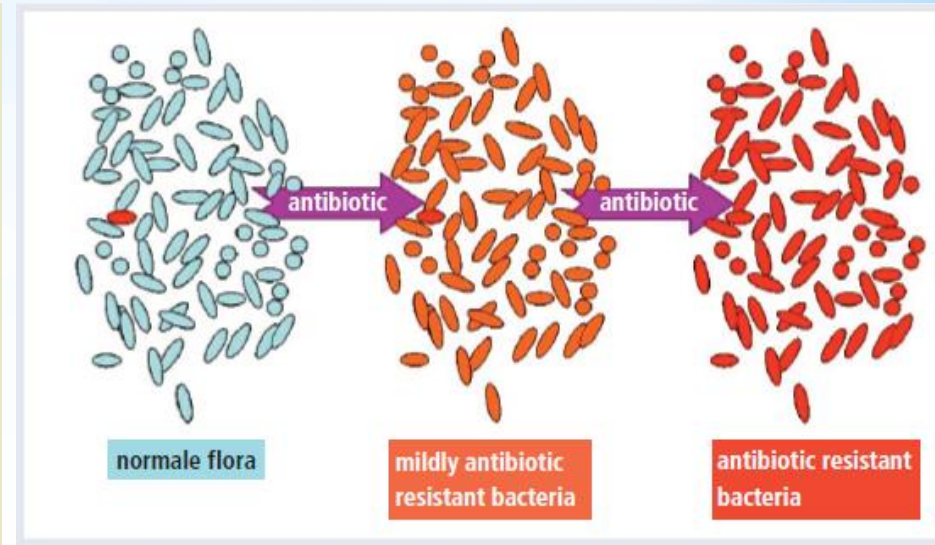
Figure 1: Percentages of travellers that acquired β -lactamase-producing Enterobacteriaceae per subregion, according to the United Nations geoscheme

5.4. Potential impacts

➤ Horizontal Gene Transfer (HGT) in environment

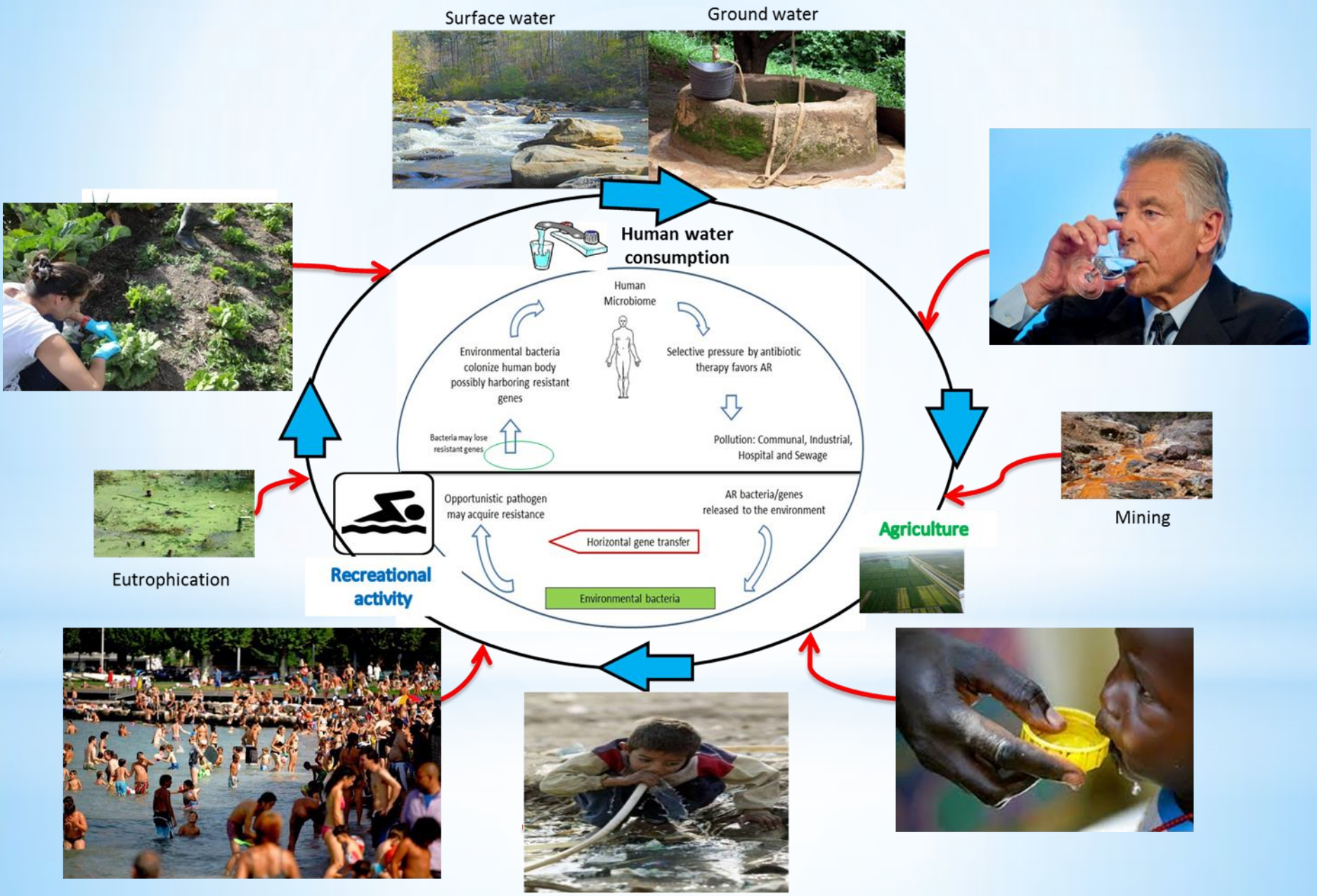


<https://www.quora.com/topic/Antibiotic-Resistance>



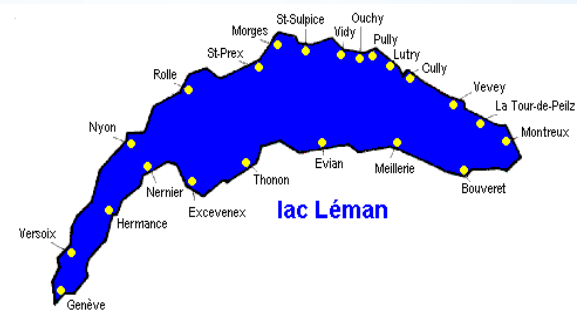
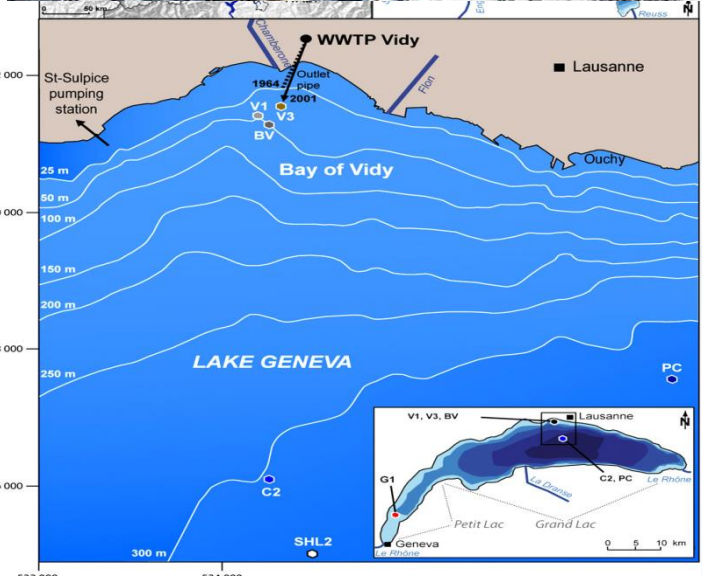
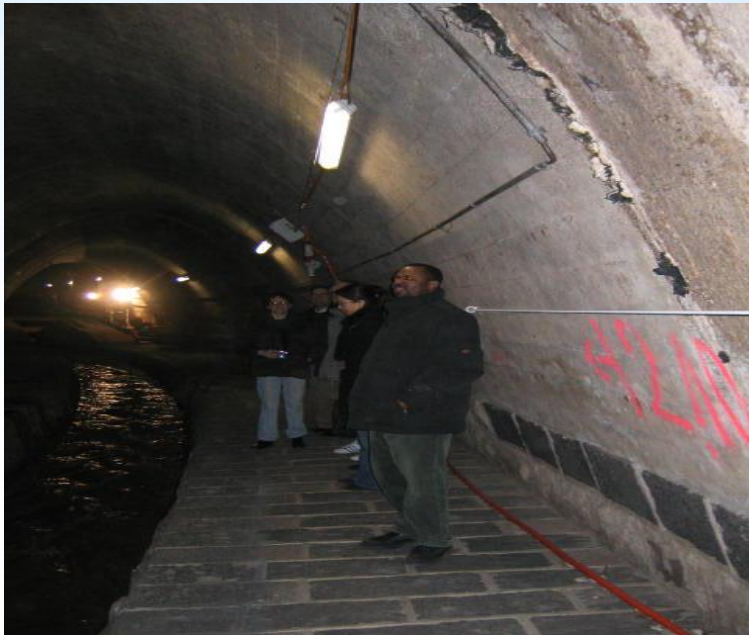
Horizontal gene transfer (HGT) between bacteria events are likely to be common in aquatic environments; integrons in particular are well suited for mediating environmental dissemination and proliferation of ARB and ARGs

➤ The return to the food and human chains

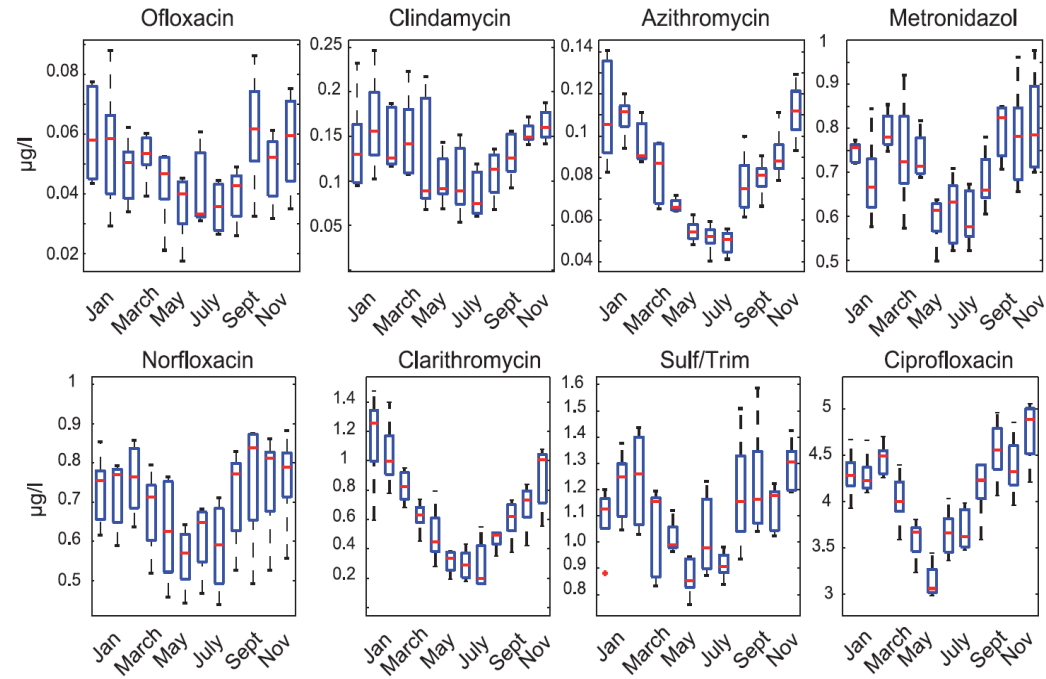
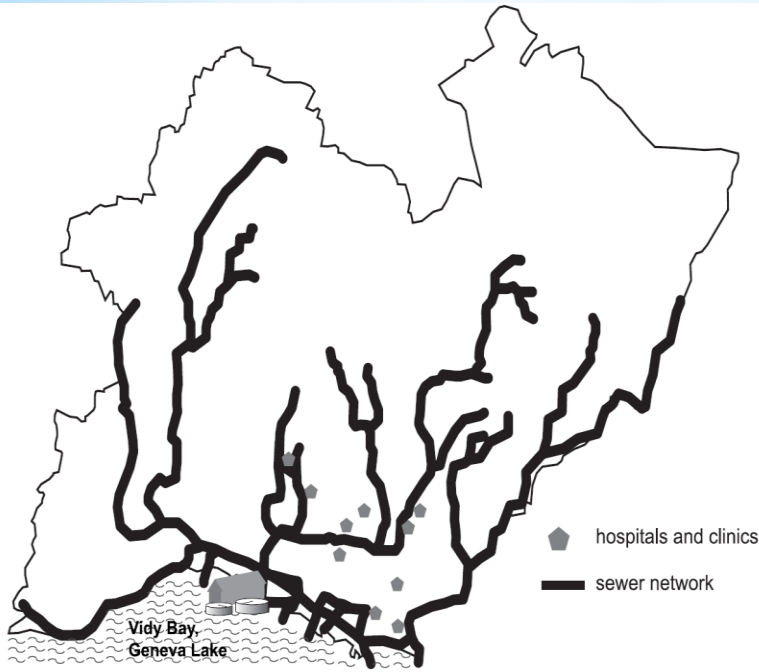


5.5. Case of Geneva Lake

Vidy Bay Lausanne

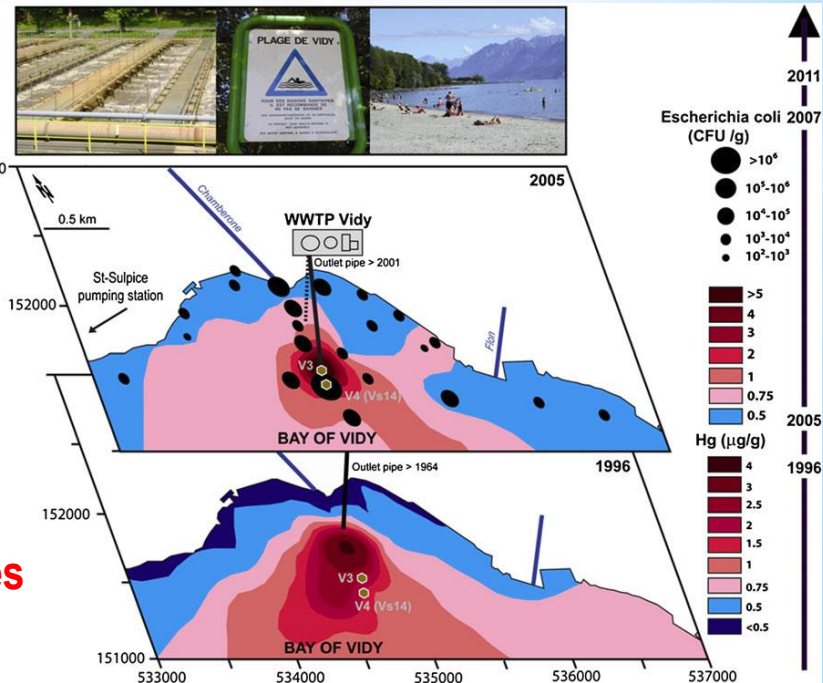
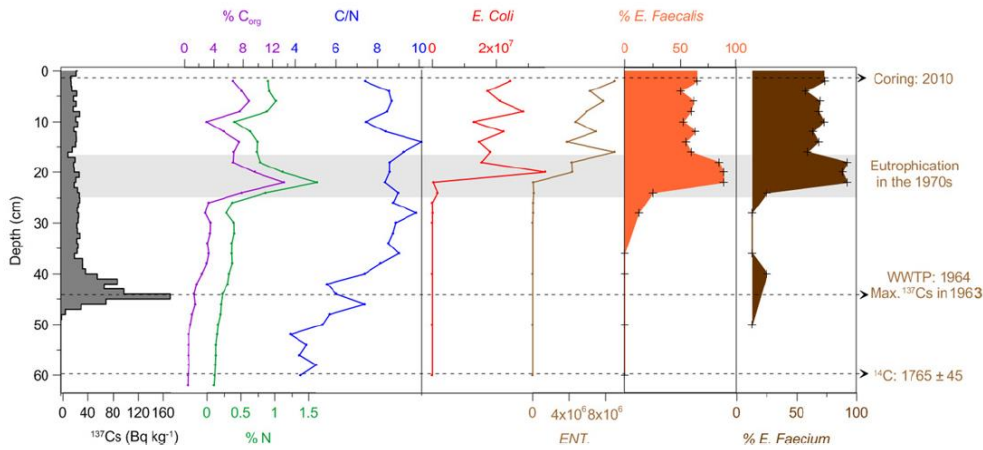
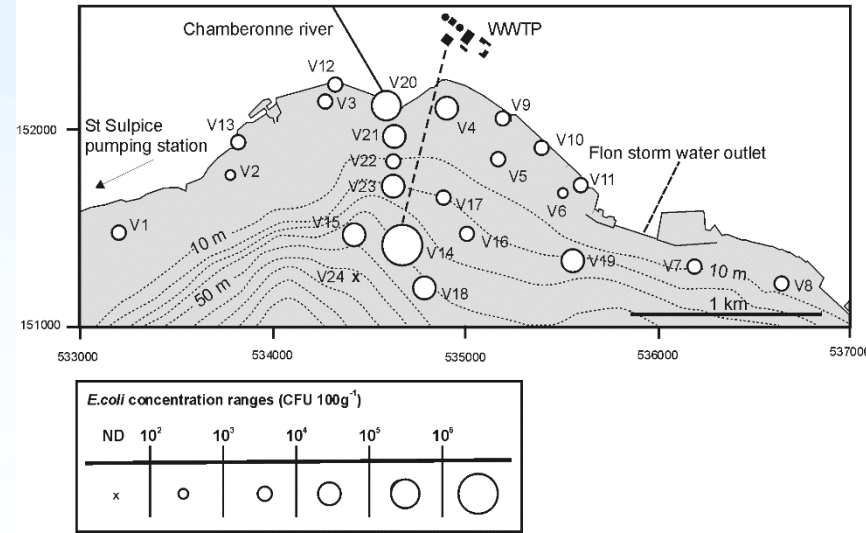
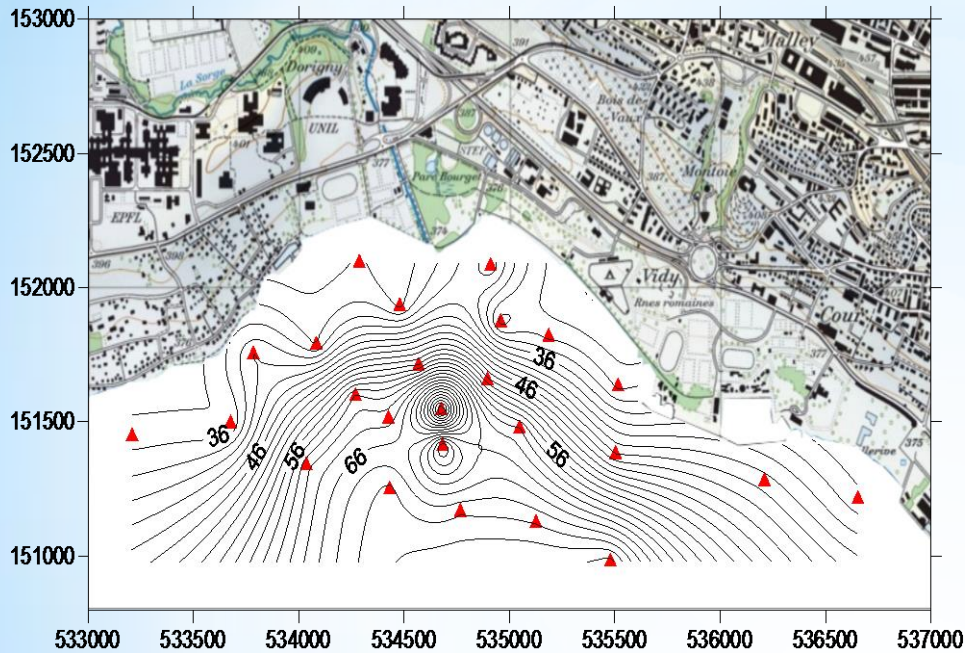


➤ Antibiotics Fluxes in Vidy Bay



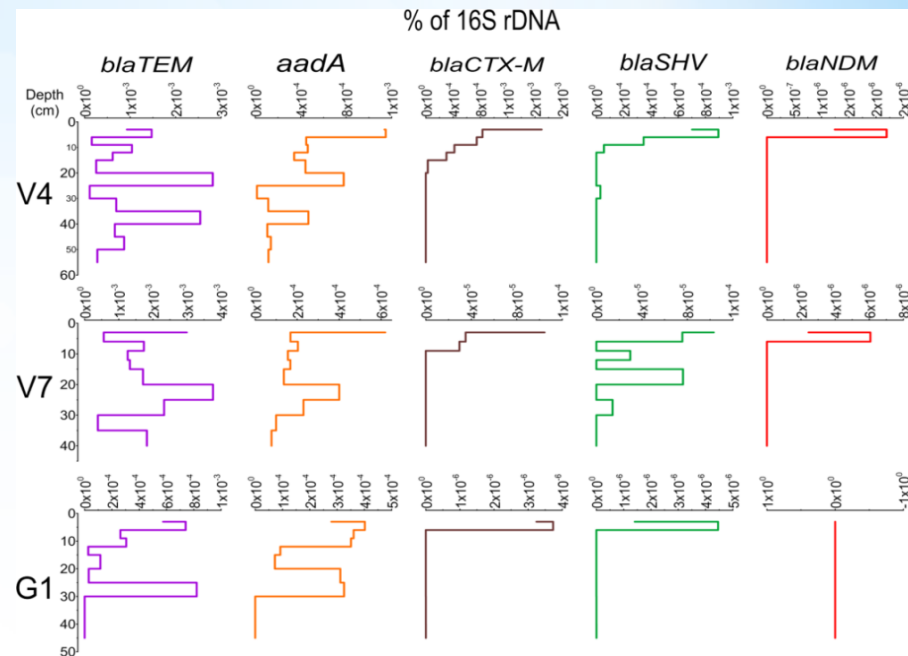
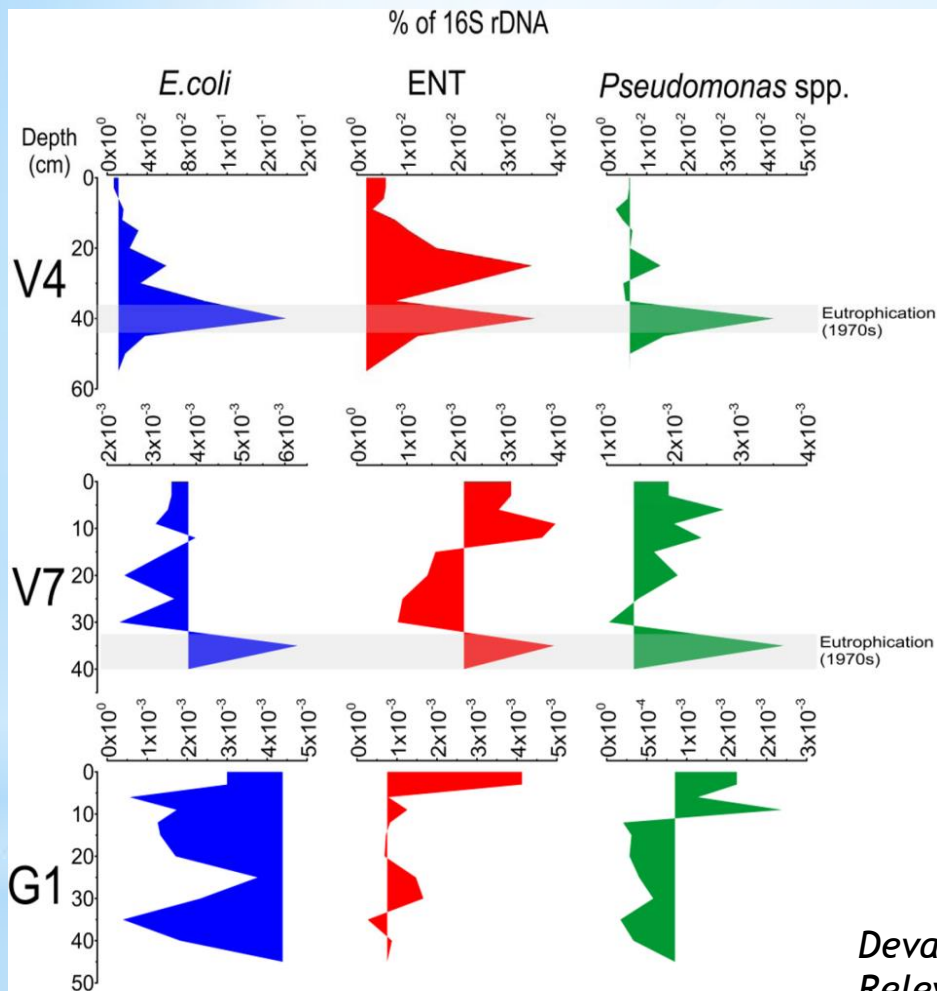
Investigation of seasonality of antibiotic concentrations in wastewater, with respect to WWTP network and hospital CHUV consumption . The study revealed important facts regarding antibiotic consumption as a source of environmental pollution.

➤ Pathogens distribution in water and surface sediments



92% of human bacteroides

➤ Clinically Bacteria and ARG resistant β -lactam genes dissemination

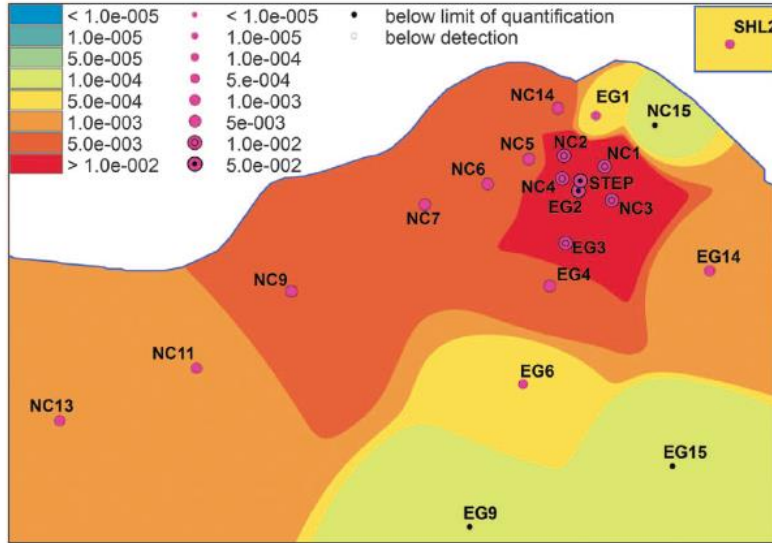


ENVIRONMENTAL
Science & Technology

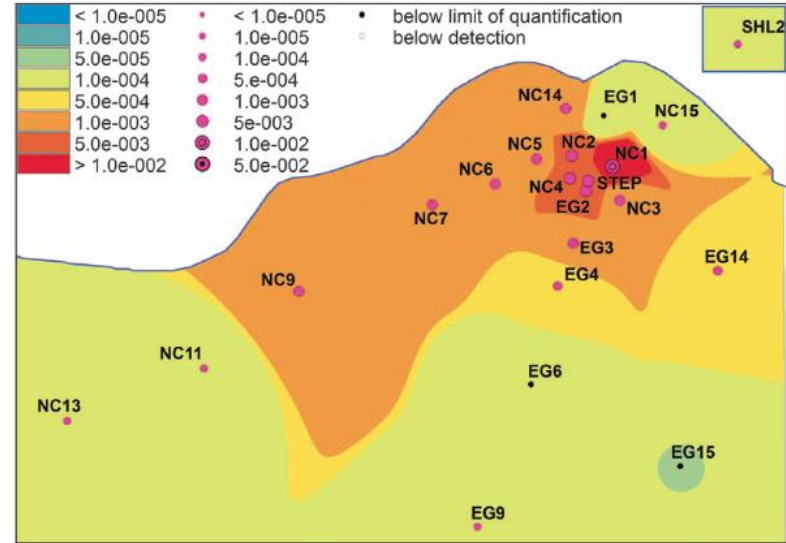
Devarajan,....Poté, 2015. Accumulation of Clinically Relevant Antibiotic-Resistance Genes, Bacterial Load, and Metals in Freshwater Lake Sediments in Central Europe

➤ Other antibiotic genes dissemination in sediment of Vidy Bay

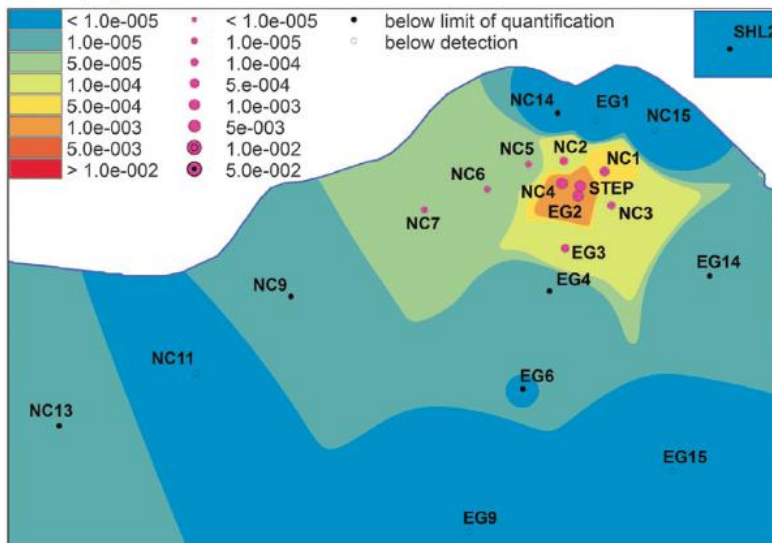
a *sul1*



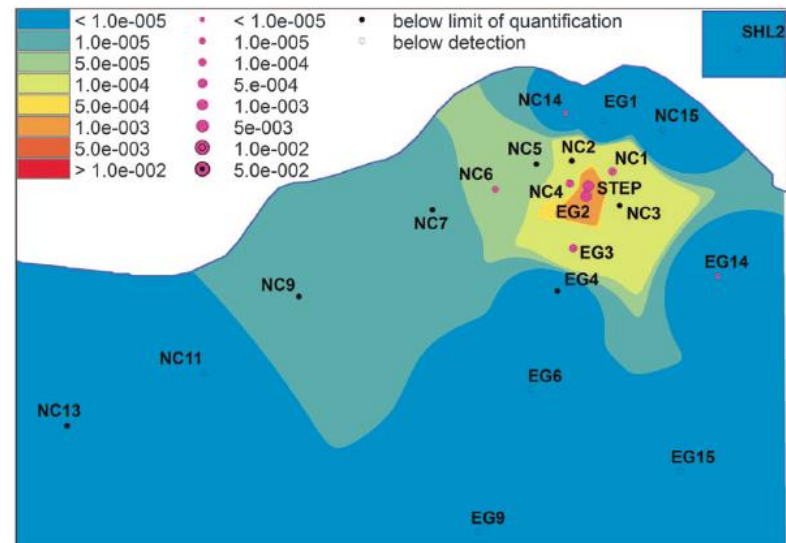
b *sul2*



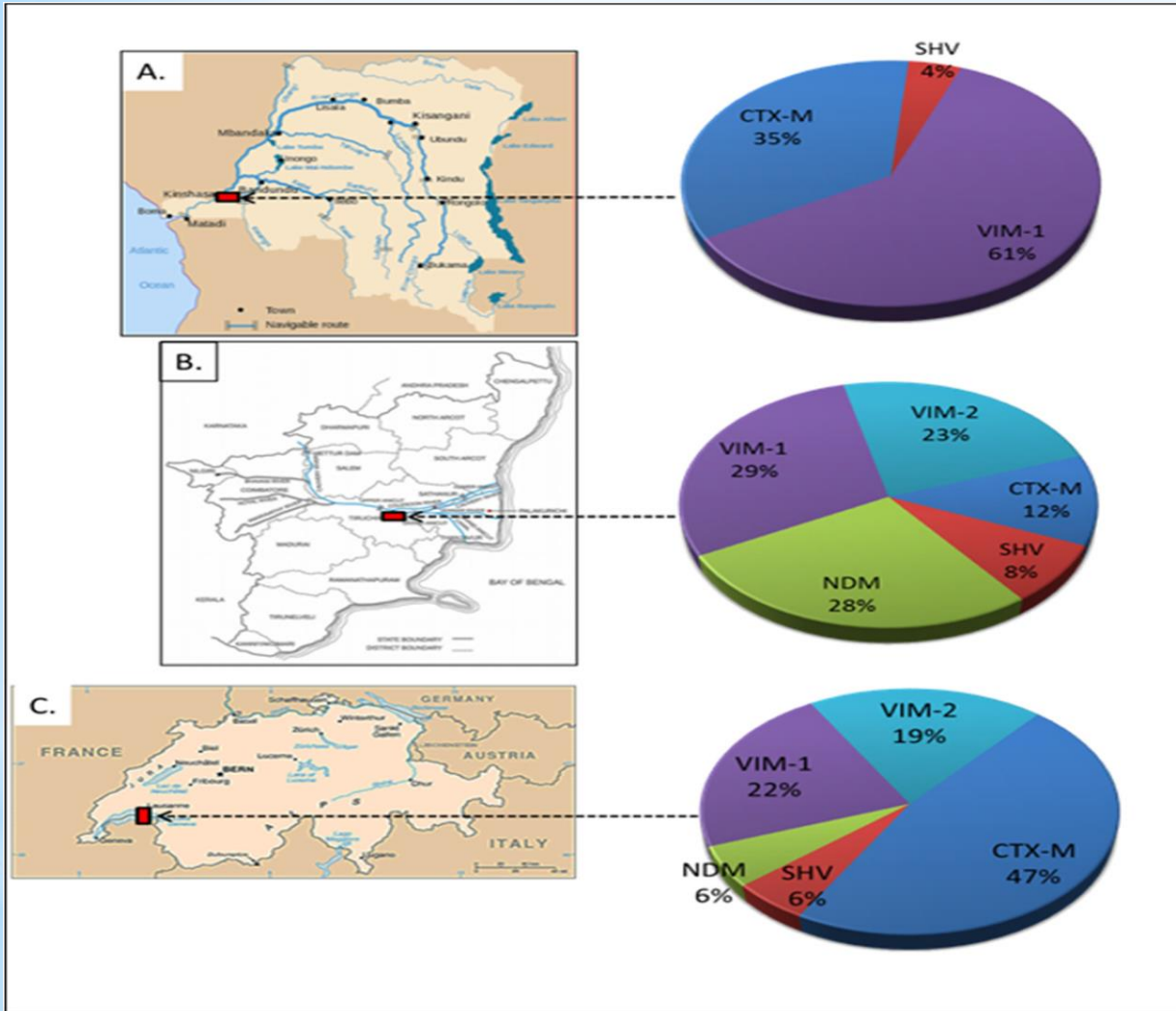
c *tet(W)*



d *tet(M)*

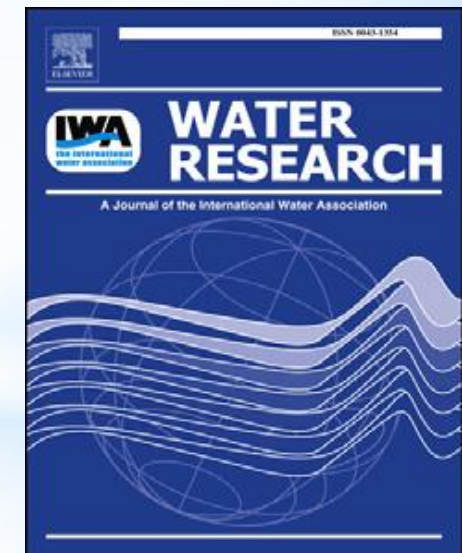


➤ Comparison Geneva and tropical conditions



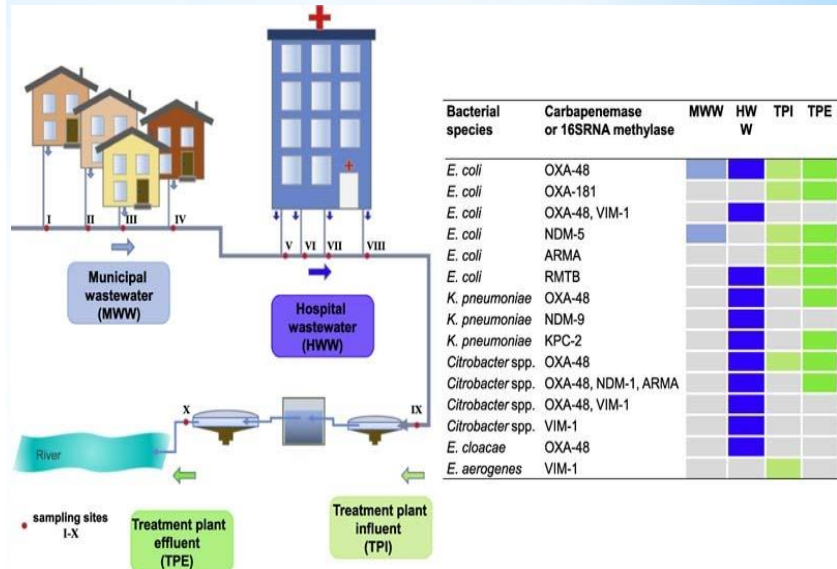
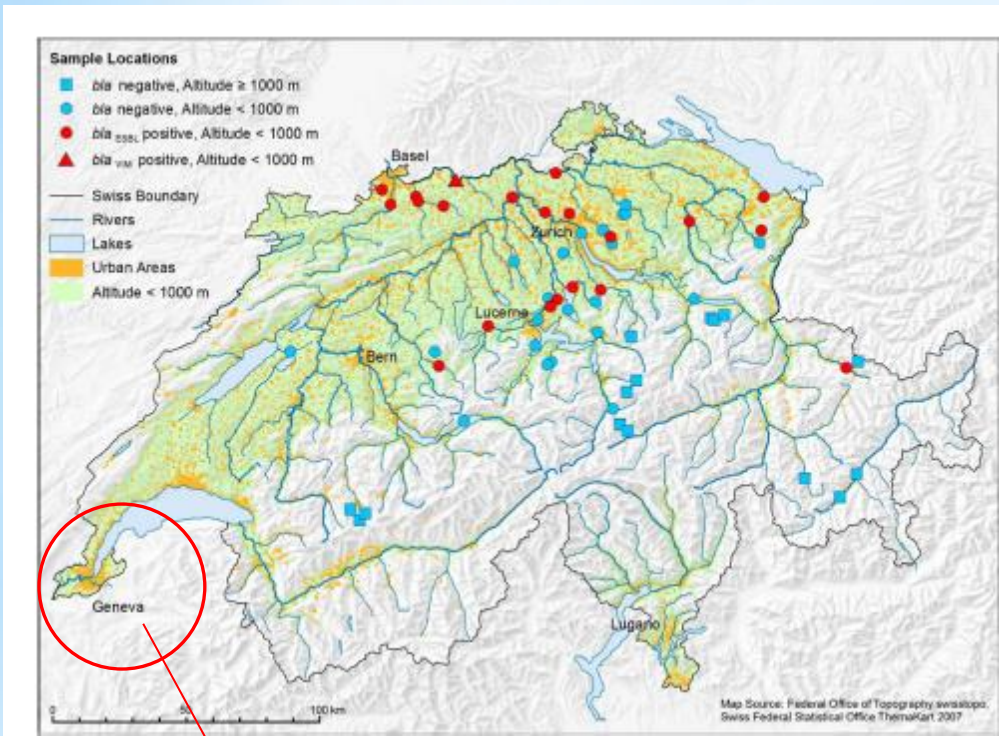
Antibiotic resistance against *Pseudomonas*

India	35-60%
Congo	18-50%
CH	12-54%



Devarajan....Poté, 2017. Antibiotic resistant *Pseudomonas* spp. in the aquatic environment: A prevalence study under tropical and temperate climate conditions. *Water Research* 115 (2017) 256-265

5.6. Epidemiology of ESBL and CRE in Geneva Lake



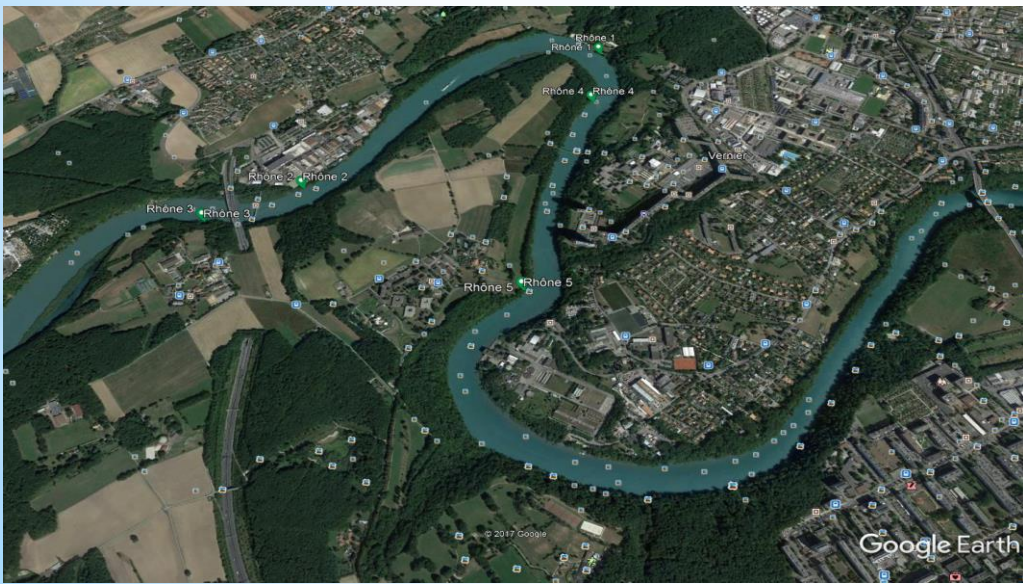
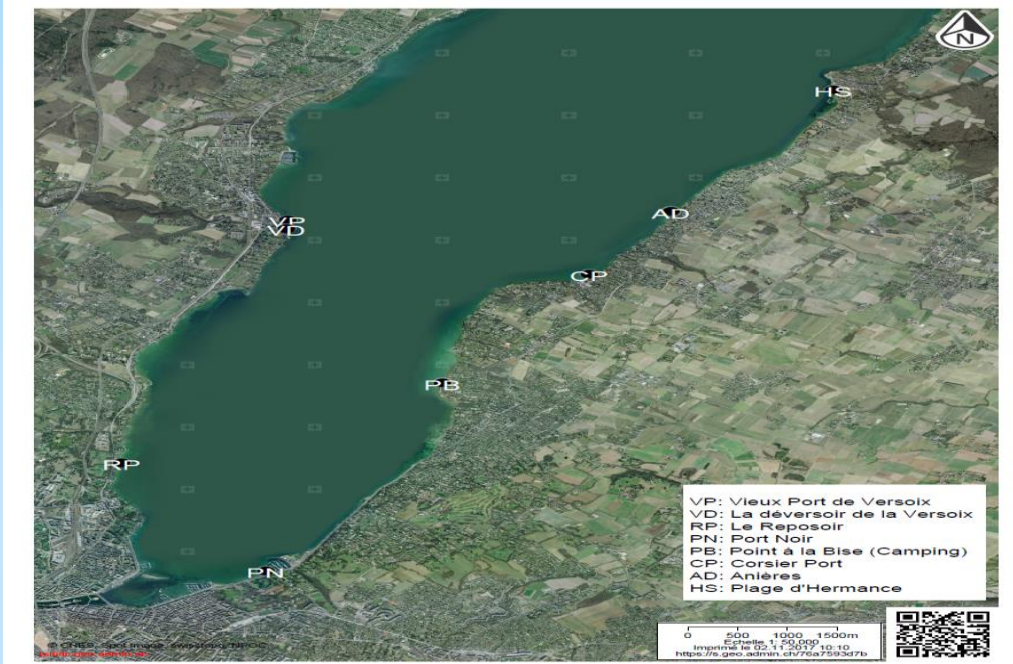
Zurfluh et al., 2017

No Quantitative data is available in Geneva canton

Zurfluh et al., 2013

Geneva, a cosmopolitan city with a foreign population of 40% provides a business friendly government and an outstanding quality of living.

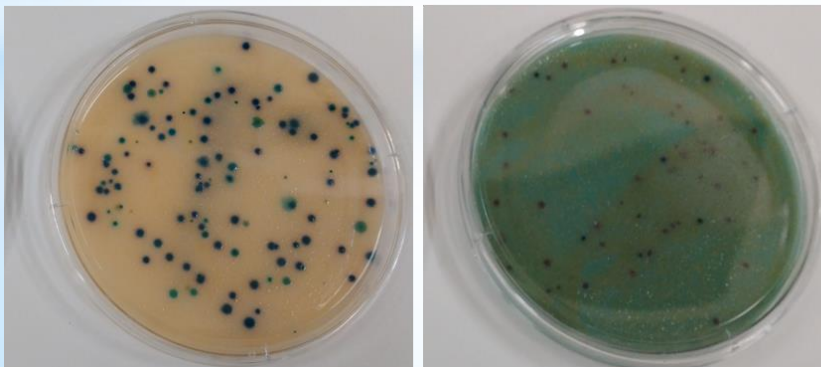
➤ Perspective study in Geneva beaches and Rhône



5.7. Potential Solution

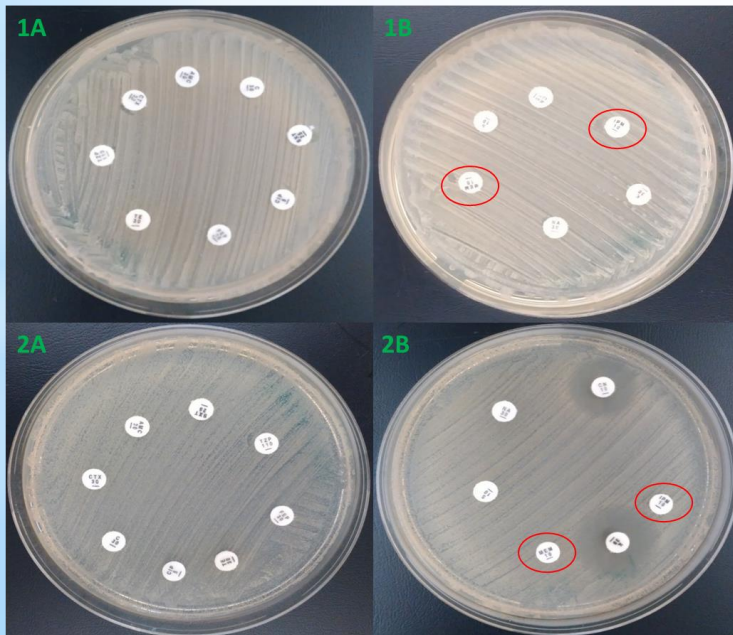
There is very difficult to find appropriate solutions. Here we can give some hypothesis:

- Performing with research in different sittings
- Acquisition of quantitative data on the dissemination of antibiotic and antibiotic resistance according to the geographical location
- Regulation of the use of antibiotics in therapeutic: Clinical and veterinary
- Reduction of these biological contaminants and optimization of waste water treatment plants
- Education and sensibilisation in developing countries



Bacterial isolates
FIB characterization
Susceptibility tests
Total DNA extraction
16S rRNA integrin class
Sequencing

The epidemiology of antibiotic resistant in non-clinical environment is for these two last decades considered as worldly alarming problem. About 25000 persons die each year in EU and more than million in developing countries. The situation can be localized, but the effects and consequences are global !! We must act now !!!!



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THANK YOU