



# Impact of meteorological conditions on the Thau lagoon's shellfish farming area

O. Serais<sup>1\*</sup>, I. Amouroux<sup>2</sup>, V. Derolez<sup>1\*\*</sup>

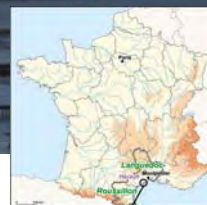
<sup>1</sup>Ifremer, Sète, France, <sup>2</sup>Ifremer, Nantes, France, <sup>3</sup>Ifremer, La Tremblade, France

\* oserais@ifremer.fr

\*\* vderolez@ifremer.fr

## Introduction

With 750 producers, 2750 tables for breeding, 13 000 tons of oysters and 2 500 tons of mussels marketed every year, the shellfish production of the Thau lagoon represents at least 10 % of the national French production and a direct turnover of 33 millions € (Rey Valette, 2004). The Thau lagoon is a semi-enclosed coastal system sensitive to faecal inputs from the watershed (280 km<sup>2</sup>). In June 2004, the Authorities classified the Thau lagoon as a « class B » area, from which live bivalve molluscs can be marketed for human consumption only after depuration. Until then, shellfish used to be collected for direct human consumption. The sanitary monitoring of the Thau lagoon shellfish growing area is conducted by the Ifremer french microbiological monitoring network for shellfish harvesting areas (Remi). The aim of the study is to determine the evolution of microbiological quality of the Thau lagoon's shellfish and the impact of meteorological conditions, with an analysis of Remi data collected during a 10 years period.



## Materials and Methods



✓ Between January 1997 and December 2006, 2 408 oysters and mussels were sampled from 9 spots in the Thau lagoon (Fig.1). Independantly from meteorological conditions, sampling was carried out every two weeks from 1997 to 1999 and monthly from 2000 to 2006. Additional samples were collected after detected pollutions and at moments of risk.

✓ *Escherichia coli* (*E.coli*) levels were determined in each sample of live bivalve mollusc using an impedancemetric method.

✓ The Meteo France rain gauge located in Sète provided daily rainfall data. A 48 hours cumulated rainfall was used to analyze the impact of rainfall on *E. coli* levels (*E. coli*/100 g Flesh and Intravalvular Liquid (F.I.L.) ).

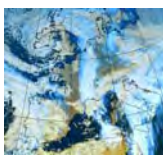


Figure 1. Sampling locations in the Thau lagoon.

## Results and discussion

### Microbiological quality of the Thau lagoon's shellfish evolution between 1997 & 2006 (regular monitoring Remi data)

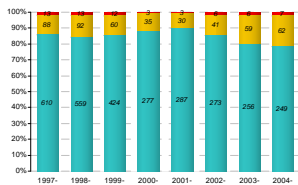


Figure 2. Distribution of *E. coli* levels in Thau shellfish sampled in the REMI network from 1997 to 2006 (regular monitoring).

■ Results > 4 600 *E.coli*/100g of F.L.I.  
■ Results [230 - 4 600] *E.coli*/100g of F.L.I.  
■ Results < 230 *E.coli*/100g of F.L.I.

For all the three year running periods between 1997 and 2006, the Thau lagoon's shellfish microbiological quality of the harvesting area has been « B », according to the European Union Regulation (Fig. 2). Some shellfish samples from the regular monitoring exceeded the health standard of 230 *E.coli*/100 g of F.I.L. (max = 21.7% (2004-2006), min = 10.3% (2001-2003)) and less than 10 % of the results exceeded 4600 *E.coli*/100 g of F.I.L. (max = 2.4% (1999-2002), min = 0.9% (2001-2003)).

### Impact of the meteorological conditions on the Thau lagoon's shellfish (regular and alert monitoring Remi data)

Between 1997 and 2006, respectively 63 and 37% of the two days consecutive periods are characterized by dry weather and rainfall conditions (Fig. 5). Though the microbiological quality of the lagoon's shellfish can episodically be altered by the two meteorological sets of conditions (Fig. 6), rainfall causes a statistically significant increase of *E. coli* levels in shellfish (W Mann-Whitney test on medians, p=1,79656E-12).

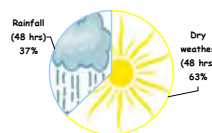


Figure 5. Percentage of 48 hours cumulated of dry weather conditions and rainfall (> 0.1 mm) in Sète between 1997 and 2006.

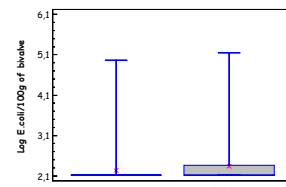


Figure 6. Log<sub>10</sub> *E. coli* levels in Thau lagoon's shellfish sampled in dry weather conditions and after 48 hours rainfall (> 0.1 mm in Sète), between 1997 and 2006.

2<sup>nd</sup> Thau quality contract => 13.6 M€ to work on sanitary sewage networks (10 M€) waste water pumping stations (3.6M€) 1996 2001

3<sup>rd</sup> Thau quality contract => 44.8 M€ to work on sanitary sewage networks (35 M€) waste water pumping stations (8.8 M€) individual wastewater treatments (1M€) 2004 2009



Figure 3. Investments on wastewater treatment systems on the Thau lagoon watershed realised during the second and third Quality contrat (municipalities on Thau watershed).

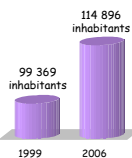


Figure 4. The Thau lagoon watershed population in 1999 and 2006 (INSEE data).

Between 1999 and 2006, the population increasing rate was of 13.5% on the Thau lagoon watershed (Fig. 3). In this period, large investments were realised by stakeholders on the watershed to improve wastewater treatment systems (Fig. 4), so that the microbiological shellfish quality remains stable (Mann-Kendall test, p=0.561).

Faecal contamination frequency in shellfish is related to the rainfall intensity (Fig. 7). In dry weather conditions, 16.8% of the results exceeded the health standard of 230 *E. coli*/100 g of F.I.L., compared to 50 % after more than 40 mm rainfall. In dry weather or after a small rainfall (< 10 mm), we got no significantly different results.

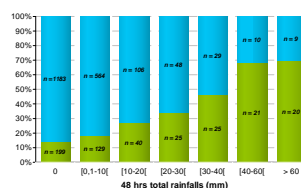


Figure 7. Distribution of *E. coli* levels in shellfish from Thau, sampled in dry weather conditions and after 48 hours of rainfall, between 1996 and 2006



Under Mediterranean climate, rainfall events are sudden and intense, they affect small coastal river flows which can abruptly surge from almost drought to flood regimes, and then convey the faecal pollution from the watersheds. Consecutively to high rainfall events, shellfish from the Thau lagoon have been involved in foodborne disease outbreaks caused by viral pathogens (2006, 2009).

## Conclusion

Data collected between 1997 and 2006 by the French monitoring network indicate that the Thau lagoon's shellfish quality meets the « class B » area standards (EU regulation), leading shellfish farmers to depurate their production before marketing it.

Our results showed that a 48 hours cumulated rainfall increases the Thau lagoon's shellfish microbiological contamination levels. However, high faecal pollution levels are frequently observed in dry weather conditions too. These microbiological contaminations lead the administrative authorities to take restrictive measures such as temporary marketing prohibitions. Consecutively to pollutions, Thau lagoon's shellfish have been involved in several Foodborne Disease Outbreaks.

In 2007, local authorities, shellfish farmers, scientists and engineering offices started a 3 years program (OMEGA Thau project) which aims at providing a management tool to help decision making for works on watershed considering the impact of each pollution source on the water and shellfish microbiological quality (Cesmat et al., 2009 - porter n°9.15). Work program on wastewater treatment systems needs to take in account the high population increasing rate on the watershed.

## References

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## Acknowledgment

