

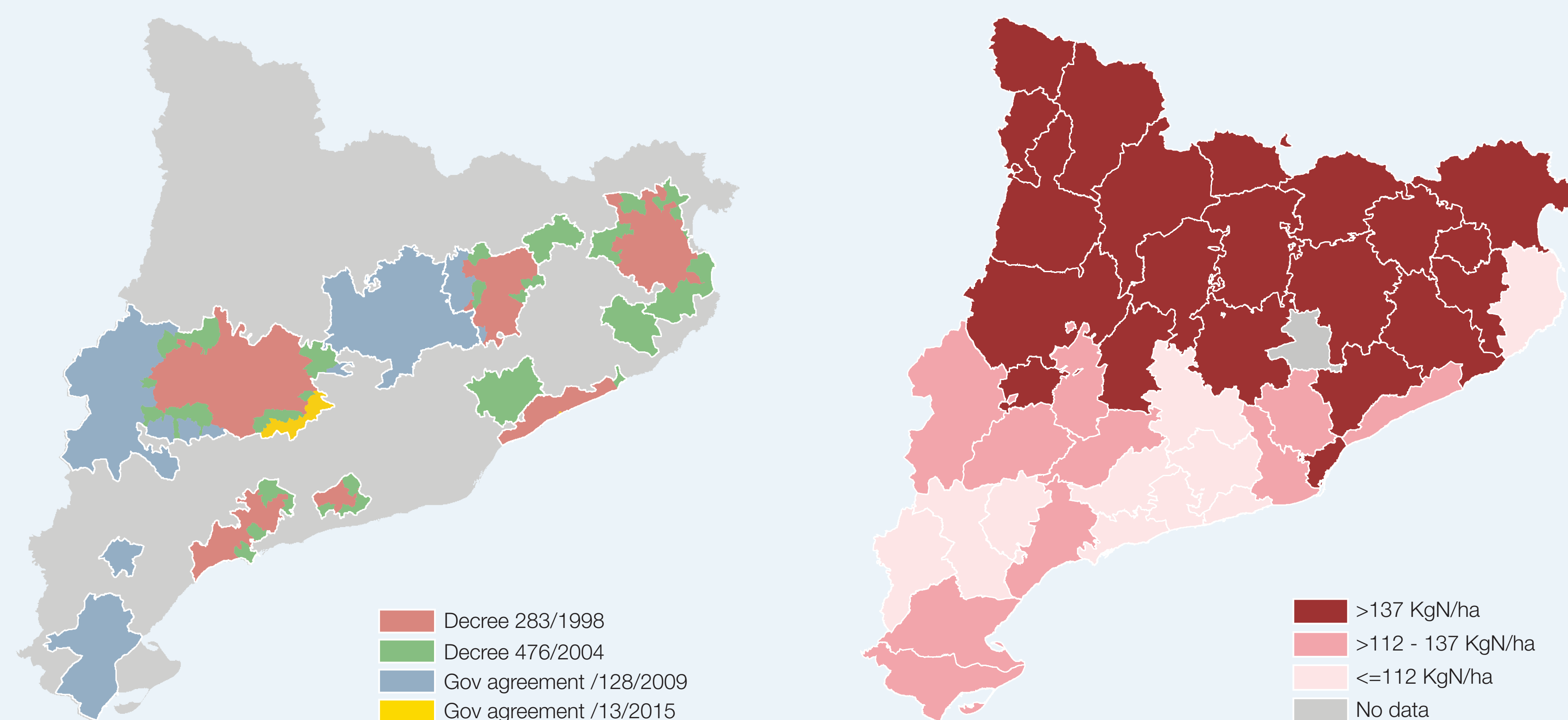
# INTEGRATION OF HYDROGEOLOGICAL AND MULTI-ISOTOPIC ANALYSIS TOGETHER WITH SPECIFIC MICROBIOLOGICAL MARKERS FOR NITRATES SOURCE IDENTIFICATION

The Catalan Water Agency (ACA) is the Catalan government's public company in charge of water planning and management. In accordance with the Water Framework Directive, environmental regulations and territorial issues, the ACA promotes the development of scientific and technical studies in order to improve problem awareness and water management.

## PRESSURES

The presence of nitrogenous compounds, especially nitrates, is the most important problem of diffuse groundwater pollution in Catalonia (NE of Spain). Moreover, nitrate is the main responsible for the bad status of groundwater bodies, and affects also surface water bodies. The vulnerable zones

occupy 34% of the Catalan territory and affect 45% of the Catalan municipalities. Nitrate sources in the environment can be diverse, nevertheless, its occurrence is mainly attributed to agricultural and livestock activity such as the application of nitrate and ammoniacal fertilizers and manure fertilization.



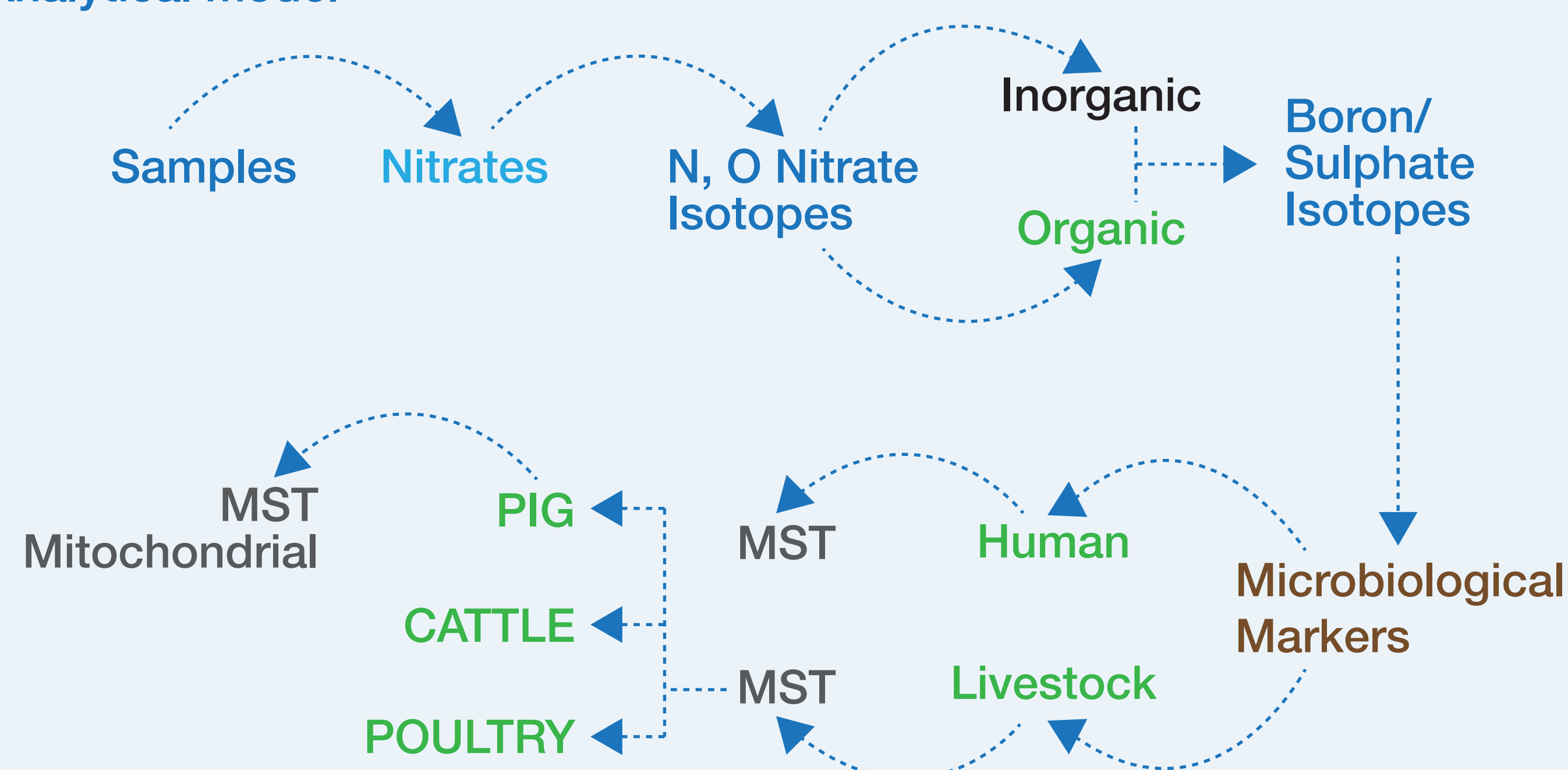
## OBJECTIVES

Due to the multiple origin of pollution, the Catalan Water Agency, the University of Barcelona and the consulting company Geoservei Projectes i Gestió Ambiental SL have developed a multidisciplinary study in order to determine the source of nitrates in specific areas of Catalonia. **The ultimate goal of this study is to accomplish requirements of the Nitrates Directive (91/676/CEE) and the Water Framework Directive (2000/60/CE) by setting a suitable programme of measures that will take into account the origin of pollution.**

## METHODOLOGY

The study has included a total of 205 samples (groundwater, surface water and urban wastewater treatment plants effluents). The methodology comprised a hydrogeological characterization taking into consideration aquifers vulnerability, as well as a hydrochemical and agronomic characterization, multi-isotopic analyses of dissolved nitrate, sulphate and boron and the detection of microbiological markers (HMBiP, Pig2Bac, CwBif, PLBif) by using molecular quantitative methods (q-PCR).

### Analytical model



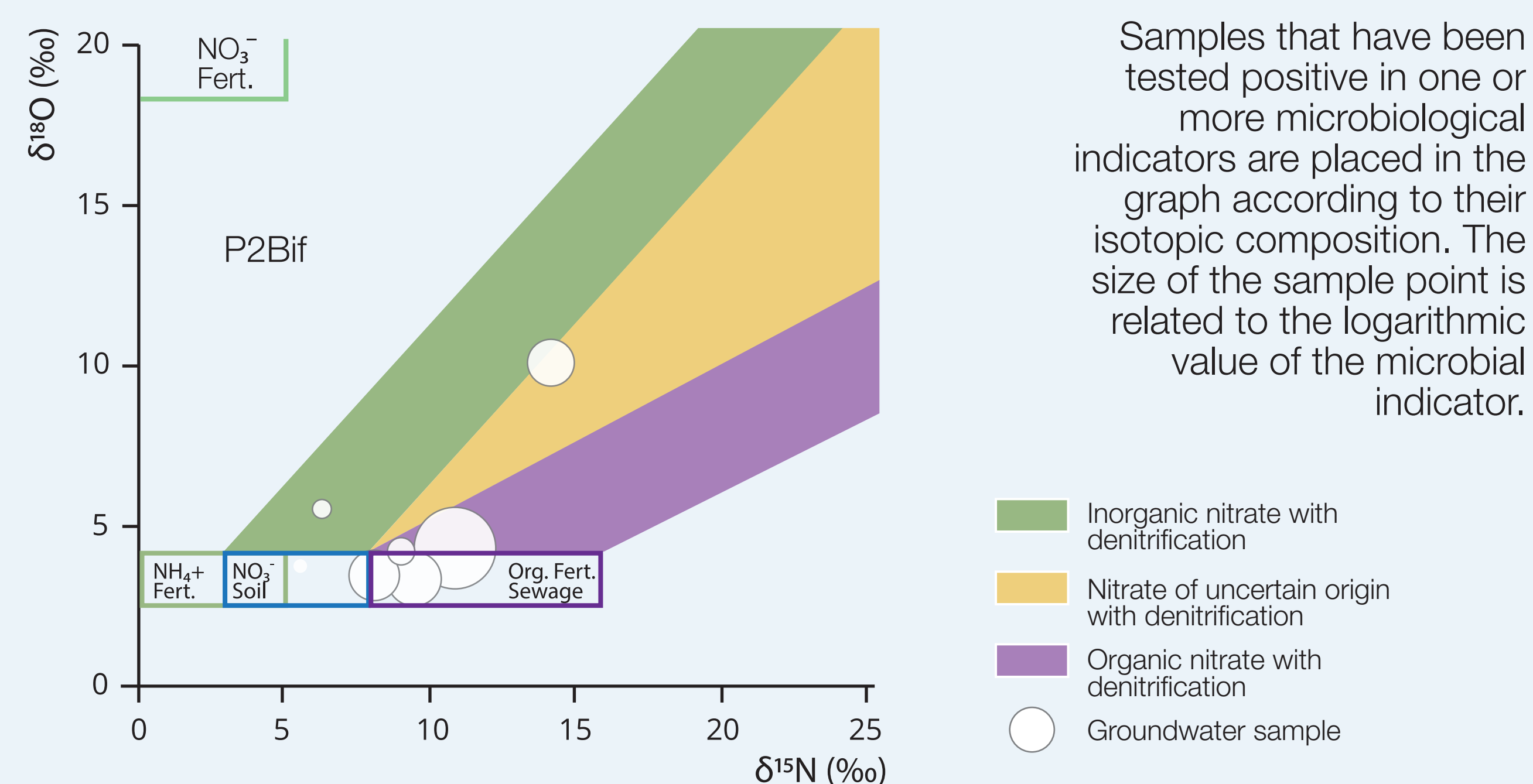
## CONCLUSIONS

- The methodology allows the use of the same conceptual model to jointly analyse groundwater and surface water.
- This is a multidisciplinary approach that integrates microbiologic studies with multi-isotopic determination to trace the origin of nitrates contamination in water with an increased accuracy. Additionally, the analysis based on the characterization of the environment and its pressures helps to fulfill these objectives.
- The results of that methodology have recently been applied for the redefinition of monitoring networks, that will allow a better characterization of nitrate contamination, as well as for reviewing vulnerable zones according to the Nitrate Directive requirements. Also, the project facilitates the proposal of recovery measures for waters affected by pollution, such as studies of recharge, actions in vulnerable areas and actions with agronomic criteria.

## RESULTS

Analytical results have been integrated with the information of pressures and the hydrogeological characterization for each sample point in order to elaborate a final diagnosis.

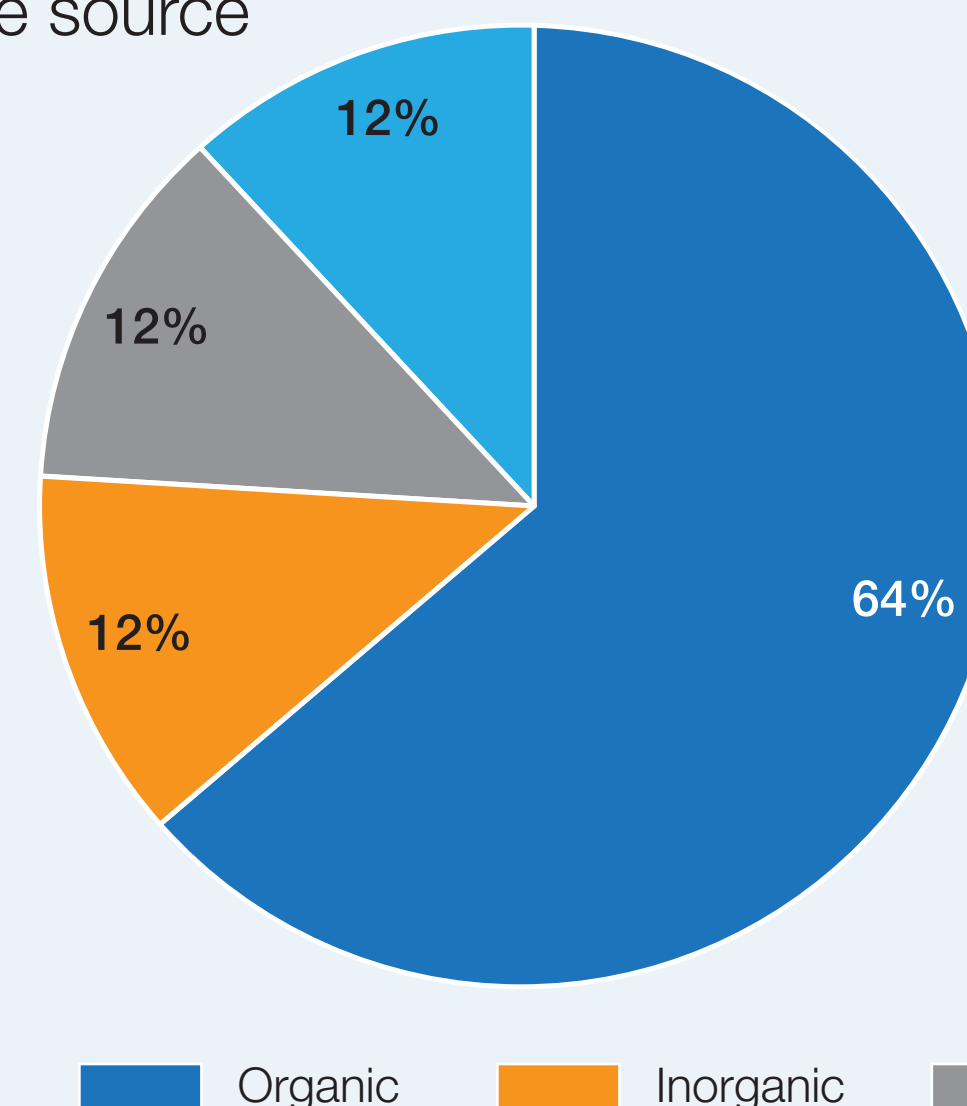
### Isotopes and microbiological indicators integration



### Relation of cause and source of pollution

For surface water, non-point and point pollution are the main type of pollution, and the principal source of contamination is organic, primarily due to wastewater. For groundwater, non-point pollution predominates, and its origin is a combination of organic and inorganic nitrate source.

#### Surface water Nitrate source



#### Groundwater Nitrate source

