IPCHEM - Information Platform for Chemicals Monitoring

Case study 3 – Mercury in bream fish

Version 2 (December 2018)

https://ipchem.jrc.ec.europa.eu

TABLE OF CONTENTS:

1 BACKGROUND

To protect human health and the environment as a whole it is particularly important to reduce pollutant emissions at source, and to identify and implement the most effective reduction measures at local, national and European level.

Mercury is one of the top ten listed chemicals by UN as potentially harmful for human health and the environment with no safe level of exposure. A major proportion of the mercury found in the environment originates from human activities, and part of it enters into aquatic ecosystems where it can be taken up by plants or consumed by small organisms that are eaten by predators. In this way, mercury can travel up the food chain and accumulate into the largest and longest-living predators, posing a serious health hazard for humans, especially children and pregnant women.

This matter was discussed in the Minamata Convention, a global treaty to protect human health and the environment from the adverse effects of mercury that came into force on the 16th August 2017. The major recommendations of the Minamata Convention include a ban on new mercury mines and a phase-out of existing ones, control measures on air emissions, and the international regulation of the informal sector for artisanal and small-scale gold mining. To date, 74 countries have committed to take measures to control man-made mercury pollution.

DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000 (establishing a framework for Community action in the field of water policy) stated the importance of defining strategies against water pollution and aimed at their progressive reduction. Accordingly, EU Environmental Quality Standards (EQSs) were established in the WFD Daughter Directive 2008/105/EC[1] and amended by Directive 2013/39/EC[2]. These Quality Standards for mercury in surface waters include protection against secondary poisoning and food uptake by man are summarised in the table 1[3].

Table 1: Quality standards for mercury from Directive 2008/105/EC as amended by Directive 2013/39/EU (first row) and from Environmental Quality Standards (EQS) dossiers published in 2006*

Substance	Protection goal	Biota quality standards (QS_{biota}) [µg/kg ww]
Mercury	Secondary poisoning	20
	Human health via consumption of fishery products	500*

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0084:0097:en:PDF
[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:226:0001:0017:EN:PDF
[3] Common implementation strategy for the water framework Directive (2000/60/EC)", Guidance document no. 32 on Biota monitoring under the water framework directive, European Commission, Technical report – 2014-083

2 CASE STUDY 3

This case study aims to identify fish concentration values of mercury, in Germany, that do not meet the limit value of 20 µg/kg, by using data available in IPCHEM platform and its functionalities.

Table 2: Parameters selected for the case study and used in IPCHEM

Chemical compound	**Mercury**
Media	Biota (Animals)
Area (region) of interest	Germany
Limit value	20 µg/kg = 20 ng/g

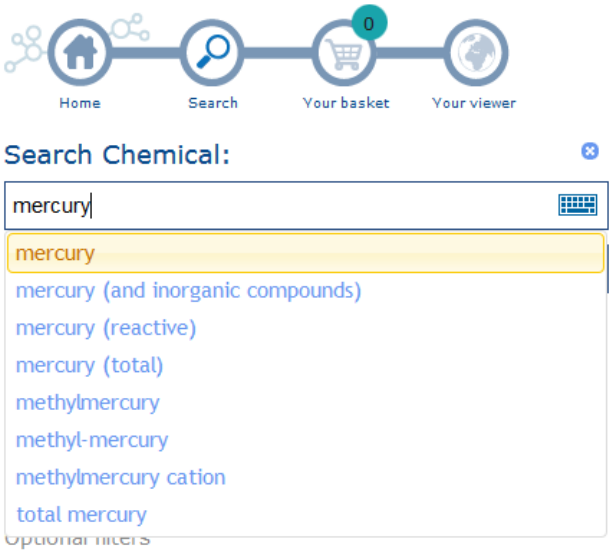
3 OPERATIONAL STEPS

3.1 Selection of Chemical

Starting from the IPCHEM home page, click on the search tool '*Search data by Chemical, Media and Country*'

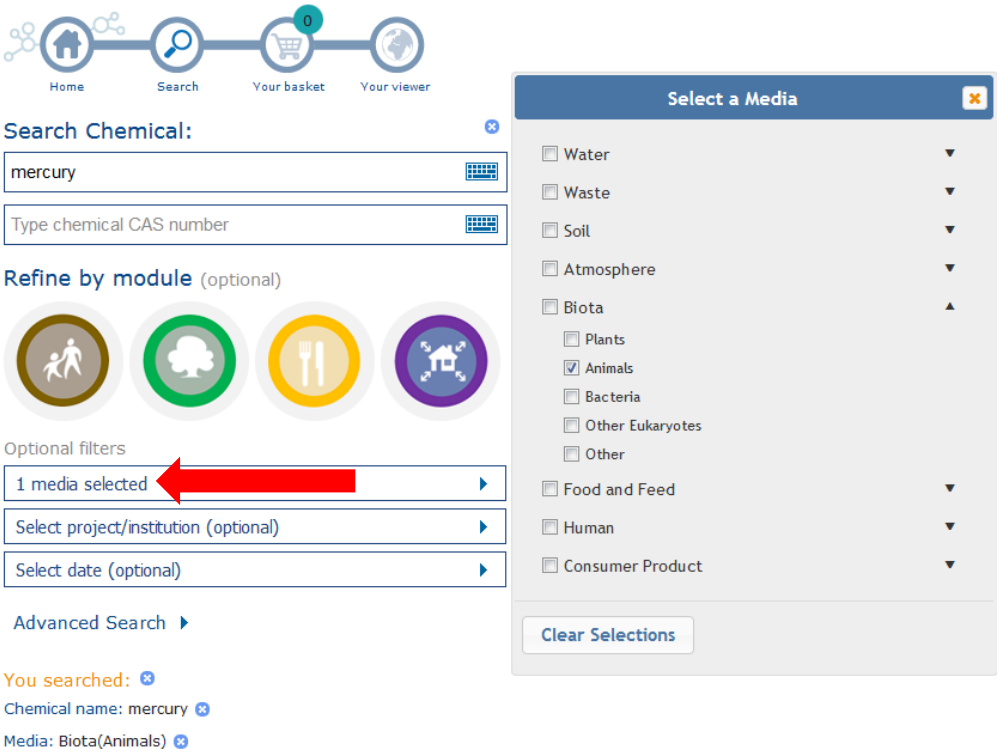
Then follow the steps described below:

→ Type the name of 'mercury' in the field called '*Type chemical name/synonymous*' and select *'mercury'* from the box list.



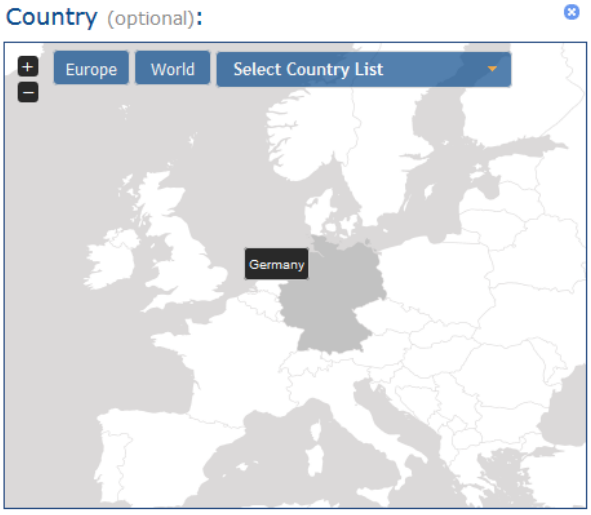
3.2 Selection of media

→ Click on the '*Select media (optional)*' and choose '*Animals*' from the check box list under the check box category names '*Biota*'.

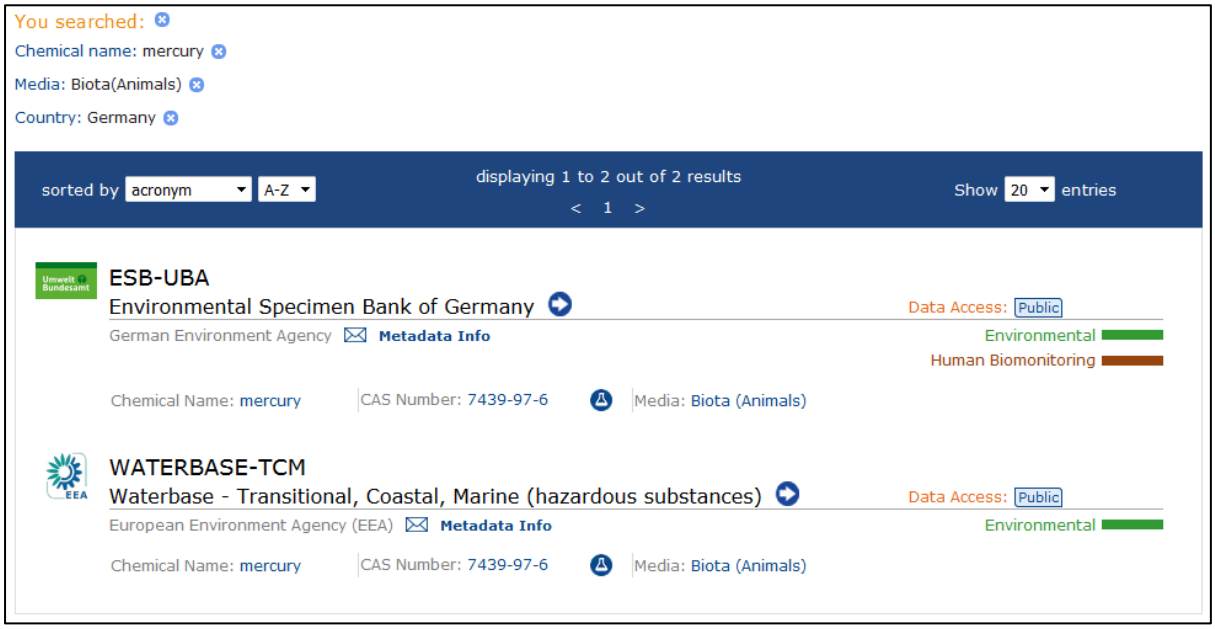


3.3 Selection of country

→ Select '*Germany*', by clicking directly on the map of Germany or by selecting from the drop-down list of countries.



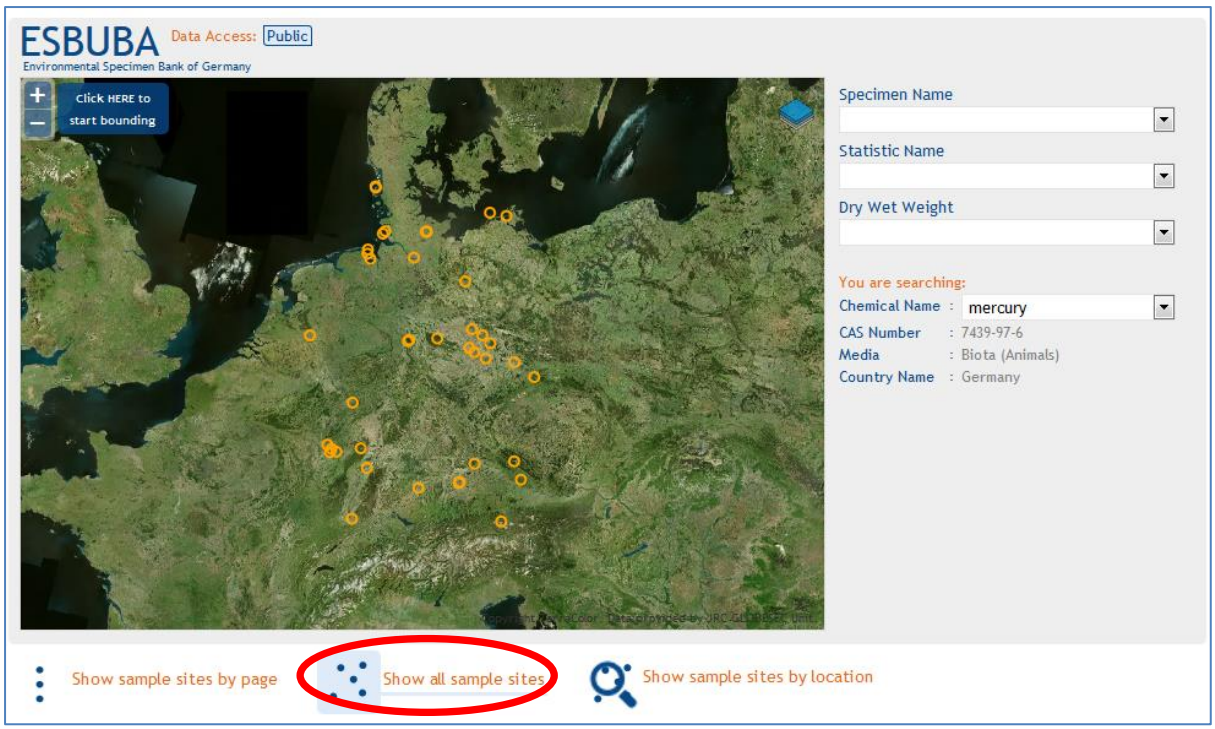
The results of the query are displayed into the search page: all data collections available in IPCHEM, which include data on mercury concentration in Biota (Animals) measured in Germany are listed in the same page.



3.4 *Selection of the database of interest*

→ Select the '*ESB-UBA – Environmental Specimen Bank of Germany*' data collection to access the related data, by clicking on the corresponding title in the databases list. By selecting the '*ESB-UBA*' database the specific Database Console appears.

→ Select '*Show all sample sites*' to display all sampling data sources onto the map.

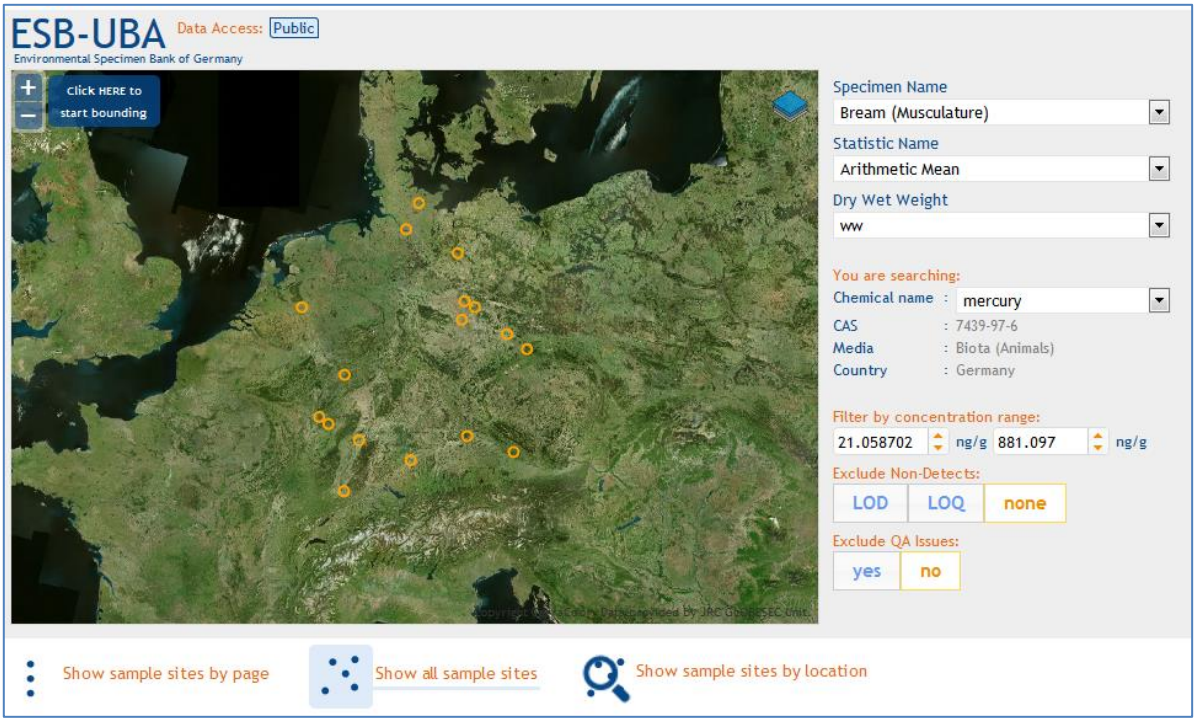


Concentration measurements data are displayed in tabular format (the so-called '*Master Table*') and onto the map, where the coloured points represent the sampling source locations.

3.5 Selection of specific 'filter criteria'

→ Choose among the filter criteria specific to the '*ESB-UBA*' database available on the top-right part of the Database Console to narrow the data selection in the following way:

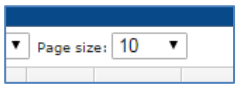
Filter	Value
Specimen Name	Bream (Musculature)
Statistic Name	Arithmetic Mean
Dry Wet Weight	Wet weight (ww)
Filter by concentration	21.05 – 881.09 ng/g



Note: the filters '*Exclude Non-Detects*' and '*Exclude QA Issues*' are respectively automatically defined as '*none*' and '*no*'.

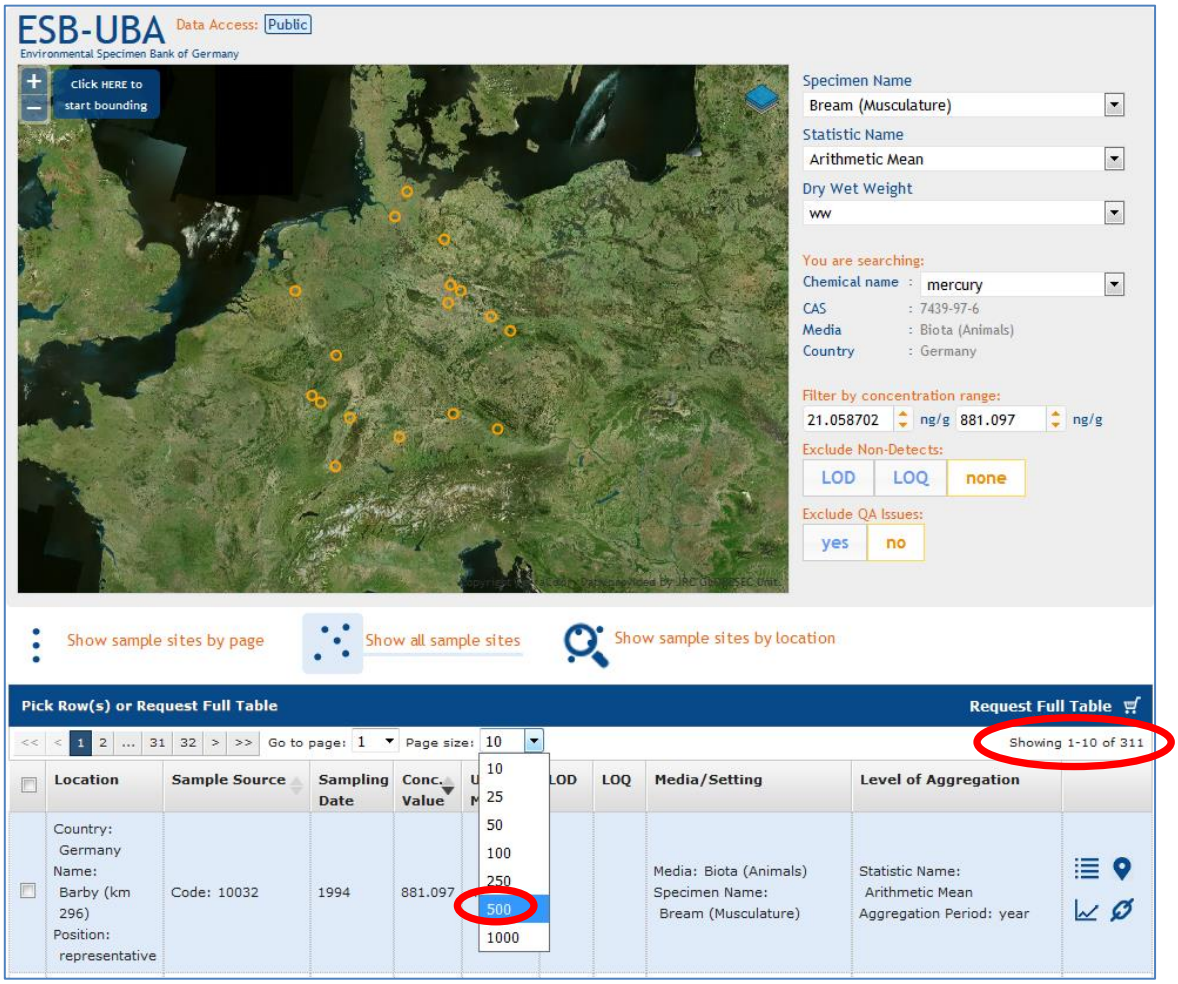
3.6 Selection of data records

→ According to the performed spatial selection, change the number of data records displayed into the Master Table from the '*Page size*' pull down list. By default the page size is set to '*10*' rows.

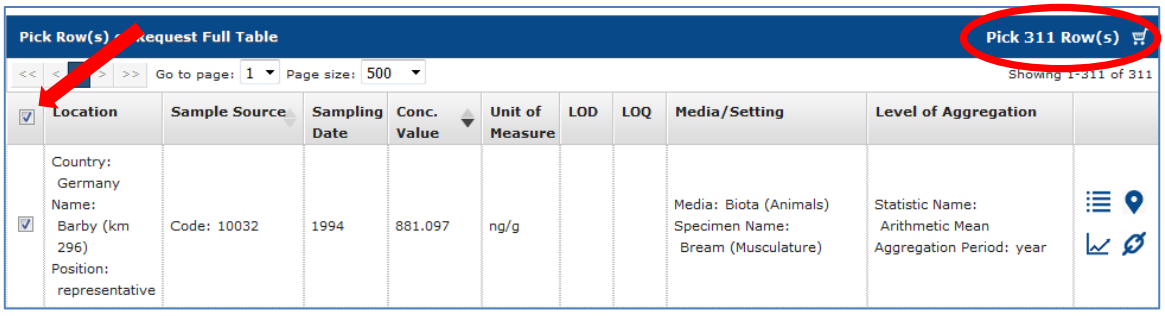


If this step is omitted, only the first 10 rows holding their corresponding data will be by default selected and stored into the Basket.

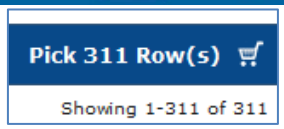
→ Set the page size to 500 from the drop-down list so that all 311 data records can be displayed into the Master Table; the number of records might change according to the size and shape of the polygon you have drawn.



→ Select all 311 records to store them into the IPCHEM Basket by picking-up the top box of the first column (indicated by the red arrow in the figure below).



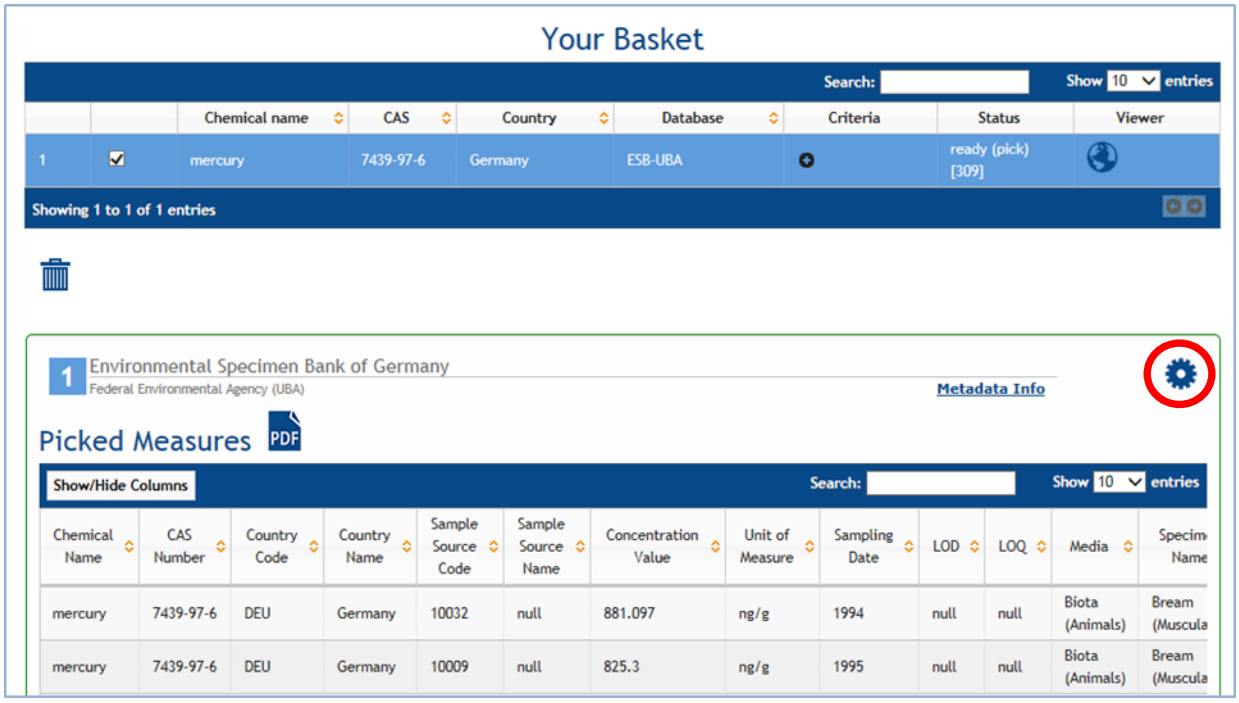
→ Click on '*Pick 311 Row(s)*', the white text next to the small shopping basket icon:



3.7 Visualisation of selected data

→ Select the shopping basket icon of the menu bar and enter into the IPCHEM Basket tool.
The number '*1*' appears at the top of the screen, near to the icon, indicating that 1 sub-set of selected (picked-up) data has been added to the IPCHEM Basket.

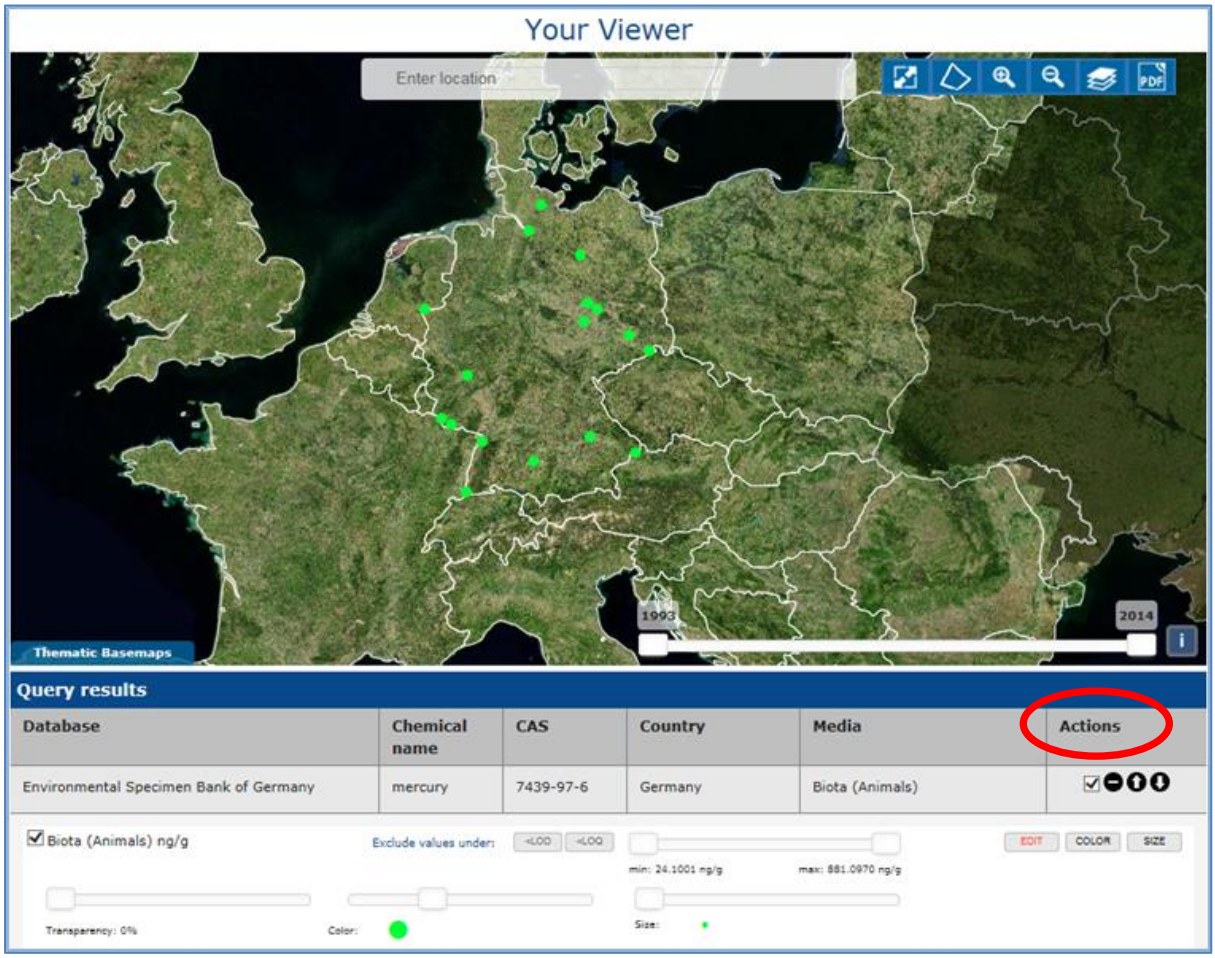
→ Click on  '*Processing*' icon (indicated by the red circle in the figure below) to process the selected data and prepare a zip folder to download for subsequent offline analysis.



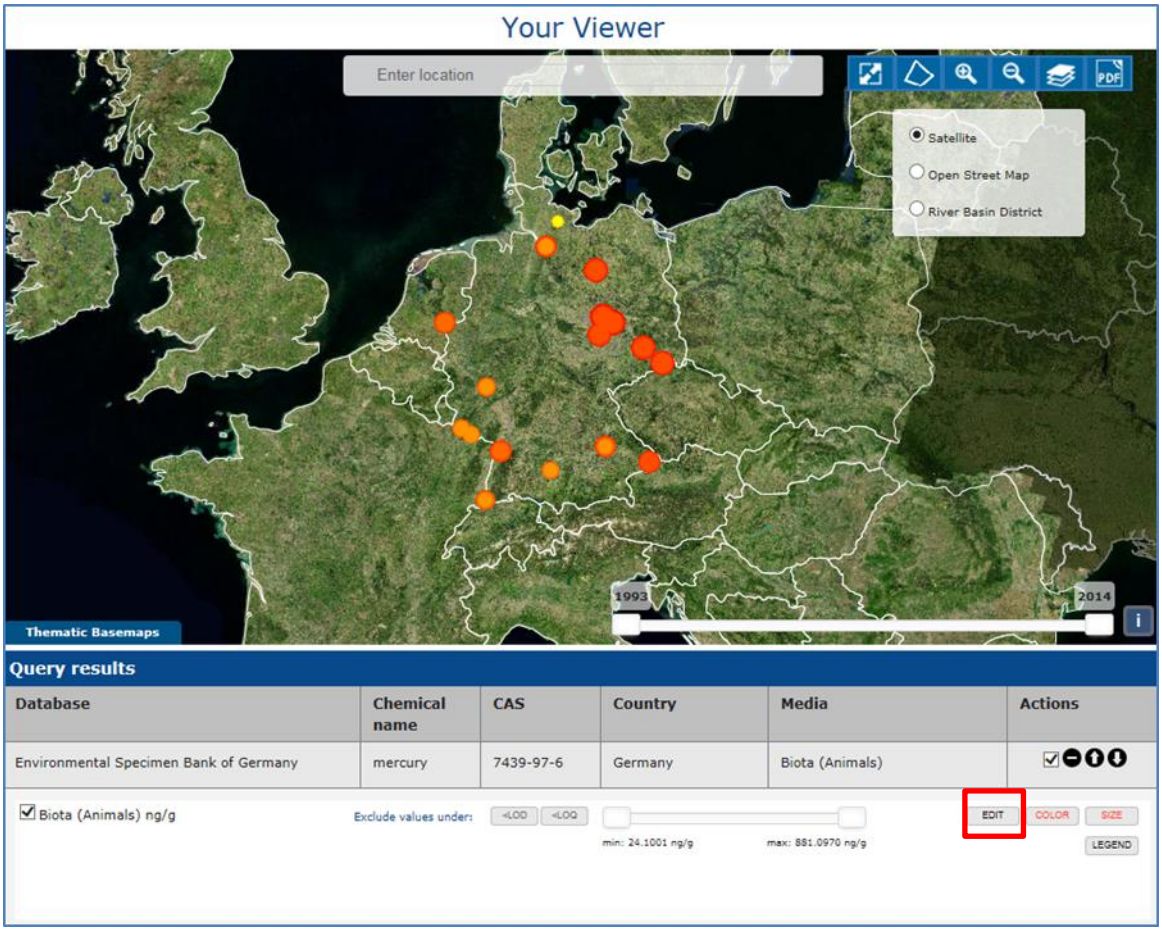
→ Select the '*Viewer/globe*' icon to enter the IPCHEM Viewer tool:

Each of the selected data that were saved into the IPCHEM Basket tool is also available as spatial layer in the IPCHEM Viewer.

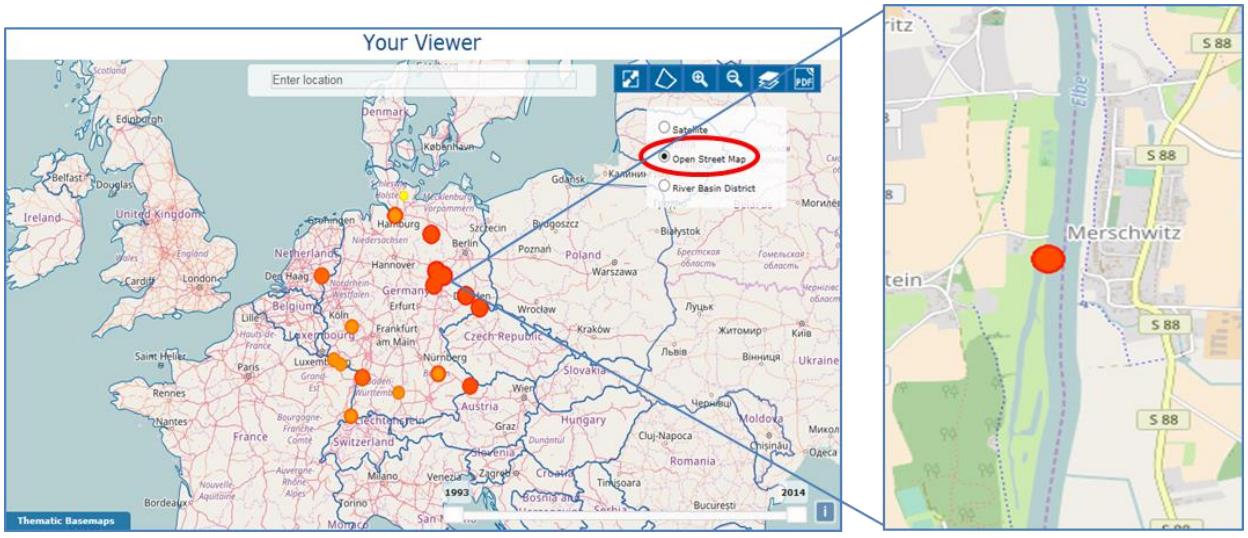
→ Pick-up the check-box in the '*Actions*' column and then click on the '**+**' button to open the IPCHEM Editor Console.



→ By selecting the '*EDIT*' button in the IPCHEM Editor Console it is possible to change the 'colour', '*size*' and '*transparency*' of the data points according to the chemical concentration at each sampling location (i.e. higher concentration corresponds to bigger and/or redder data points).



→ Click on  and then choose '*Open Street Map*' as Basemap layer to identify the location/source of the specific sampling data.

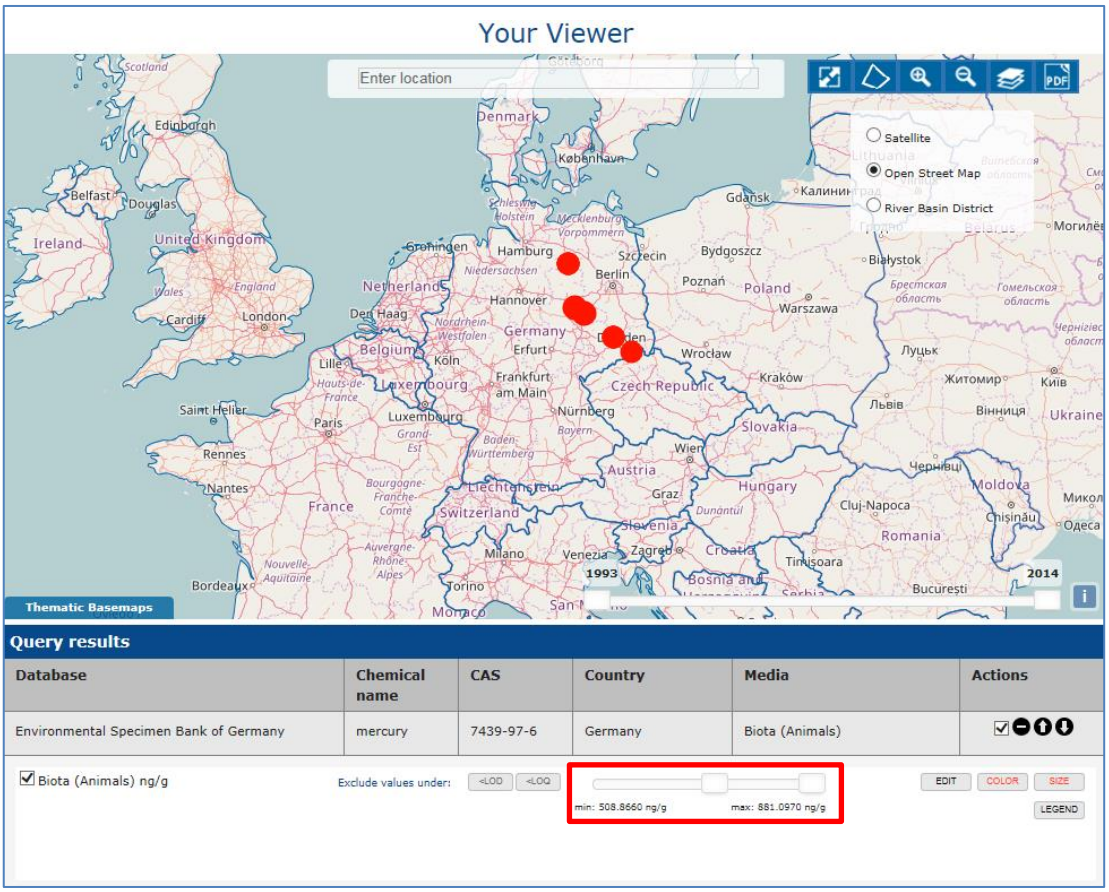


Careful analysis of each data point reveals that most are associated to three main European rivers:

- Elbe, one of the major rivers of Central Europe, running from the Czech Republic through Germany to the North Sea;
- Danube, the second largest river in Europe;
- Rhine, begins in Switzerland flows through the Germany and eventually empties into the North Sea in the Netherlands.

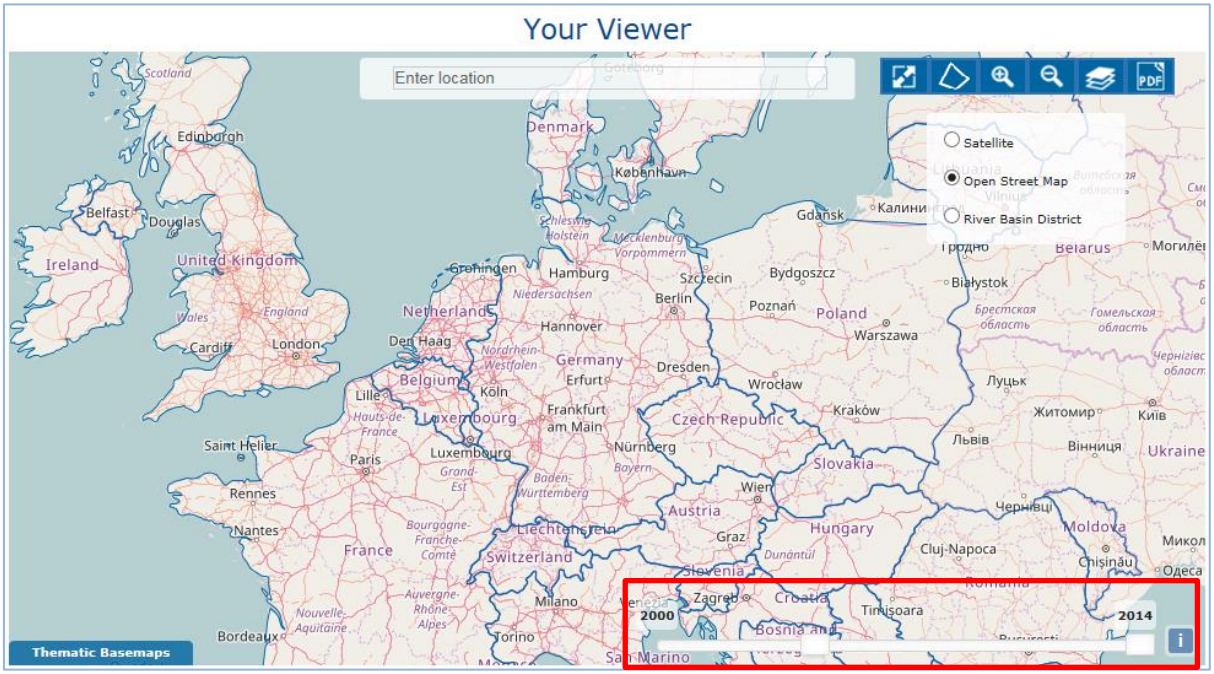
In these rivers secondary predators appear to be at particular **risk of poisoning** by feeding the fish with mercury levels higher than the *'Quality Standard'* value of 20 µg/kg of prey tissue. Ultimately, this situation presents a serious health hazard for humans, as mercury can travel up the food chain and accumulate into the largest and longest-living predators.

→ In the IPCHEM Editor Console it is possible to narrow down the concentration range (*500 ng/g – 880 ng/g*) of the measurements displayed onto the map.



Using this tool, the concentration values are tuned to show sampling locations where mercury concentration in fish is higher than the allowed maximum level for human consumption (*500 ng/g wet weight*). This means that according to EU Environmental Quality Standards (EQSs) fish studied in these locations would not be suitable for human consumption.

→ Refine the time-period and tune the data selection by moving the time-slider (2000-2014) as shown in the figure below.



When adjusting the time period from year 2000 until 2014 no dots appear on the map, meaning that mercury concentration of the studied bream fish matched the requirements for fish and fishery products intended for human consumption (500 ng/g wet weight).

The tools of the IPCHEM platform enabled a coordinated approach for collecting and assessing the data relative to concentrations of mercury in bream fish all over Germany for a time period of 14 years. In this country, 17 source locations where mercury concentrations exceeded the EU Environmental Quality Standards (EQSs) (aiming for protecting against secondary poisoning of predators or representing the maximum levels allowed for human consumption) were identified.

In this case study all source locations showed mercury levels higher than the recommended for protecting against secondary poisoning of predators; in 5 locations (until the year 2000) the concentration in bream fish was higher than the allowed maximum level for human consumption.