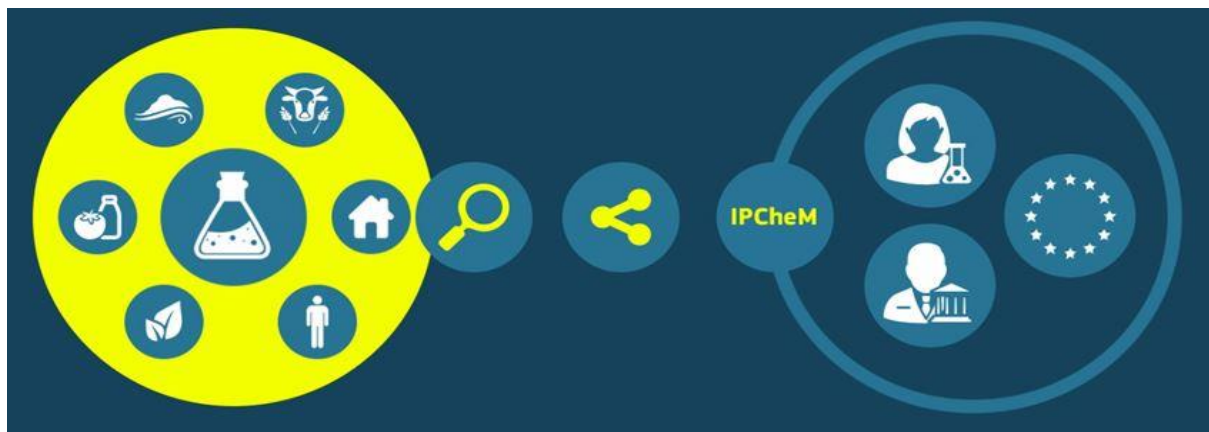


IPCHEM - Information Platform for Chemicals Monitoring

Case study 3 – Mercury in bream fish

Version 2 (December 2018)



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

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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/EC¹ and amended by Directive 2013/39/EC². These Quality Standards for mercury in surface waters include protection against secondary poisoning and food uptake by man are summarised in the table 1³.

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}) [$\mu\text{g}/\text{kg ww}$]
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.



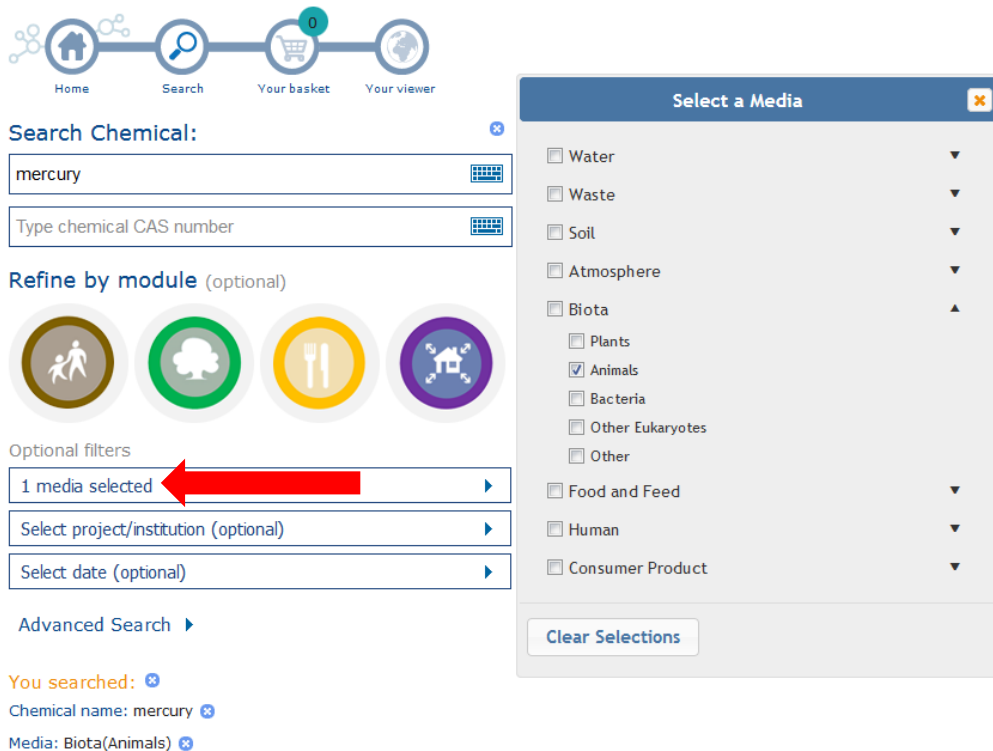
Search Chemical: ✕

- mercury
- mercury (and inorganic compounds)
- mercury (reactive)
- mercury (total)
- methylmercury
- methyl-mercury
- methylmercury cation
- total mercury

Optional filters

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'.

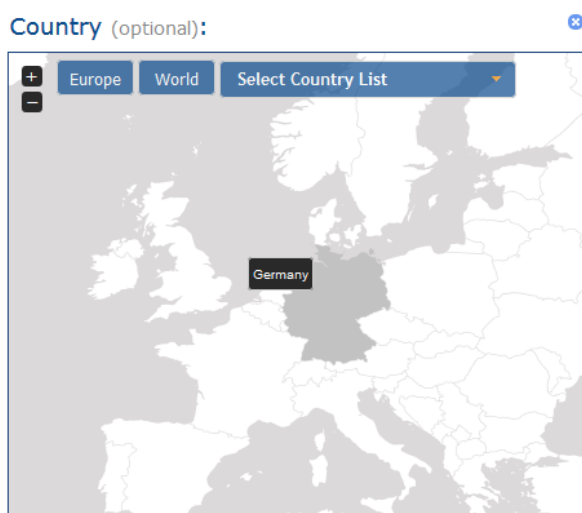


The screenshot shows the search interface with the following elements:

- Navigation icons: Home, Search, Your basket (0), Your viewer.
- Search Chemical: Input field containing 'mercury'.
- Refine by module (optional): Four circular icons representing different modules.
- Optional filters:
 - 1 media selected (highlighted with a red arrow)
 - Select project/institution (optional)
 - Select date (optional)
- Advanced Search button.
- Search results summary:
 - You searched: [x]
 - Chemical name: mercury [x]
 - Media: Biota(Animals) [x]
- 'Select a Media' dialog box:
 - Water []
 - Waste []
 - Soil []
 - Atmosphere []
 - Biota [] (expanded):
 - Plants []
 - Animals [x]
 - Bacteria []
 - Other Eukaryotes []
 - Other []
 - Food and Feed []
 - Human []
 - Consumer Product []
 - Clear Selections button.

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 screenshot shows the 'Country (optional):' filter with the following elements:

- Map of Europe with Germany highlighted.
- Dropdown menu: Europe, World, Select Country List.

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.

You searched: [✕](#)
Chemical name: mercury [✕](#)
Media: Biota(Animals) [✕](#)
Country: Germany [✕](#)

sorted by [acronym](#) [A-Z](#) displaying 1 to 2 out of 2 results Show [20](#) entries

ESB-UBA
Environmental Specimen Bank of Germany [➔](#) Data Access: [Public](#)
German Environment Agency [✉](#) [Metadata Info](#)
Chemical Name: mercury CAS Number: 7439-97-6 [⚠](#) Media: Biota (Animals)
Environmental [█](#)
Human Biomonitoring [█](#)

WATERBASE-TCM
Waterbase - Transitional, Coastal, Marine (hazardous substances) [➔](#) Data Access: [Public](#)
European Environment Agency (EEA) [✉](#) [Metadata Info](#)
Chemical Name: mercury CAS Number: 7439-97-6 [⚠](#) Media: Biota (Animals)
Environmental [█](#)

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.

ESBUBA Data Access: [Public](#)
Environmental Specimen Bank of Germany

Specimen Name
Statistic Name
Dry Wet Weight

You are searching:
Chemical Name : mercury
CAS Number : 7439-97-6
Media : Biota (Animals)
Country Name : Germany

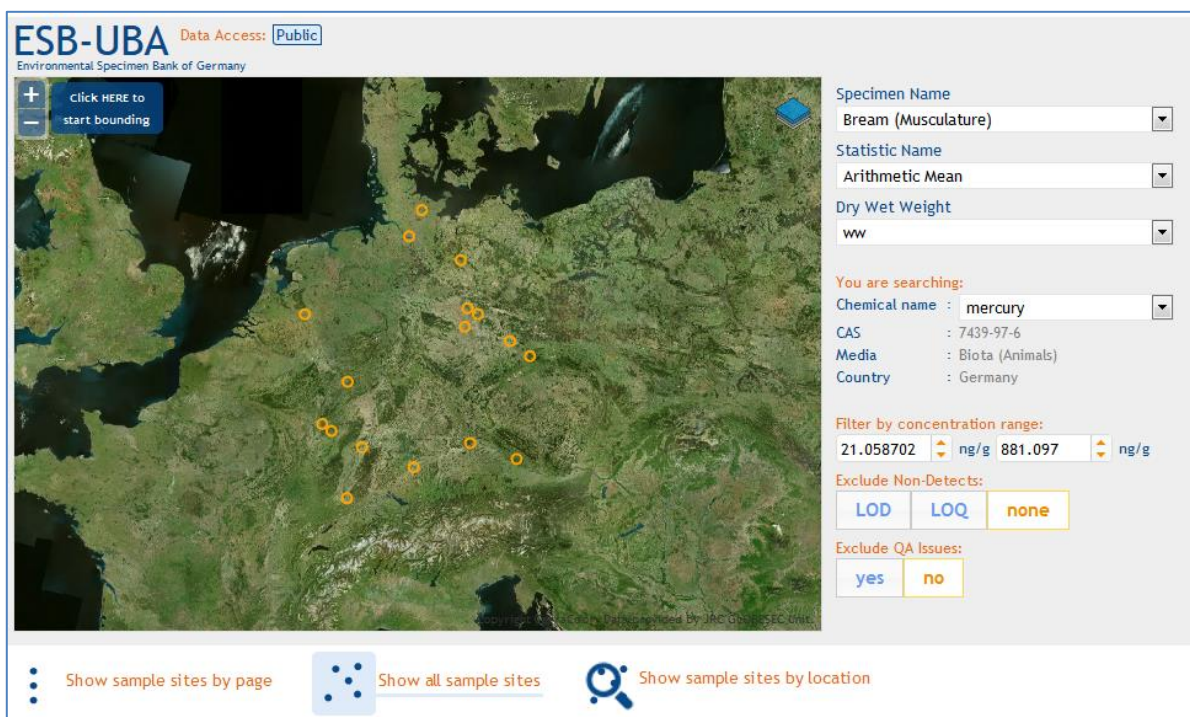
[⋮](#) Show sample sites by page [⋮](#) **Show all sample sites** [🔍](#) Show sample sites by location

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



The screenshot shows the ESB-UBA database interface. On the left, there is a map of Germany with several orange circular markers representing sample sites. A button labeled 'click HERE to start bounding' is visible. On the right side, there is a filter panel with the following settings:

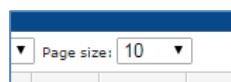
- Specimen Name: Bream (Musculature)
- Statistic Name: Arithmetic Mean
- Dry Wet Weight: ww
- You are searching:
 - Chemical name: mercury
 - CAS: 7439-97-6
 - Media: Biota (Animals)
 - Country: Germany
- Filter by concentration range: 21.058702 ng/g to 881.097 ng/g
- Exclude Non-Detects: LOD, LOQ, none (selected)
- Exclude QA Issues: yes, no (selected)

At the bottom, there are three buttons: 'Show sample sites by page', 'Show all sample sites', and 'Show sample sites by location'.

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.



The screenshot shows a pull-down menu for 'Page size' with the value '10' selected.

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.

ESB-UBA Data Access: Public
Environmental Specimen Bank of Germany

Click HERE to start bounding

Specimen Name: Bream (Musculature)
Statistic Name: Arithmetic Mean
Dry Wet Weight: ww

You are searching:
Chemical name: mercury
CAS: 7439-97-6
Media: Biota (Animals)
Country: Germany

Filter by concentration range:
21.058702 ng/g 881.097 ng/g

Exclude Non-Detects: LOD LOQ none
Exclude QA Issues: yes no

Show sample sites by page Show all sample sites Show sample sites by location

Pick Row(s) or Request Full Table Request Full Table Showing 1-10 of 311

<input type="checkbox"/>	Location	Sample Source	Sampling Date	Conc. Value	Unit of Measure	LOD	LOQ	Media/Setting	Level of Aggregation
<input type="checkbox"/>	Country: Germany Name: Barby (km 296) Position: representative	Code: 10032	1994	881.097	ng/g			Media: Biota (Animals) Specimen Name: Bream (Musculature)	Statistic Name: Arithmetic Mean Aggregation Period: year

→ 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).

Pick Row(s) Request Full Table Pick 311 Row(s) Showing 1-311 of 311

Go to page: 1 Page size: 500

<input checked="" type="checkbox"/>	Location	Sample Source	Sampling Date	Conc. Value	Unit of Measure	LOD	LOQ	Media/Setting	Level of Aggregation
<input checked="" type="checkbox"/>	Country: Germany Name: Barby (km 296) Position: representative	Code: 10032	1994	881.097	ng/g			Media: Biota (Animals) Specimen Name: Bream (Musculature)	Statistic Name: Arithmetic Mean Aggregation Period: year

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

Pick 311 Row(s)

Showing 1-311 of 311

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.

Your Basket

Search: Show 10 entries

		Chemical name	CAS	Country	Database	Criteria	Status	Viewer
1	<input checked="" type="checkbox"/>	mercury	7439-97-6	Germany	ESB-UBA	+	ready (pick) [309]	

Showing 1 to 1 of 1 entries

1 Environmental Specimen Bank of Germany
Federal Environmental Agency (UBA) [Metadata Info](#)

Picked Measures

Show/Hide Columns Search: Show 10 entries

Chemical Name	CAS Number	Country Code	Country Name	Sample Source Code	Sample Source Name	Concentration Value	Unit of Measure	Sampling Date	LOD	LOQ	Media	Specim Name
mercury	7439-97-6	DEU	Germany	10032	null	881.097	ng/g	1994	null	null	Biota (Animals)	Bream (Muscula)
mercury	7439-97-6	DEU	Germany	10009	null	825.3	ng/g	1995	null	null	Biota (Animals)	Bream (Muscula)

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



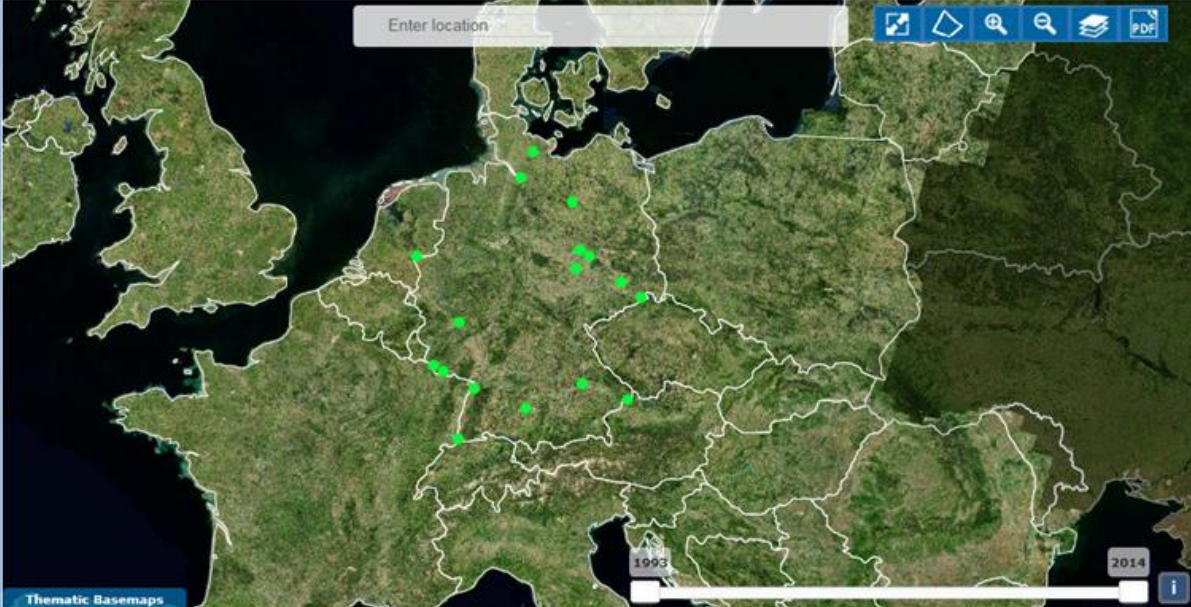
Each of the selected data that were saved into the IPCHEM Basket tool is also available as spatial layer in the IPCHEM Viewer.

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



Your Viewer

Enter location



1993 2014

Thematic Basemaps

Query results

Database	Chemical name	CAS	Country	Media	Actions
Environmental Specimen Bank of Germany	mercury	7439-97-6	Germany	Biota (Animals)	<input checked="" type="checkbox"/> + - 0 0

Biota (Animals) ng/g

Exclude values under: -LOD -LOD

min: 24.1001 ng/g max: 881.0970 ng/g

Transparency: 0% Color: ● Size: ●


EDIT COLOR SIZE

→ 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).

The screenshot shows the 'Your Viewer' interface. At the top, there is a search bar labeled 'Enter location'. Below it is a map of Europe with several red and orange circular markers representing sampling locations. A legend in the top right corner shows three options: 'Satellite' (selected), 'Open Street Map', and 'River Basin District'. Below the map is a 'Query results' table with columns: Database, Chemical name, CAS, Country, Media, and Actions. The table contains one row: Environmental Specimen Bank of Germany, mercury, 7439-97-6, Germany, Biota (Animals). Below the table, there are filters for 'Biota (Animals) ng/g' and 'Exclude values under:'. The 'EDIT' button is highlighted with a red box.

Database	Chemical name	CAS	Country	Media	Actions
Environmental Specimen Bank of Germany	mercury	7439-97-6	Germany	Biota (Animals)	<input checked="" type="checkbox"/>



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

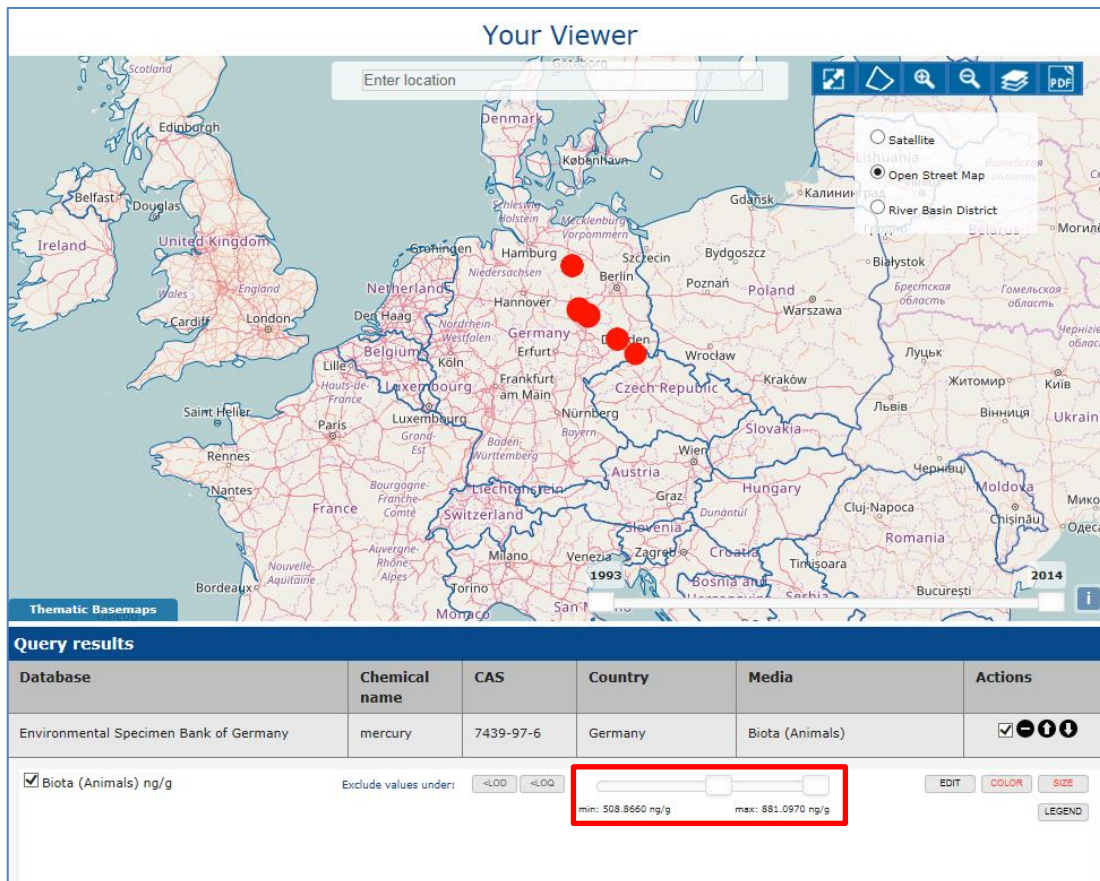
The screenshot shows the 'Your Viewer' interface with the 'Open Street Map' button circled in red. An inset map on the right shows a zoomed-in view of a specific location, Merschwitz, with a red marker. The inset map shows a river, the Elbe, and several roads labeled 'S 88'.

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.



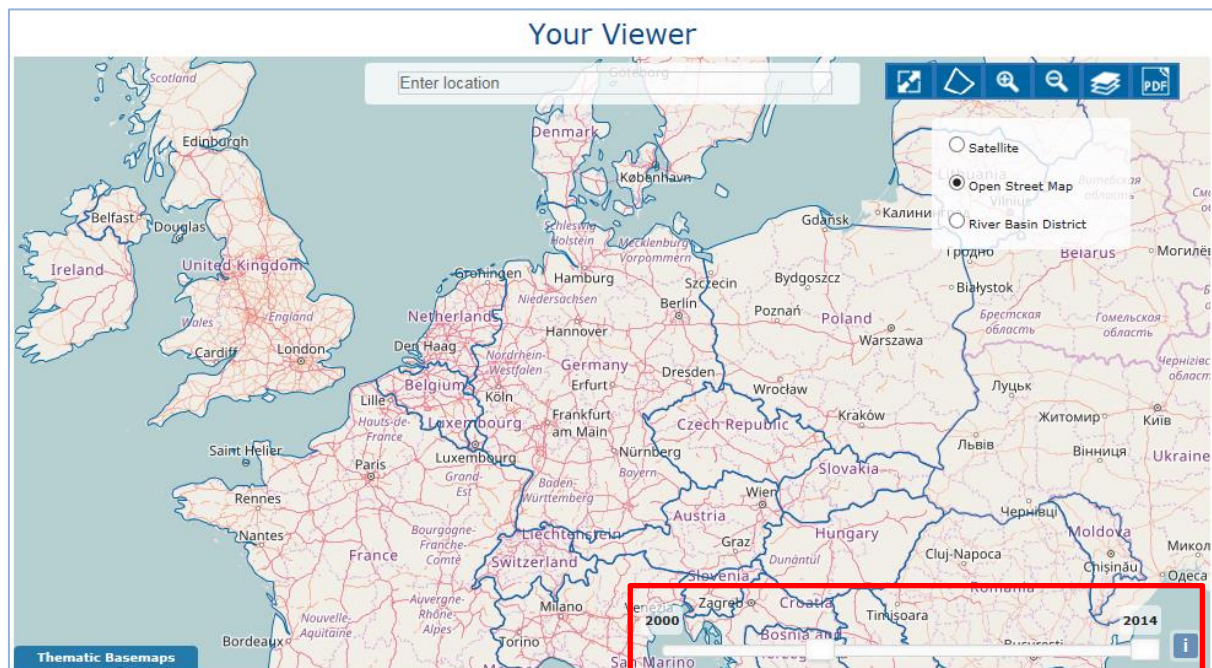
The screenshot shows the 'Your Viewer' interface. At the top, there is a search bar labeled 'Enter location'. Below the search bar is a map of Europe with several red dots indicating sampling locations. The map includes various geographical features and labels for countries and cities. Below the map, there is a 'Query results' section with a table and a filter control.

Database	Chemical name	CAS	Country	Media	Actions
Environmental Specimen Bank of Germany	mercury	7439-97-6	Germany	Biota (Animals)	<input checked="" type="checkbox"/>  

Below the table, there is a filter control for 'Biota (Animals) ng/g'. It includes a checkbox, a label 'Exclude values under:', and a range slider. The slider is set to a range from 508.8660 ng/g to 881.0970 ng/g. The slider has 'min: 508.8660 ng/g' and 'max: 881.0970 ng/g' labels. There are also 'EDIT', 'COLOR', 'SIZE', and 'LEGEND' buttons.

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.