GMP Data Warehouse – a supporting tool of effectiveness evaluation of the Stockholm Convention on Persistent Organic Pollutants

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RECETOX

MU
IBA

UNIVERSITAS MASARYKIANA BRUNENSIS

Persistent organic pollutants

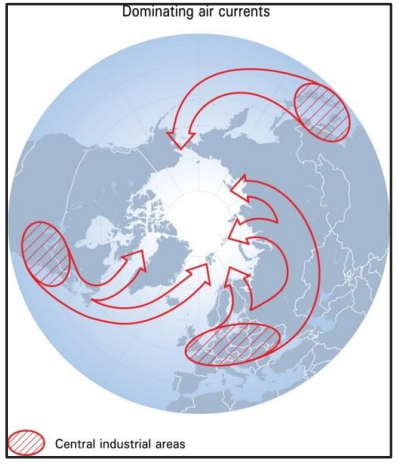
Use

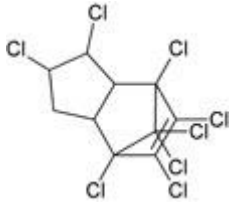
- Pesticides (DDT, chlordane…)
- Industry (PCBs)

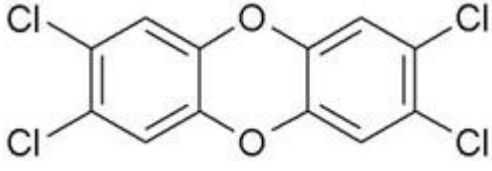
  (paints, hydraulic devices, transformers, flame retardants etc.)
- Combustion processes (dioxins)

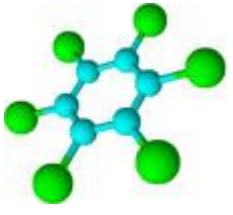
Characteristics

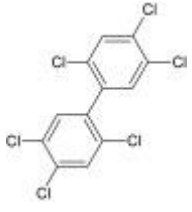
- Acute toxicity
- Chronic toxicity
- Cancerogenicity, embryo-, immunotoxicity
- Persistence, bioaccumulation
- Long distances transport











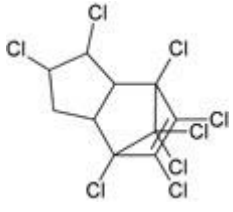
Stockholm Convention

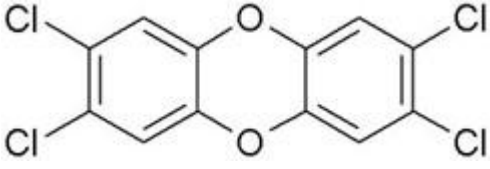
Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

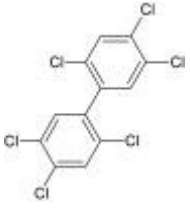
Stockholm Convention on persistent organic pollutants (POPs)

- Signed in 2001, entered into force in 2004
- **Twenty-eight chemical compounds** for which the countries must take measures to **eliminate** or **restrict** the production and use or reduce the **unintentional releases**.

1. Aldrin
2. Chlordane
3. Chlordecone
4. Dieldrin
5. Endrin
6. Heptachlor
7. Hexabromobiphenyl
8. Hexabromodiphenyl ether and heptabromodiphenyl ether
9. Hexachlorobenzene (HCB)
10. Alpha hexachlorocyclohexane
11. Beta hexachlorocyclohexane
12. Lindane
13. Mirex
14. Pentachlorobenzene
15. Polychlorinated biphenyls (PCBs)
16. Endosulfan
17. Tetrabromodiphenyl ether and pentabromodiphenyl ether
18. Toxaphen
19. DDT
20. PFOS
21. Polychlorinated dibenzo-p-dioxins
22. Polychlorinated dibenzofurans
23. Hexabromocyclododecane
24. Hexachlorobutadiene
25. Pentachlorophenol, its salts and esters
26. Polychlorinated naphthalenes
27. Short-chain chlorinated paraphins
28. Decabromodiphenyl ether



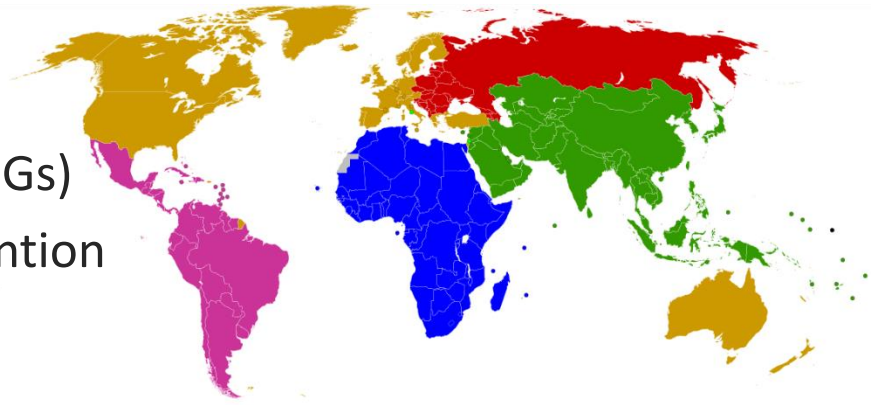




Global monitoring plan for POPs

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

- Mandate: Article 16 of the Stockholm Convention and decisions SC-3/19, SC 4/31 and SC-5/18 adopted by the COP
- Objectives
  - Tracking of POPs concentrations in the environment and human beings in time
  - Effectiveness evaluation of international efforts to reduce releases of the POPs listed in the Stockholm Convention into the environment
- Coordination
  - Global Coordination Group (GCG)
  - 5 Regional Organization Groups (ROGs)
  - Secretariat of the Stockholm Convention
- Harmonization, methodology:
  - Guidance on the Global Monitoring Plan for Persistent Organic Pollutants



Global monitoring plan for POPs

Stockholm Convention
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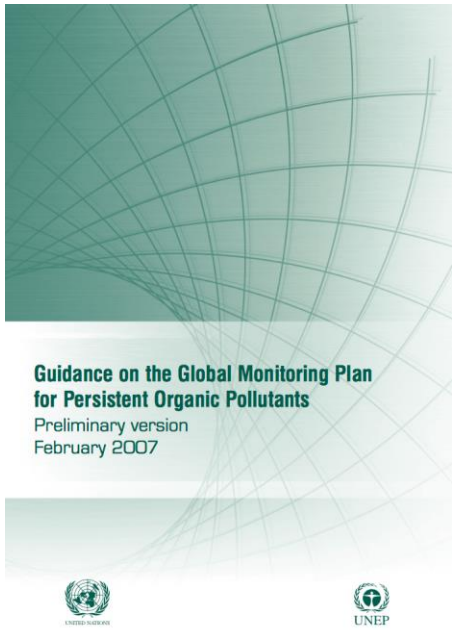


Global monitoring plan for POPs

Stockholm Convention Regional Centre for Capacity Building and the Transfer of Technology

Substances to be monitored
GMP Guidance, chapter 2.2. table 2.2.

	Compounds to be Monitored			
	Air	**Human Milk**	**Human Blood**	**Water**
Initial POPs				
Aldrin	Aldrin	Aldrin	Aldrin	Water has not been recommended as a core matrix for the lipophilic and nonpolar initial twelve POPs; therefore, analysis of surface waters is not recommended
Chlordane	*cis*- and *trans*-chlordane; and *cis*- and *trans*-nonachlor, oxychlordane	*cis*- and *trans*-chlordane; and *cis*- and *trans*-nonachlor, oxychlordane	*cis*- and *trans*-chlordane; and *cis*- and *trans*-nonachlor, oxychlordane	
DDT	4,4'-DDT, 2,4'-DDT and 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, 2,4'-DDD	4,4'-DDT, 2,4'-DDT and 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, 2,4'-DDD	4,4'-DDT, 2,4'-DDT and 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, 2,4'-DDD	
Dieldrin	Dieldrin	Dieldrin	Dieldrin	
Endrin	Endrin	Endrin	Endrin	
HCB	HCB	HCB	HCB	
Heptachlor	Heptachlor and heptachlorepoxide	Heptachlor and heptachlorepoxide	Heptachlor and heptachlorepoxide	
Mirex	Mirex	Mirex	Mirex	
PCB	ΣPCB_6 (6 congeners): 28, 52, 101, 138, 153, and 180	ΣPCB_6 (6 congeners): 28, 52, 101, 138, 153, and 180	ΣPCB_6 (6 congeners): 28, 52, 101, 138, 153, and 180	
	PCB with TEFs* (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189	PCB with TEFs* (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189	PCB with TEFs* (12 congeners): 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189	
PCDD/PCDF	2,3,7,8-substituted PCD/PCDF (17 congeners)	2,3,7,8-substituted PCD/PCDF (17 congeners)	2,3,7,8-substituted PCD/PCDF (17 congeners)	
Toxaphene	Congeners P26, P50, P62	Congeners P26, P50, P62	Congeners P26, P50, P62	

Global monitoring plan for POPs

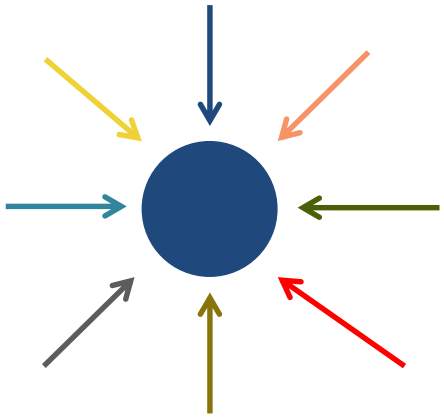
Stockholm Convention Regional Centre for Capacity Building and the Transfer of Technology

Substances to be monitored
GMP Guidance, chapter 2.2. table 2.2.

POPs listed at COP-4				
	Air	Human Milk	Human Blood	Water
Chlordecone	Chlordecone	Chlordecone	Chlordecone	
α-HCH	α-HCH	α-HCH	α-HCH	
β-HCH	β-HCH	β-HCH	β-HCH	
γ-HCH	γ-HCH	γ-HCH	γ-HCH	
Hexabromobiphenyl	PBB 153	PBB 153	PBB 153	
Pentachlorobenzene	PeCBz	PeCBz	PeCBz	
c-penta BDE c-octa BDE	BDE 47, 99, 153, 154, 175/183 (co-eluting) Optional: BDE 17, 28, 100	BDE 47, 99, 153, 154, 175/183 (co-eluting) Optional: BDE 100	BDE 47, 99, 153, 154, 175/183 (co-eluting) Optional: BDE 100	
PFOS[6]	PFOS, NMeFOSA, NEtFOSA, NMeFOSE, NEtFOSE (linear and sum of PFOS)	PFOS (linear and sum of PFOS)	PFOS (linear and sum of PFOS)	PFOS (linear and sum of PFOS)
POPs listed at COP-5				
Endosulfan	α-, β-endosulfan; and endosulfan sulfate	α-, β-endosulfan; and endosulfan sulfate	α-, β-endosulfan; and endosulfan sulfate	
POPs listed at COP-6				
HBCD	α-HBCD, β-HBCD, γ-HBCD	α-HBCD, β-HBCD, γ-HBCD	α-HBCD, β-HBCD, γ-HBCD	α-HBCD, β-HBCD, γ-HBCD

GMP data collection

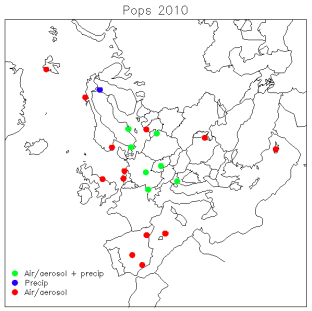
- GMP objective – put global data on POPs together
- Preferably by utilizing existing data and supporting capacity building in regions with a lack of data sources
- Main data sources – existing international and national monitoring programmes
- Data collection from heterogeneous sources



- Do we have suitable and sufficient sources of data?
- Are we able to utilize the data effectively?
- Are the data mutually comparable and interpretable?

Sufficient data sources?

Air-active monitoring



EMEP

- European Monitoring and Evaluation Programme
- 21 countries (Europe)
- OCPs, indicator PCBs, dl-PCBs

AMAP

- Arctic Monitoring and Assessment Programme
- 5 countries
- OCPs, indicator PCBs

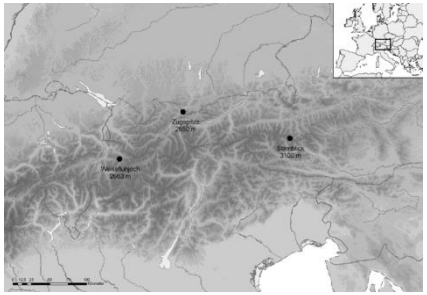
IADN

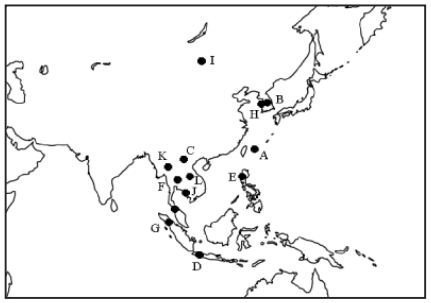
- Integrated Atmospheric Deposition Network
- 2 countries (Canada, USA)
- OCPs, indicator PCBs

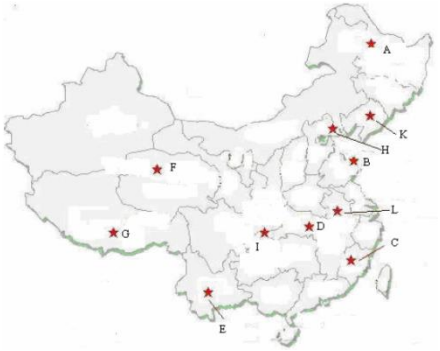
Sufficient data sources?

Stockholm Convention Regional Centre for Capacity Building and the Transfer of Technology

Air-active monitoring







MONARPOP

- Monitoring Network in the Alpine Region for Persistent and other Organic Pollutants
- 3 European countries
- OCPs, indicator PCBs, PBDEs, dl-PCBs, PCCD/Fs

POPs Monitoring Project in East Asian Countries

- 8 countries
- OCPs

POPs Background Survey

- 1 country (China)
- PCBs, PCDDs

Chemicals in the Environment

- 1 country (Japan)
- OCPs, dl-PCBs, PBDEs, PCCD/Fs

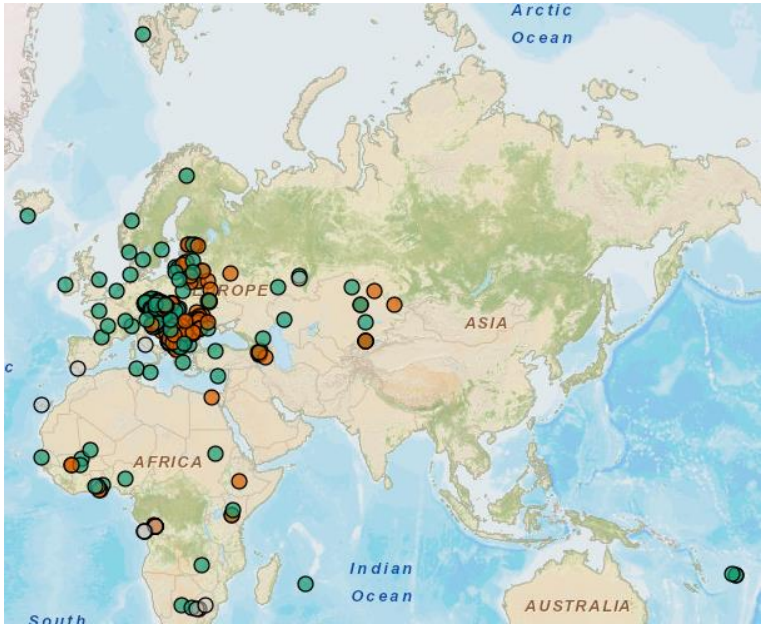
Sufficient data sources?

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

Air-passive monitoring

GAPS

- 43 countries
- OCPs, PCBs, PCDD/Fs



MONET

- 55 countries
- OCPs, PCBs, PCCD/Fs

Sufficient data sources?

Human milk

WHO human milk surveys

- 68 countries
- OCPs, PCBs, PCDD/Fs
- Several rounds since 1987; recently with UNEP

Countries	Round 1	Round 2	Round 3	Round 4	Round 5
	1987-1989	1992-1993	2000-2003	2004-2007	2008-2012
Antigua and Barbuda					x
Australia			x		x
Austria	x	x			
Barbados					x
Belgium	x	x	x	x	x
Brazil			x		
Bulgaria			x		
Canada	x	x			
Chile					x
Croatia			x		
Congo					x
Cote d'Ivoire					x
Cyprus				x	
Cuba					x
Czech Republic			x	x	
Djibouti					x
Denmark	x	x			
Egypt			x		
Ethiopia					x
Fiji			x	x	x
Finland	x	x	x	x	
Germany	x	x	x		
Georgia					x
Ghana					x
Haiti				x	x
Hong Kong			x		x
Hungary			x	x	
India					x
Indonesia					x
Ireland			x		x
Italy			x		
Israel					x
Jamaica					x
Kenya					x
Countries	Round 1	Round 2	Round 3	Round 4	Round 5

	1987-1989	1992-1993	2000-2003	2004-2007	2008-2012
Kiribati				x	x
Korea, Rep.					x
Lithuania					x
Luxembourg			x	x	
Mali					x
Marshall Islands					x
Mauritius					x
Mexico					x
Moldova					x
Netherlands	x	x	x		
New Zealand	x		x		x
Niue					x
Niger					x
Nigeria					x
Norway	x	x	x	x	
Palau					x
Peru					x
Philippines			x		
Romania			x		
Russian Fed.			x		
Samoa					x
Senegal					x
Solomon Islands					x
Slovak Republic			x	x	
Spain		x	x		
Syria					x
Sudan				x	
Sweden	x		x	x	
Switzerland					x
Tajikistan					x
Togo					x
Tonga					x
Tuvalu					x
Uganda				x	
Ukraine			x		
United Kingdom	x	x			
Uruguay					x
USA	x		x		

Source:
Human exposure to POPs across the Globe: POPs levels and human health implications. Results of the WHO/UNEP Survey (UNEP 2012)
UNEP/POPS/COP.6/INF/33

Sufficient data sources?

Human blood

- National surveys
- **Blood source**
  - Blood – other
  - Blood – maternal
  - Blood – children
  - Blood – cord
- **Fraction**
  - Plasma
  - Serum
  - Whole blood

Sufficient data sources?

Water

- Recommended for PFOS only

Reliable sources:

- Established monitoring sites
- Cruises
- Publications

Comparability and interpretability

- Data heterogeneity among the monitoring programmes
  (sampling frequency, compounds, data granularity…)

- It is essential to design a standardized data structure and set up a basic level for data quality and reliability
  („A chain is only as strong as its weakest link“)

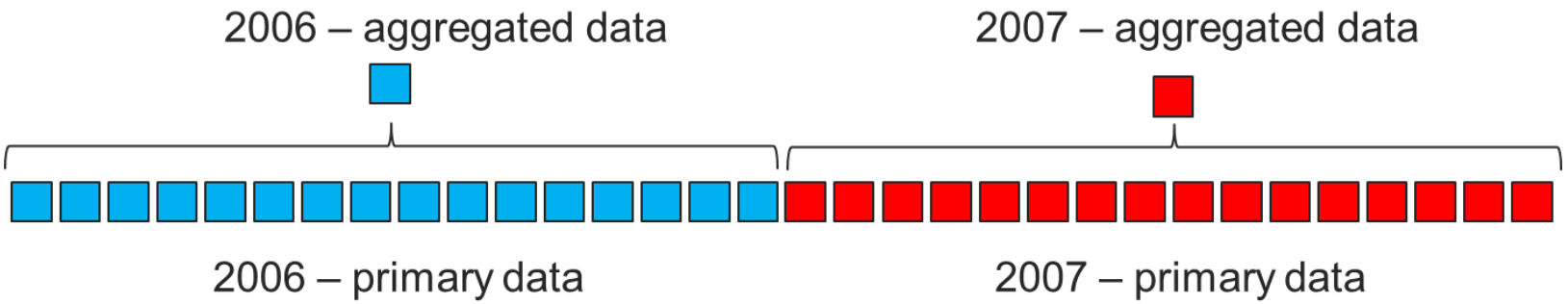
Correct aggregation and interpretation

- unambiguous determination of compound (parameter), matrix, unit, time scale, sampling method etc.

- **Nomenclature:**
  DDT × ddt; p,p-DDT × p,p‘-DDT;
  endosulfan I × endosulfan alpha
- **Sums description:**
  “chlordanes”, “PCBs”, “DDTs” … (what is inside?)
- **Units:**
  pg/m^3 × ng/m^3; pg/l × pg/g fat

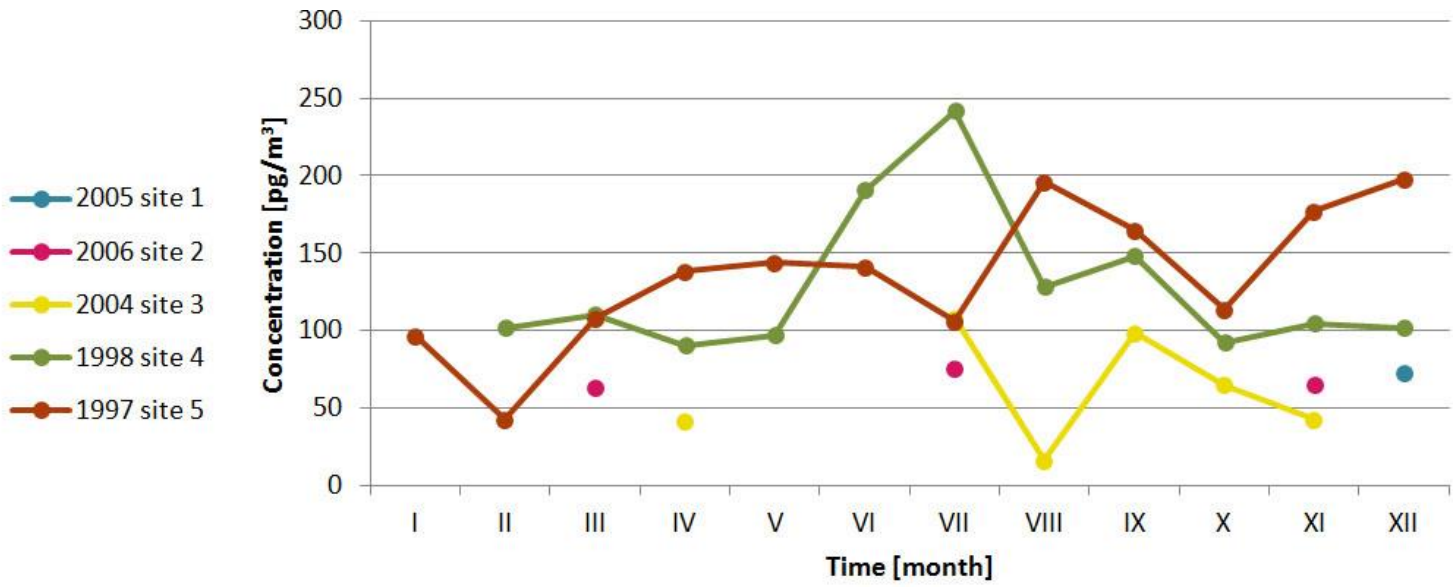
Correct aggregation and interpretation

- Crucial step in the data preprocessing
- Homogenize primary sampling data with various granularity to aggregated values characterizing given year

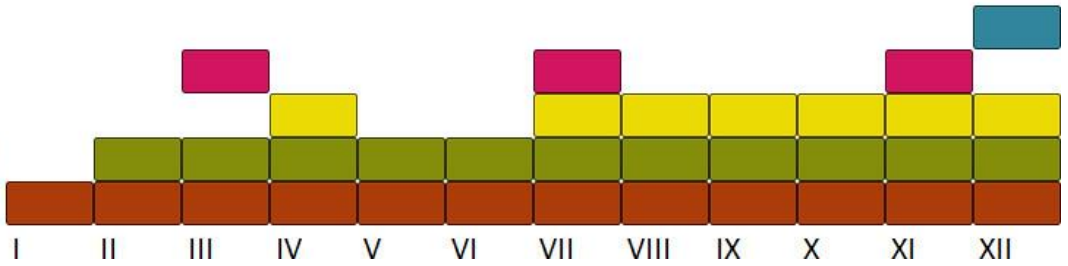


- The data in given year are described by:
  - Number of samples
  - Central tendency (mean, median)
  - Variability
  - Data quality – sampling frequency and equidistance

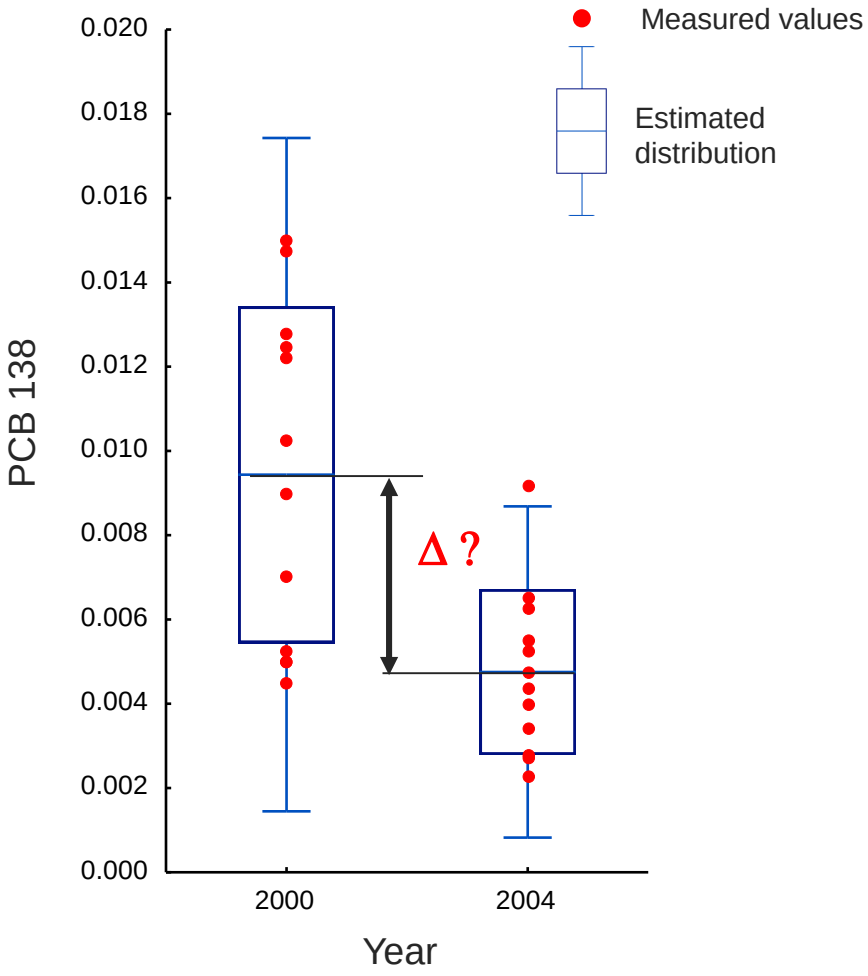
Correct aggregation and interpretation

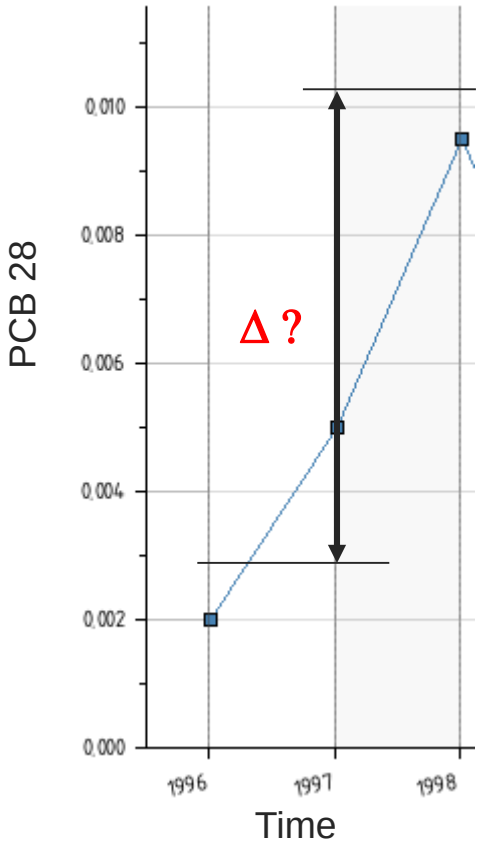


2005 site 1	low density, non-equidistant
2006 site 2	low density, equidistant
2004 site 3	transitional, non-equidistant
1998 site 4	high density, non-equidistant
1997 site 5	high density, equidistant

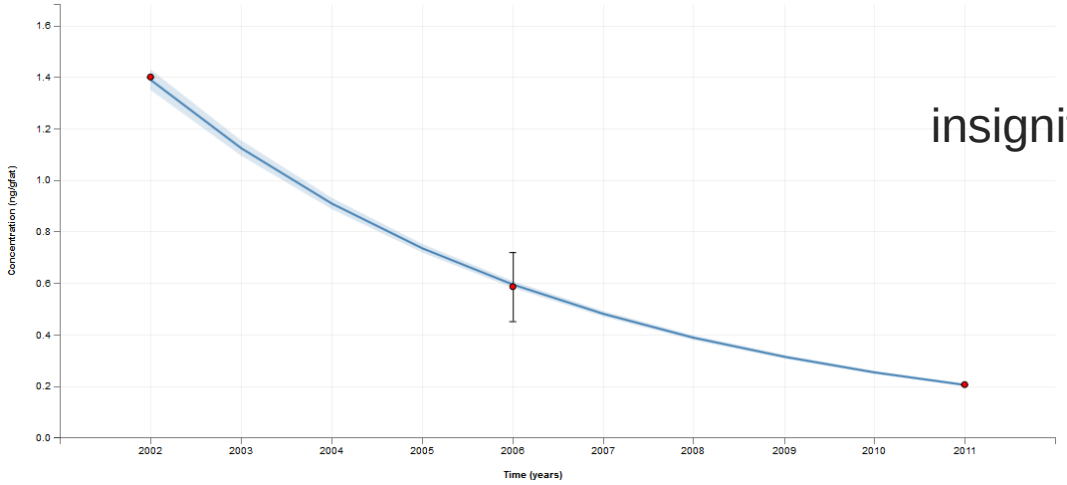


Trends assessment

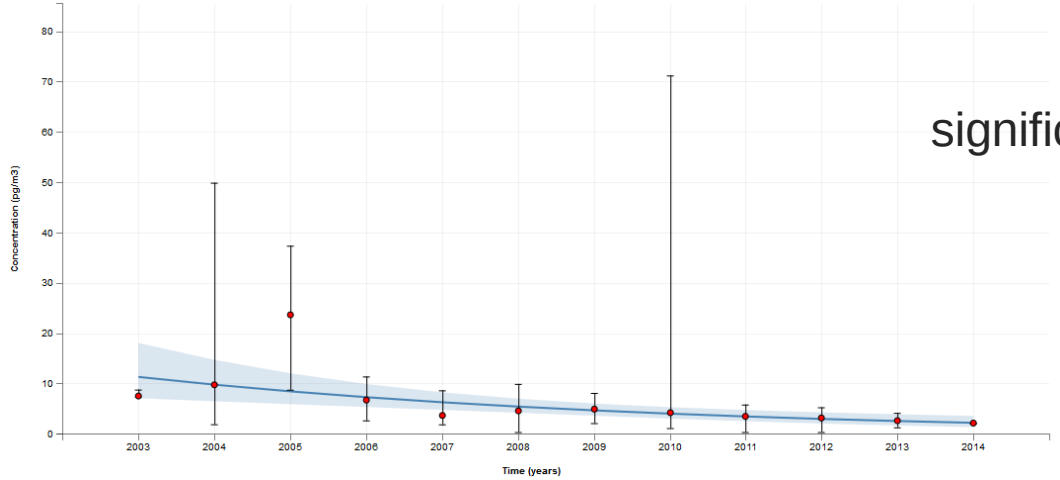




Trends assessment



insignificant trend



significant trend

Global monitoring plan – the past

- 2007
  - GMP launched
  - GMP Guidance v. 01 published
- 2008
  - First data collection campaign
  - Further data collection campaigns in 6-year intervals

Global monitoring plan – the past

- 2009
  - Five regional monitoring reports adopted by the COP4





Available at: http://chm.pops.int/Implementation/GlobalMonitoringPlan/MonitoringReports/tabid/525/Default.aspx

Global monitoring plan – the past

- 2011–2014
  Mandate of the GMP Global Coordination Group and Secretariat of the SC to RECETOX and IBA MU to perform:
  - Propose an electronic system for next **data collection** campaigns
  - Develop visualization tools to facilitate data browsing and analysis

GMP data collection

GMP Guidance, chapter 6.5.2.

GMP data storage (compilation and archiving)

"The data reporting model that is being suggested involves compiling and archiving primary GMP data within a 'regional data repository' in each of the 5 geographic regions. In addition to the regional data centres, a single GMP 'data warehouse' will be established to compile and archive aggregated data, data products and results"

GMP Data Warehouse (GMP DWH)

Experience with GMP1 reflected in proposals for future GMP campaigns and GMP DWH design:

- Electronic data collection
- Standardized parametric data structure
- Standardized predefined code lists
- Visualization tools

GMP Data Warehouse

PCB 153 was monitored at the Košetice station in 2013. 26 values were collected by means of air-active sampling. Median value was 1.457 pg/m^3, mean value 1.633 pg/m^3, maximum concentration reached 4.382 pg/m^3.

Air-active monitoring of PCB 153 at the Košetice station was performed in 2013. Median of the total 26 values was 1.457 pg/m^3. Mean value was higher and reached 1.633 pg/m^3.

Site	Year	Parameter	N	Mean	Median	Minimum	Maximum	Unit
Košetice	2013	PCB 153	26	1.633	1.457	0.506	4.382	pg/m^3

GMP Data Warehouse

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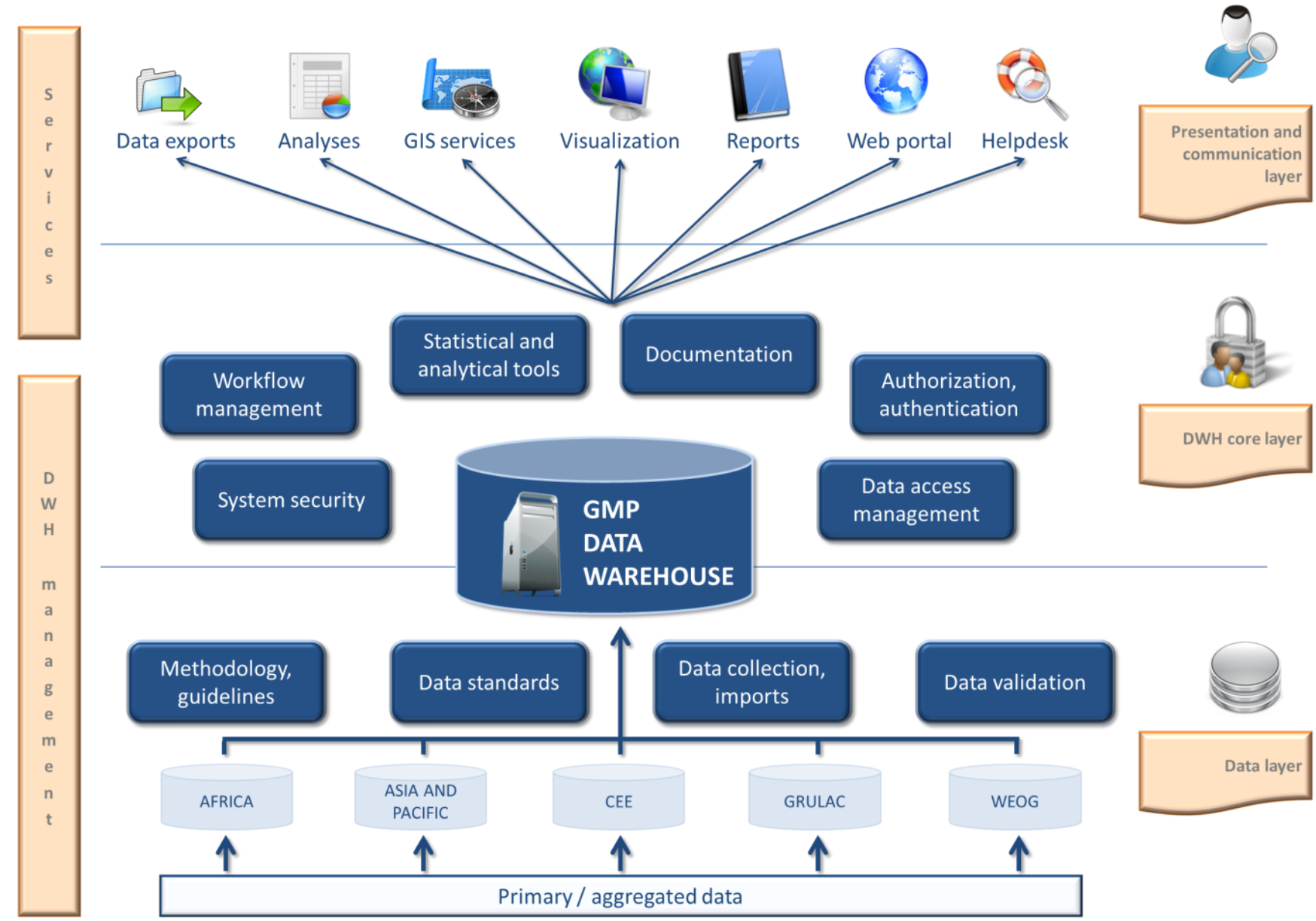

GMP data collection

- Data providers identified by ROGs

- Data reported as:
  - Annually aggregated
  - Primary (and later aggregated in GMP DWH)
- By means of:
  - Online forms
  - MS Excel sheets
  - Public data sources (EBAS, NatChem, GENASIS)

- **Important: data ownership must always be respected!**

GMP data collection

Stockholm Convention
Regional Centre for Capacity Building
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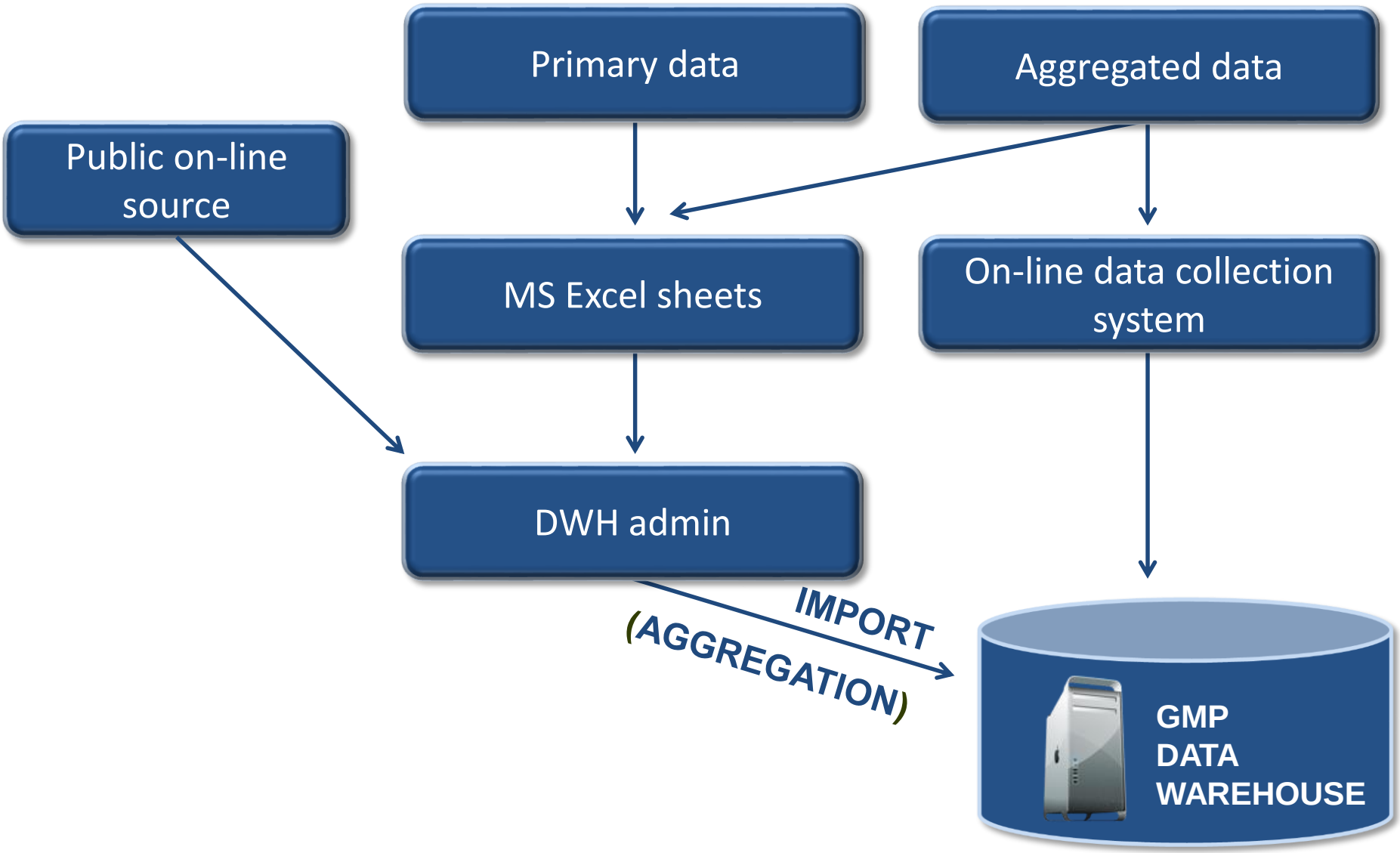

GMP DWH data flow

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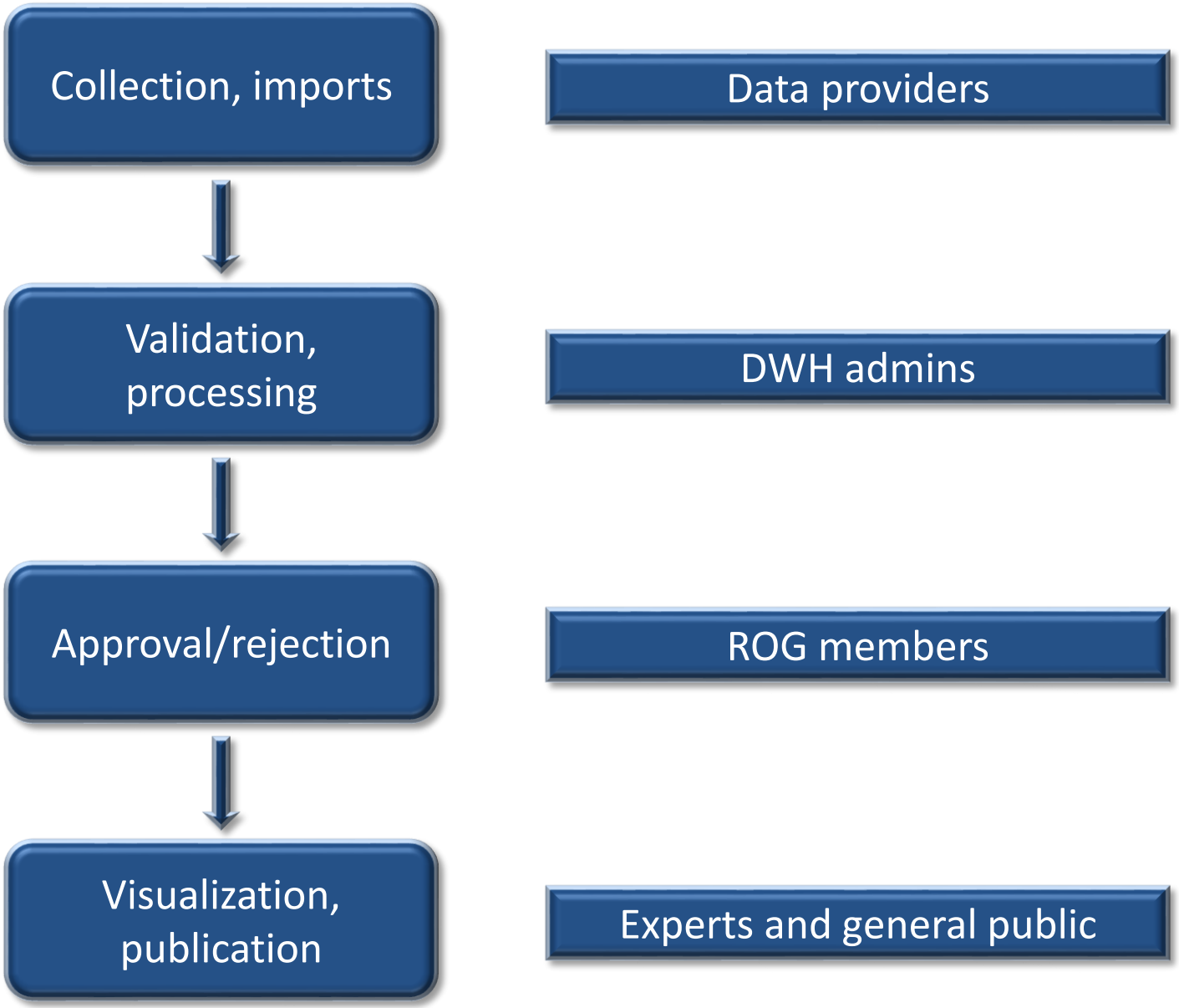

Data access management

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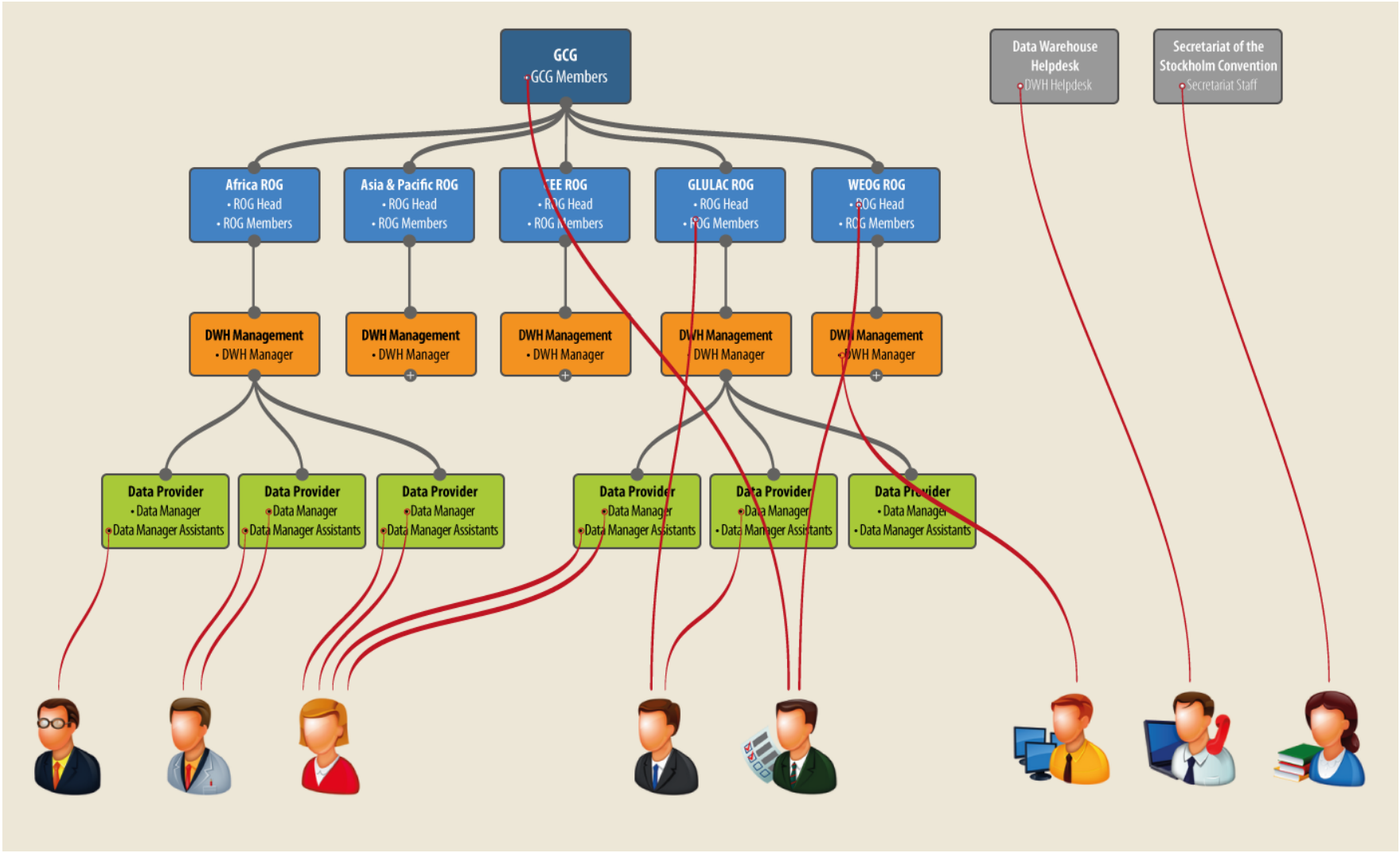
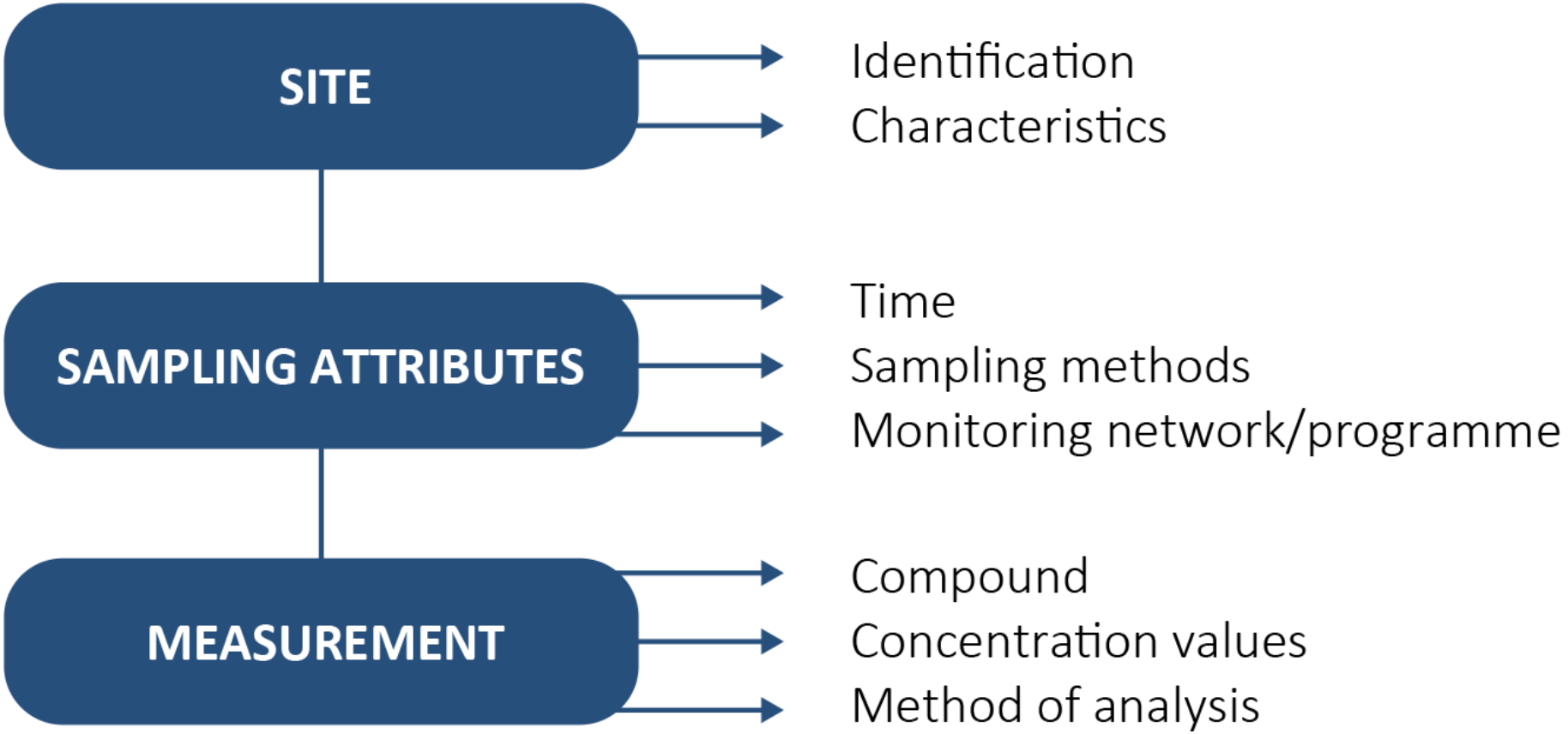
User groups

Users ⟷ User rights



Data structure

- All items grouped into 3 hierarchical sections:



Data structure – air

Stockholm Convention Regional Centre for Capacity Building and the Transfer of Technology

Site

- Site ID (number)
- Site name (text)
- Longitude (number)
- Latitude (number)
- Region (code list)
- Country (code list)
- Site type (code list)
- Potential source type (code list)

Sampling attributes

- Year (number)
- Start of sampling (number)
- End of sampling (number)
- Type of sampling (code list)
- Type of passive sampling (code list)
- Recalculation (code list)
- Calibration description (text)
- Monitoring programme/network (text)

Measurement

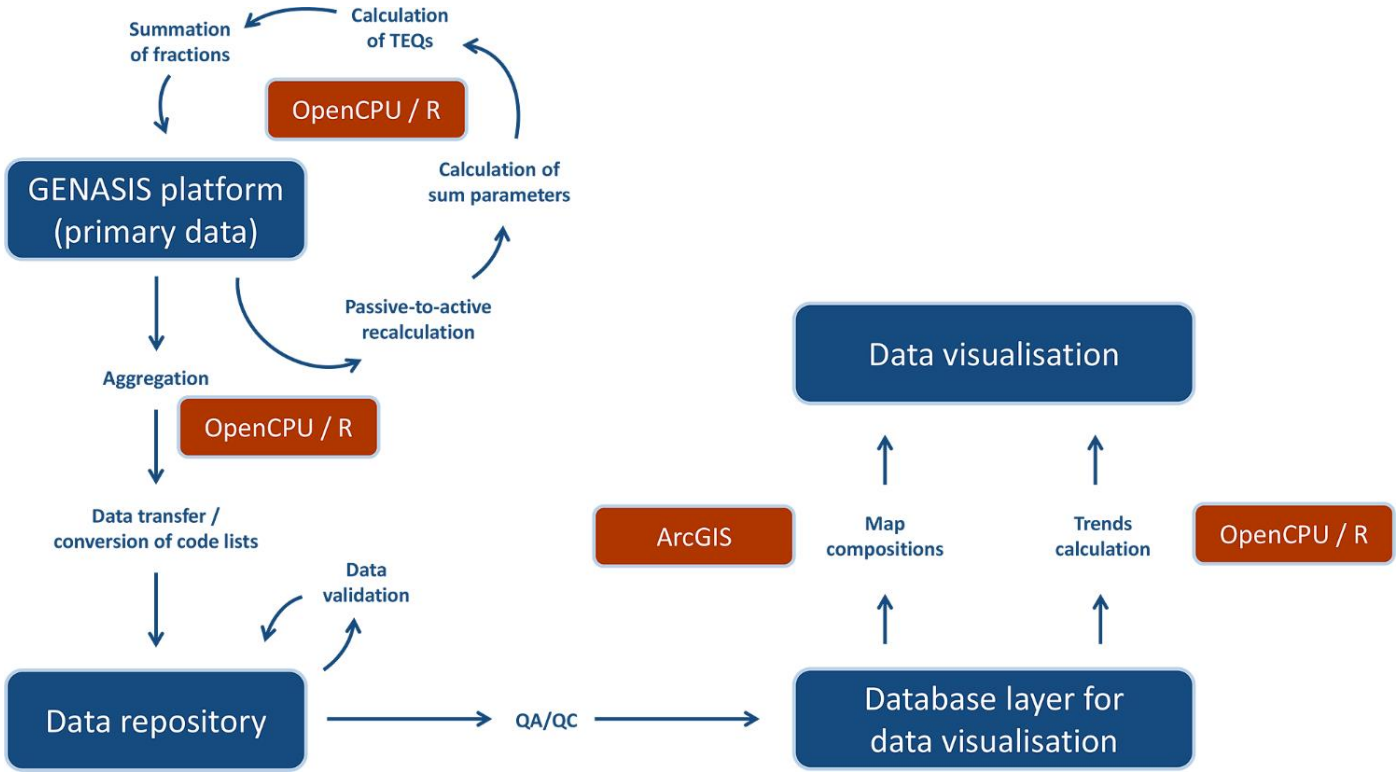
- Chemical – group (code list)
- Parameter (code list)
- Method (code list)
- LOQ (number)
- No. of values (number)[A]
- No. under LoQ (number)[A]
- Value (number)[P]
- Value (mean) (number)[A]
- Value (median) (number)[A]
- Minimum (number)[A]
- Maximum (number)[A]
- 5th percentile (number)[A]
- 95th percentile (number)[A]
- SD (number)[A]
- Laboratory (text)

[A] – the item is valid for aggregated data reporting only
[P] – the item is valid for primary data reporting only

Statistical and analytical tools

- R package
- Data aggregation
- Trend assessment

Find more at:
http://www.genasis.cz/time-series/



GMP DWH – where to start

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

Web portal

- Information on GMP
- System documentation

http://www.pops-gmp.org/

Data repository

- Authorised access
- Data import, processing, validation
- Data approval

http://dwh.pops-gmp.org/

Data visualization

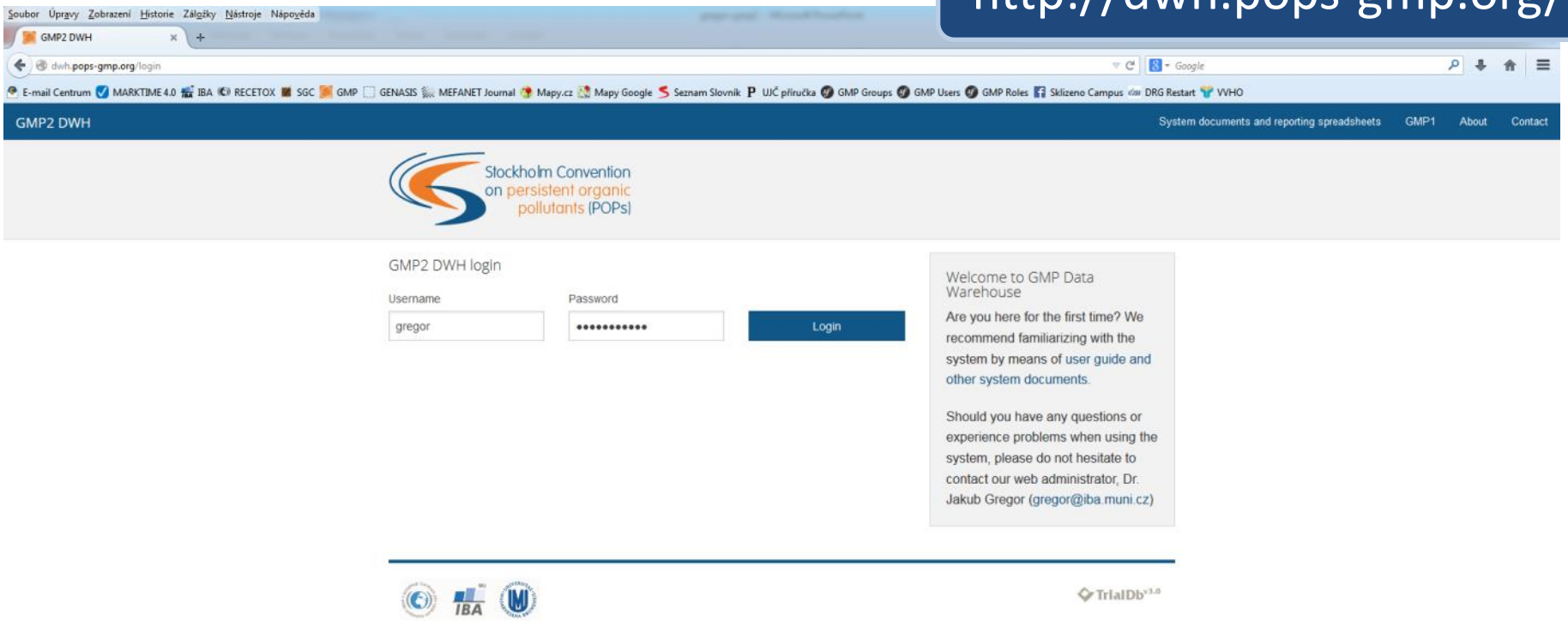
- Public access
- Descriptive statistic analysis
- Time trends assessment

http://visualization.pops-gmp.org/2014/

Data collection – online forms

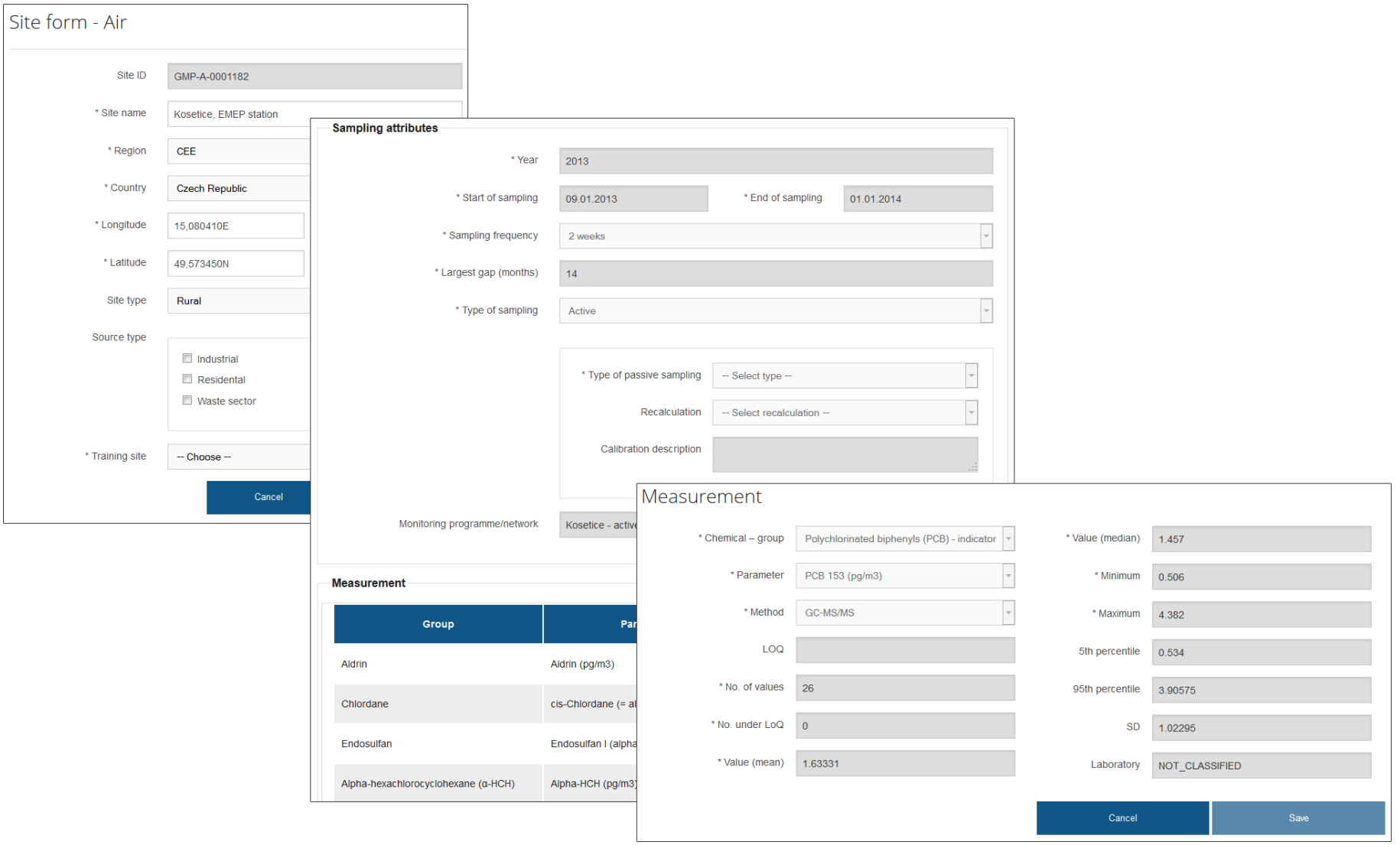
Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

http://dwh.pops-gmp.org/



Data collection – online forms

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology



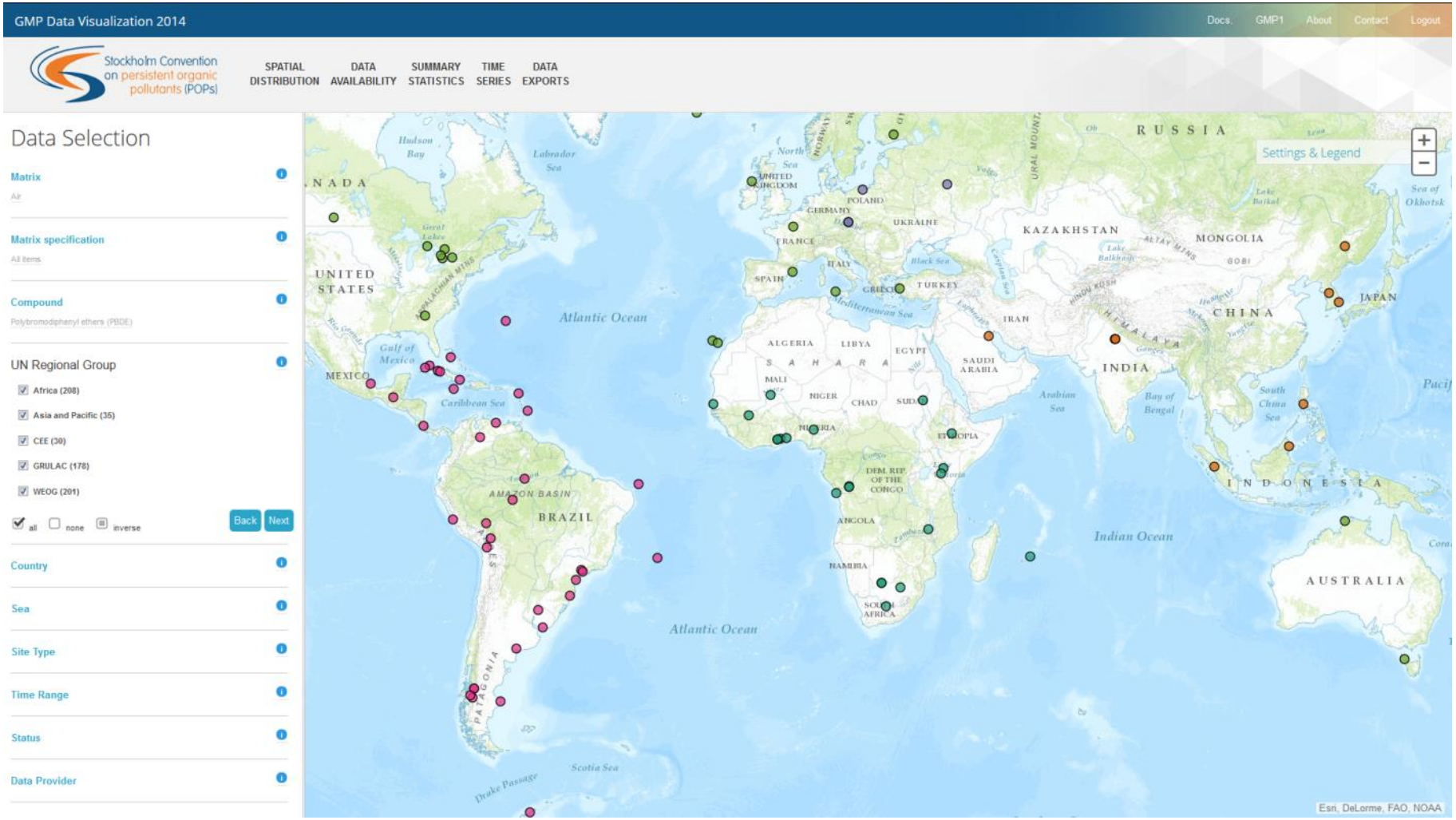
Data visualization – GMP 2 (2014)

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

http://visualization.pops-gmp.org/2014/

Data visualization – GMP 2 (2014)

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology



Data visualization – GMP 2 (2014)

Stockholm Convention
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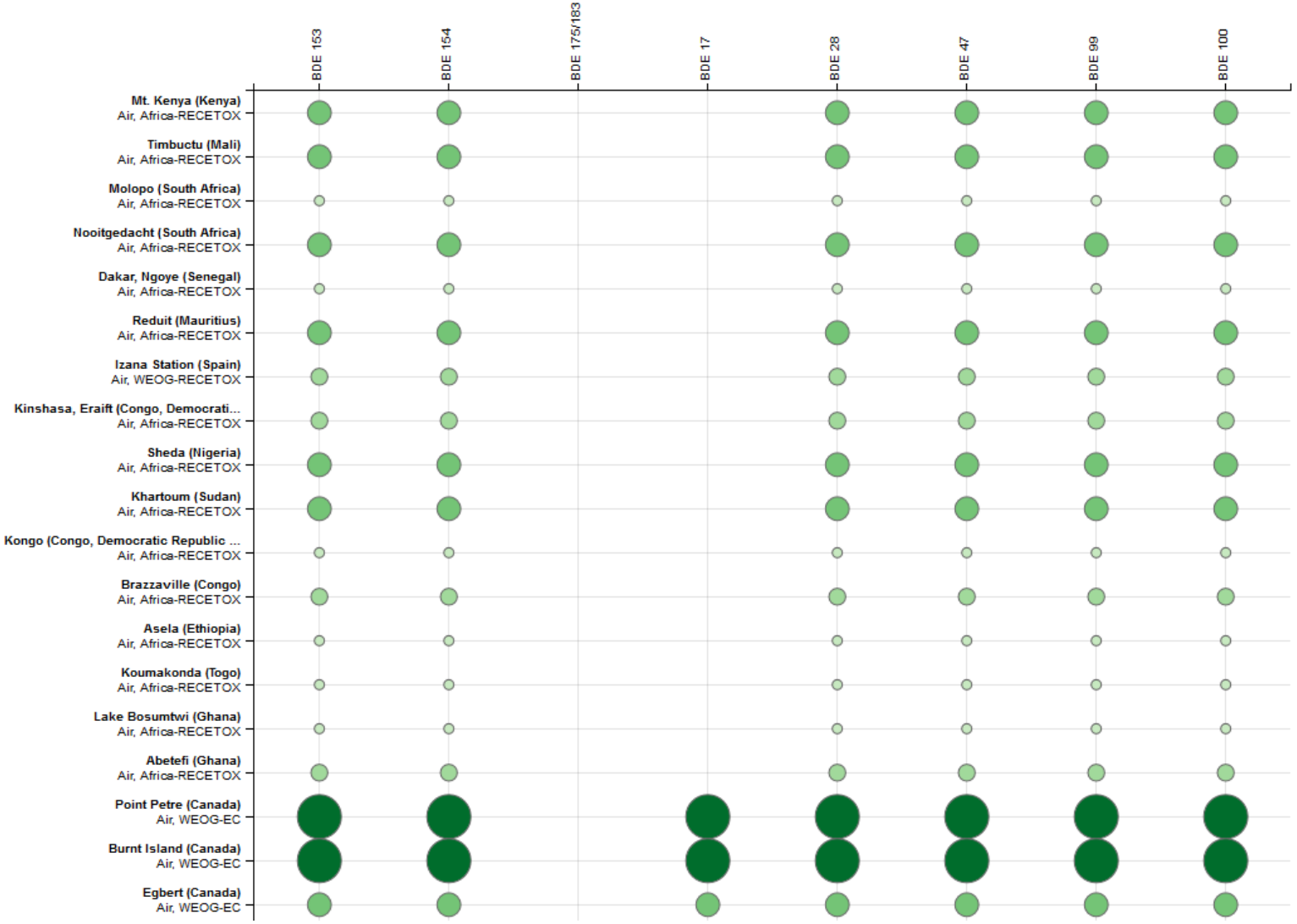
and the Transfer of Technology



Data visualization – GMP 2 (2014)

Stockholm Convention
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and the Transfer of Technology

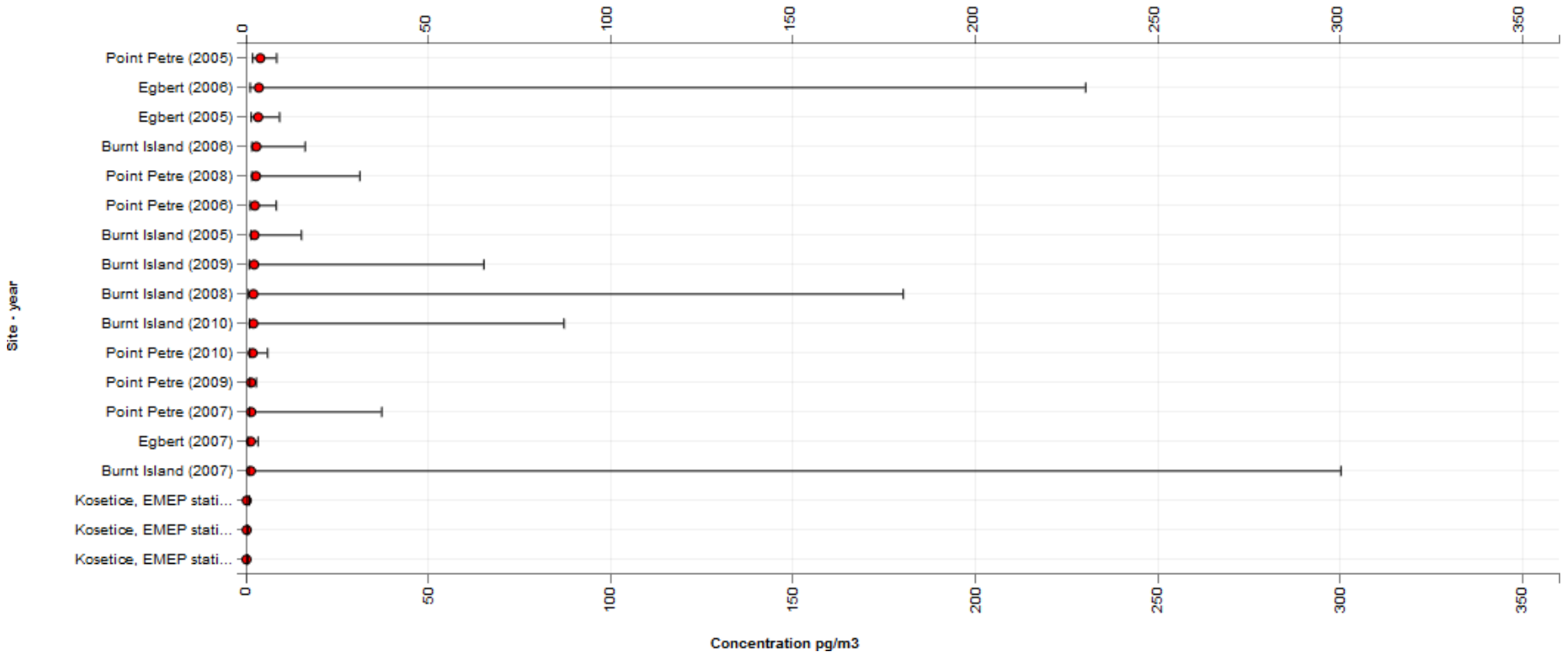
Matrix: Air

Matrix specification: Active

Compound: Polybromodiphenyl ethers (PBDE

Parameter: BDE 99

Unit: pg/m3



Data visualization – GMP 2 (2014)

Stockholm Convention
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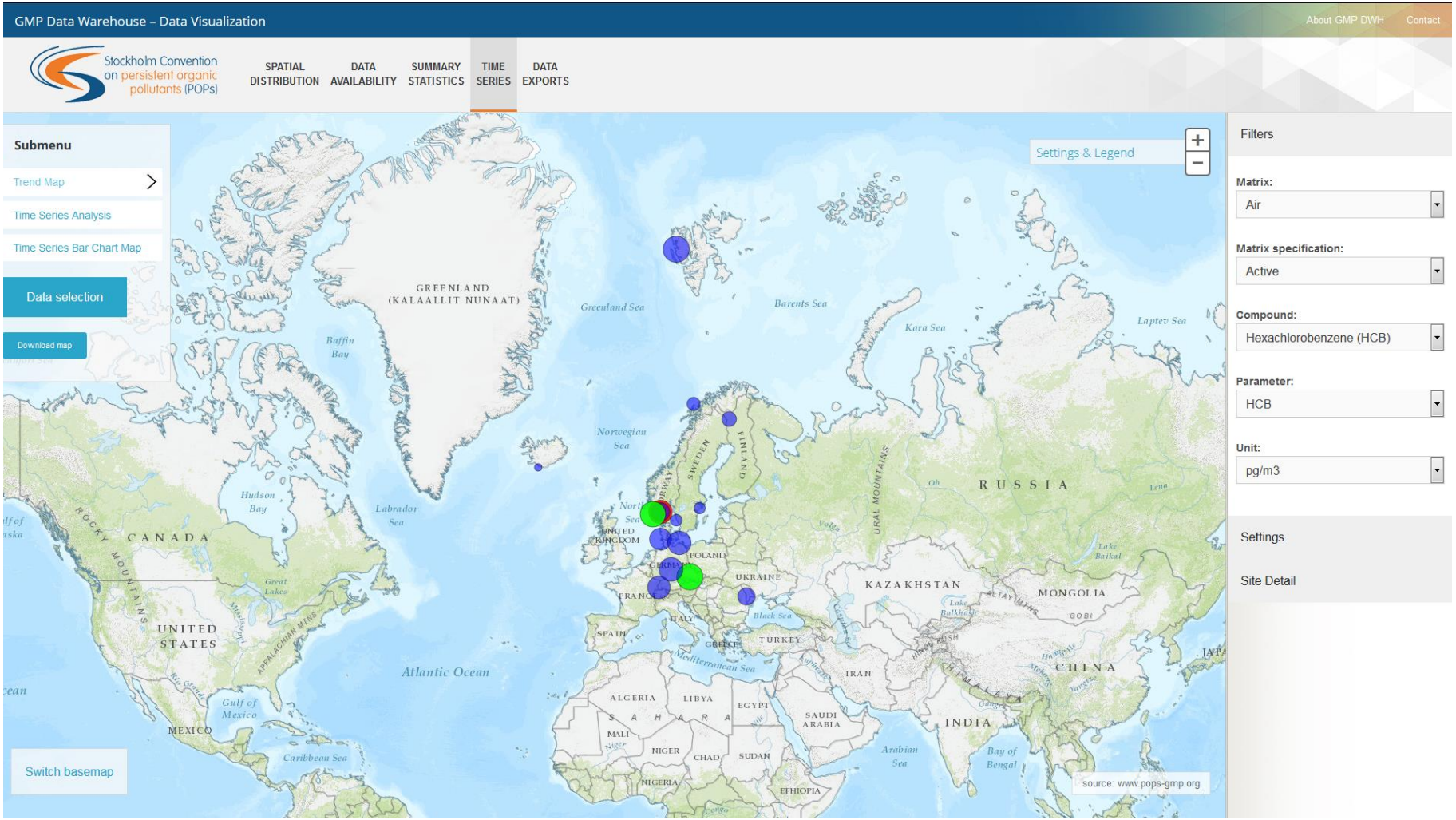


Data visualization – GMP 2 (2014)

Stockholm Convention
Regional Centre for Capacity Building
and the Transfer of Technology

Matrix: Air

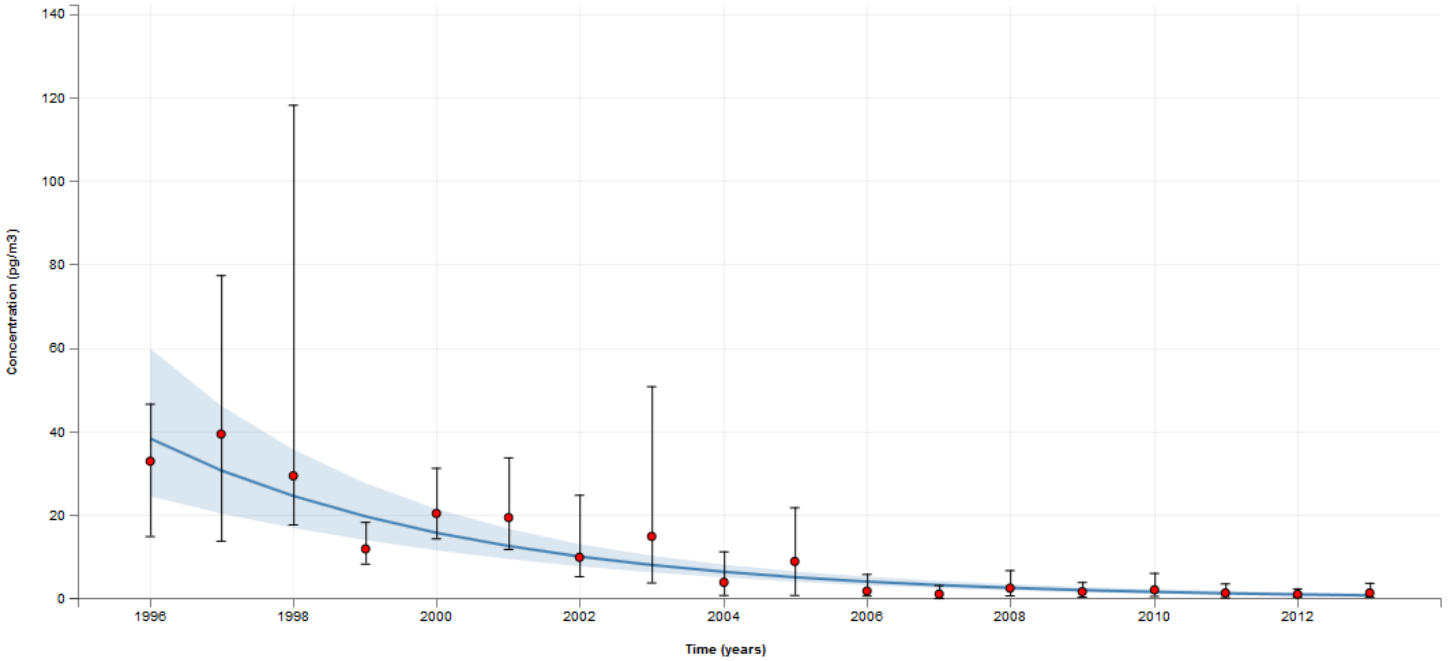
Matrix specification: Active

Compound: Polychlorinated biphenyls (PCB) -

Parameter: PCB 153

Unit: pg/m3

Site: Kosetice, EMEP station



Summary

Mean	11.428 pg/m3
Median	6.5 pg/m3
Minimum / maximum	1.15 – 39.5 pg/m3
5th percentile / 95 percentile	1.1925 – 33.975 pg/m3

Trend description

Delta	-31.543 pg/m3
Mann-Kendal test	-0.79085 (p = 2.2949E-7)
Daniels test	-0.9257 (p = 0)

Data visualization – GMP 2 (2014)

Stockholm Convention Regional Centre for Capacity Building and the Transfer of Technology

Export Sites

Show 25 entries

Search:

Site ID	Site Name	Latitude	Longitude	UN Region	Country	Site Type	Data Provider
GMP-A-0000358	Leova II	46,488330N	28,283330E	CEE	Moldova, Republic of		CEE-NILU
GMP-A-0000360	Sevan, Tsovagyug						
GMP-A-0000361	Amberd						
GMP-A-0000362	Artashat						
GMP-A-0000363	Berezinsky nature reserve						
GMP-A-0000364	Visokoie						
GMP-A-0000365	Lazaropole						
GMP-A-0000366	Bujkovci						

Analytical Methods Summary

Show 25 entries

Search:

Matrix	Compound	Analytical Method
Air	Aldrin	GC-MS-NCI
Air	Aldrin	GC-MS/MS
Air	Aldrin	GC-MS/MS
Air	Alpha-hexachlorocyclohexane (α-HCH)	GC-MS
Air	Alpha-hexachlorocyclohexane (α-HCH)	GC-MS/MS
Air	Alpha-hexachlorocyclohexane (α-HCH)	GC-MS
	Alpha-	

Data Sources Summary

Show 25 entries

Search:

Matrix	Matrix Specification	Monitoring Programme	First Year	Last Year	Num. of Compounds	Num. of Sites
Air	Active	AMAP	2008	2009	12	1
Air	Active	EMEP	2009	2010	7	2
Air	Active	Kosetice	1996	2011	20	1
Air	Active	Kosetice - active air sampling	2012	2013	21	1
Air	Active	NOT_CLASSIFIED	2012	2012	8	1
Air	Passive	APOPSBAL	2004	2004	7	1
Air	Passive	GAPS	2004	2009	12	3
Air	Passive	MONET - CEEC	2006	2008	7	54
Air	Passive	MONET - CZ	2003	2014	7	15
Air	Passive	MONET - EU	2009	2013	7	21
Air	Passive	NOT_CLASSIFIED	2011	2012	7	4

How to access

- GMP DWH is implemented fully on-line and accessible via Internet

- Standard web browsers (Internet Explorer, Mozilla Firefox, Google Chrome)
  – recent versions highly recommended!



THANK YOU FOR YOUR ATTENTION

www.pops-gmp.org

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