Workshop 'Modélisation 3D de la Plaine du Rhône / 3D Modellierung des Rhonetals'
Visp, 22.06.2017

New cantonal tools for addressing data requirements for groundwater modelling and decision-making issues

CREALP - Centre de recherche sur l'environnement alpin

Pascal Ornstein

Summary

1. **General framework**
2. **Groundwater modelling overview**
3. **Cantonal tools to manage and collect data**
4. **Data integration to GW model construction: example of boreholes information processing**
5. **Cantonal tools for decision-making :** QuantES Monitor / QualES Monitor / STRATES-VS

General Framework

- Groundwater is used for a variety of purposes : drinking water supply, domestic use, farming, industrial processes, etc.
- Groundwater exploration, exploitation and monitoring (water conservation) generates huge amount of data.
- Accurate and reliable information about groundwater resources (including quantity and quality) is critical for supporting planning and decision-making processes.
- Need to focus on efficient data management, reliable analysis and effective tools for dissemination of data.

General Framework

- Groundwater management strategy and policy must be based on :
  - *knowledge of the past and present behaviour of the groundwater system,*
  - *the expected responses to future changes (e.g. to climate change),*
  - *the assessment and the understanding of the uncertainties in those responses*
- Over last decades **groundwater models** and **NITCs** have proven to be useful tools for efficiently addressing such issues, supporting the decision-making process and promoting alternative management approaches

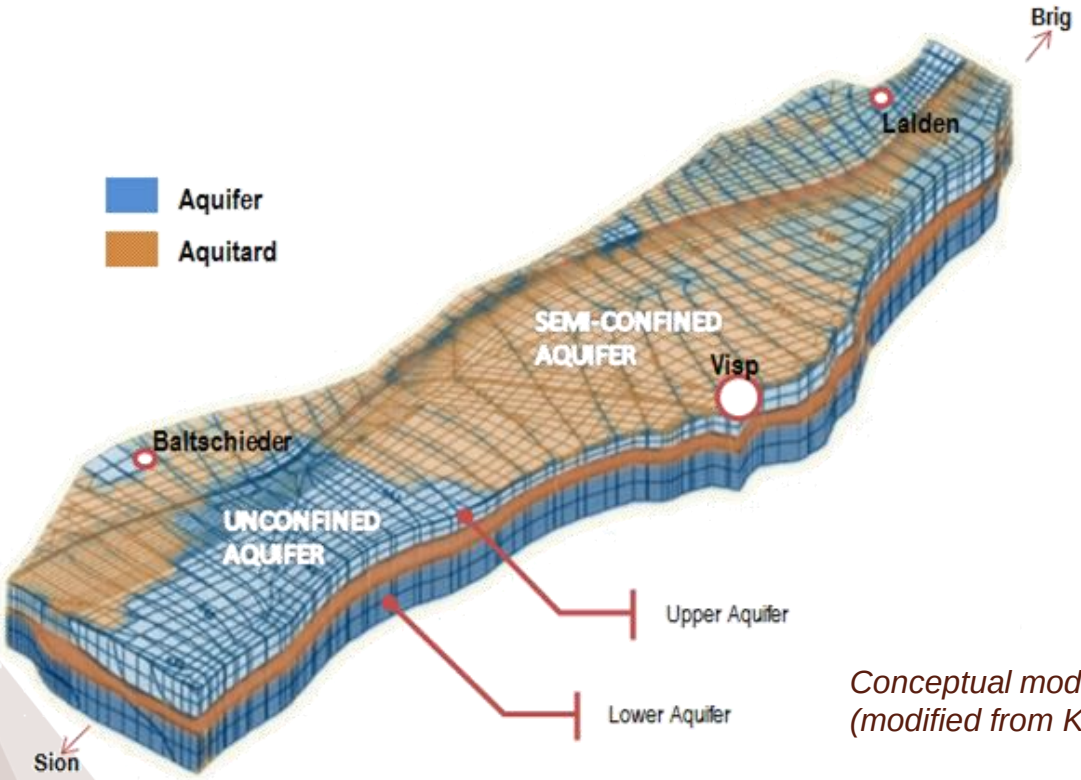
Groundwater modelling - overview

- A groundwater model is any computational method that represents an approximation of a natural (groundwater) system (*Anderson and Woessner 1992, modified*)
- As such, groundwater models are, by definition, a simplified representation of a complex reality
- Groundwater modelling can be applied to investigate and/or solve a broad range of groundwater problems. Two types models are classically implemented :
  - *Groundwater flow model (simulate the water levels and flow process)*
  - *Solute transport model (simulate the migration of solutes or heat)*

Groundwater modelling - overview

- A groundwater model study is a multistep process :

  First stage consists of compiling all relevant geological and hydrogeological data related to the groundwater basin to be modeled. This information is used to design a **conceptual model** of the basin

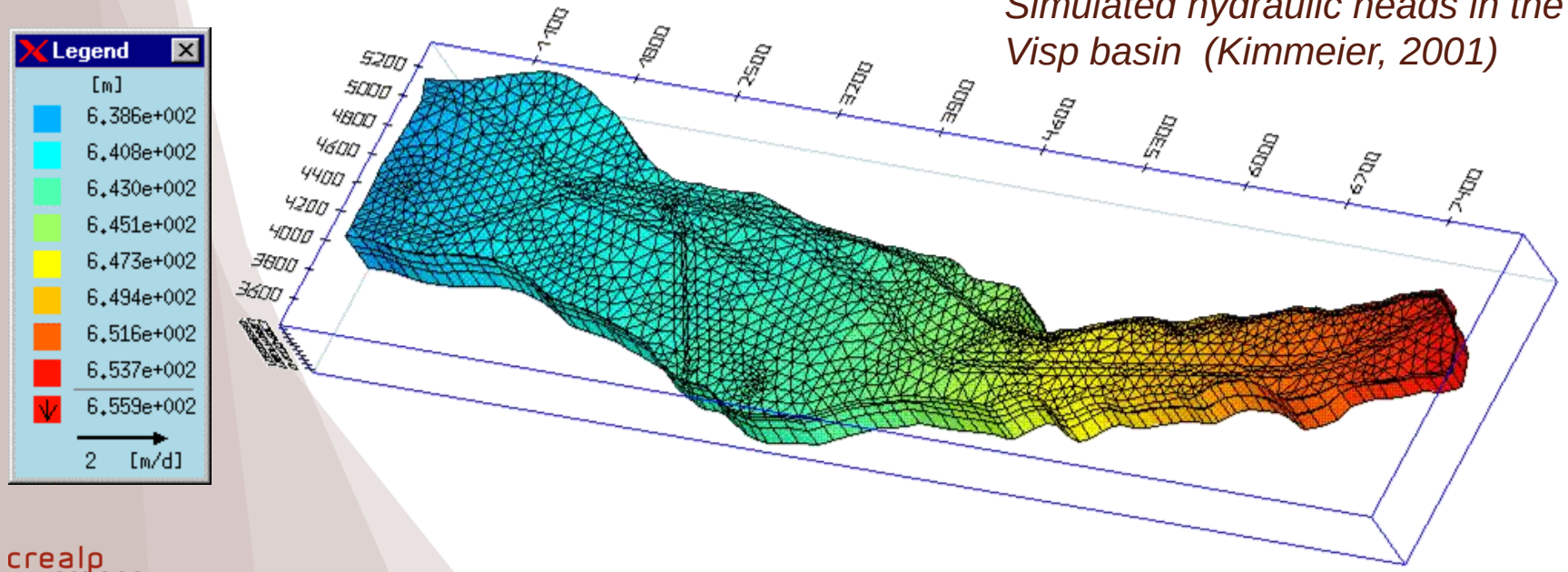


Conceptual model of the Visp basin (modified from Kimmeier, 2001)

Groundwater modelling - overview

- A groundwater model study is a multistep process :

  Next phase consists in implementing the **numerical model**. This model is used i) to integrate the set of geological and hydrogeological data, ii) to test hypothesis made in the conceptual model.



Simulated hydraulic heads in the Visp basin (Kimmeier, 2001)

Groundwater modelling - overview

Conceptualisation and implementation of a model requires a set of quantitative data that fall in two categories (not exhaustive):

Physical framework :

- Topography
- Landuse
- Geology
- Types of aquifers
- Aquifers thickness and lateral extent
- Aquifer boundaries
- Water courses

(*modified from Kumar, 2015)*

Hydrological model input:

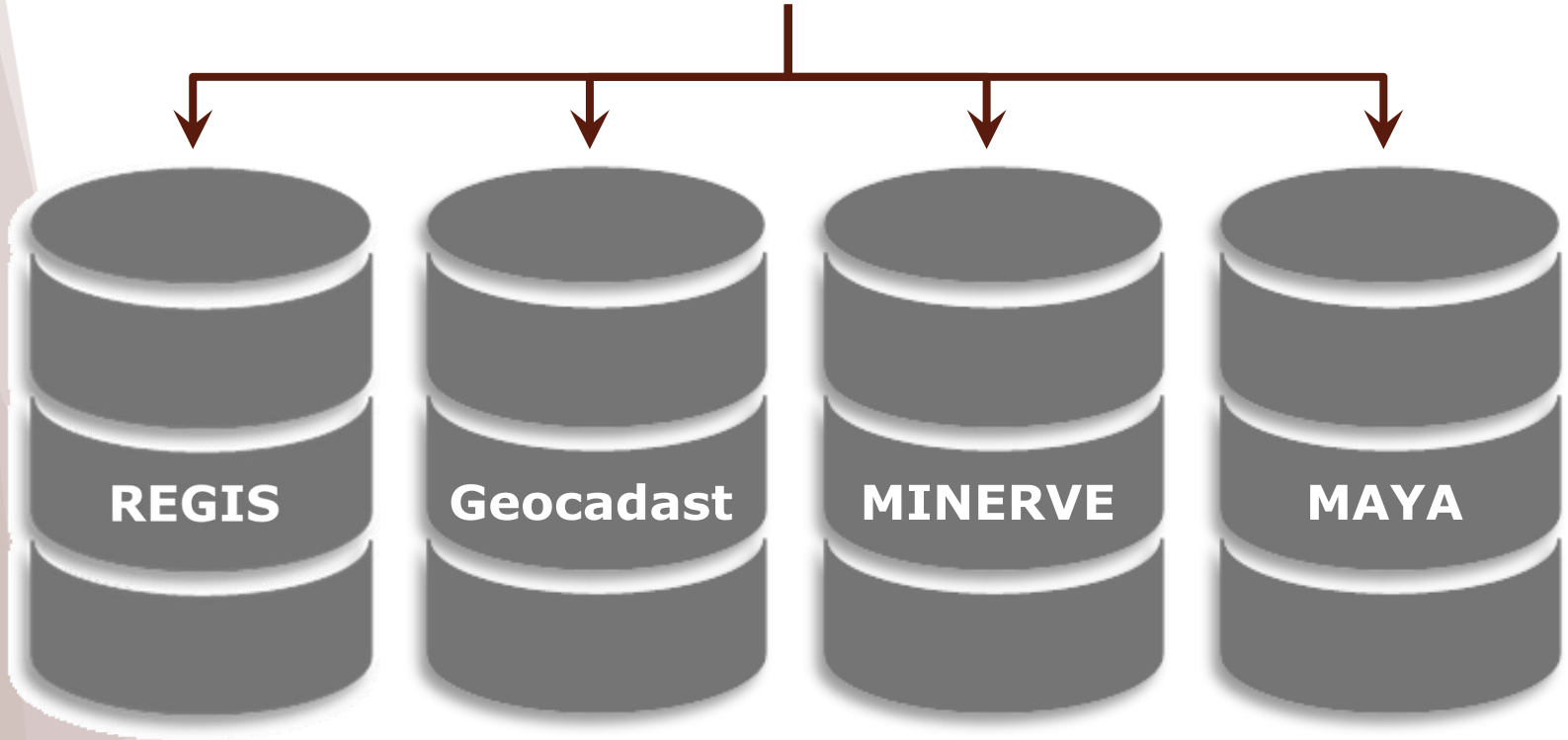
- Water table elevation
- Recharge areas (type and extent)
- Rate of recharge
- Dischagre areas (type and extent)
- Rate of discharge
- Boundary conditions
- Surface water (H, Q)

Groundwater modelling - overview

- Success of any modelling study is strongly depending upon :
  - *the location and availability of the required data*
  - *the spatial distribution, richness and validity of the data*
- Collection, organization, analysis and data checking (QA) stages form an integral part of the modelling process

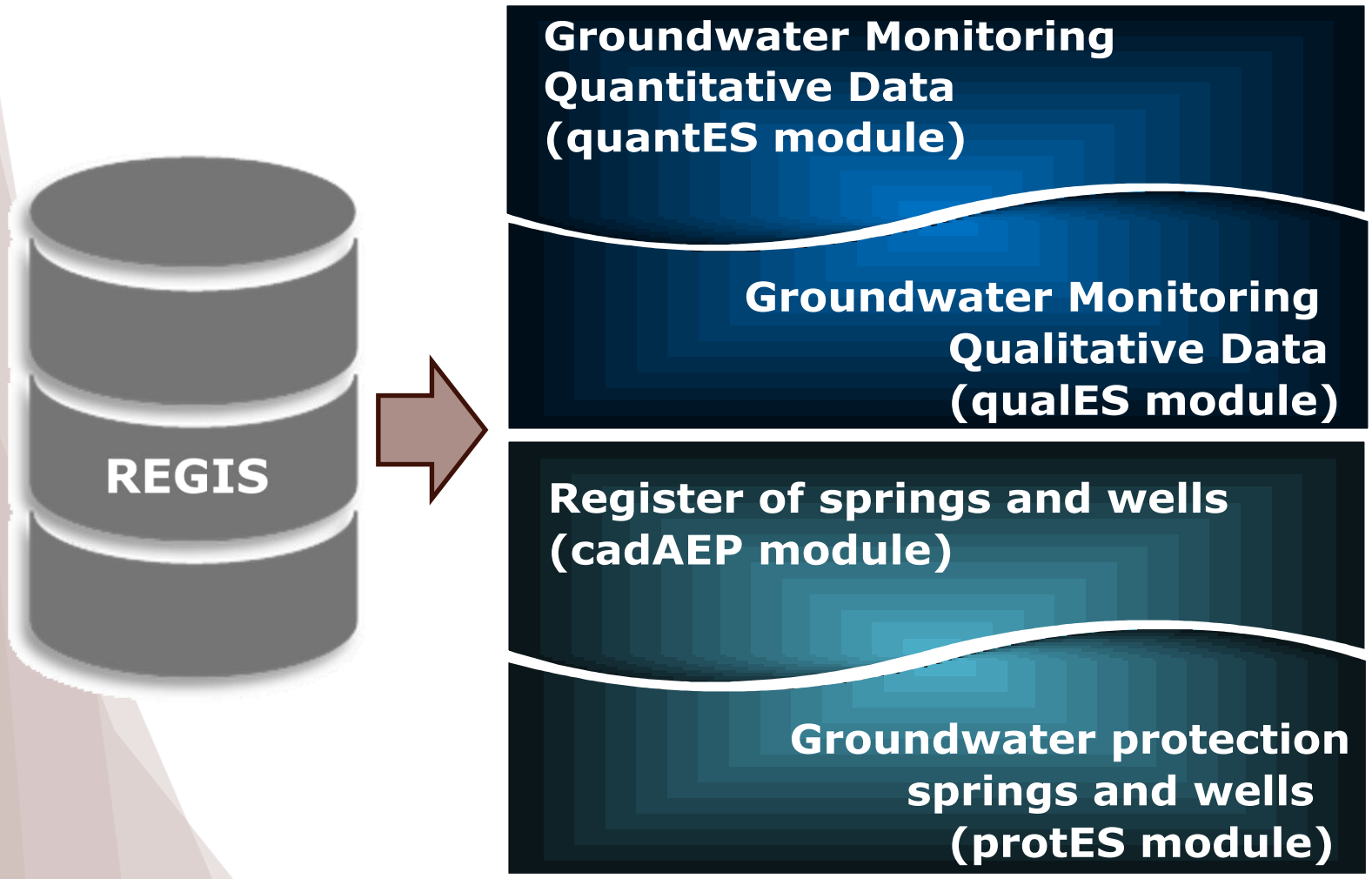
Cantonal tools to manage and collect data

Cantonal data repositories



Groundwater Data	Boreholes Data	Hydro-Meteo Data	Meteo Data (spatial)
(2003)	(2013)	(2015)	(2016)

Tools to manage and collect data



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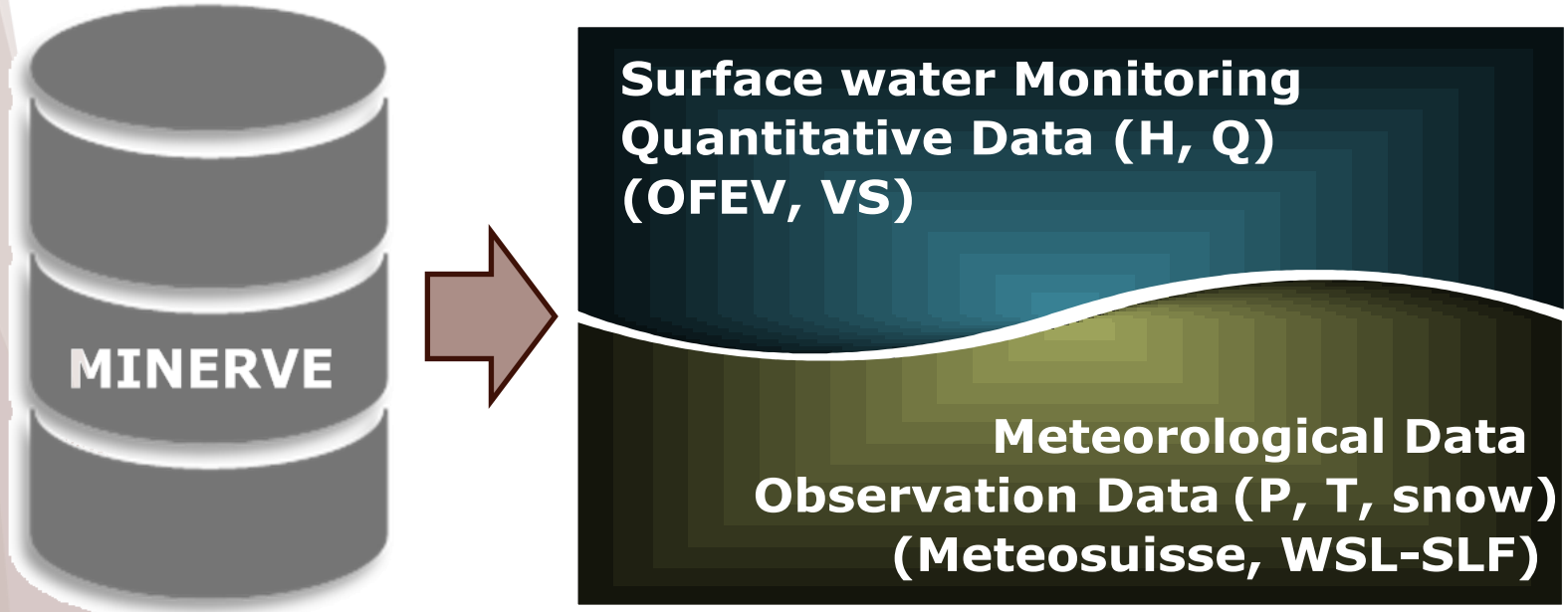

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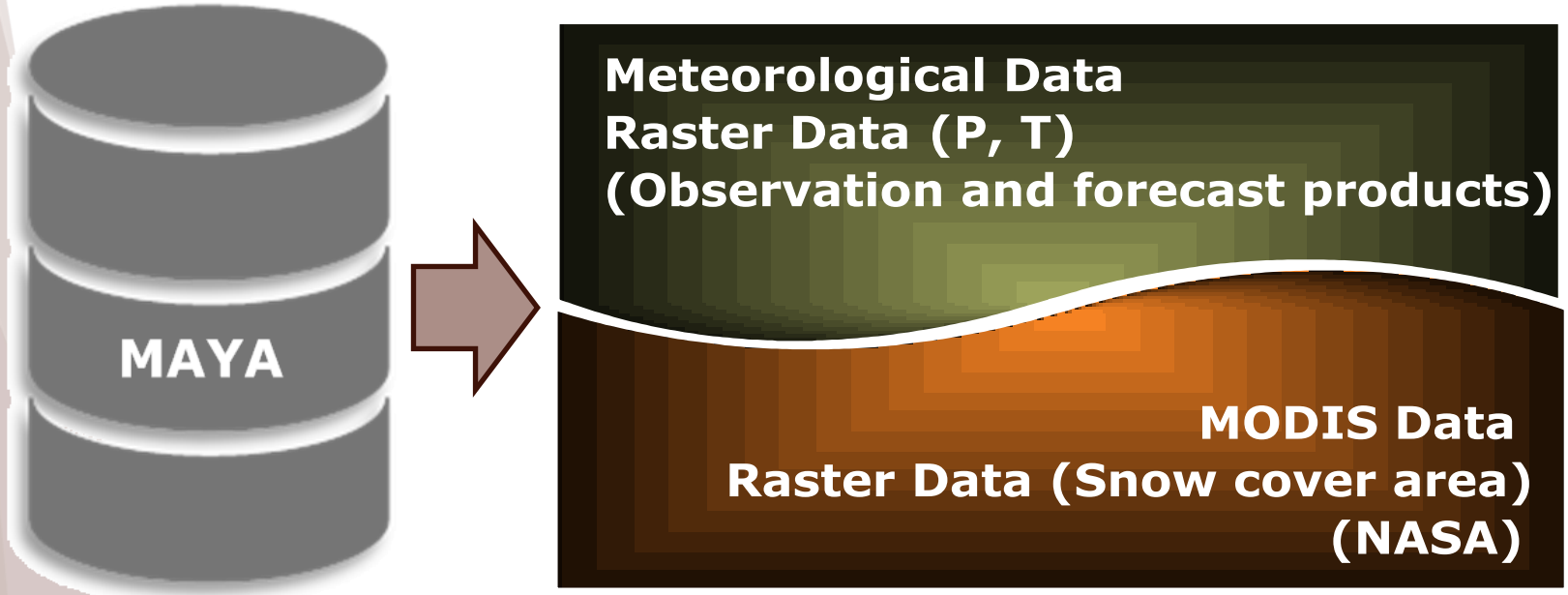

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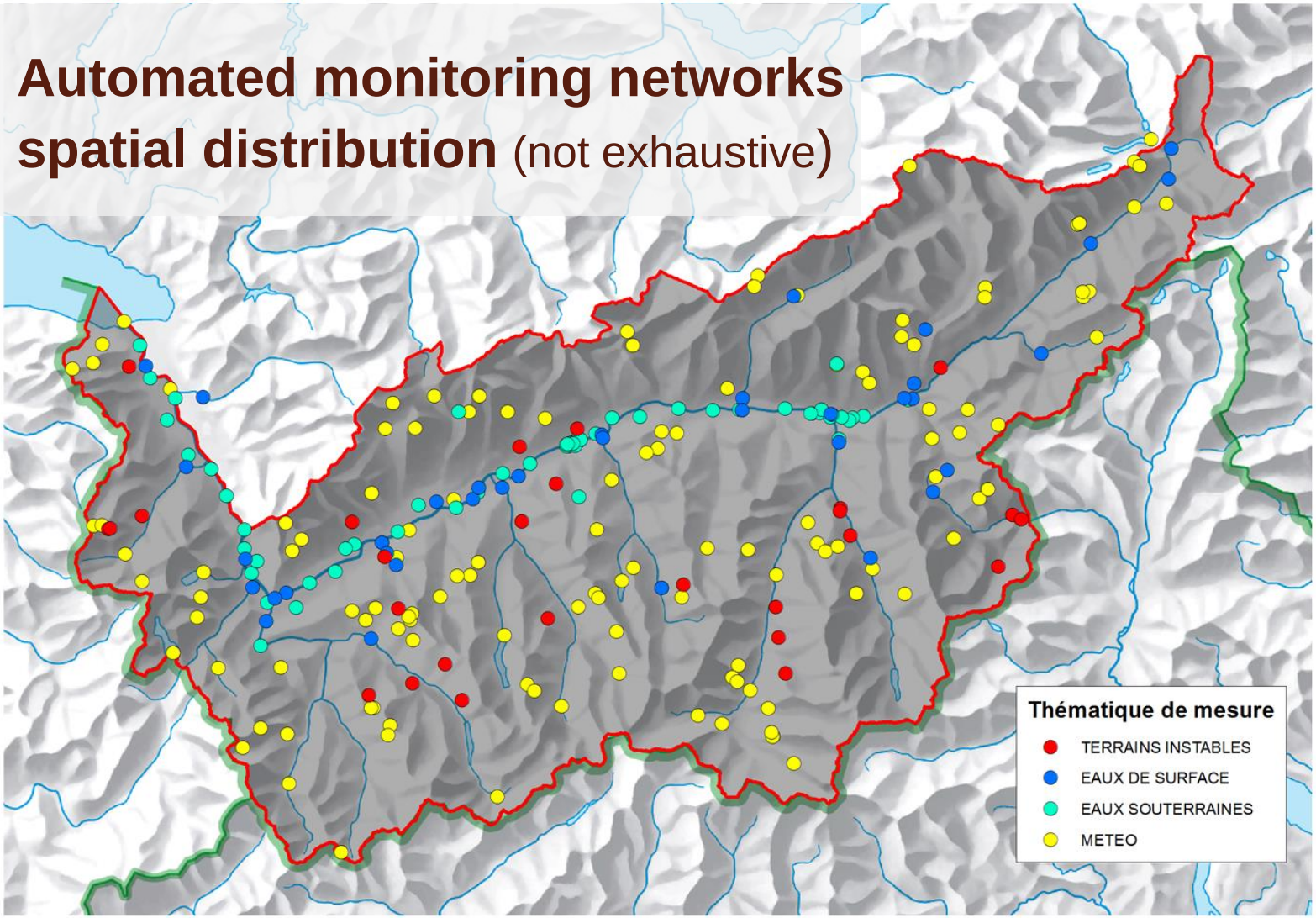
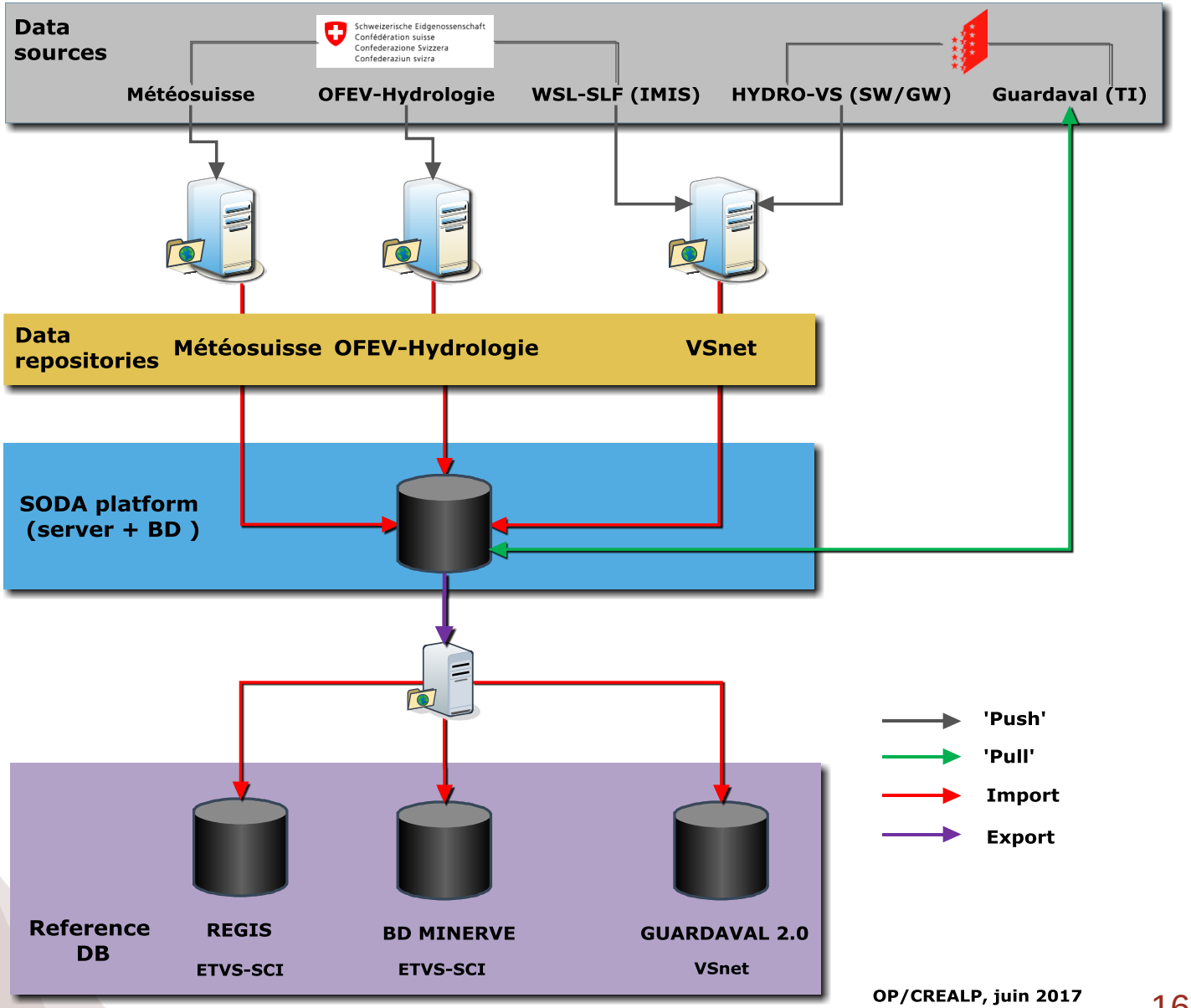


SODA : Simultaneous Online Acquisition Data

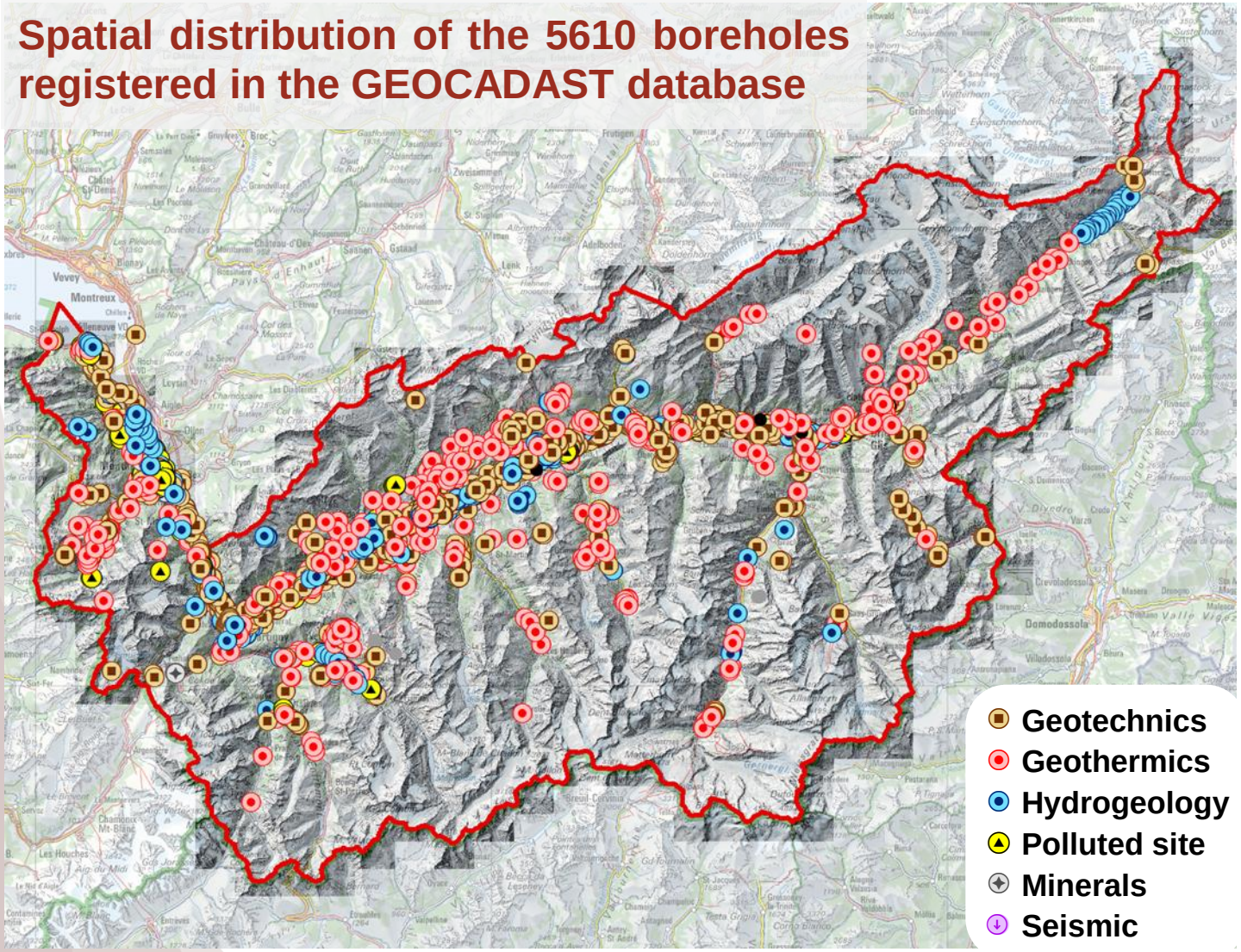
- Platform for data acquisition (push and pull mode) using multiple communication channels (GSM, UMTS, GPRS, Internet, radio, satellite, etc.) and supporting data loggers from different manufacturers.
- Allround solution for data acquisition, raw data storage and data dissemination in various formats.
- Project initiated by Canton Valais late 2015
- Platform implemented during year 2016-2017 and currently in final testing phase

Tools to manage and collect data

SODA



GW model construction: example of data integration



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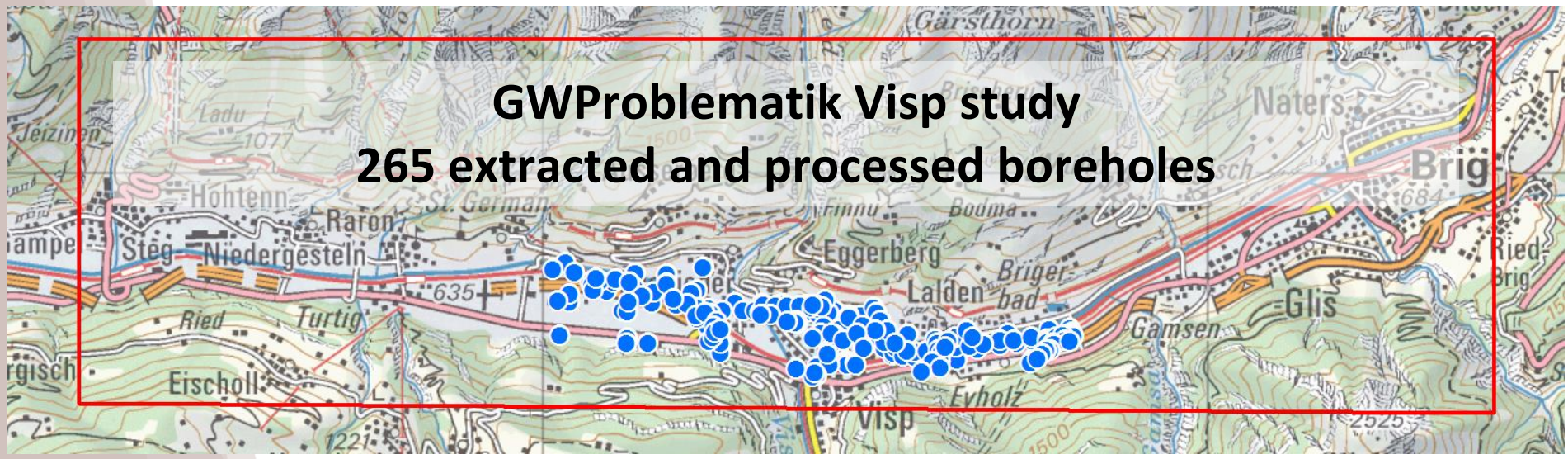
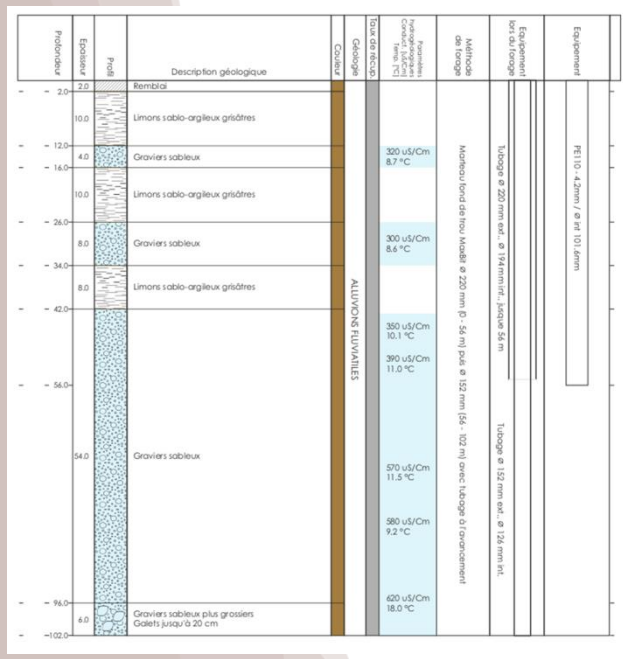


GW model construction: example of data integration

Profondeur	Epaisseur	Profil	Description géologique	Couleur	Géologie	Taux de récup.	Paramètres hydrogéologiques Conduct. [uS/Cm] Temp. [°C]	Méthode de forage	Equipement lors du forage	Equipement
2.0	2.0		Remblai							
12.0	10.0		Limons sablo-argileux grisâtres							
16.0	4.0		Graviers sableux				320 uS/Cm 8.7 °C			
26.0	10.0		Limons sablo-argileux grisâtres							
34.0	8.0		Graviers sableux				300 uS/Cm 8.6 °C			
42.0	8.0		Limons sablo-argileux grisâtres							
56.0	54.0		Graviers sableux		ALLUVIONS FLUVIATILES		350 uS/Cm 10.1 °C 390 uS/Cm 11.0 °C 570 uS/Cm 11.5 °C 580 uS/Cm 9.2 °C	Marteau fond de trou MaxBit ø 220 mm (0 - 56 m) puis ø 152 mm (56 - 102 m) avec tubage à l'avancement	Tubage ø 220 mm ext., ø 194 mm int., jusque 56 m Tubage ø 152 mm ext., ø 126 mm int.	PE 110 - 4.2mm / ø int 101.6mm
96.0							620 uS/Cm 18.0 °C			
102.0	6.0		Graviers sableux plus grossiers Galets jusqu'à 20 cm							

GW model construction: example of data integration

A Digital encoding of geological information



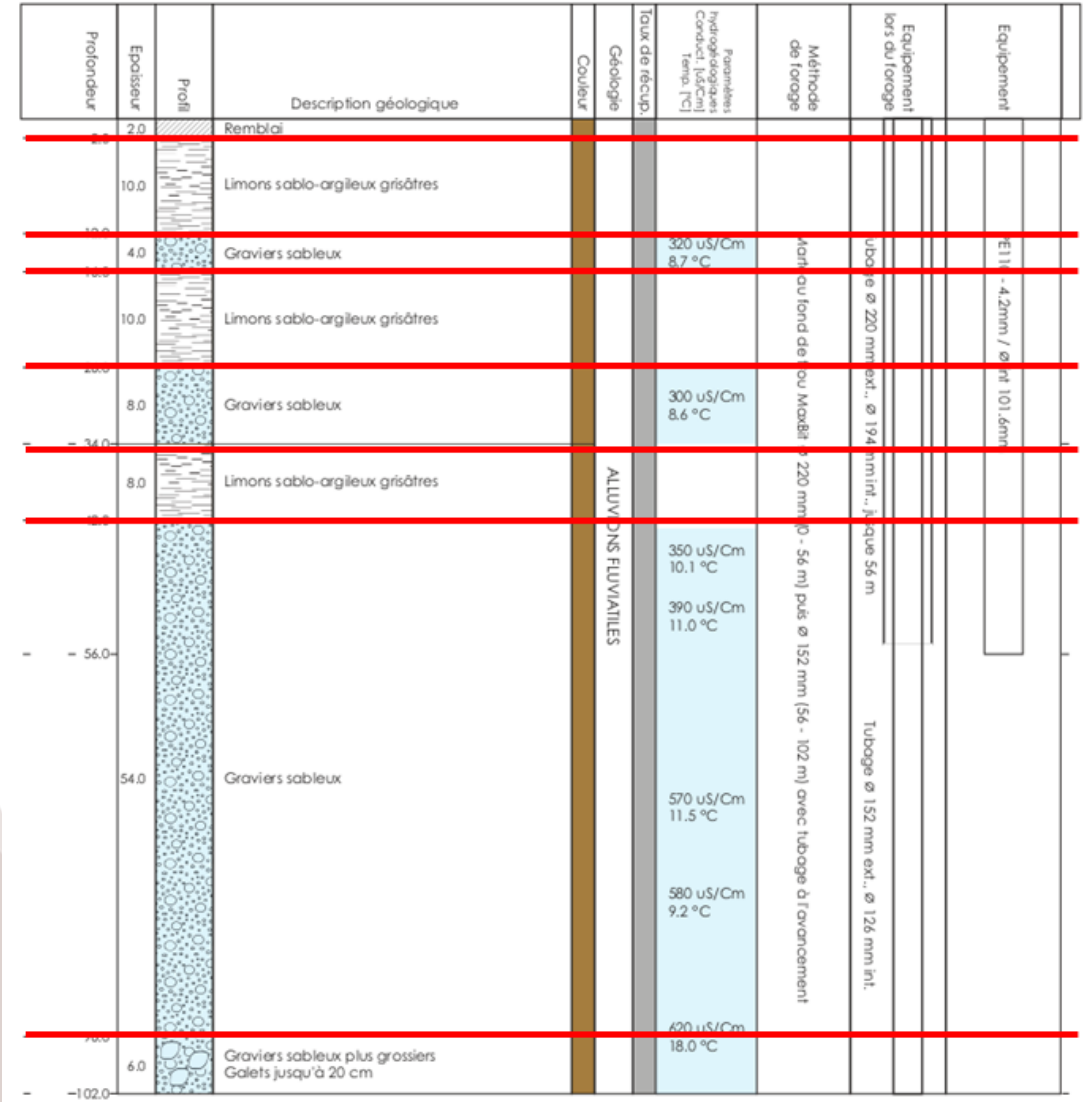
Lithological units - *According to Clavien (1986)*		
Code	**Description**	**USCS Classification****
BaF	Backfill (artificial)	N/A
FloD	Flood deposits	SM, ML, SP, SW, SM-SC, CL, OL, SC-OL
FluvD	Fluvial deposits	GW, GP, GM, GC, GM-ML, SC, SP, SM
SwaD	Swampy deposits	SM, ML, SM-ML, OL, CL, SC, GM
GlaD	Glacial deposits	GM-ML
PalS	Paleosol	N/A
BR	Bedrock	N/A

Description du LITHO-K Code

Attributs	Valeurs											
Position	1	2	3	4	5	6	7	8	9	10	11	12
Litho_CD	Z	3	-	-	-	-	-	-	-	-	-	-
Litho_DSC	Sable modérément fin											

GW model construction: example of data integration

A Digital encoding of geological information



Code LITHO_UNIT

- BaF
- FloD
- FluD
- SwaD
- FluD
- SwaD
- FluD
- FluD

GW model construction: example of data integration

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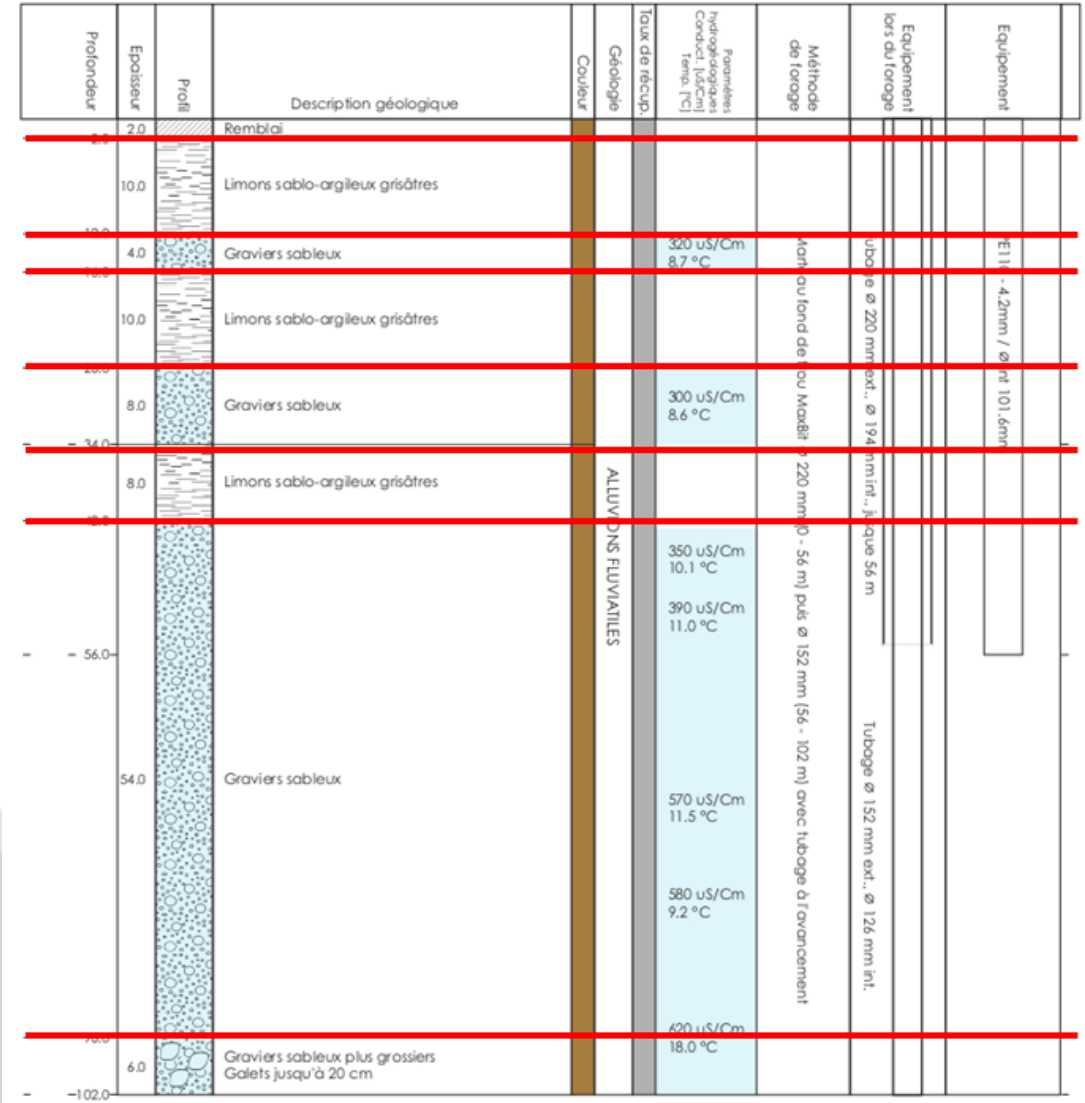
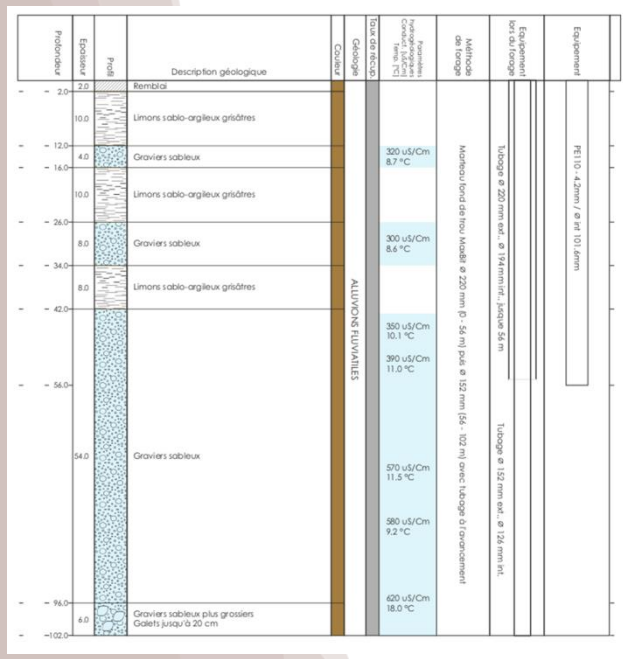


GW model construction: example of data integration

B Digital encoding of hydrogeological information

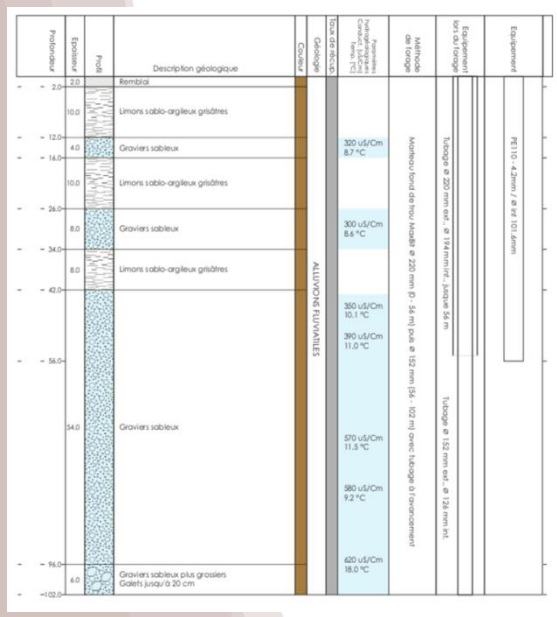


Geohydrological units *1) According to Kimmeier (2001)*		
Code	**Litho-unit**	**Comment**
UpSil	Upper silts	Kimmeier (2001) proposed a a groundwater flow model for the Visp region. For this research work, the Visp aquifer was interpreted as a multilayered aquifer. Four geohydrological units was identified : The Upper and the Lower aquifers covered by the Upper and the Intermediate silts sequences
UpGrav	Upper gravels	
IntSil	Intermediate silts	
LoGrav	Lower gravels	

Geohydrological units *2) Modified from REGIS*	
Code	**Description**
FGW	Water-bearing subsurface layer (free groundwatwater)
DKL	Low permeable subsurface layer (cover of a confined or semi-confined aquifer)
WBL	Water-bearing layer
SDL	Low permable layer
BAS	Base of the geohydrological model: base of the porous aquifer

GW model construction: example of data integration

B Digital encoding of hydrogeological information



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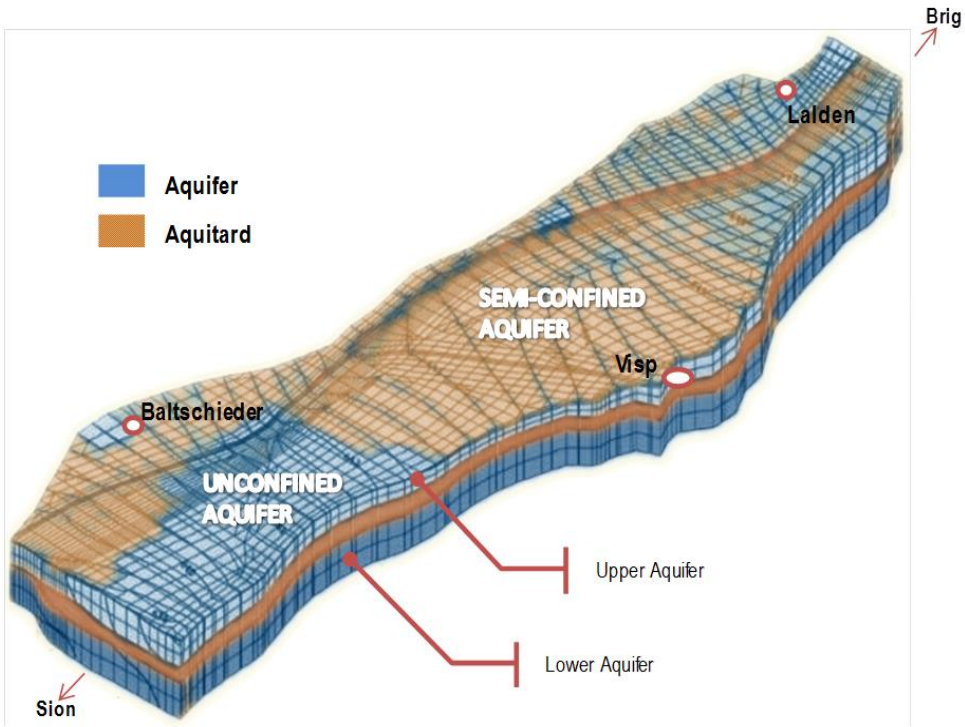

Conceptual model of the Visp aquifer (modified from Kimmeier, 2001).

GW model construction: example of data integration

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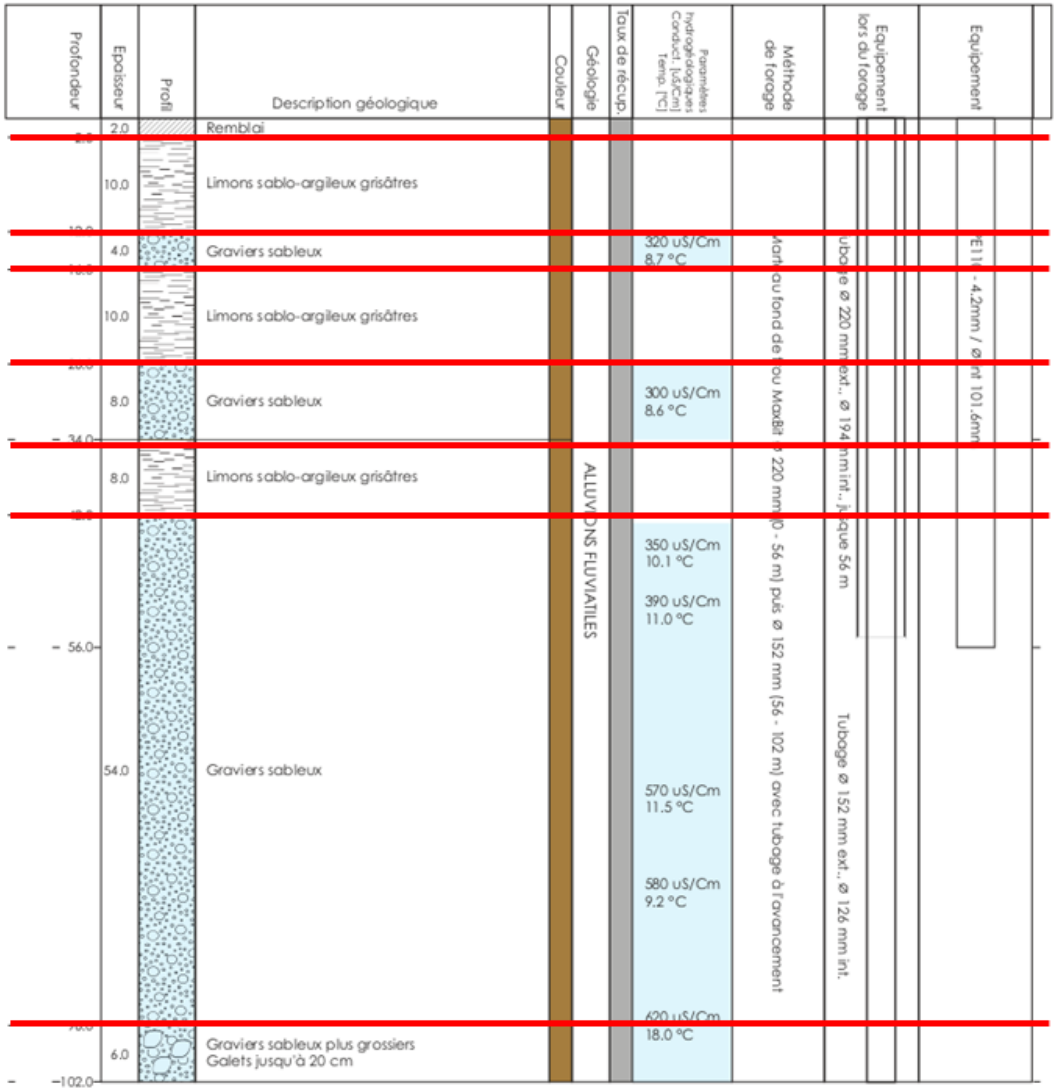
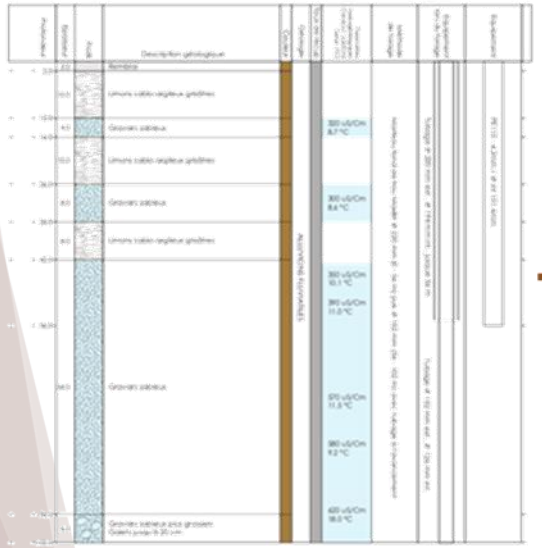
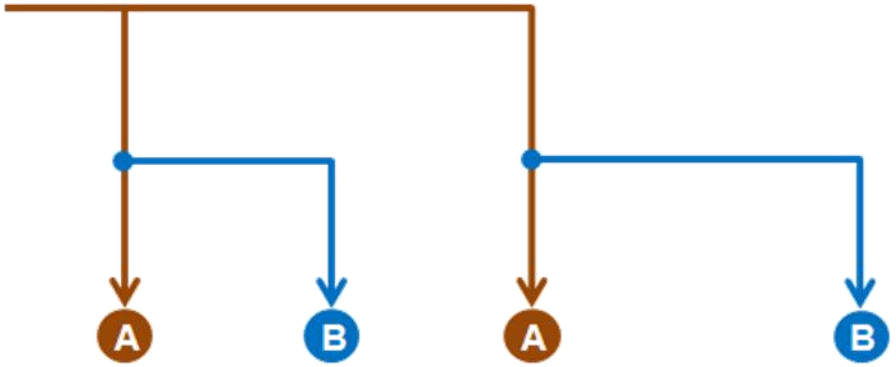


GW model construction: example of data integration

Result of digital encoding of boreholes information



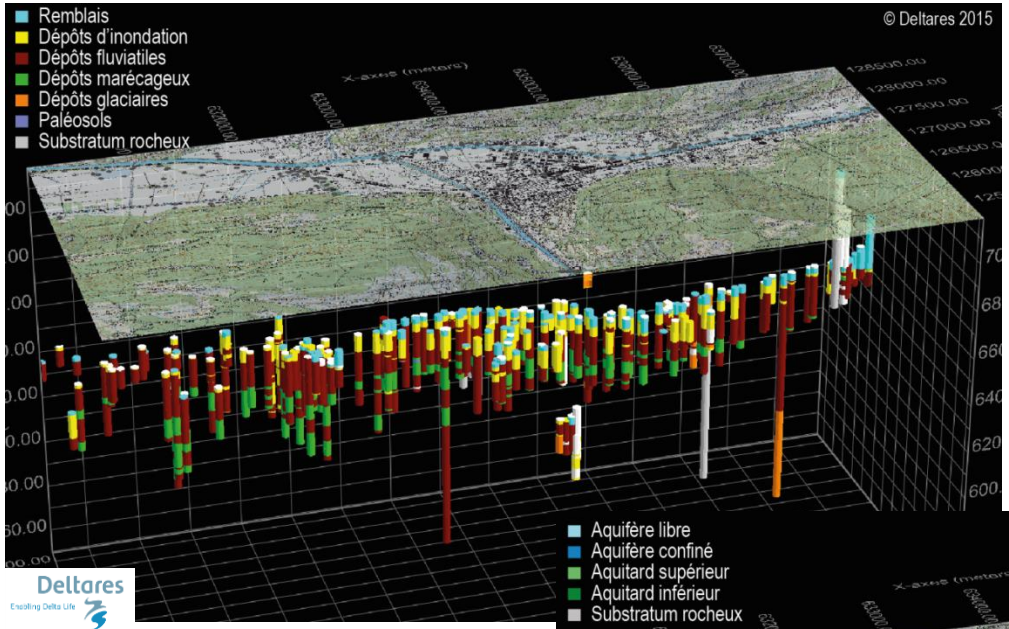


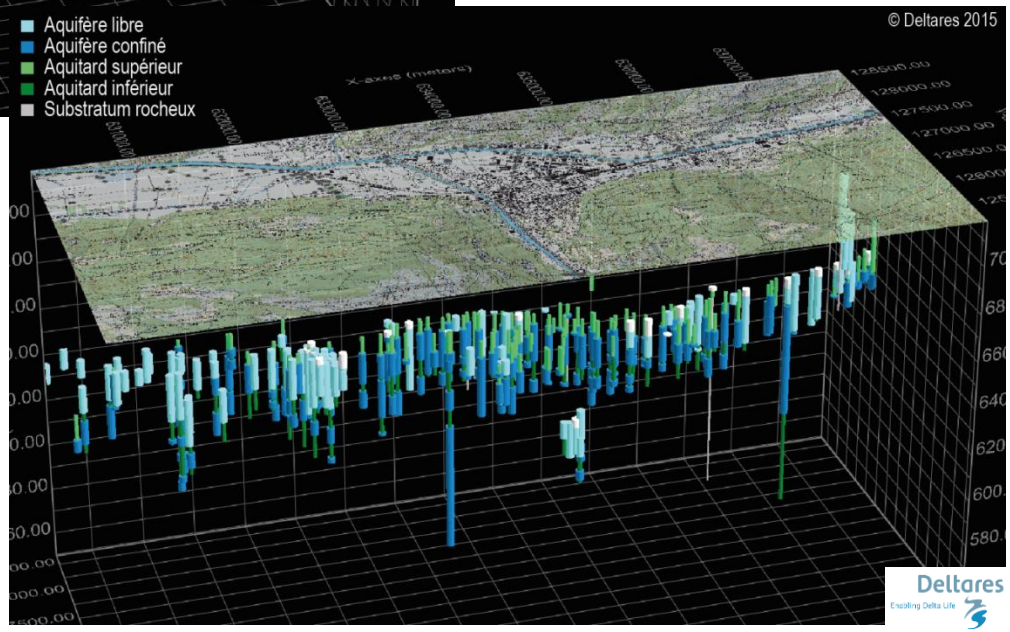
BOREHOLE ID	LAYER_THICKNESS	LITHO_UNIT_CD	HYDRO_UNIT_CD	LITHOK_CD	K [m/d]	K [m/s]
15240	2.00	BaF	XXX	----------	-9999	-9999
15240	10.00	FloD	DKL	L--33-------	0.01	1.16E-07
15240	4.00	FluvD	WBL	G--3--------	102	1.18E-03
15240	10.00	SwaD	SDL	L--33-------	0.01	1.16E-07
15240	8.00	FluvD	WBL	G--3--------	102	1.18E-03
15240	8.00	SwaD	SDL	L--33-------	0.01	1.16E-07
15240	54.00	FluvD	WBL	G--3--------	102	1.18E-03
15240	6.00	FluvD	WBL	G7-3-------2	-9999	-9999

N.B. : -9999 = Nodata for K value

GW model construction: example of data integration

Result of digital encoding of boreholes information





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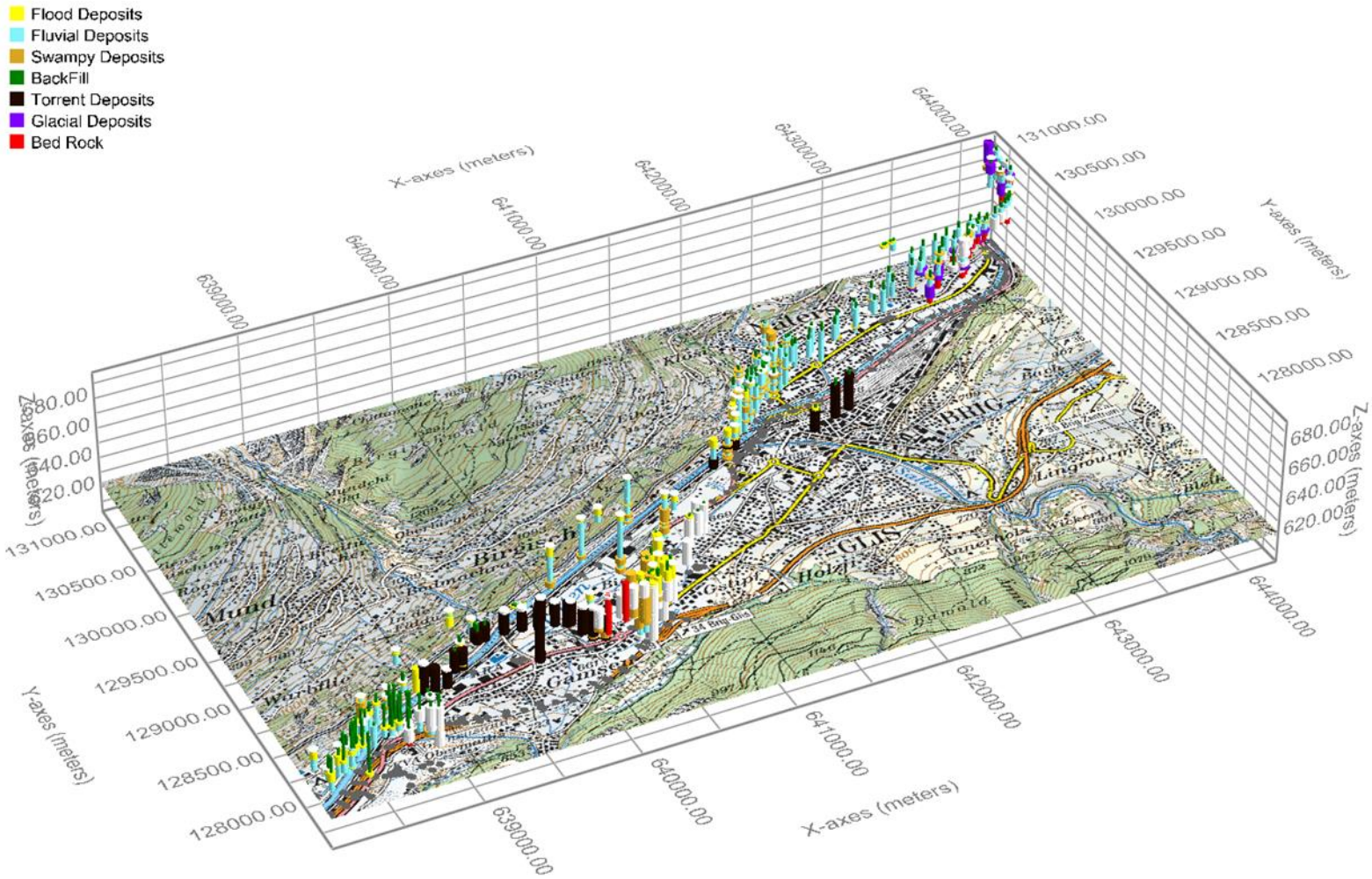

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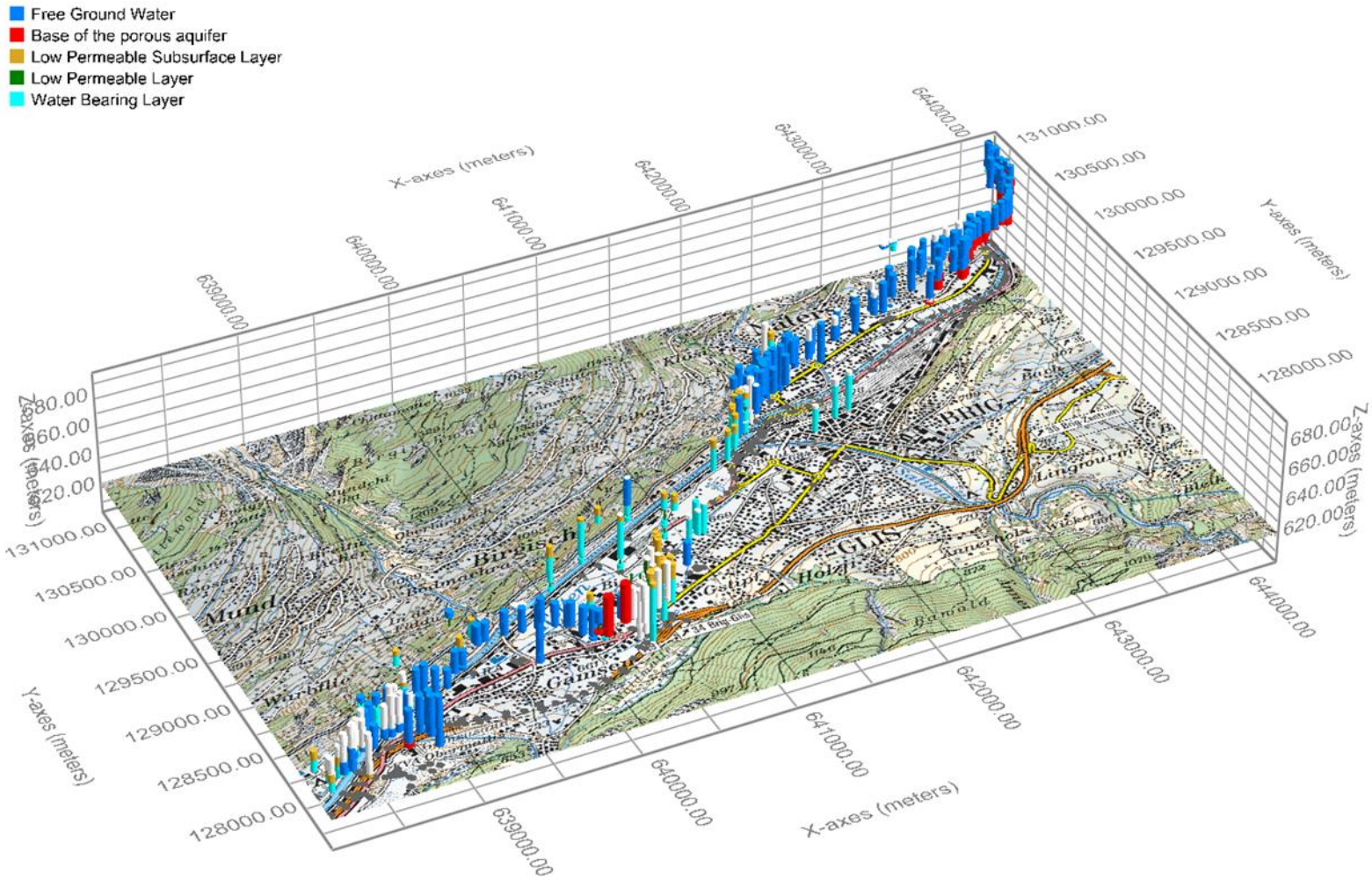
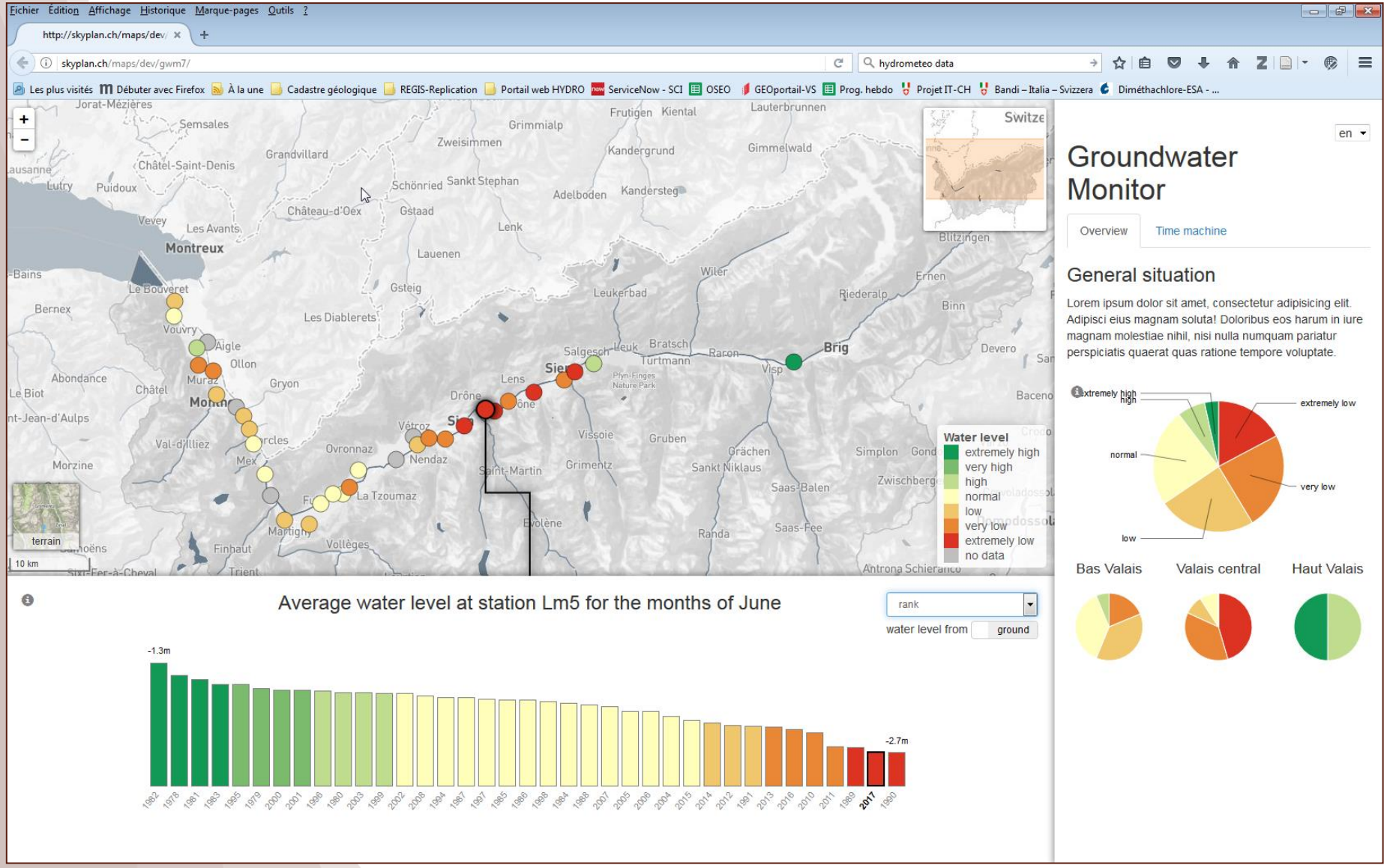


Cantonal tools for decision-making

- **Mid 90's – early 20's** → collect and formatting of historical data
- **Early 20's – mid 20's** → Implementation of REGIS DB for groundwater data archiving and managing
- **Mid 20's** → focus to data dissemination
- **Mid 2010s** → focus to data valorization

Tools for decision-making : QuantES Monitor



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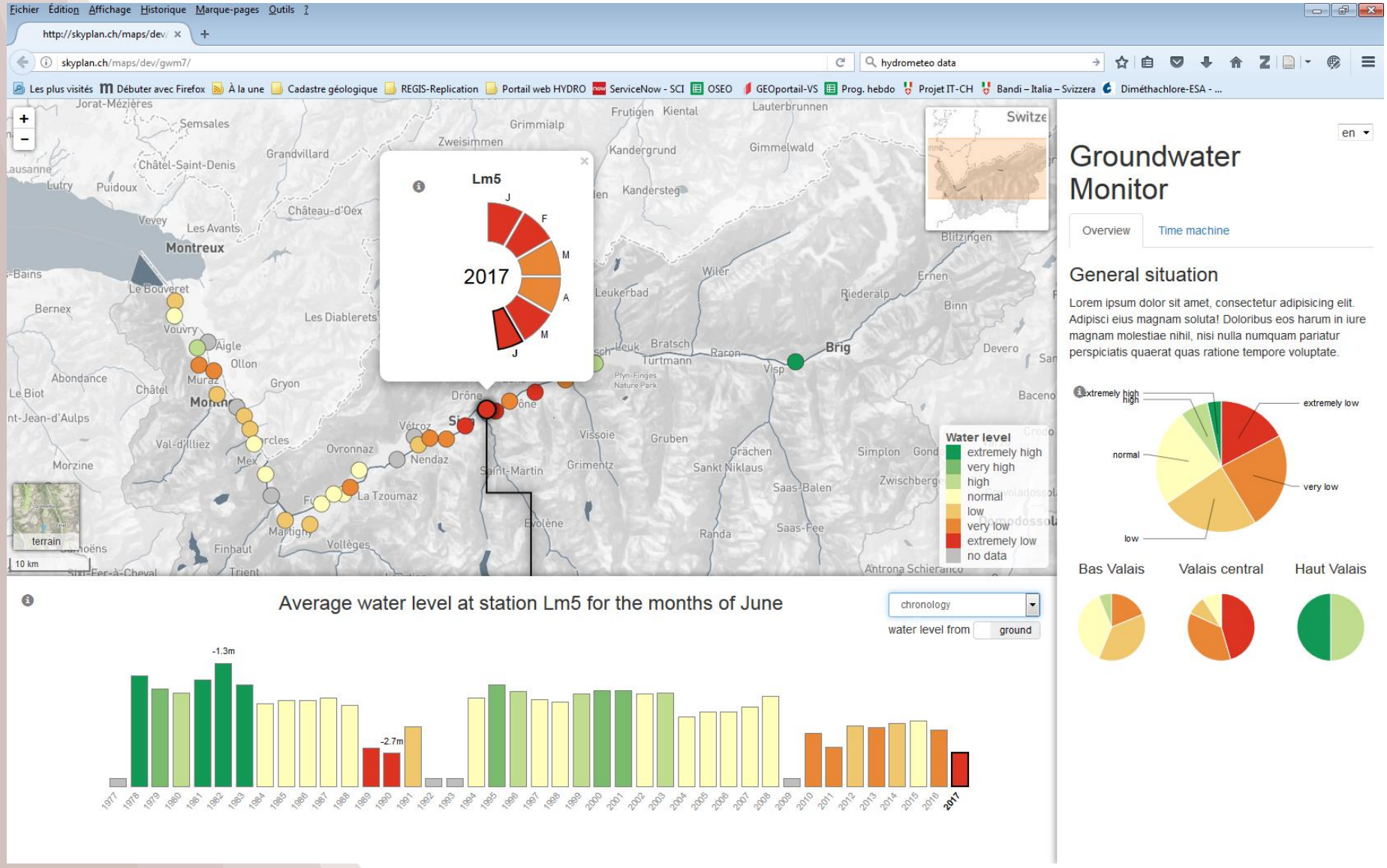

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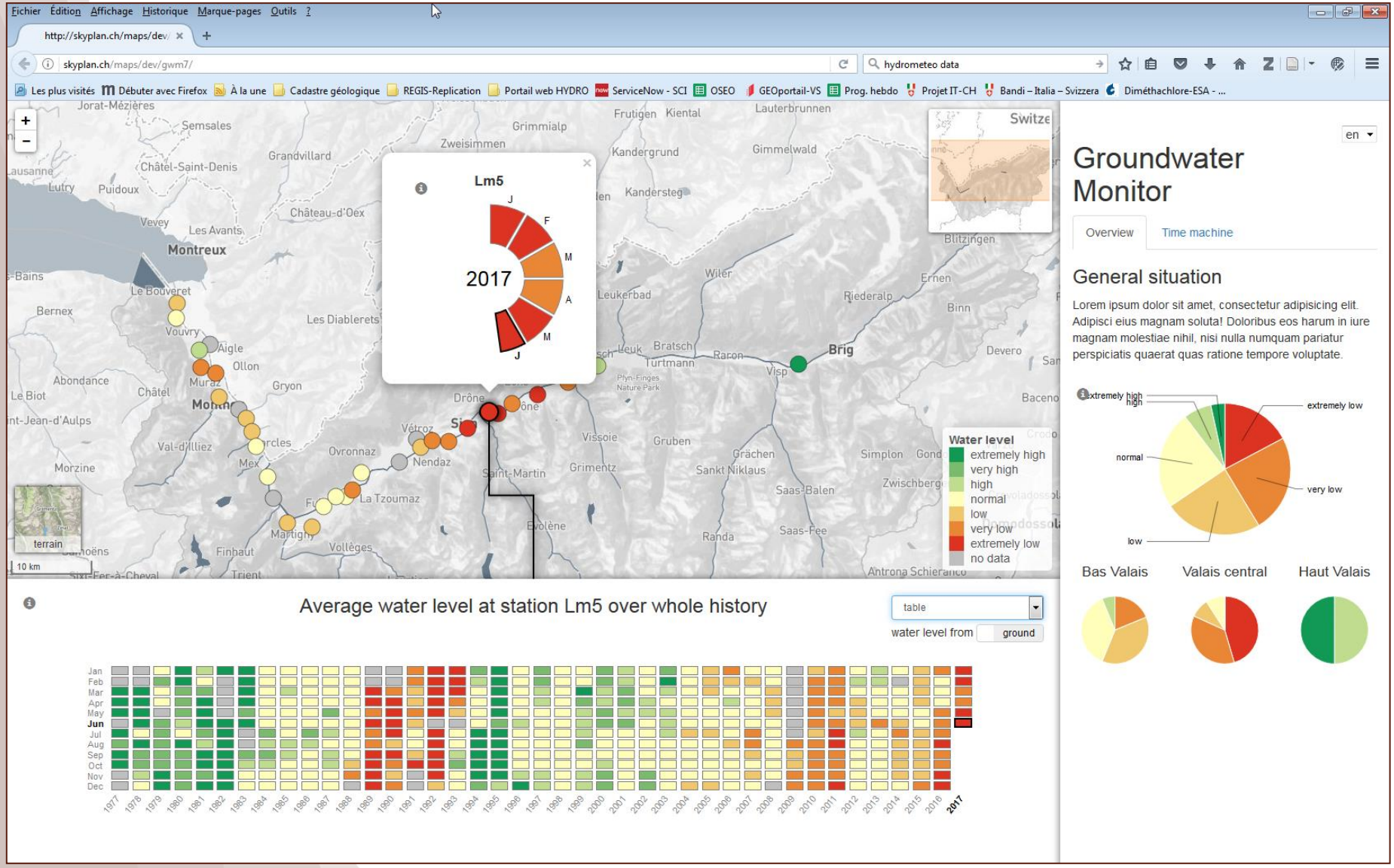

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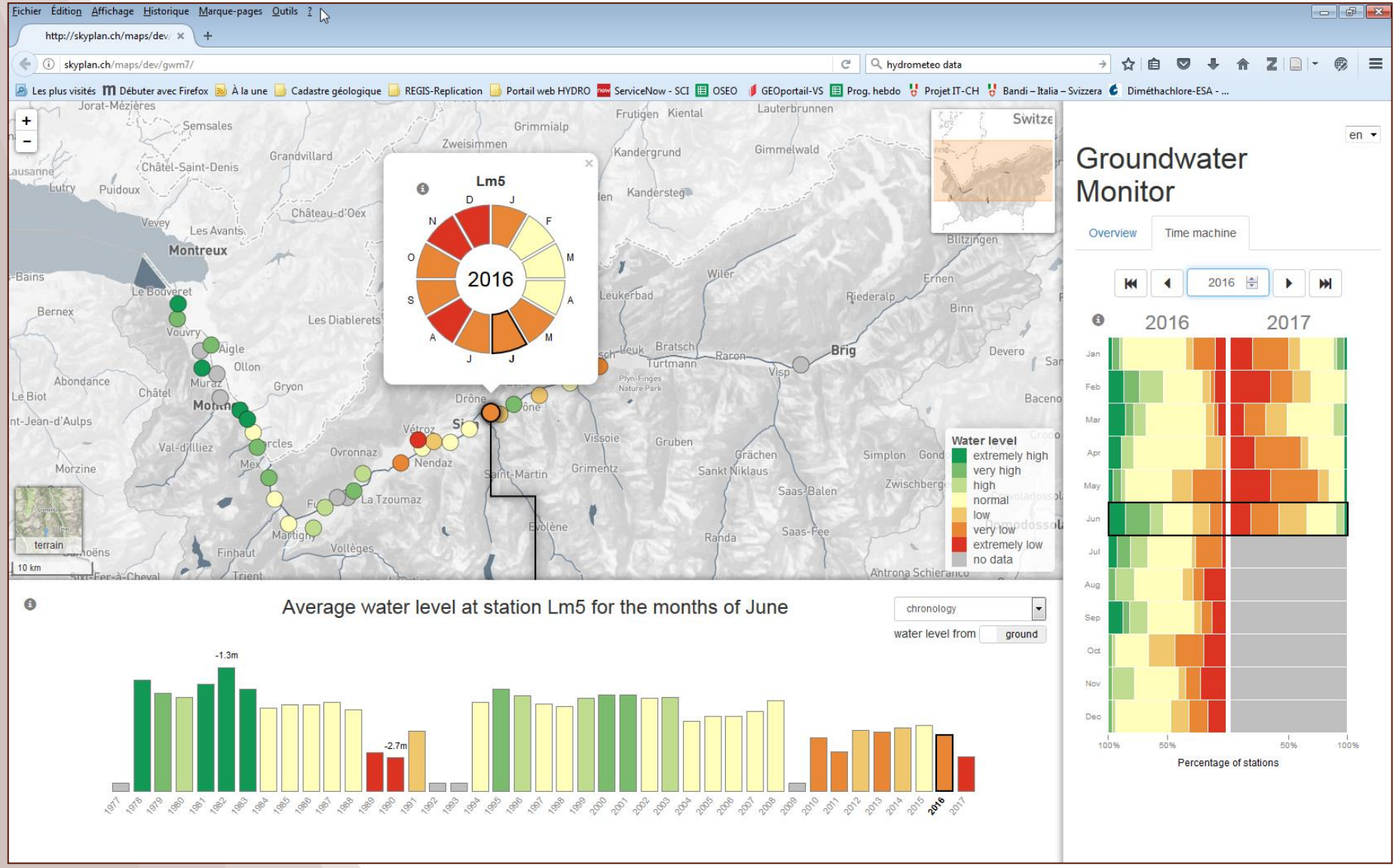

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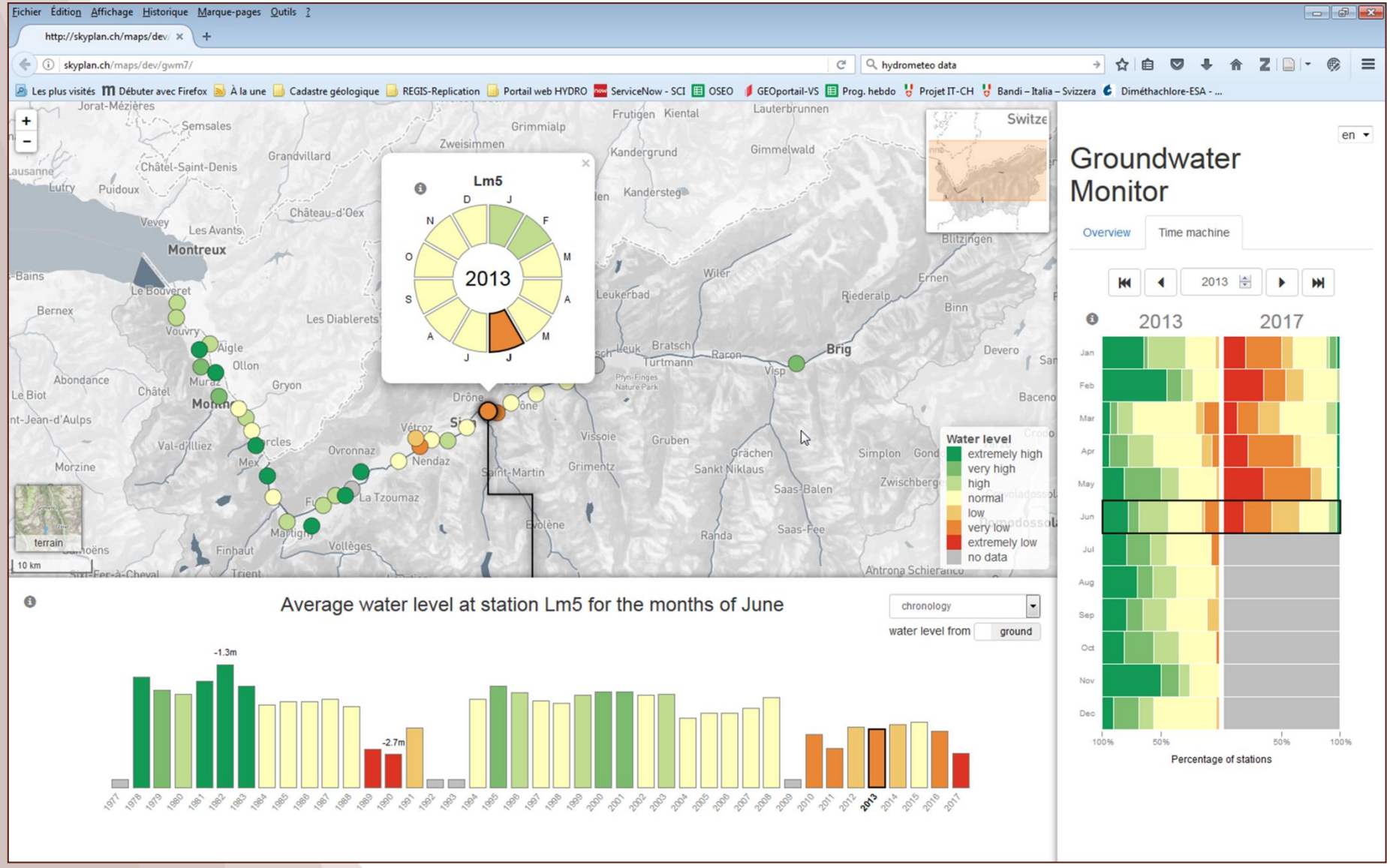

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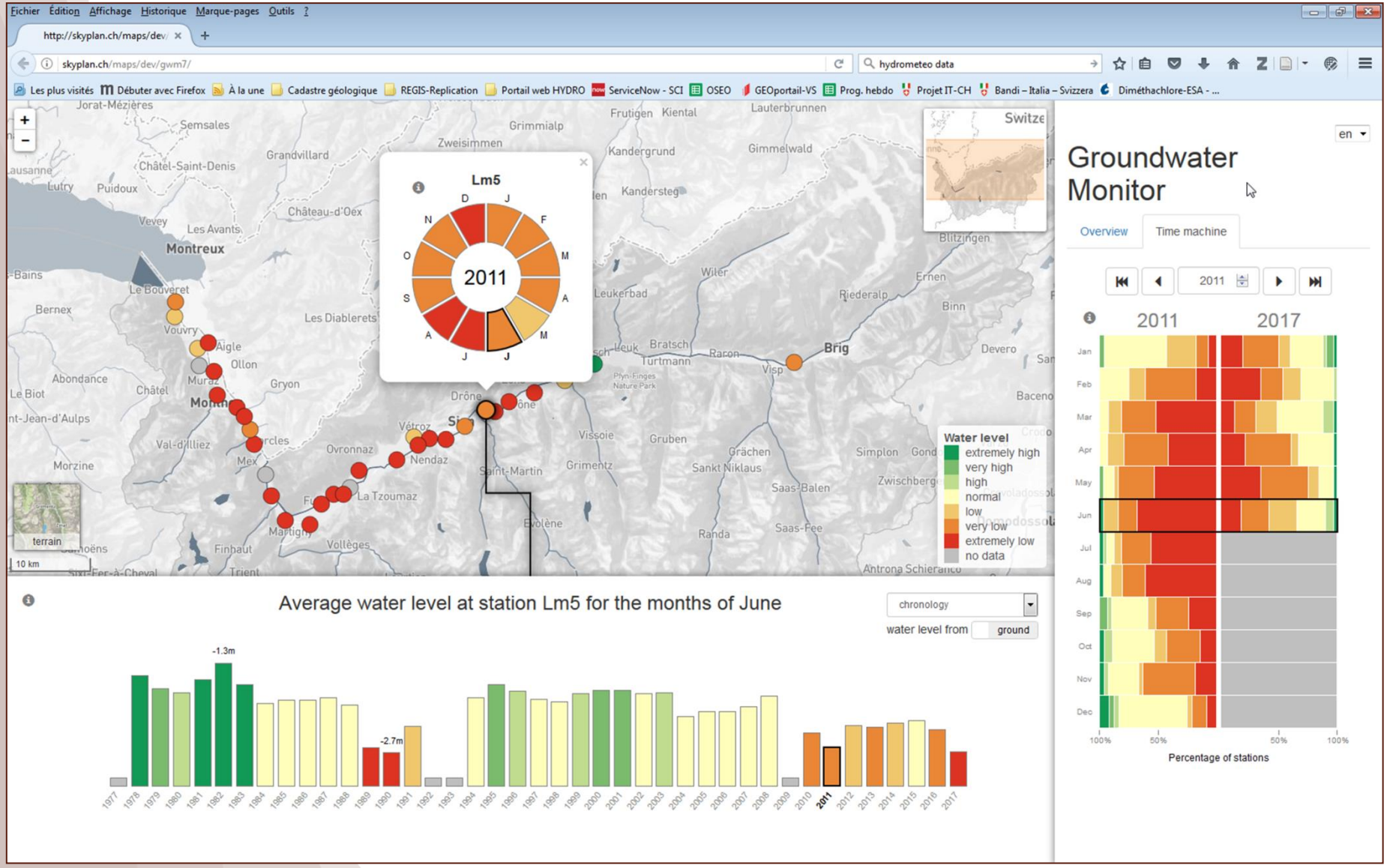

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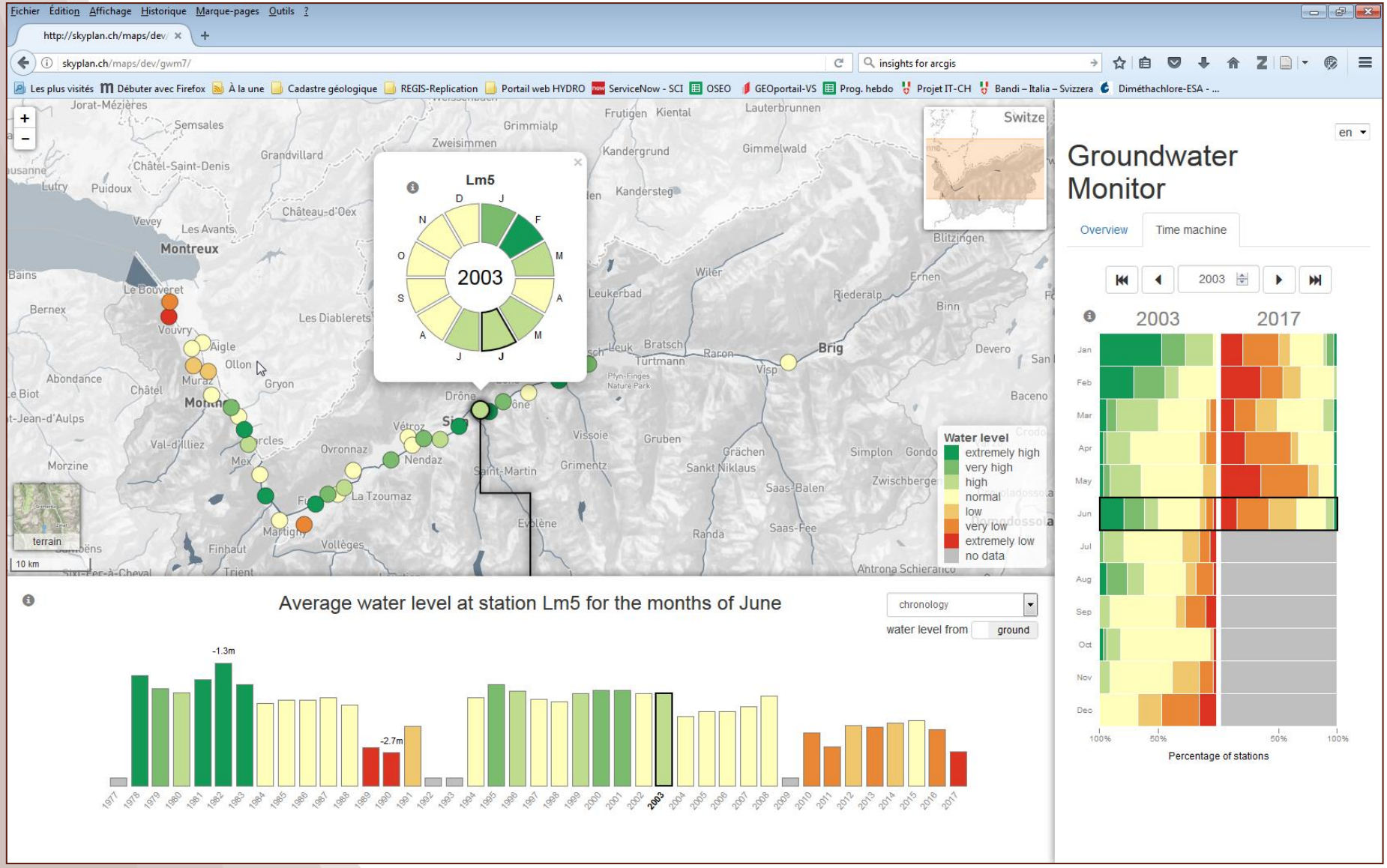

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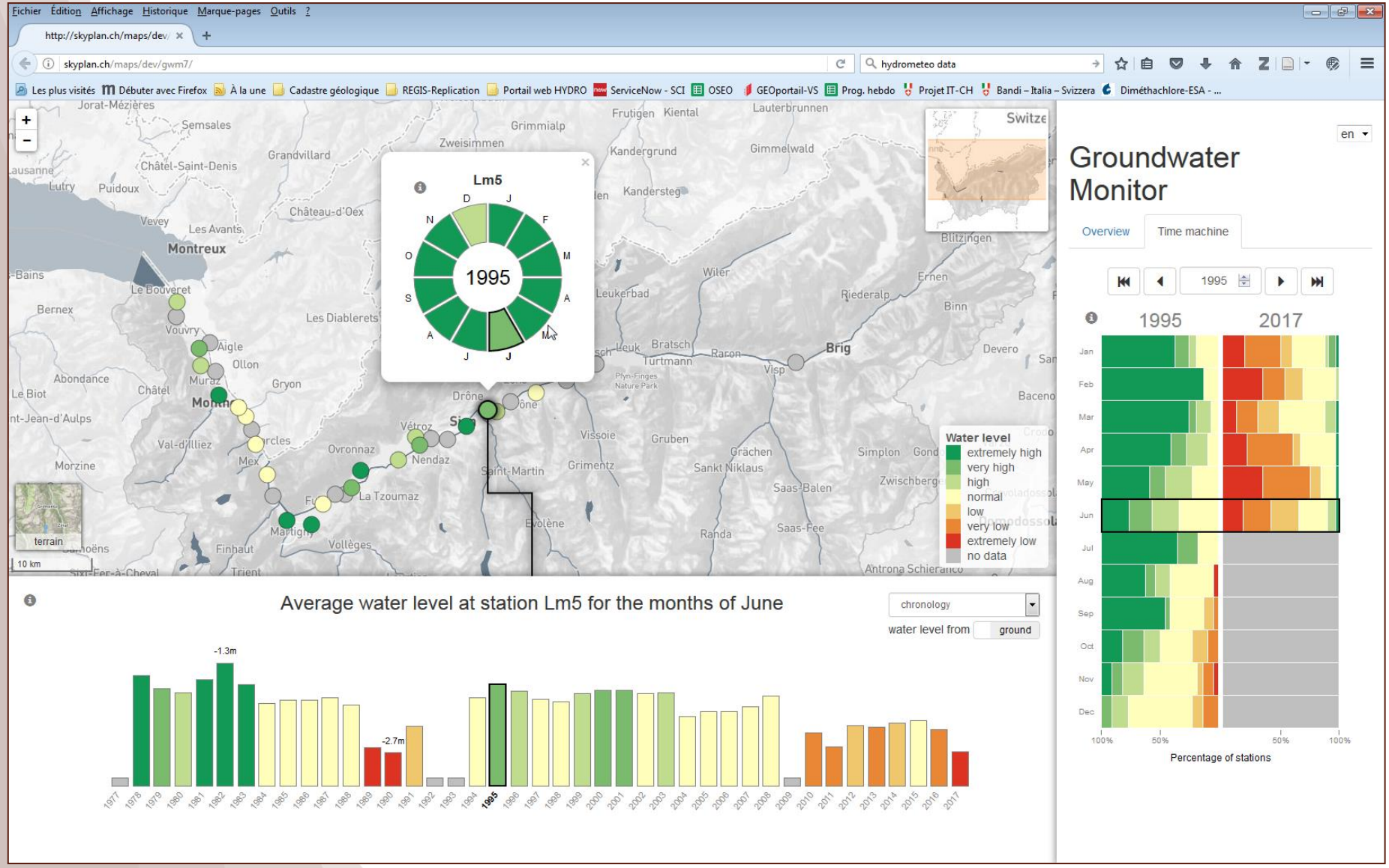
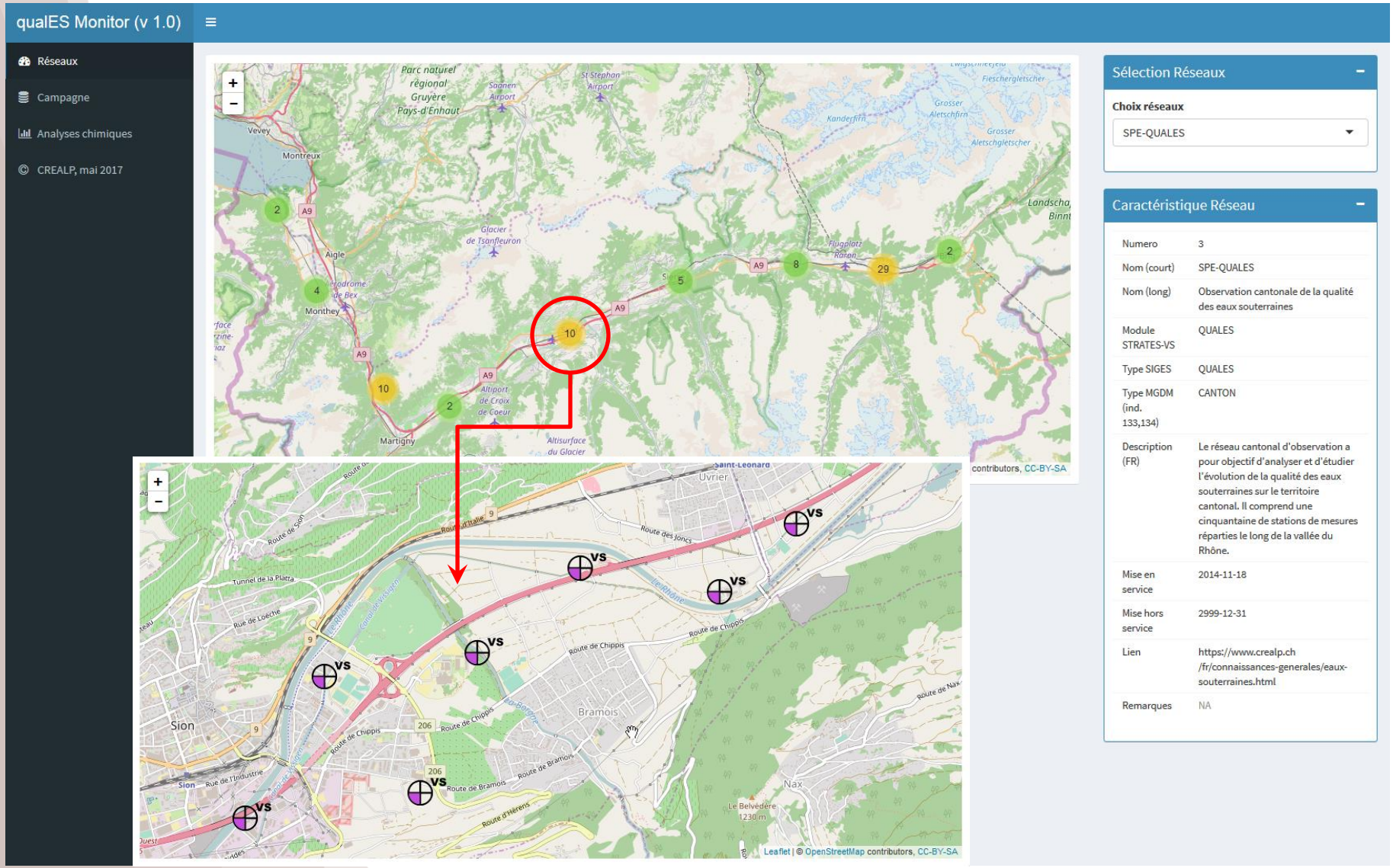


Tools for decision-making : QualES Monitor

- **2015**: Design and implementation of the data model for handling groundwater qualitative data (campaigns, samples, analyses, parameters, MTC limits, analytic methods, etc.) in **REGIS DB**
- **2015-2016:** compiling and formatting of historical data for loading in **REGIS DB**
- **2017**: Implementation of prototype of **qualES monitor** web-based application

Tools for decision-making : QualES Monitor



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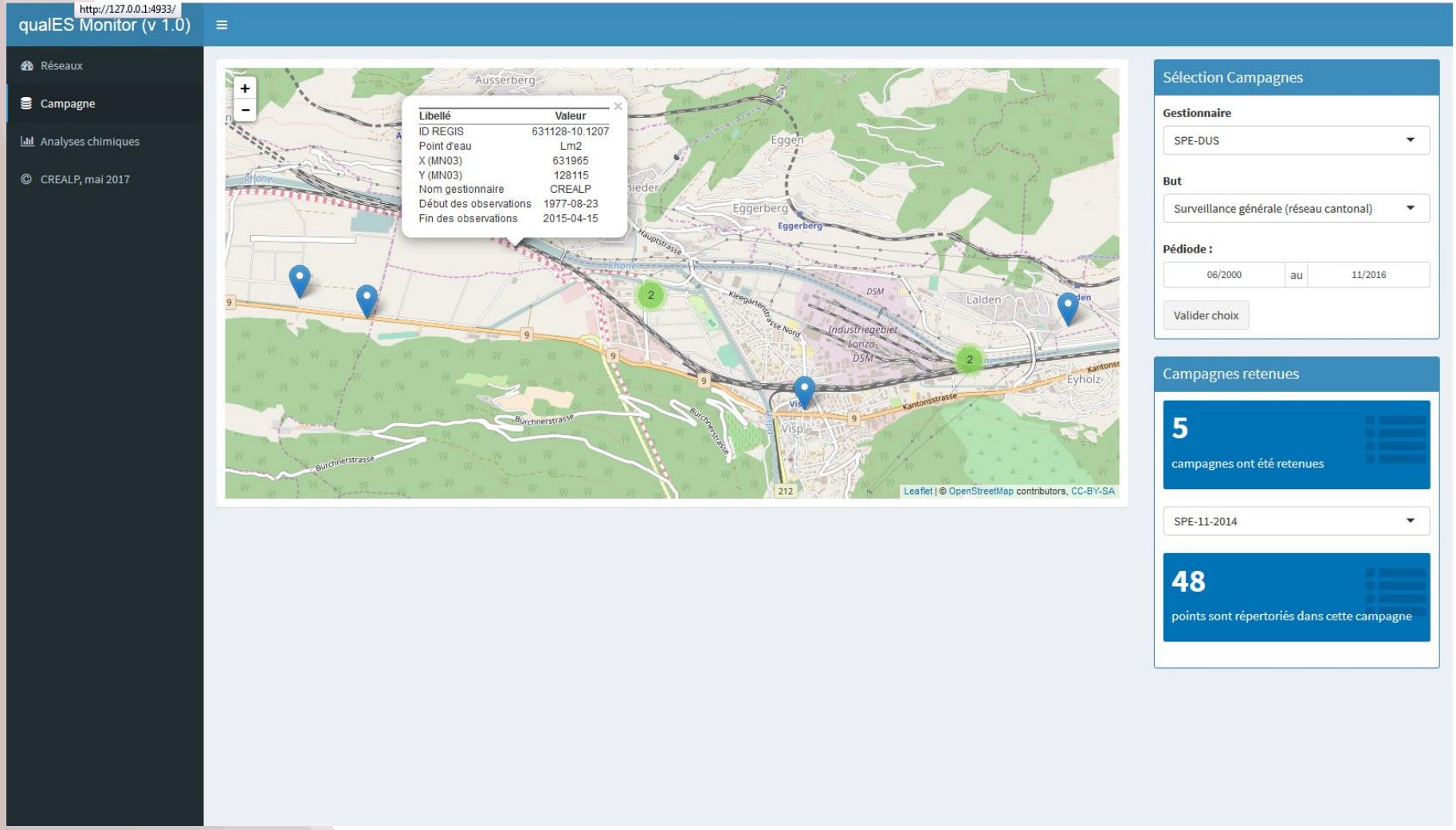
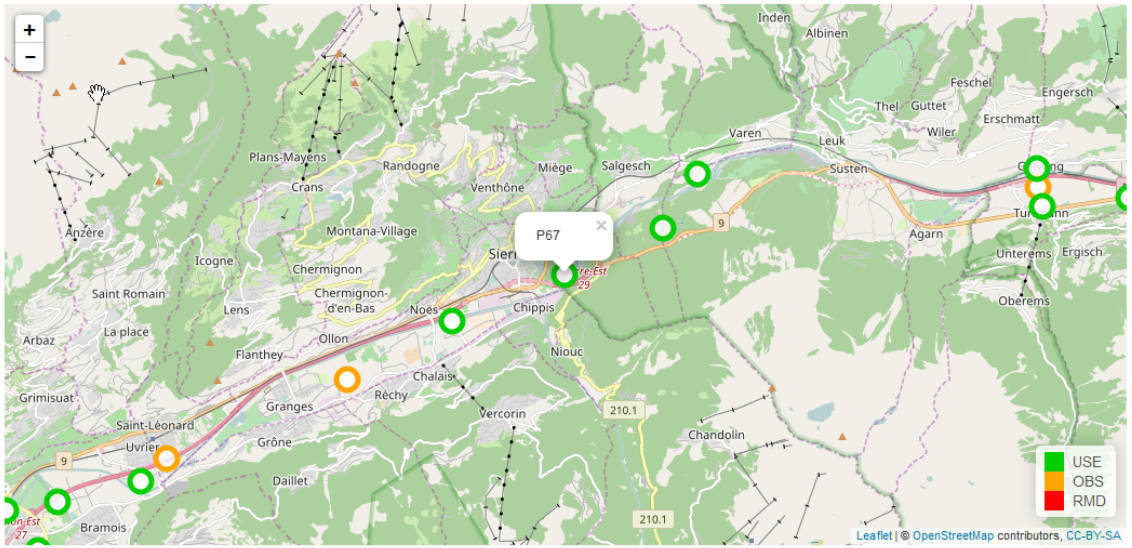


Tools for decision-making : QualES Monitor

qualES Monitor (v 1.0)

- Réseaux
- Campagne
- Analyses chimiques
- © CREALP, mai 2017



Campagne n° 146

Show 6 entries Search:

Station	X	Y	Date		Valeur	Limite de qualité Au	Unité
Lm4	603294	123693	2016-11-21		1.4	OBS	µg/l
RN38	595725.39	119531.67	2016-11-22		0.4	USE	µg/l
LHG 6552 - Muraz, Pl	561015	125658	2016-11-22	<	0.2	USE	µg/l
Lm9b	574235	108034	2016-11-20		0.3	USE	µg/l
MAR2	574218	106677	2016-11-20		0.4	USE	µg/l
P24	611011.45	127381.67	2016-11-27		0.3	USE	µg/l

Showing 1 to 6 of 55 entries Previous 1 2 3 4 5 … 10 Next

Sélection Paramètre

Paramètres analysés (153)

1_4_Dioxane

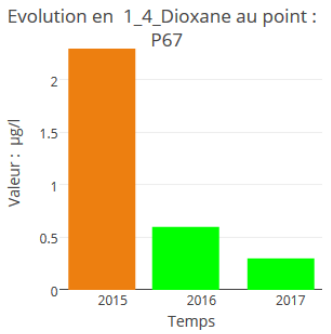
Sélection campagnes

Campagnes 1_4_Dioxane (20)

Nom de la campagne	SPE-11-2016
Autorité responsable	SPE-DUS
Début de la campagne	2016-11-21
Fin de la campagne	2016-11-30

Chronique des observations | Statistiques

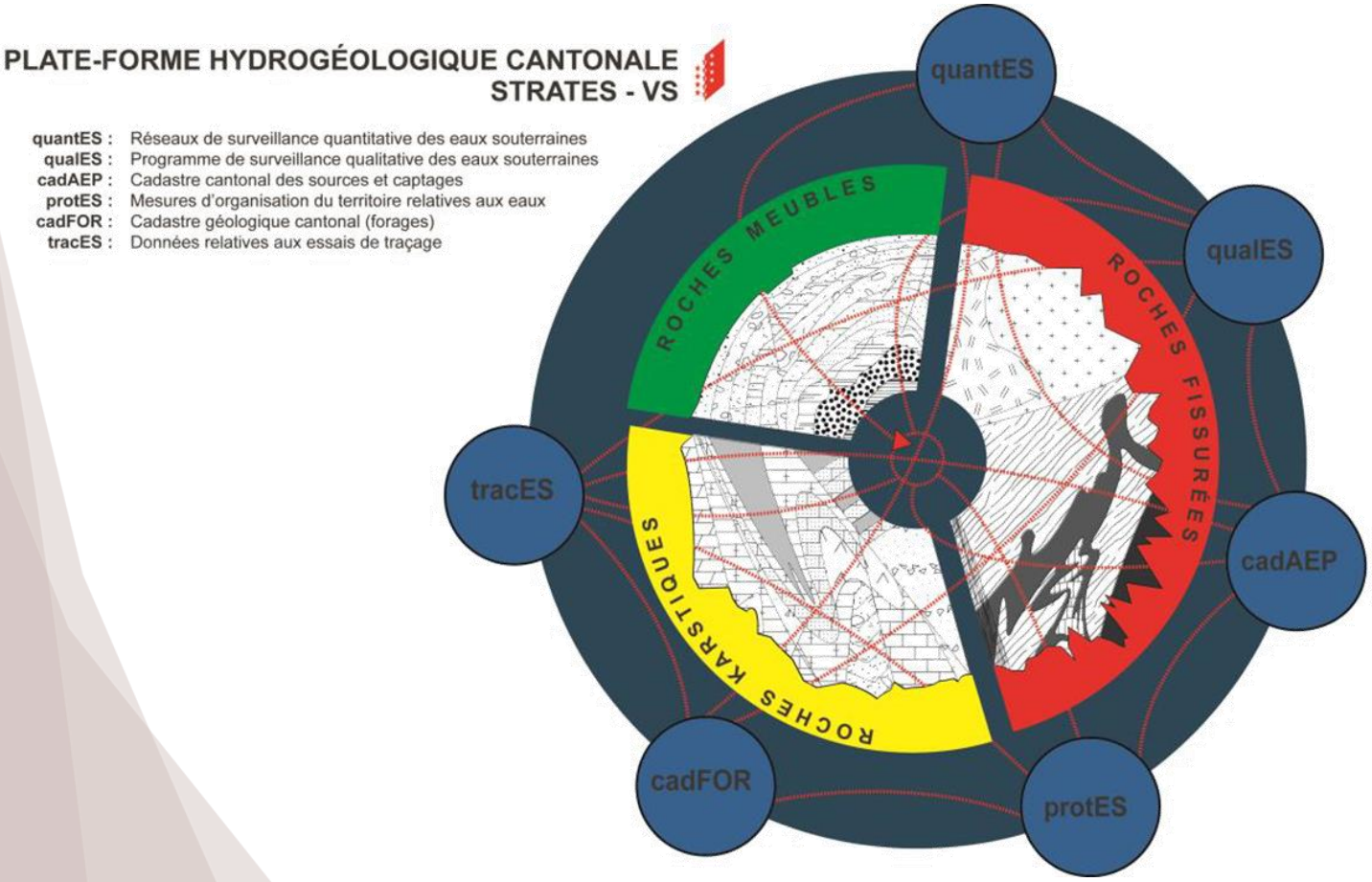
Seuil



Tools for decision-making : STRATES-VS

StrATES-VS: **S**urveillance en **t**emps **r**éel et **A**cquisitions de la **T**erre et des **E**aux **S**outerraines en **Valais**

→Cantonal Geohydrological Infomation system ←

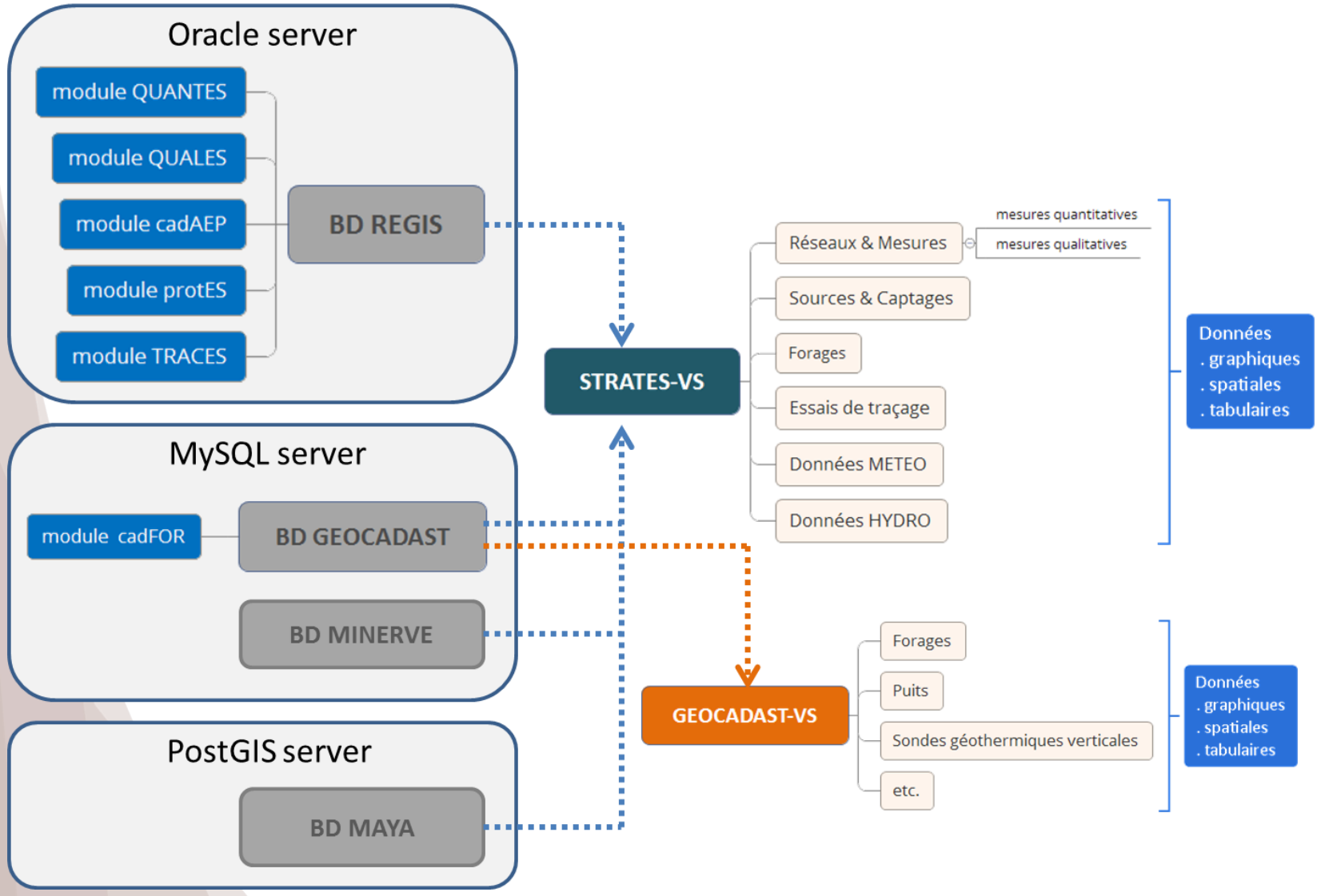


Tools for decision-making : STRATES-VS

The future platform **STRATES-VS** is intented to support pratictionners as well as cantonal authorities (water manager, decision-makers, etc.) by offering :

- On-line centralized access to groundwater and subsurface information (quantitative and qualitative observation data, boreholes data, monitoring networks, etc.)
- Decision support tools (e.g. maps, indicators, etc.)
- Web-based, data analytics workbench to explore, visualize, and analyze data and possibly, deliver consolidated answers to future changes (e.g. to climate change)

Tools for decision-making : STRATES-VS



THANK YOU FOR YOUR ATTENTION

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