QGIS Server into the wild

Feedback from the 3Liz team

by *Michaël Douchin*

3liz

A French company dedicated to create and share **open-source GIS solutions**

- QGIS Server **core developers**
- QGIS and QGIS Server plugins
- Creators of Lizmap Web Client to publish QGIS projects online
- We offer **PostgreSQL/PostGIS** courses
- and QGIS, PostgreSQL, Lizmap Web Client **support**

QGIS Server

The power of QGIS **Desktop** in the "cloud"

QGIS Server

> QGIS Server is an **open source** WMS, WFS, OGC API for Features 1.0 (WFS3) and WCS implementation

QGIS Server is able to **serve data** according to **standard protocols** as described by the Open Geospatial Consortium (OGC):

which means: **Ask questions (requests) and get answers (responses)**:

- "Give me a JPEG of the layers 'Rivers' at this scale and in this area"
- "Please pass me some vector data for this layer 'Towns' where the name begins with A"

QGIS Server uses **QGIS as back-end** for the GIS logic and for map rendering: 1 **QGIS project** = 1 MAP service / the **same visualization libraries** = the same map rendering

Server

QGIS Server services

- **WMS**: Web Map Service 1.1.1 and 1.3.0 -> Images of layers
- **WFS**: Web Feature Service 1.0.0 and 1.1.0 -> Vector features
- **OGC API - Features** (WFS3) -> Vector features
- **WCS**: Web Coverage Service 1.0.0 and 1.1.1 -> Publish Raster data
- **WMTS**: Web Map Tile Service 1.0.0 -> Publish web map tiles

QGIS Server additional features

- **Redlining**: pass geometries and labels and draw them above map features -> `GetPrint` `GetMap`
- **Filter** specific features with a QGIS **subset string** (SQL Like) with `FILTER` or with an **expression** with `EXP_FILTER` for -> `GetMap` `GetPrint` `GetFeatureInfo`
- **Selection**: the `SELECTION` parameter allow passing a list of **feature ids** -> `GetMap` `GetPrint`
- **Build HTML feature info** with QGIS map tip: `WITH_MAPTIP` for the `GetFeatureInfo` request -> use **Expressions** to create **rich HTML content**.

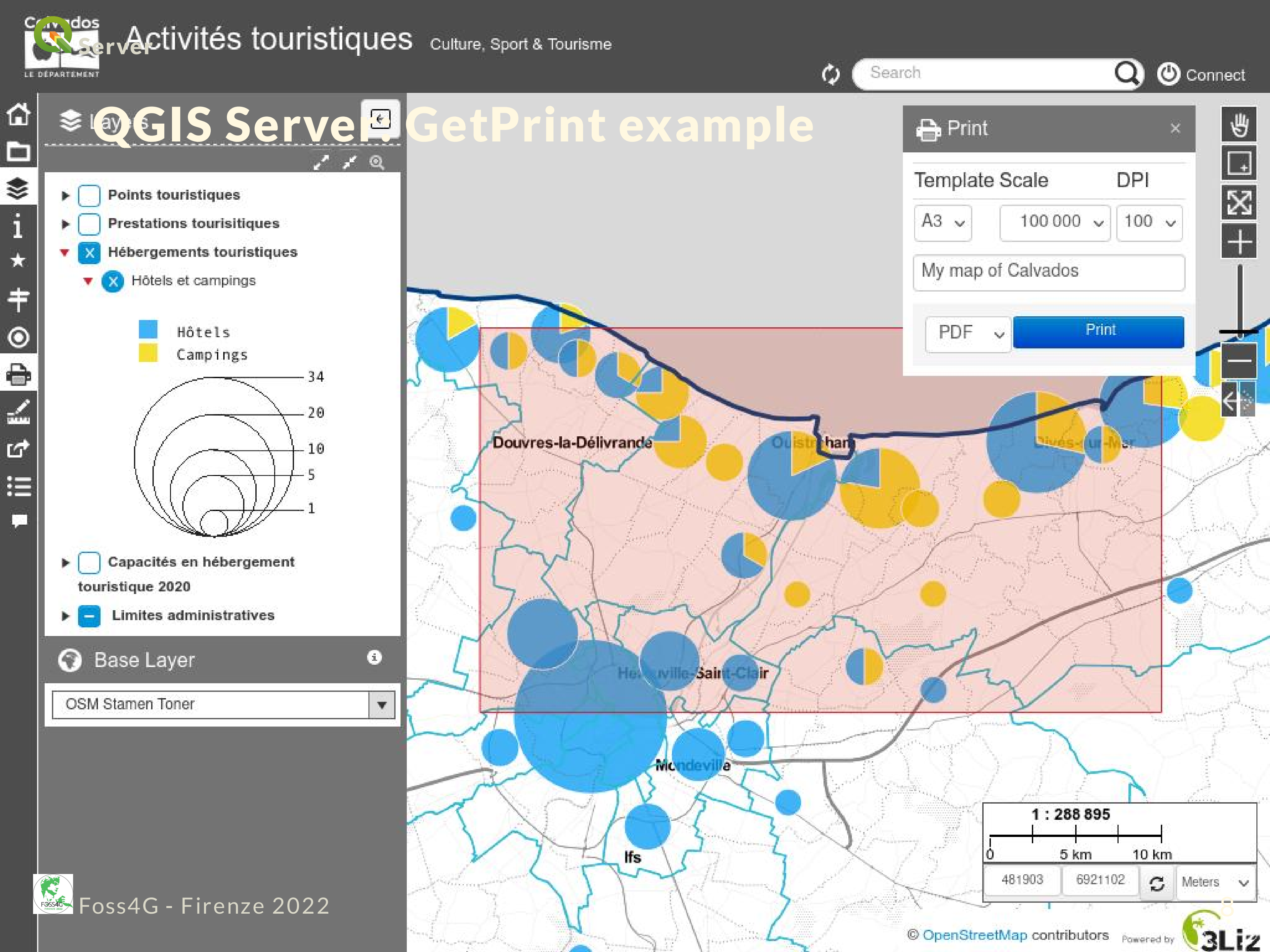
Germany
Write label he
Italy

QGIS Server specific requests

Additional requests:

- **GetProjectSettings**: Returns specific information about QGIS Server and a given QGIS project
- **GetSchemaExtension**: Returns XML metadata about optional extended capabilities
- **GetPrint**:
  - Returns a **QGIS layout** export as PDF, PNG, SVG.
  - Support **Atlas** configured in the layout
  - Additional parameters for **redlining**, **selection**, **filter**, etc.

QGIS Server: GetPrint example



Activités touristiques Culture, Sport & Tourisme

Layers

- Points touristiques
- Prestations tourisitiques
- Hébergements touristiques
  - Hôtels et campings
- Capacités en hébergement touristique 2020
- Limites administratives

Base Layer: OSM Stamen Toner

Print

Template	Scale	DPI
A3	100 000	100

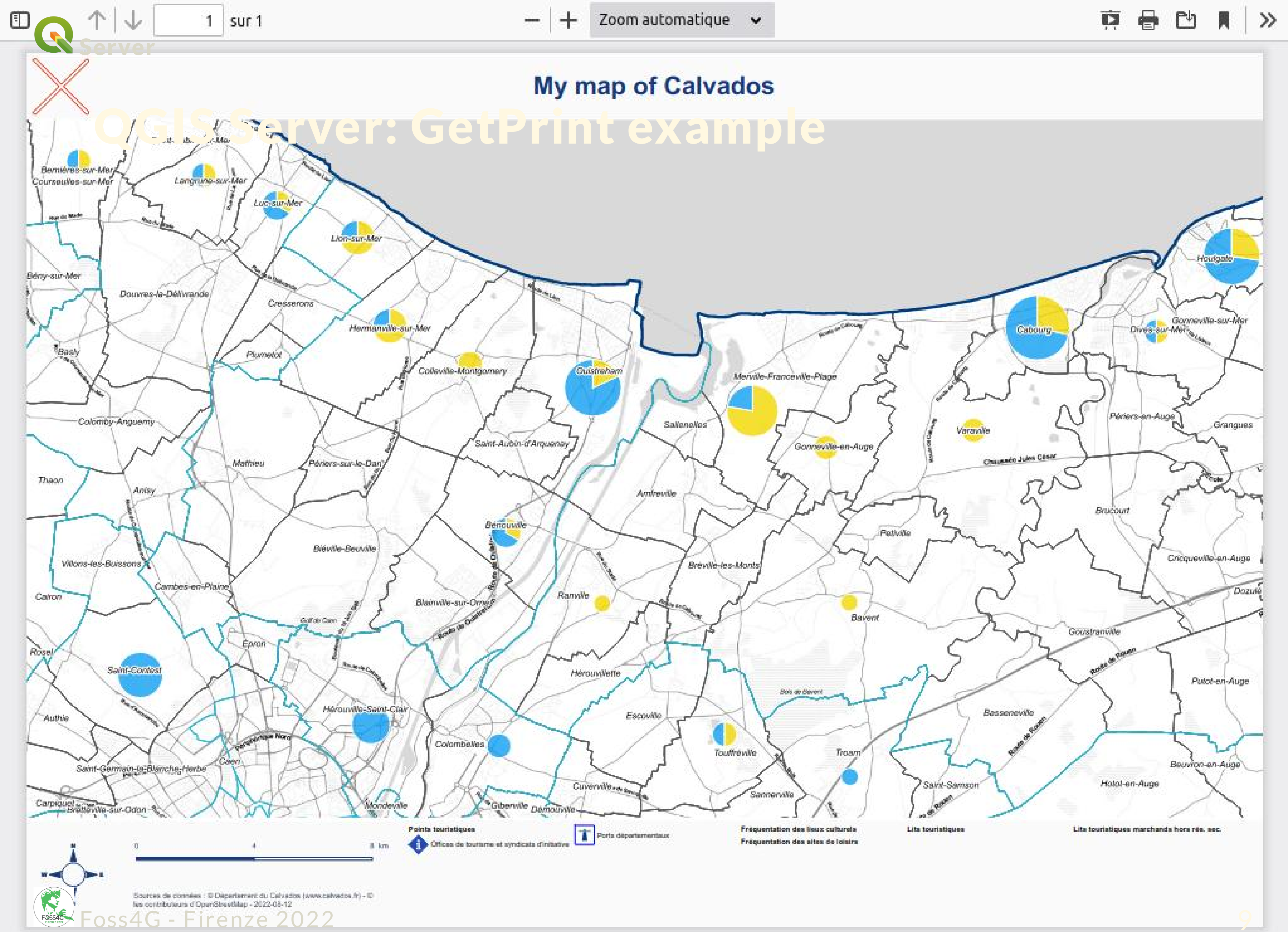
My map of Calvados

PDF Print

1 : 288 895

481903 6921102 Meters

QGIS Server: GetPrint example



My map of Calvados

Points touristiques

Offices de tourisme et syndicats d'initiative

Ports départementaux

Fréquentation des lieux culturels

Fréquentation des sites de loisirs

Lits touristiques

Lits touristiques marchands hors rés. sec.

Sources de données : © Département du Calvados (www.calvados.fr) - © les contributeurs d'OpenStreetMap - 2022-08-12

OGC certification

Since its beginning, a lot of work has been done to respect the **OGC specifications**:

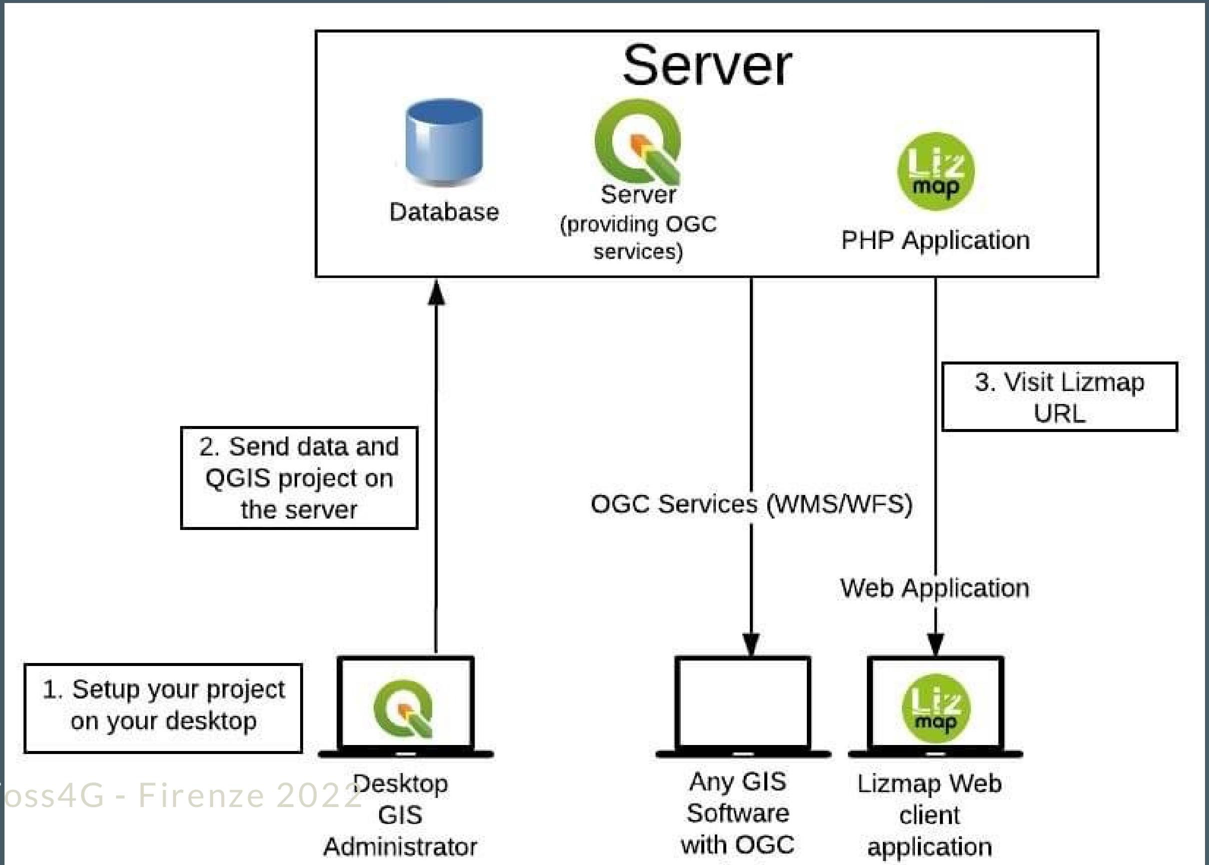
- **since 2018**, it is certified as official OGC reference implementation
- A complete **test suite** has been created to easily check the current status
- **Recent test report**: http://test.qgis.org/ogc_cite/ogcapif/latest/report.html

Lizmap Web Client

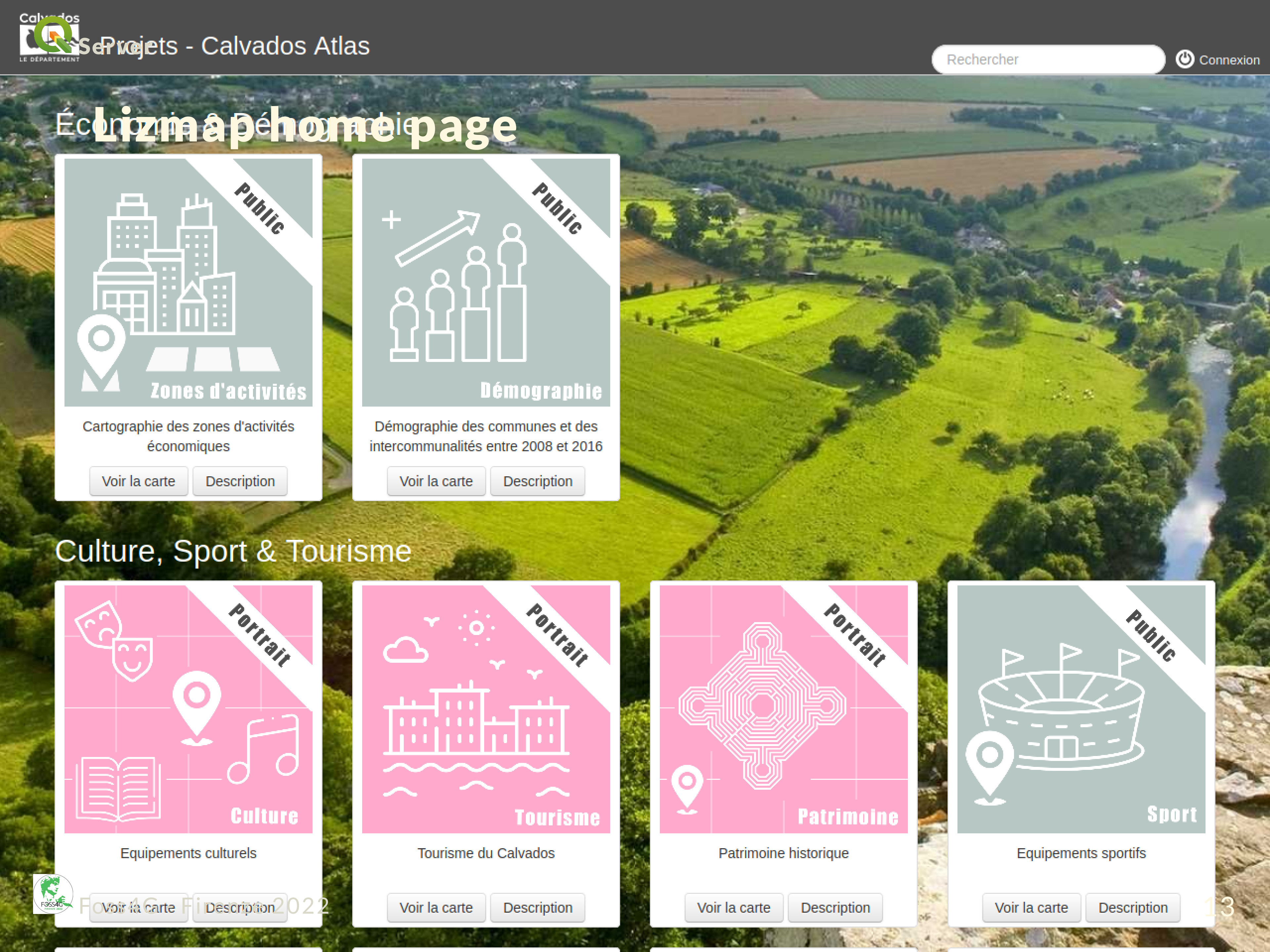
Create web applications based on your QGIS projects

Lizmap Web Client

LWC is an **open-source** software developed by **3liz** which allows creating & publishing **web map applications** based on **QGIS projects** with the help of **QGIS Server**



Lizmap home page



Projets - Calvados Atlas

Économie & Démographie

Cartographie des zones d'activités économiques

Démographie des communes et des intercommunalités entre 2008 et 2016

Culture, Sport & Tourisme

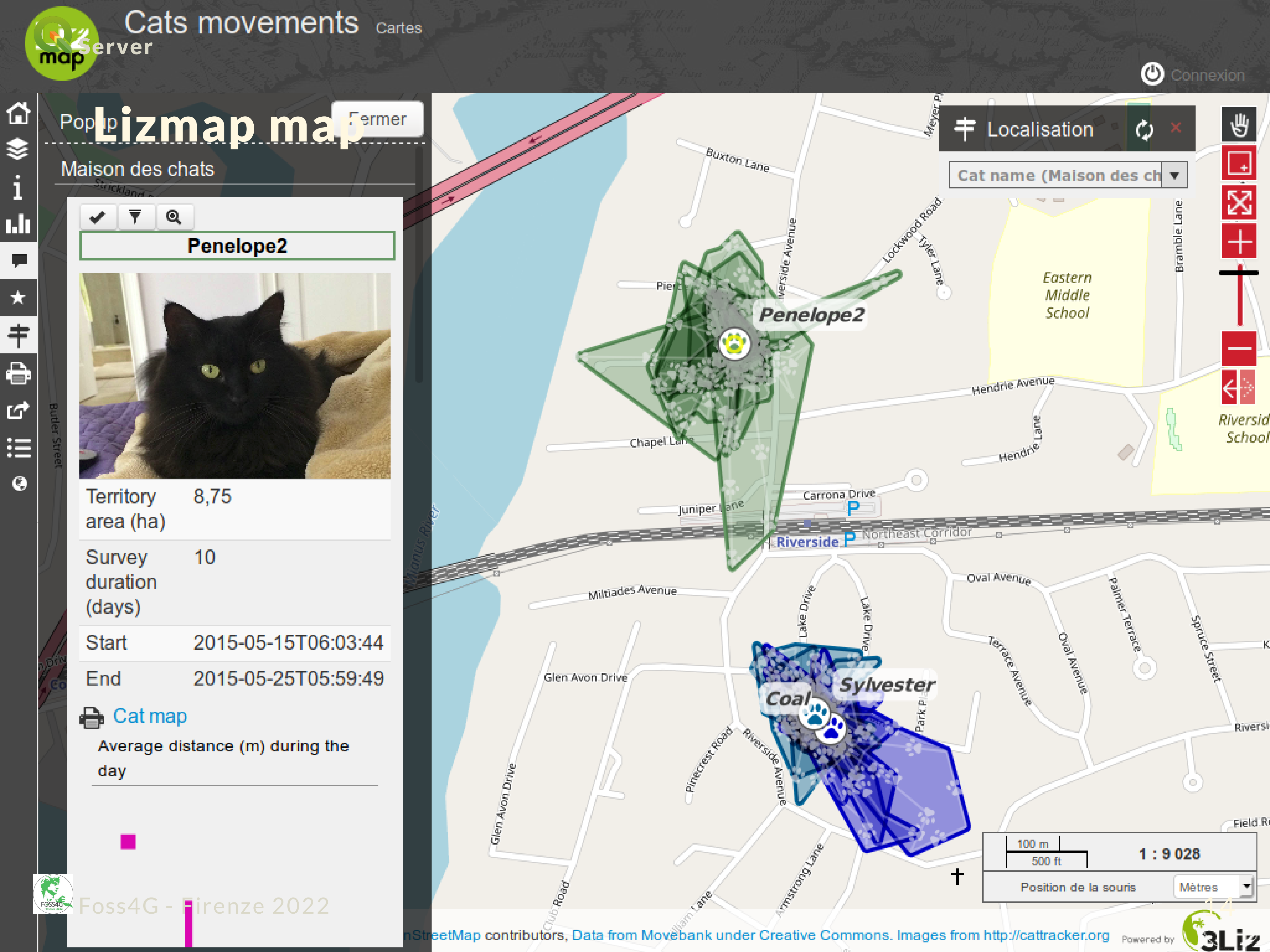
Equipements culturels

Tourisme du Calvados

Patrimoine historique

Equipements sportifs

Lizmap map



Maison des chats

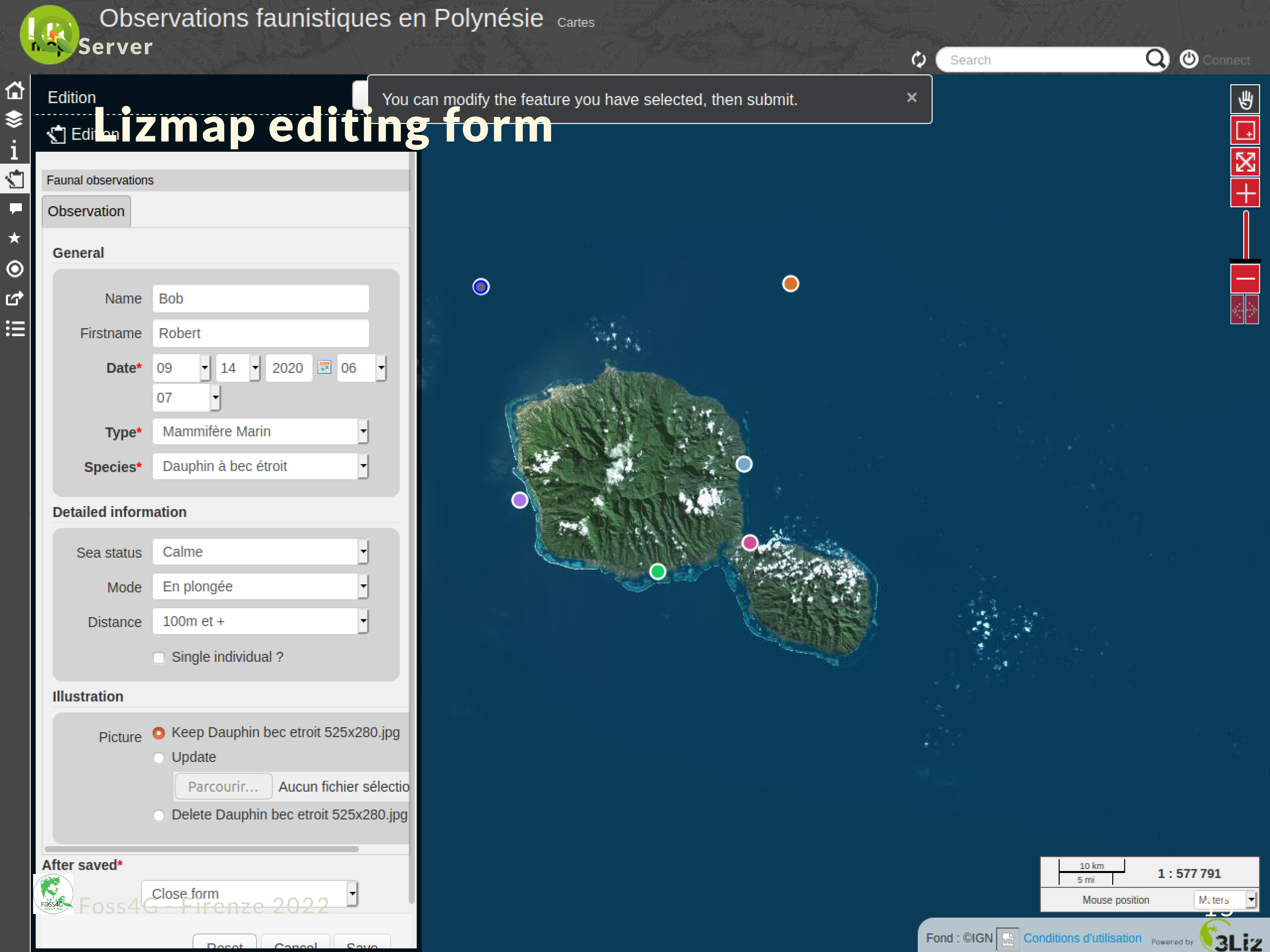
Penelope2	
Territory area (ha)	8,75
Survey duration (days)	10
Start	2015-05-15T06:03:44
End	2015-05-25T05:59:49

Cat map

Average distance (m) during the day

nStreetMap contributors, Data from Movebank under Creative Commons. Images from http://cattracker.org

Lizmap editing form



Observations faunistiques en Polynésie Cartes

You can modify the feature you have selected, then submit. ×

Edition

Edition

Faunal observations

Observation

General

Name	Bob
Firstname	Robert
Date*	09 ▾ 14 ▾ 2020 06 ▾ 07 ▾
Type*	Mammifère Marin ▾
Species*	Dauphin à bec étroit ▾

Detailed information

Sea status	Calme ▾
Mode	En plongée ▾
Distance	100m et + ▾
	□ Single individual ?

Illustration

Picture
● Keep Dauphin bec etroit 525x280.jpg
○ Update
Parcourir... Aucun fichier sélectio
○ Delete Dauphin bec etroit 525x280.jpg

After saved* Close form ▾

Reset Cancel Save

LizCloud

3liz hosting plan for QGIS Server, Lizmap & PostgreSQL

LizCloud

3liz proposes **Spatial server hosting plans** based on:

- QGIS Server
- Lizmap Web Client
- PostgreSQL/PostGIS

One instance = 1 Lizmap Web Client + 1 PostgreSQL database

2 main offers:

- on a **shared** server
- on a **dedicated** server

LizCloud key figures

QGIS Server is used by 3liz in **production** context since **10 years**

- More than **40 servers**
- More than **200** QGIS Server **workers** (at least 4 workers per server)
- QGIS Server **versions** from **3.10** to **3.22**
- More than **3 million requests per week** to QGIS Server
- **99,99%** requests without errors
- Mainly **GetMap WMS requests**
- **GetCapabilities** are **the longest requests** = QGIS project **loading**
- **GetMap Response times** are very good and depend a lot on the QGIS project, layer, configuration complexity (symbology, number of features, expressions, etc.)
    - 50% (median): **20 ms -> 500 ms**
    - percentile 95: **150 ms -> 2 seconds**

QGIS Server hosting challenges

We choose **to trust our users** and let them use the **full power** of QGIS

- **QGIS projects** can be heavy: **up to 400 layers**
- We **accept every QGIS compatible vector and raster format**, except proprietary formats
- **PostgreSQL views and complex queries** can take time to respond
- **External WFS or WMS servers** can be slow or unreachable
- **Layer configuration** (symbology) can lead to poor performances

Main issues

- **Project loading time**: the **first** request on a QGIS project initializes all the layers and print layouts. Then a cache is used.
- **Memory consumption**: QGIS Server memory usage cannot yet be shared between workers (no shared project cache)

Solutions

- **Support**: we help our clients to improve their QGIS projects, layers underlying data, PostgreSQL queries, etc.
- **Monitor and alert**: we store metrics for the key components: QGIS Server, Lizmap, PostgreSQL databases, file storage
- **Contribute**: we help to improve QGIS Server (core contributors since QGIS Server start)
- **Develop** new tools to address encountered issues: **py-qgis-server**, QGIS Server plugins, qgis-plugin-manager, etc.
- **Proxy** requests from QGIS Server to external resources
- **Architecture**: parallelize requests with several QGIS Server workers, use cache, separate services, etc.

Monitor & alert

Store and view metrics

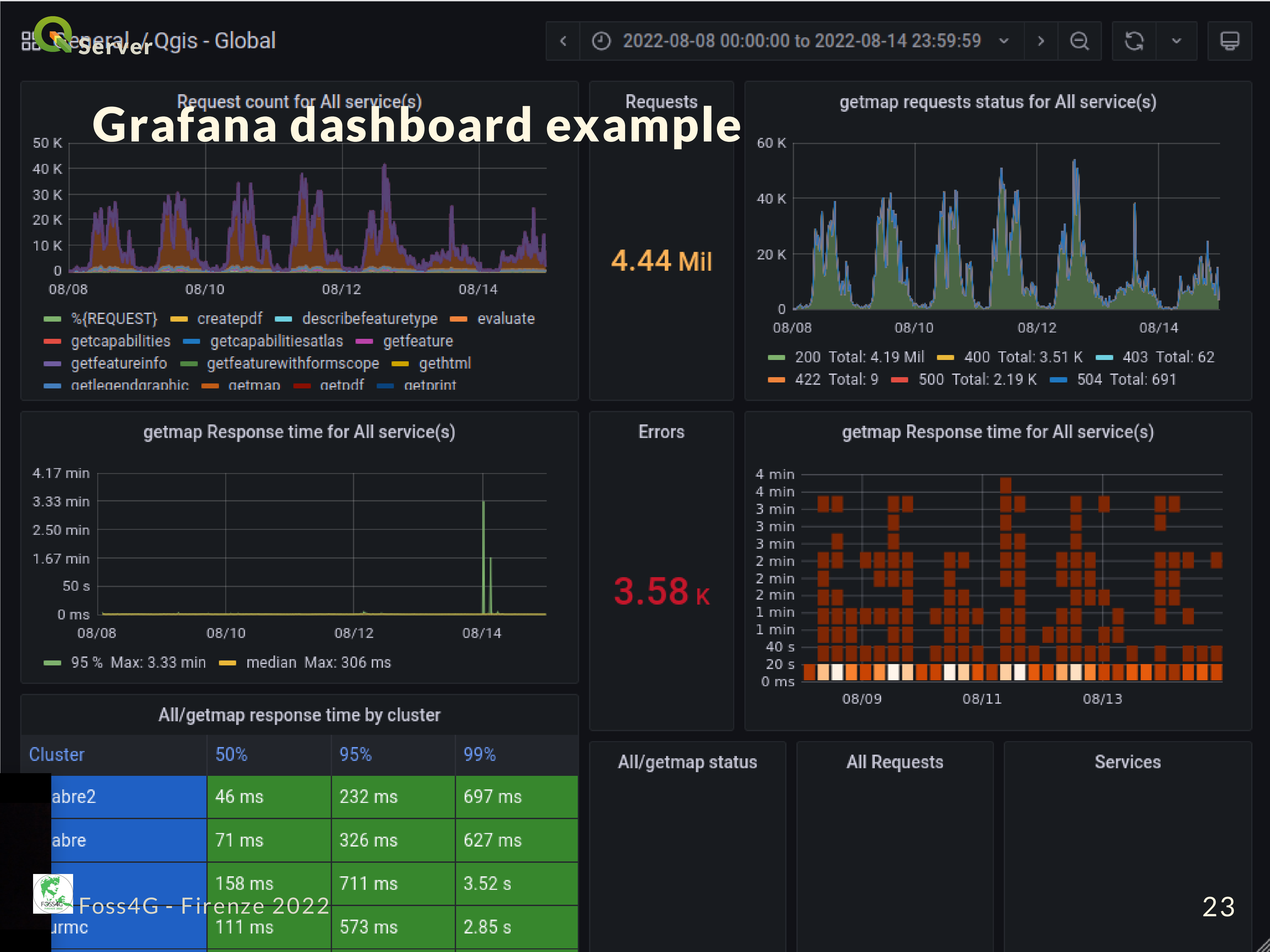
Each service is monitored:

- **Lizmap & QGIS Server requests** with time, status, project & parameters, instance name, physical server ID, etc.
- **PostgreSQL databases**: the number of connections, databases size, errors, etc.
- **Server metrics**: CPU, memory, disk status, network bandwidth, etc.

We integrated all the metrics in **Grafana** to have a complete vision of the services, and also store aggregated metrics to see how it evolves during long periods.

Alerting is also configured to send **emails & SMS** for critical issues: website down, disk 80% full, memory almost full, etc.

Grafana dashboard example



All/getmap response time by cluster

Cluster	50%	95%	99%
abre2	46 ms	232 ms	697 ms
abre	71 ms	326 ms	627 ms
[illegible]	158 ms	711 ms	3.52 s
urmc	111 ms	573 ms	2.85 s

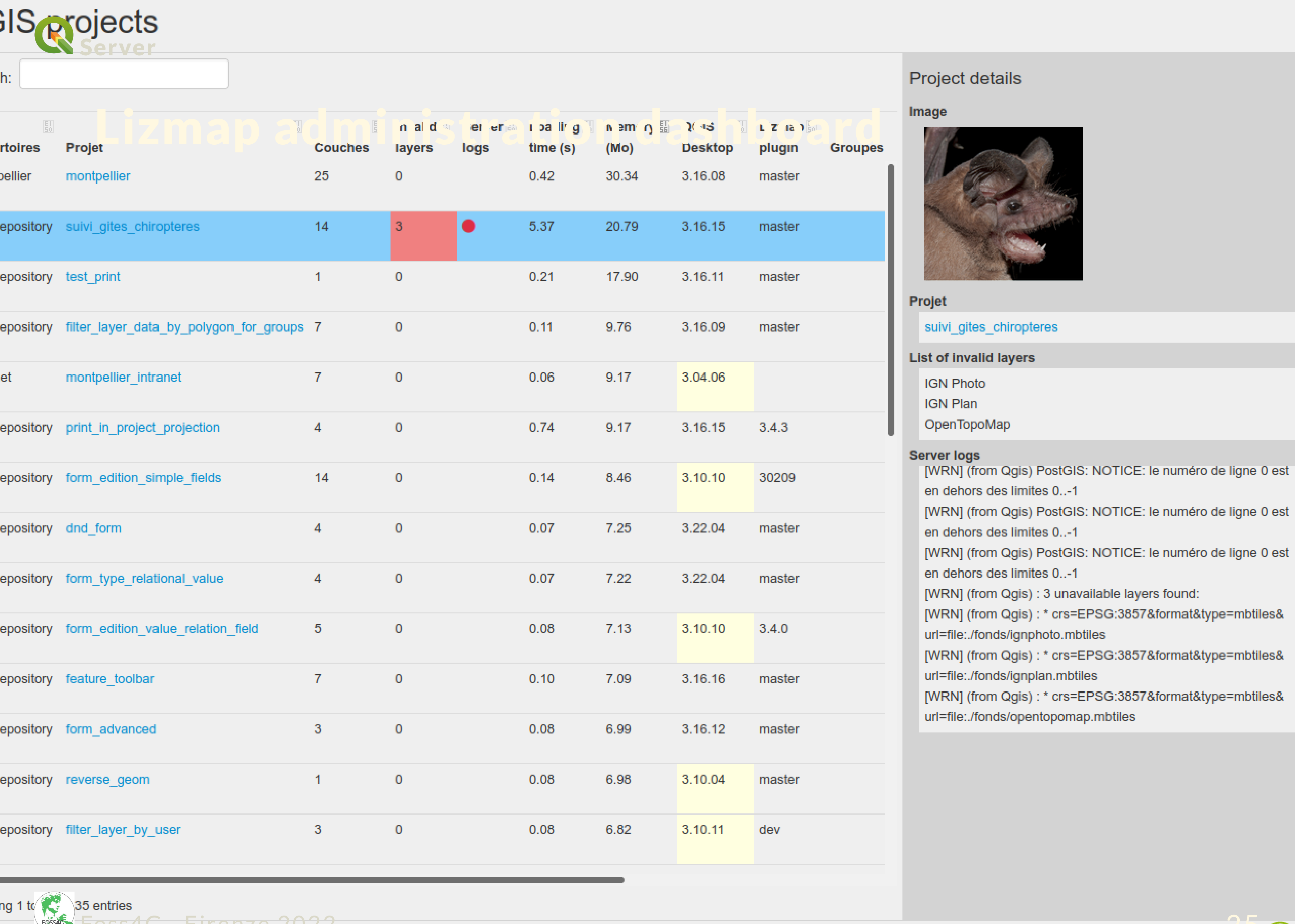
Help Lizmap administrator to evaluate the published QGIS projects

The idea is to show the publisher of the projects helpful information on its QGIS projects:

- QGIS **desktop version** / QGIS **Server version**
- **Layer count**
- **Last date** of modification
- **Invalid layers count** and list of layer names
- **Memory** used to load the project (Mo)
- **Loading time** of the project (seconds)
- **QGIS Server Log** written when loading the project

Depending on the values displayed, a **yellow or red background** will help to focus on **potential issues to solve**

Lizmap administration dashboard



GIS projects

h:

rtoires	Projet	Couches	Invalid layers	Server logs	Loading time (s)	Memory (Mo)	QGIS Desktop	Lizmap plugin	Groupes
pellier	montpellier	25	0		0.42	30.34	3.16.08	master	
epository	suivi_gites_chiropteres	14	3	●	5.37	20.79	3.16.15	master	
epository	test_print	1	0		0.21	17.90	3.16.11	master	
epository	filter_layer_data_by_polygon_for_groups	7	0		0.11	9.76	3.16.09	master	
et	montpellier_intranet	7	0		0.06	9.17	3.04.06		
epository	print_in_project_projection	4	0		0.74	9.17	3.16.15	3.4.3	
epository	form_edition_simple_fields	14	0		0.14	8.46	3.10.10	30209	
epository	dnd_form	4	0		0.07	7.25	3.22.04	master	
epository	form_type_relational_value	4	0		0.07	7.22	3.22.04	master	
epository	form_edition_value_relation_field	5	0		0.08	7.13	3.10.10	3.4.0	
epository	feature_toolbar	7	0		0.10	7.09	3.16.16	master	
epository	form_advanced	3	0		0.08	6.99	3.16.12	master	
epository	reverse_geom	1	0		0.08	6.98	3.10.04	master	
epository	filter_layer_by_user	3	0		0.08	6.82	3.10.11	dev	

ng 1 t 35 entries

Project details

Image

Projet

suivi_gites_chiropteres

List of invalid layers

IGN Photo
IGN Plan
OpenTopoMap

Server logs

```
[WRN] (from Qgis) PostGIS: NOTICE: le numéro de ligne 0 est en dehors des limites 0..-1
[WRN] (from Qgis) PostGIS: NOTICE: le numéro de ligne 0 est en dehors des limites 0..-1
[WRN] (from Qgis) PostGIS: NOTICE: le numéro de ligne 0 est en dehors des limites 0..-1
[WRN] (from Qgis) : 3 unavailable layers found:
[WRN] (from Qgis) : * crs=EPSG:3857&format&type=mbtiles&url=file:./fonds/ignphoto.mbtiles
[WRN] (from Qgis) : * crs=EPSG:3857&format&type=mbtiles&url=file:./fonds/ignplan.mbtiles
[WRN] (from Qgis) : * crs=EPSG:3857&format&type=mbtiles&url=file:./fonds/opentopomap.mbtiles
```

Improve QGIS Server & develop specific tools

QGIS Server improvements

The **3liz team** contributes to the effort of improving QGIS Server for every version, for example:

- Implement **service module registry**: use a modular approach for each service (WMS, WFS, WCS, etc.)
- **Project properties** tool to check if the project is ok to serve
- **Improve the QGIS project loading times**. Fresh example: open the project in read-only mode to avoid unnecessary requests to database providers (PostgreSQL, Oracle, etc.)
- **Fix bugs or regressions** discovered in new versions: memory leaks, high memory usage for big JPEG files in composers, etc.
- Improve **unit test suite** to avoid regressions

Blog post: https://www.3liz.com/en/news/qgis-ltr-3-22.html

Py-Qgis-server

Python QGIS embedded WMS/WFS/WCS **asynchronous scalable server** https://docs.3liz.org/py-qgis-server/

- Easy configuration: **environment variables** or simple **ini file**
- Multiple **parallel workers**
- Fair **queuing request** dispatching
- **Timeout** for long-running/stalled requests
- Full support of QGIS server **plugins**
- **Auto-restart** trigger for workers based on memory, number of requests, etc.
- Support adding new **projects cache handlers** as python extension
- **Preloading** of Qgis projects in a static cache
- Control the exposition of **QGIS API** to secure access

QGIS Server plugins

The 3liz team developed several plugins for QGIS Server:

- **WFSOutputExtension**: add more formats for the **WFS service** (SHP, KML, ODS, XLSX, etc.)
- **AtlasPrint**: extend QGIS Server to allow exporting a PDF from a **print layout with Atlas**
- **WMTS Cache**: allow to cache the map tiles served by QGIS Server
- **Lizmap Server**: allow to evaluate QGIS Expressions (feature, layer, global context), help to control access to data

Documentation: https://docs.3liz.org/plugins/#server

To install server plugin, you can use our **qgis-plugin-manager** Python tool: https://github.com/3liz/qgis-plugin-manager

Py-QGIS-WPS

-> example of a complementary tool for QGIS Server

Py-QGIS-WPS is an implementation of the **Web Processing Service** standard from the OGC based on the **QGIS Processing API**.

This implementation allows you to expose and run on a server:

- QGIS Processing **algorithms** available on Desktop
- QGIS Processing **models and scripts**
- QGIS plugins having a **Processing provider**

It is written in **Python** and is a fork of PyWPS.

Conclusion

- QGIS Server is a great OWS server with **the power of QGIS desktop**
- A continuous process under the hood to **improve performance and robustness**
- The **3liz team** helps with **core contributions**, **plugins** development, new **tools**, **ideas** and **support**
- You cannot just install and use QGIS Server: as any server, it needs **monitoring and alerting**, and a good **architecture**
- **3liz** proposes a **production-ready hosting service** with QGIS Server, PostgreSQL & **Lizmap Web Client**

Resources

- QGIS Server documentation: https://docs.qgis.org/latest/en/docs/server_manual/
- 3liz documentation with plugins, tools, tutorials, etc: https://docs.3liz.org
- Twitter: @3liz_news and @LizmapForQgis
- Email: info@3liz.com

Thanks for your attention !

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Github: @mdouchin

A big thanks to the QGIS community !

Some were here just before the Foss4G conference for the QGIS developer meeting