MANIFESTS DSS

IMPLEMENTATION GUIDE

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1. Background

In the event of a maritime accident involving Harmful and Noxious Substances (HNS), the maritime authorities must make numerous decisions to organize the best response strategy, that is, the one that minimizes the risks to human health (including rescuers, crew members and coastal communities), for the marine environment, for maritime safety and for socio-economic activities and facilities. While many key decisions and considerations are prescribed in national or regional contingency plans, operational response activities will generally need continuous adjustment or revision to reflect the latest information available as the contamination event evolves. In such a rapidly changing situation, an efficient two-way information exchange between decision-making authorities and response teams on the ground can greatly facilitate both, decision-making and organizational processes.

The purpose of work package 5 of the Manifests project (Manifests decision support system) is to develop an efficient information system that helps (1) decision makers understand the situation at stake and its likely evolution in the coming hours and days; (2) identify the population, ecosystems and socio-economic assets at risk and (3) share useful information with response teams deployed at sea, in the air or on the coast.

Building on the experience gained and development carried out during the previous HNS-MS and MARINER projects, the MANIFESTS decision support system (DSS) will integrate several services, including the DSS Common Operational Picture (COPtool).

This COPtool refers to a system designed so that during a contingency, the exchange of information that occurs between the maritime authorities and the different response teams (sea, coast, air) is carried out in the most efficient way possible, ensuring that all actors involved in the crisis committee and response teams can access the same data. These can be standard reports (such as the Standard Pollution Observation Report of the Bonn Agreement), images, videos and any other georeferenced data collected by response teams, as well as satellite observations, model simulation results, exclusion areas, location of response media, requests for new response actions shared by the crisis.

The COPtool documentation is composed by:

- Installation guides.

- User Manual.
- DSS Implementation report (this document).

2. Objective

The purpose of this document is to explain the structuring of a contingency in reference to the information handled during said contingency and the users of this information.

In the first part of the document, the different sources of information that are usually present during an episode of marine pollution will be described, considering both their temporal and spatial specificities. In addition, the layers of data and reports that are generated during the accident in relation to the fight against pollution and the different participating users and their functionalities will also be explained.

In the second part, the technological solution for the insertion and distribution of information for the different actors in the contingency will be described to later specify in detail each type of information layer to be distributed.

A first part of the document will describe the problem to be addressed, that is, the exchange of information with the different actors during a contingency, as well as the proposed solution. In addition, the different sources of information that are usually present during an episode of marine pollution will be described, considering the temporal and spatial specificities of the same. The layers of data and reports generated during the accident in relation to the fight against pollution and the different users involved and their functionalities will be explained.

In the second part, the technological solution for the insertion and distribution of information for the different actors in the contingency will be described. Then, it will be explained in detail each type of information layer to be distributed.

3. Structure Of The Decision Support System

This section describes the different elements of the response decision system. A Decision Support System or DSS (Decision Support System) is a computer system that helps the decision-making process. In rather more specific terms, a DSS is "an interactive, flexible and adaptable computer-based information system specially developed to support unstructured management problem solving to improve decision making. It uses data, provides a friendly interface, and allows decision-making in the analysis of the situation" (Turban, E. 1995).[1]

The proposed DSS is based on the following elements:

1. A resource center that centralizes and gives access to management protocols, guidelines, reports and other sources of knowledge, such as sensitivity maps useful for assessing risks and planning response actions. It will consist of a web tool for the management of this information and the management of data insertion and simulations, contingencies and users. It will be called **COPtool**.
2. An application accessible to all response teams, coast guard officers and maritime authorities in order to efficiently exchange information on the latest developments of the pollution event and response actions. This application will be called from now on, **COP Viewer**.
3. A series of databases and associated procedures to include those internal sources of each organization in the resource center and be managed by the COPtool. This set of tools will be called **Auxilia COP.**

Before explaining each of these elements, one must understand the whole schema of a DSS for marine pollution contingencies.

3.1. Schema of a DSS for marine pollution contingencies

When making decisions for the response to a marine accident, the availability of up-to-date information is essential. This information is usually georeferenced,that means one property of it is a location in the space. This kind of information is often called information layers, since they become a set of superimposed maps. Some of these layers have been created before the contingency, such as the coastline, bathymetry, or areas of environmental importance, and some of them are generated during the contingency, for example, the prediction of drifters, the positions of the spots, or the situation of the anti-pollution equipment in use.

On the other hand, for using this information effectively during a contingency, this information must be distributed quickly, efficiently, and safely to the different actors involved in the crisis, such as the contingency management, political advisers, or staff involved. The needed information for each of

[1] Turban, E. (1995). Decision support and expert systems: management support systems. Englewood Cliffs, N.J., Prentice Hall. ISBN 0-02-421702-6

them is usually not the same. In addition, the degree of confidentiality of the same is not always the same and therefore there will be information that will not be available to all users.

Fig. 1: Elements in a contingency: On the one hand, there are layers of information (prior to the contingency or generated during it). On the other, there are various actors involved in the contingency with different degrees of access to this information.

The challenge of this work is to create a system where a wide variety of information, mostly georeferenced, is available quickly and efficiently by the different actors involved, without overloading each of them with information and, at the same time, guaranteeing layers of confidentiality when necessary.

The DSS is able to easily create a Common Operational Picture (COP) for each contingency customized to each user. This means that, on the one hand, there will be access to the precise information of each contingency and on the other, each user depending on their level, will be able to access different information.

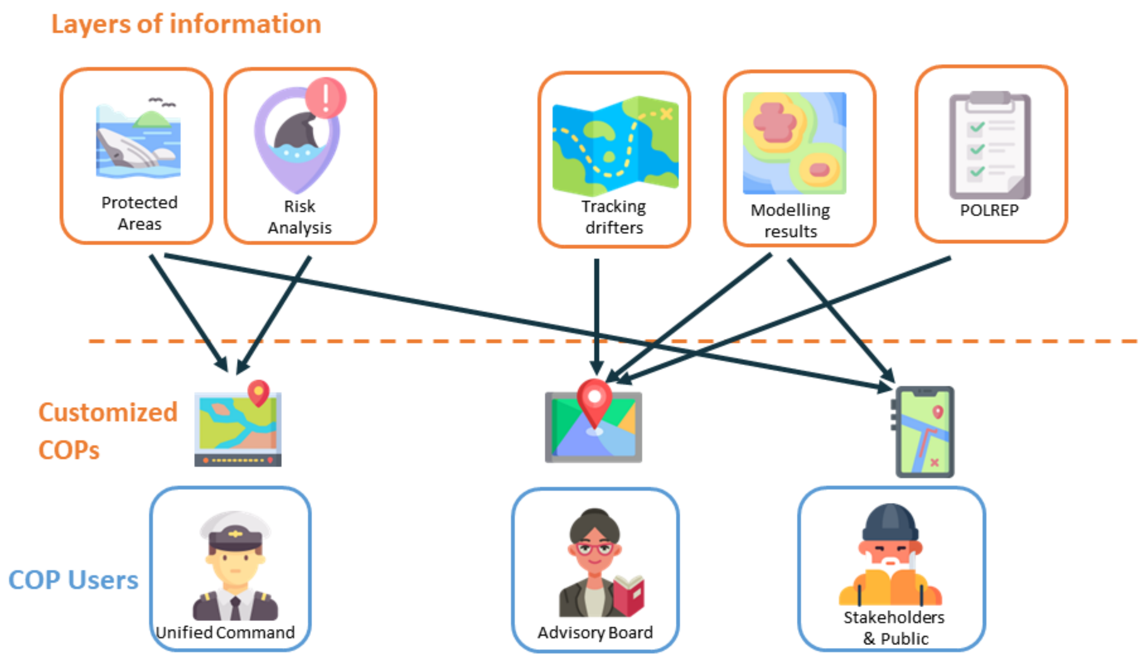

Fig. 2: Users will consult the information layers through a COP (Common Operational Picture) tailored to the contingency and their needs.

In addition, much of the information is generated manually during the contingency: POLREP reports, other reports, pictures, etc. Therefore, the DSS must not only collect information prepared before the accident but also equip itself with systems that allow it to ingest data and information generated during the contingency. Therefore, beyond the users with access to information, there will be users with the ability to insert information.

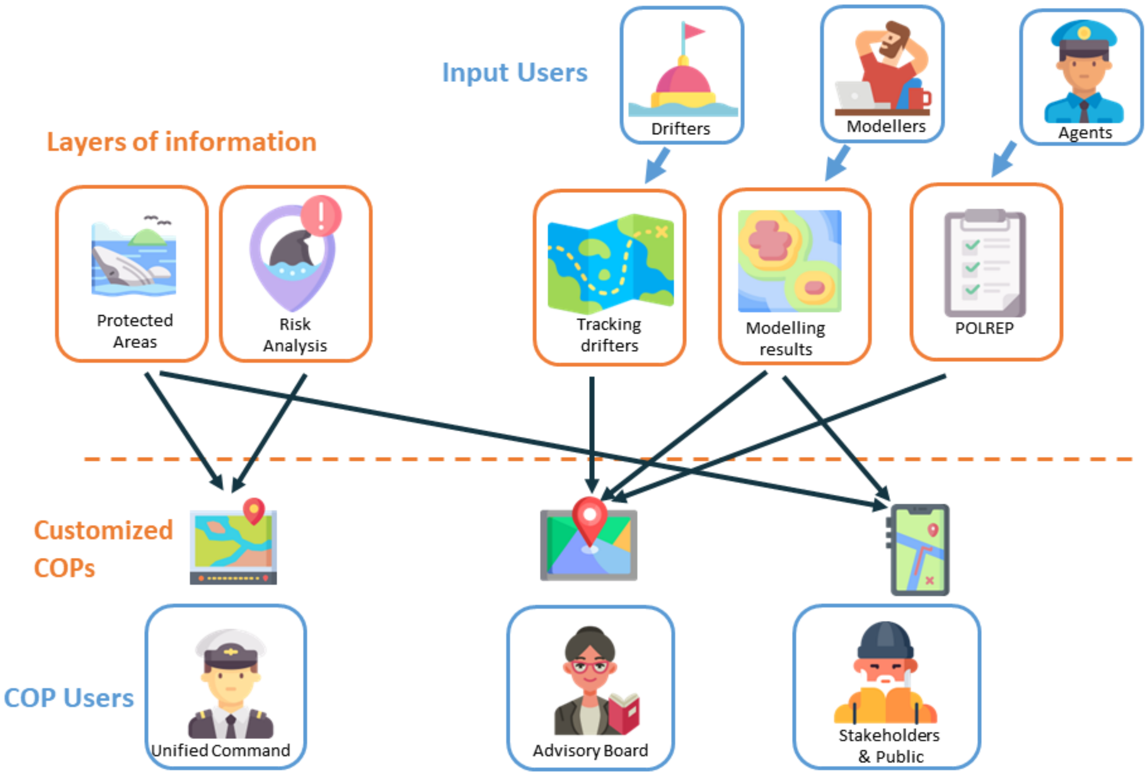

Fig. 3: In addition to the above elements, information layers and COPs users, there are other users of the system that are the information insertors, either manually generated as POLREP reports or in a more automatic way such as model results or drift buoy positions.

Above these COP users and input users, a **COPs Manager** is needed to manage the different users who can use the system during the contingency, as well as what information is accessible during it. The COPs Manager is the user who creates a COP for a given contingency, associates users with that contingency, and attributes the necessary layers to it. Each user will be able to consult the layers associated with that contingency depending on the access permissions they have at the time of the contingency. Users with the lowest level of confidenciality will not be able to view and query layers that are restricted to the higher ones.

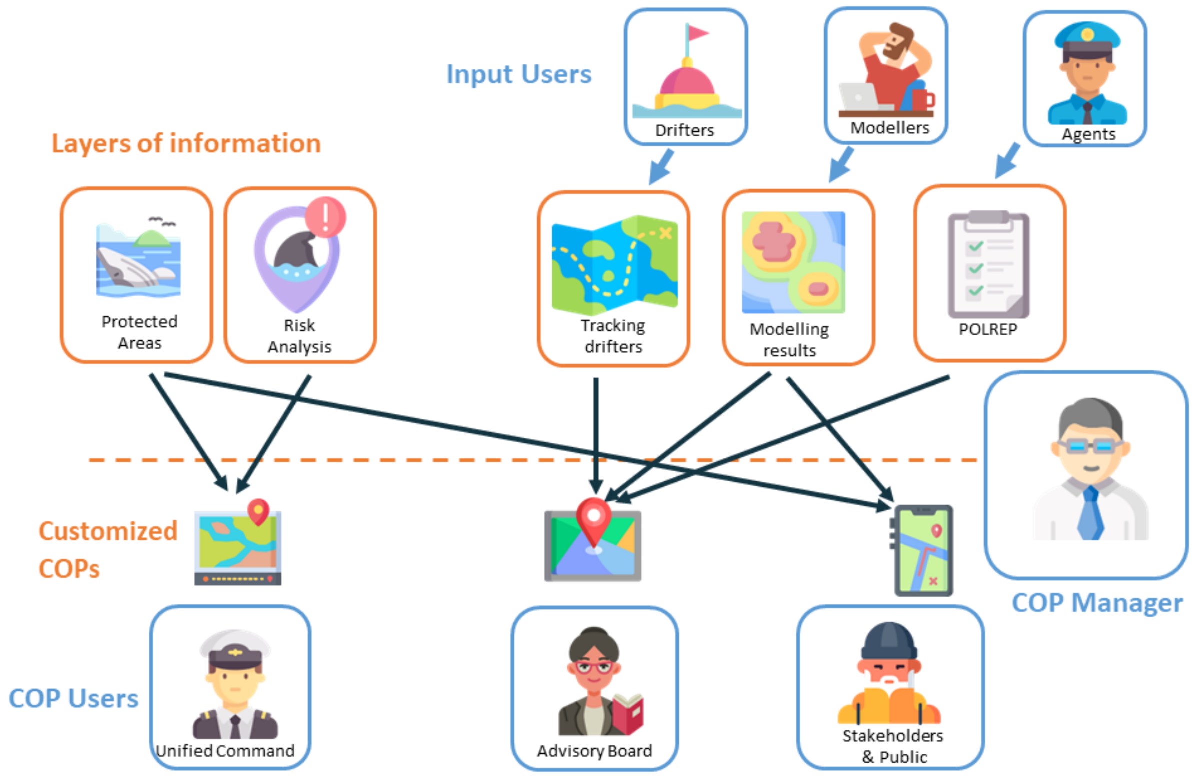

Fig. 4: There is the COPs Manager user whose main task is to create the different COPs customized for each user when the contingency occurs.

Like any computer system, there's a super user or Administrator who manages the tool and has two main functions: giving access to the tool to the rest of the users and establishing the addresses and metadata of the information that will be available for access in future contingencies.

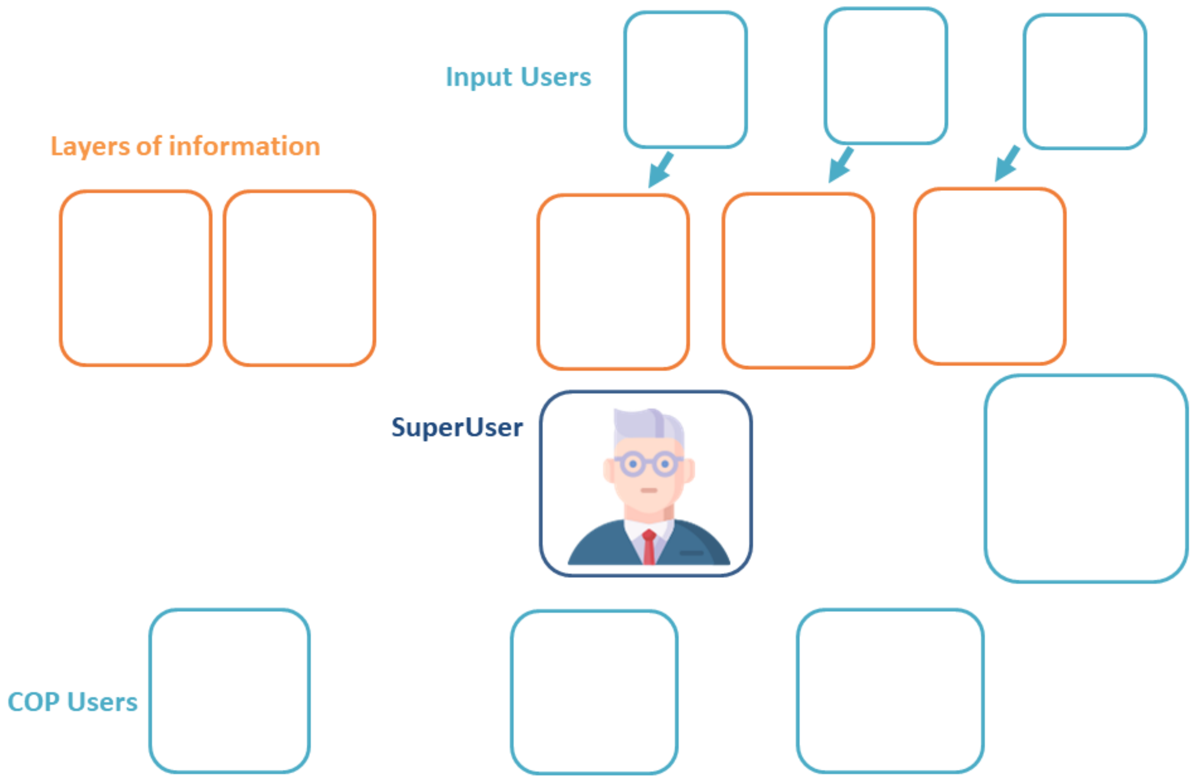

Fig. 5: In addition to these users, there is the Administrator user who inserts all the layers that will be available in the system and manages the access of the rest of the users.

It is necessary to distinguish between the COPtool Manager and the COPs Manager for the different contingencies. The first one gives access to all users (including the COPs manager) and includes in the system the references for the different layers of information contained in the data base, while the second determines which users have access to the specific information for a contingency.

3.2. Use of DSS prior to any contingency

A normal use of DSS prior to any contingency would be as follows:

1. The Administrator **inserts layers** of information into the system. This means that there will be a reference to a WMS (Web Map Service) address for each layer and therefore that the information of this layer can be included in a future contingency.

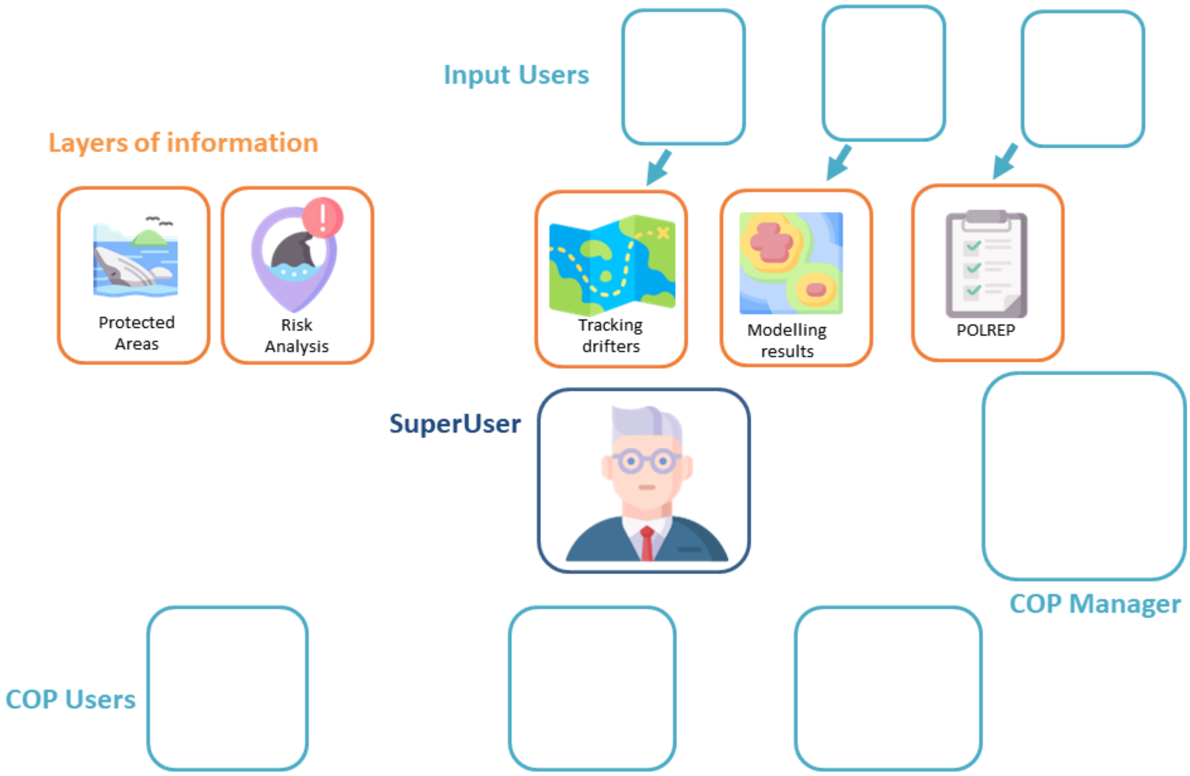

Fig. 6: The Administrator inserts the information layers into the referenced system with a WMS address.

2. The Administrator **enables access** to other users: they can have different functionalities. The main users are:

   a) **COPs Manager**: Allows you to create a COP for a contingency, choose the layers of information that can be seen in that contingency and which users can see them.

   b) **COP Viewer users:** They are users to consult the COPs of the contingencies to which they have access. Keep in mind that not all users have the same level of query, regardless of whether they have access to a contingency or not.

   c) **Inserting users**: These are users who have the ability to insert information and reports. They can be users insertors of POLREP, POLREP Costa reports, communications, maps, etc.

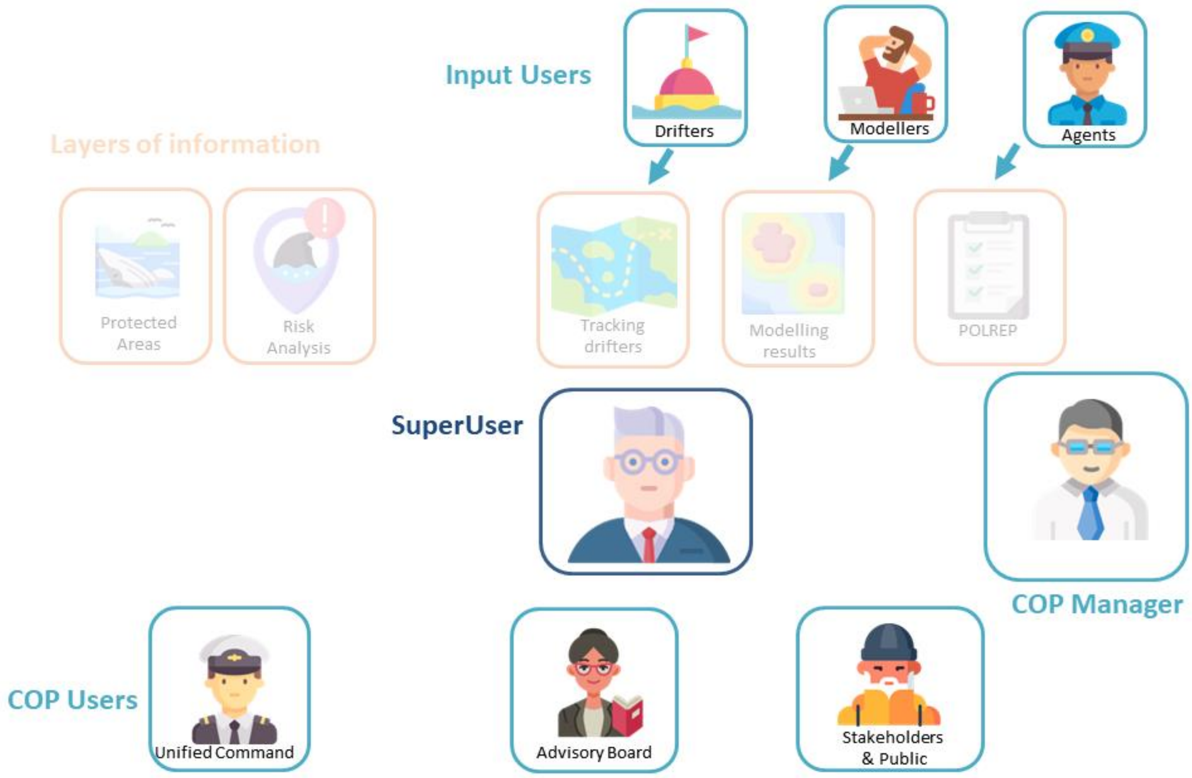

Fig. 7: The Administrator gives access to other users: COPs Manager, COPs Viewer users and Inserting Users.

3.3. Use of DSS during contingency

El uso del DSS durante la contingencia es como sigue:

1. The COPs Manager **creates a new COP** for that contingency, including the different layers of information that can be consulted and the users who have access. He or she can also link reports, photos, and maps to that contingency.
2. **COP Viewer Users can access the COP** of that contingency and consult the information to which they have access.
3. **Inserting Users can insert** POLREP, SCAT, reports, pictures, or documents. If these reports are linked to the contingency, it may be consulted as information about it.
4. **Automatic or external processes** will insert information into the data base. The usual information that is included in these external processes are simulations, drift buoys, etc.

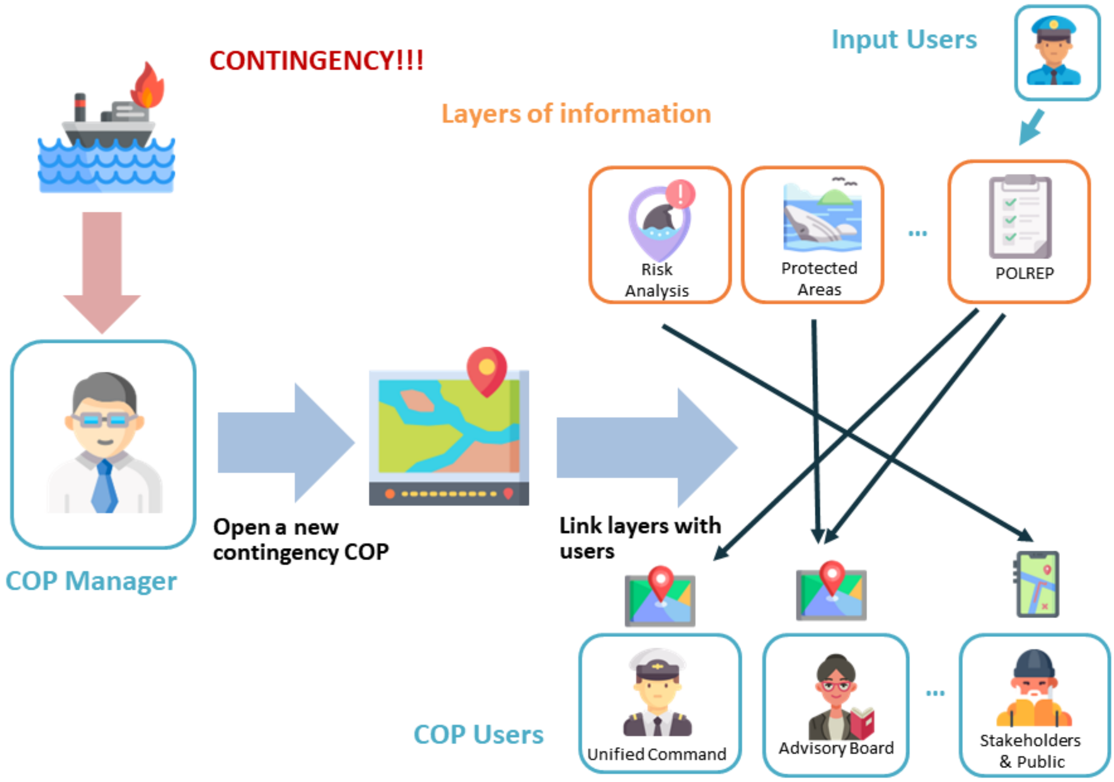

Fig. 8: During a contingency the COPs Manager opens a new contingency in the DSS,and assigns layers of information and users to that new contingency.

The result is that a COP Viewer User can access a COP of the contingency that allows him or her to visualize the layers of that contingency visualizing only the layers he has access to. The COP Manager carries out the customization of the COP to each contingency and each COP Viewer User in a relatively short time, no more than a few minutes.

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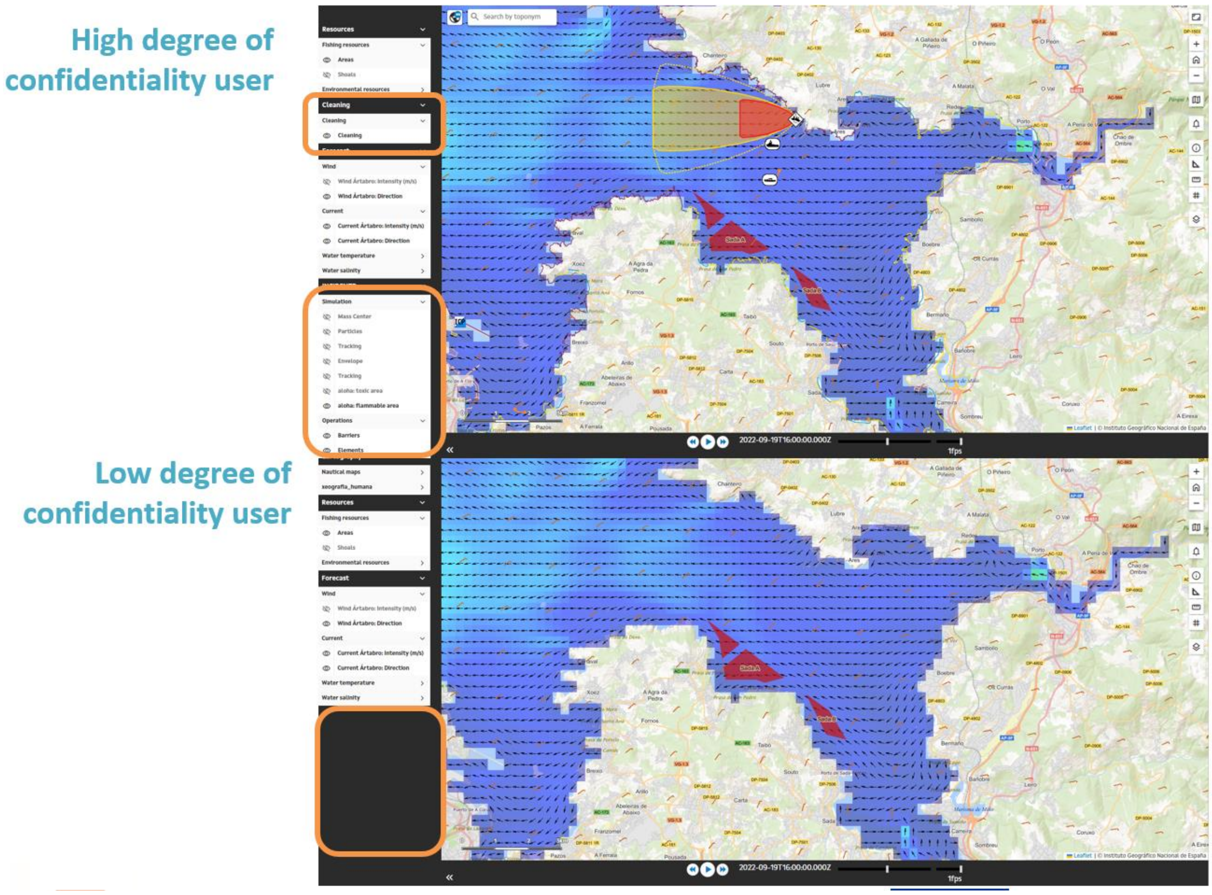

Fig. 9: COP viewer of the same contingency for two users with different degrees of confidentiality. The user with low confidentiality (bottom) is not allowed access to all layers of a user with a higher degree of confidentiality (above), as shown by the orange rectangles.

In addition, these contingencies receive different inputs from the different Inserting Users, which are automatically updated for consultation by COP Viewer Users.

3.4. Elements of DSS: Sources of information

This section will describe the different types of information layers that are commonly used when making decisions during a contingency. It should be noted that these layers depend on the specific information needs and availability of each organization. The following classification is a general guide and not a rigid scheme.

In general, the layers of information needed for decision-making during a contingency can be classified into:

1) **Pre-contingency information:** This includes all layers of information that exist regardless of whether there is a contingency or not. It also includes dynamic information that exists event if there isn't a contingency, like meteorological or hydrodynamic predictions.

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It can be divided into:

- *Static information:* includes information on base layers, cartography, fishery and environmental resources and a coastal inventory.
- *Dynamic information:* This information varies over time and exists whether there is contingency or not. This includes information from meteorological, hydrodynamic, and wave models, satellite observations, HF radar, or automatic platforms, and layers with AIS or ship location information.

2) **Information created during the contingency:** This consists of the information of the contingency. Here it is contemplated:

- Results of prediction models of spot drifts, HNS, toxic clouds, and exclusion areas.
- Drifter tracks and spill monitoring systems
- Location of assets and booms, tactical maps, etc.
- POLREP, SCAT, pictures, documents and reports.

Typical sources during a contingency can be outlined in the following figure:

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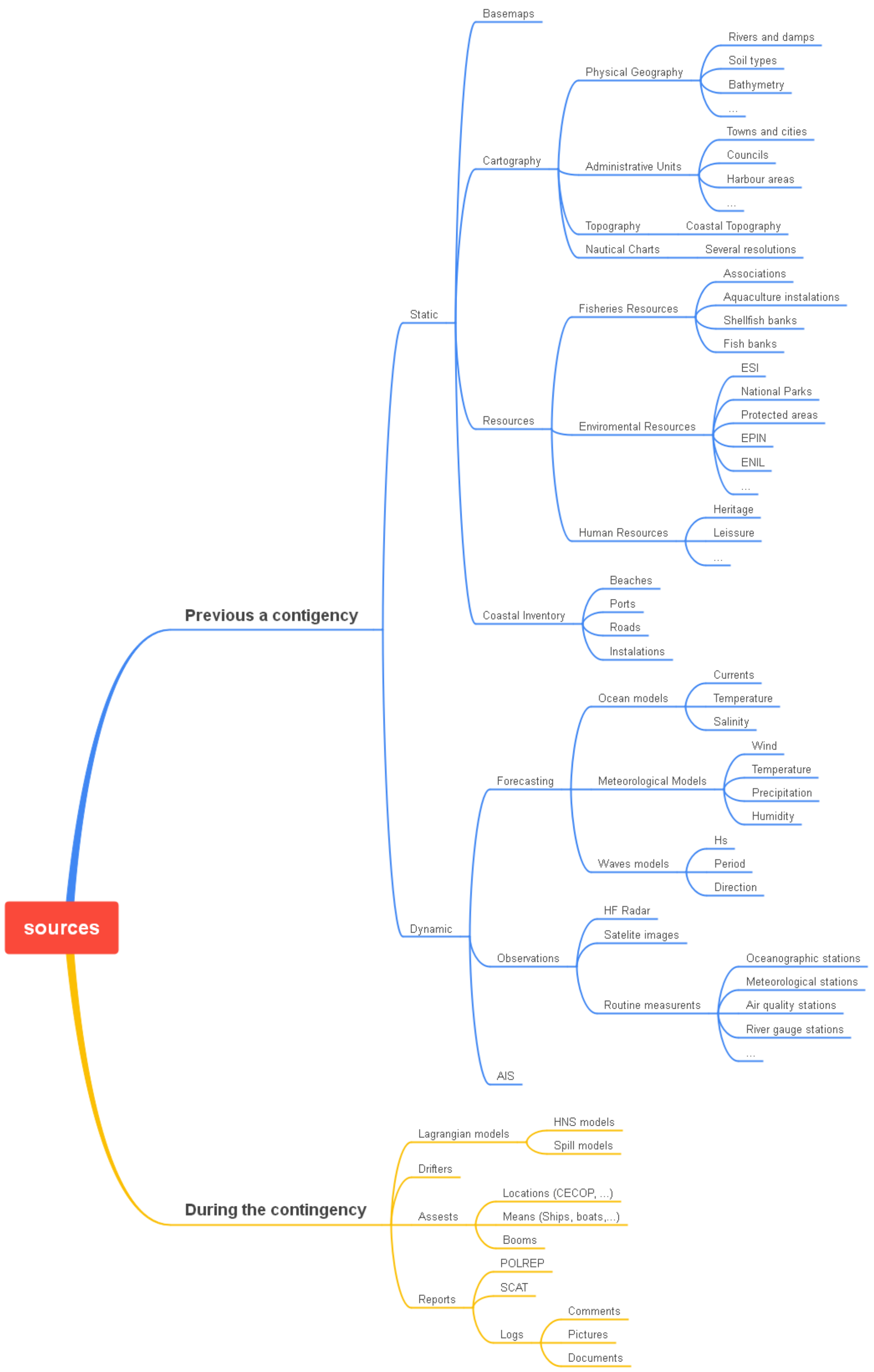

Fig. 10:Kind of information managed during a contingency: there are two large groups: the information created prior to the contingency and the other one generated during and for the contingency.

References to these sources of information are made through the Open Geospatial Consortium (OGC (https://www.ogc.org) service, called Web Map Service (WMS). This service basically consists of a web service that enables the access a thematic map, with certain functionalities, such as obtaining information about the items represented. Thus, each layer included in the COPtool will be associated with a WMS address that will provide the information in the form of a searchable geographical layer. It is the function of the COPtool to store these references.

Therefore, the connection between the COP viewer and the information layers is made through this type of services. This allows us to include in the viewer any type of layer that is served through WMS, whether from servers external to the system or own servers.

For the information stored in the organization itself, whether from the DSS-COPtool database or others, it is proposed to provide this WMS service through a Geoserver (https://geoserver.org).

A more detailed explanation of this implementation will be given later.

3.5. DSS Elements: Users

As it has been referenced before, from a conceptual point of viewe there are several types of users: Administrator, COPs Manager, COP Viewer Users, Inserting Users, etc.

However, when implementing the system it has been chosen to create only two users: Administrator and User, which can be assigned one or more functionalities or modules:

- **Administrator**: Super user, with access to all modules, as well as the management of users and information layers of the system.
- **User:** With access to those modules (one or several) assigned by the administrator.

The different modules that allow users to perform each of the functions are:

Módulo	Funciones
User Management	Creation/editing of user accounts.
Layer Management	Managing the information layers that are available in the system.
Management of COP (Common Operational Picture)	Management of the information to be distributed during the contingency.

POLREP	Insertion of POLREP reports into the system.
SCAT	Insertion of SCAT reports in the system.
Reports	Insertion of information derived from different inspections (photos, videos, comments, etc.)
COP Viewer	

The user management and layer management modules are unique to the administrator user, and only the administrator user can make changes. The rest of the users will be able to access one or several modules depending on the permissions granted by the administrator at the time of registering in the system.

For example, a COP Manager at the conceptual point, is a User with the COP Management functionality from the point of implementation. This change allows the existence of users with different functionalities, providing greater plasticity to the DSS.

Additionally, users will also have different levels of access to the information layers, with level 1 having the lowest access to information and level 3 having the highest access. These generic access levels can be modified for each user and contingency if necessary.

4. System Implementation

The system can be divided into three components:

- **COPtool:** Software consisting of a graphical interface and an associated database for user management, and its modules.

- **COP Viewer:** Software for exploring the maps of a contingency managed by the COPtool.

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- **Auxiliary COP:** Database with other relevant information such as model results, drifter tracks, etc. and associated inserting scripts. This component depends largely on the availability of this information by the agency so its implementation is not always similar and necessary.

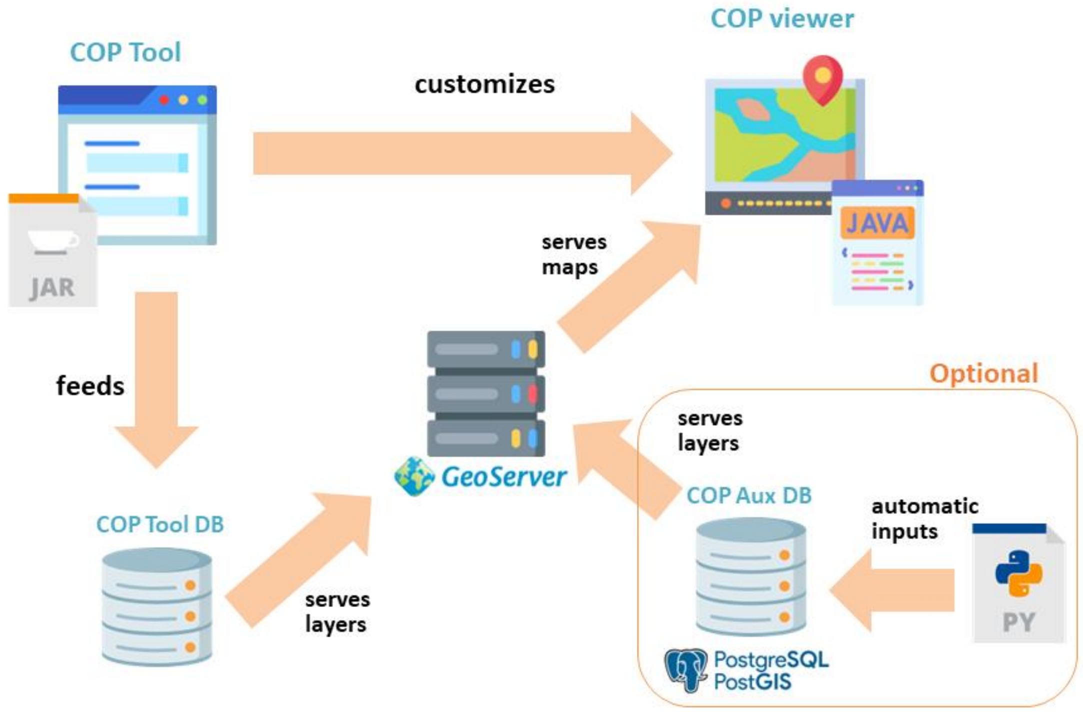

Fig. 11: Implementation of the complete system with its relationships.

COPtool relations with COP Viewer are:

• The COPtool customizes the information available for consultation through the COP Viewer and it depends on the contingency and the validated user. The COP Viewer receives a configuration file with certain specifications each time it is accessed through COPtool. The specifications are addresses of WMS map services that will be displayed in the COP Viewer.

• WMS map services can be external to the organization or internal. In this case, they can come from the COPtool database or from the Auxiliary COP database and both need a WMS map server implemented. We recommend Geoserver software as WMS server.

4.1. COPtool

The purpose of COPTool is the relationship between the COPTOOL database and the users, whether they are administrators and/or users, this relationship is carried out through an interface. Once they have been validated, the users can perform their previously registered functions, be it administration, consultation, or information insertion. This interface has various modules, which are visible depending on the level of user access to them. It also manages the different COPs for each contingency, the information inserted in each contingency and the query to the COP Viewer once the user has been validated.

The users can access this interface through a web browser, and after validation they are able to perform the tasks they have access to.

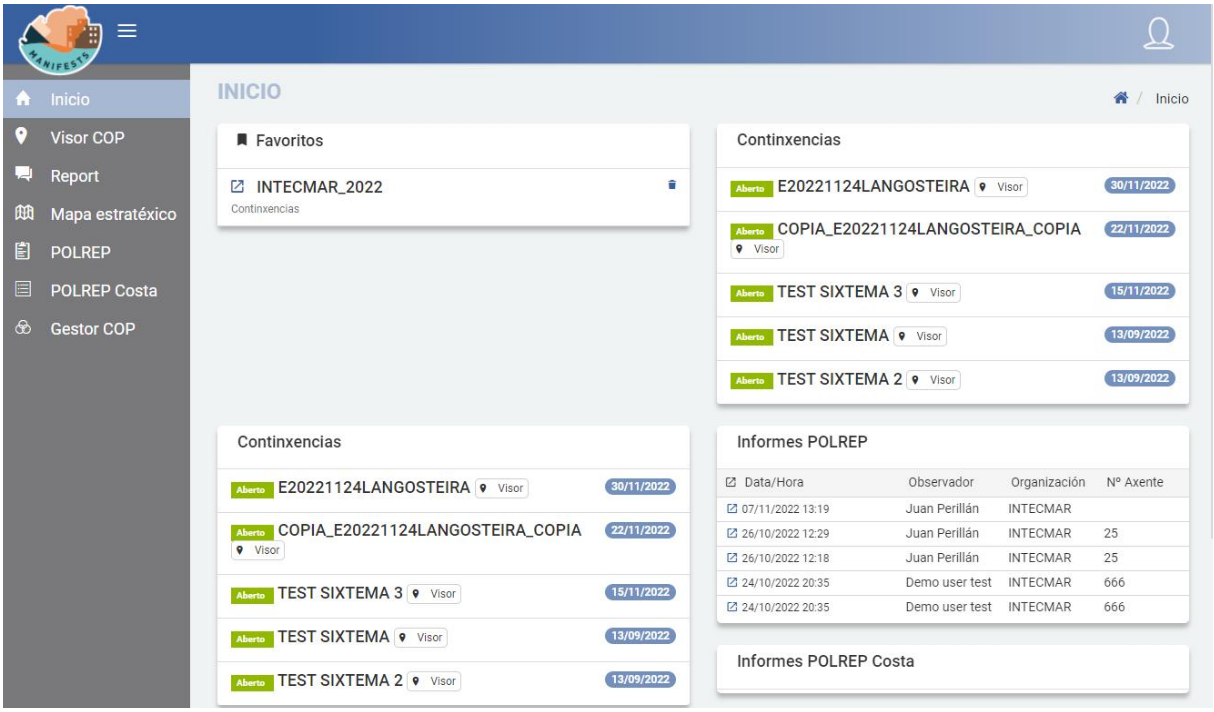

Fig. 12: COPtool initial screenshot after user validation.

From the implemention point of view, the COPtool is based on microservices programmed in Java (WEB and API). Along with these microservices, the COPtool is associated with a PostGIS database that we will call COPTOOL-DB and that will be described in chapter 5.

4.2. COP Viewer

If the user wants to view one of the COPs they have access to, the COPtool redirects them to another web page with the COP of the contingency and the information that specific user is allowed to view.

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To do this, the COPTool creates an XML configuration file that tells the COP Viewer the specifications of that COP: visible layers, access to reports, permissions, etc.

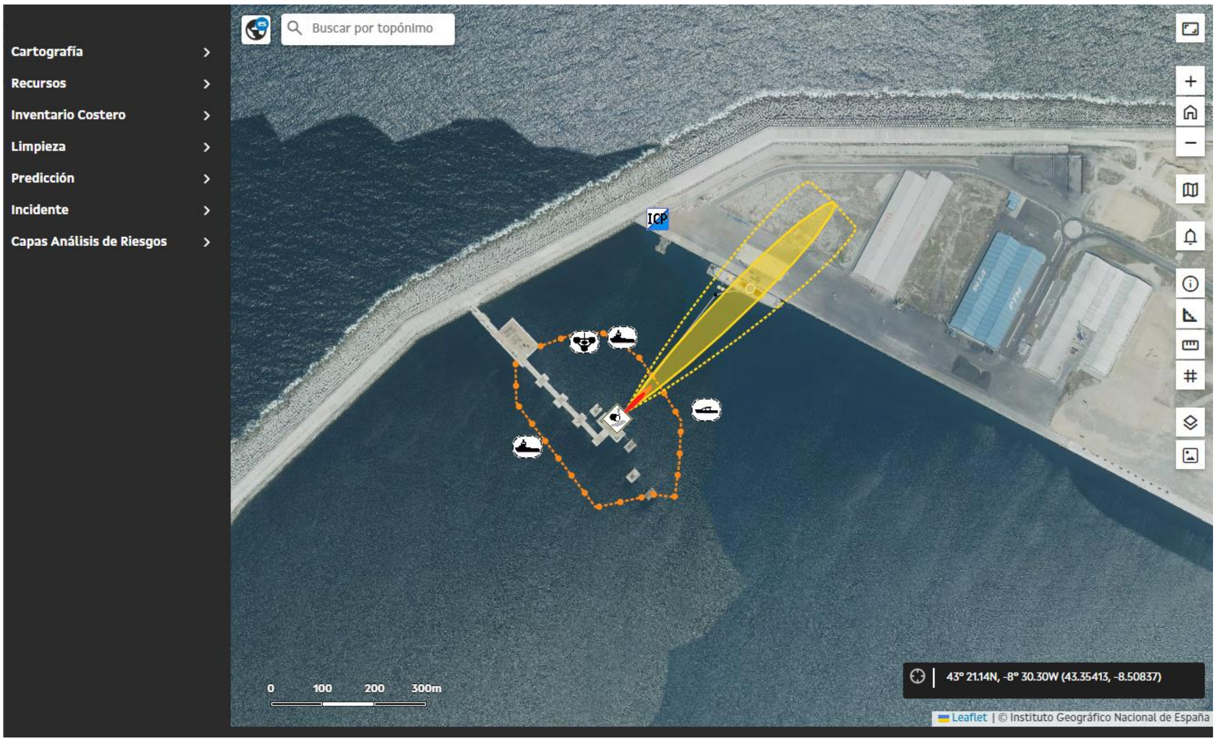

Fig. 13: COP Viewer showing different information of a contingency: dispersion of a simulated cloud, boom locations, means positions, etc.

The code of the COP Viewer has been coded in JavaScript and PHP.

4.3. Auxiliary database and associated scripts

In addition to this database that manages the COPtool, there can be information that, being included in the COP, is sufficiently independent of the tool and at the same time sufficiently dependent on the specific agency to belong to a different database. We will call this database COPTOOL_AUX, which will be described later.

Data to be included in this auxiliary database may be the positions of the drifters, the results of a Lagrangian model or the exclusion zones of an air pollution model such as ALOHA.

Associated with this database, different scripts have been created for the insertion of the information, which have been written using Python. However, as indicated at the beginning, this database and its scripts are strongly dependent on the agency, so their implementation.

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Here is the original implementation based on PostGIS scripted in Python and using GeoServer as map server.

4.4. Relationships between the different components

The relationship between database information and the COP Viewer is established through web services, mainly the Web Map Service (WMS) of the Open Geospatial Consortium (OGC).

Thus, when a user accesses a contingency COP through the COPtool, it creates an COP configuration XML file, which is interpreted by the COP Viewer. Among other things, this configuration file defines the different layers of information that this user can consult. These information layers are maps served by web services, mainly WMS.

Therefore, the XML file mainly relates a user and a contingency with the different WMS layers. As mentioned before, there is an Administrator who has the ability to include layers and classify them into groups and panels. Before a layer can be used by any specific COP, this layer must be included in the system, storing these references to its WMS address.

This address can be internal, that is, it will use the WMS service established in the agency itself, or external, that means, it belongs to WMS servers that are outside the databases managed by the COPtool and its ecosystem. For the service, a GeoServer server is used that provides the different layers of both the COPTOOL database and the COPTOOL_AUX.

5. DATABASE AND INFORMATION MANAGER

This part will describe the implementation of the databases and what information it contains.

5.1. Database Server

The DSS uses as a database engine the PostgreSQL (https://www.postgresql.org/) software in its version 9.5.1 to which the PostGIS extension (https://postgis.net/) has been added to create databases with the capacity to store geographic objects.

5.2. Databases

COPTool uses a main database called COPTOOL. The two main functions of this database are:

1. Manage users, layers, and COPS

2. Store those data that are entered manually, that is:
   1. POLREP Report
   2. POLREP Costa Report
   3. Reports, documents and photos of a contingency.

In addition to this COPTOOL database, there will be the necessary databases to store all the necessary internal information, such as model outputs, derivative buoys, etc. In the example case, this database is called COPTOOL_AUX and each entity is stored in a schema.

5.2.1. COOPTOOL. Management of users, layers and POPs

The COPTOOL database allows you to manage the users of the system, defining the responsibilities/functions of each of them. These functions will be translated as access to modules on the platform.

The following diagram shows a simplified version of the tables related to the User table, the logic of which has been moved to the database.

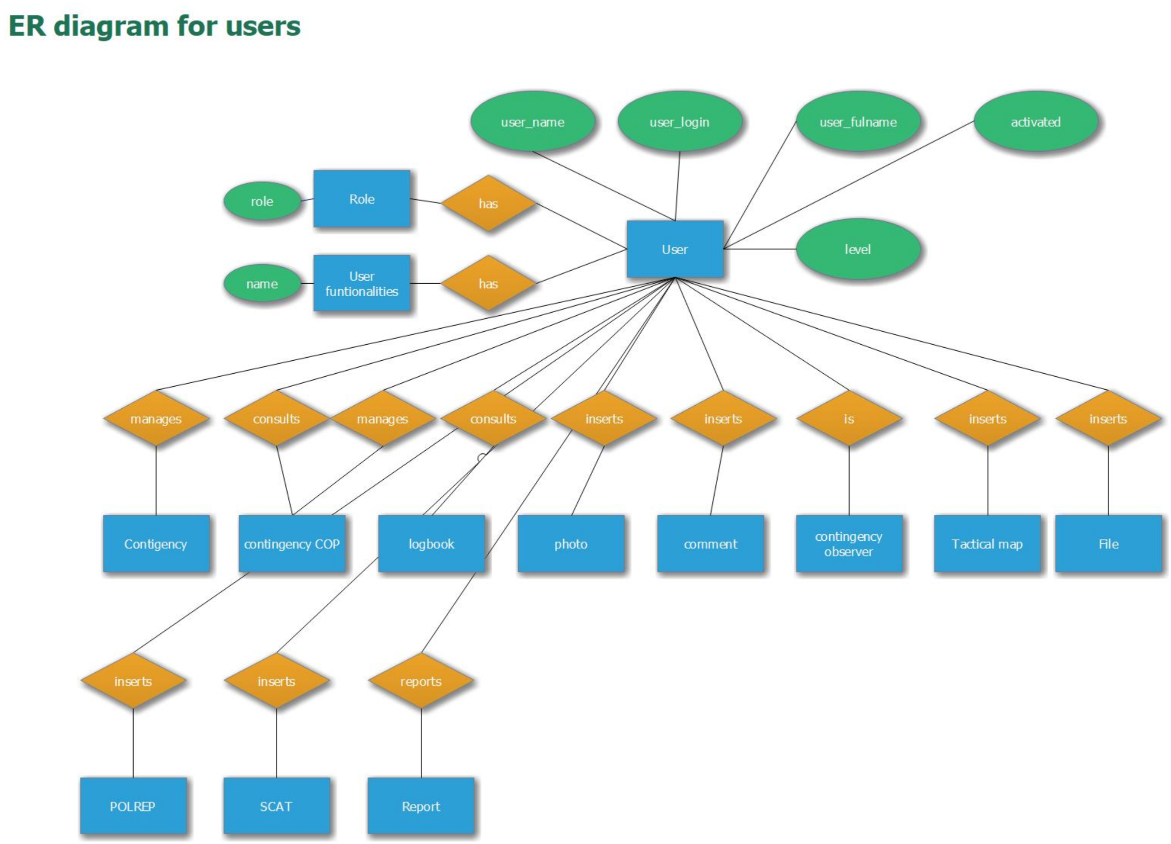

Fig. 14: Entity-Relationship diagram for Users.

This Entity-Relationship diagram is transposed to the database in the following schema:

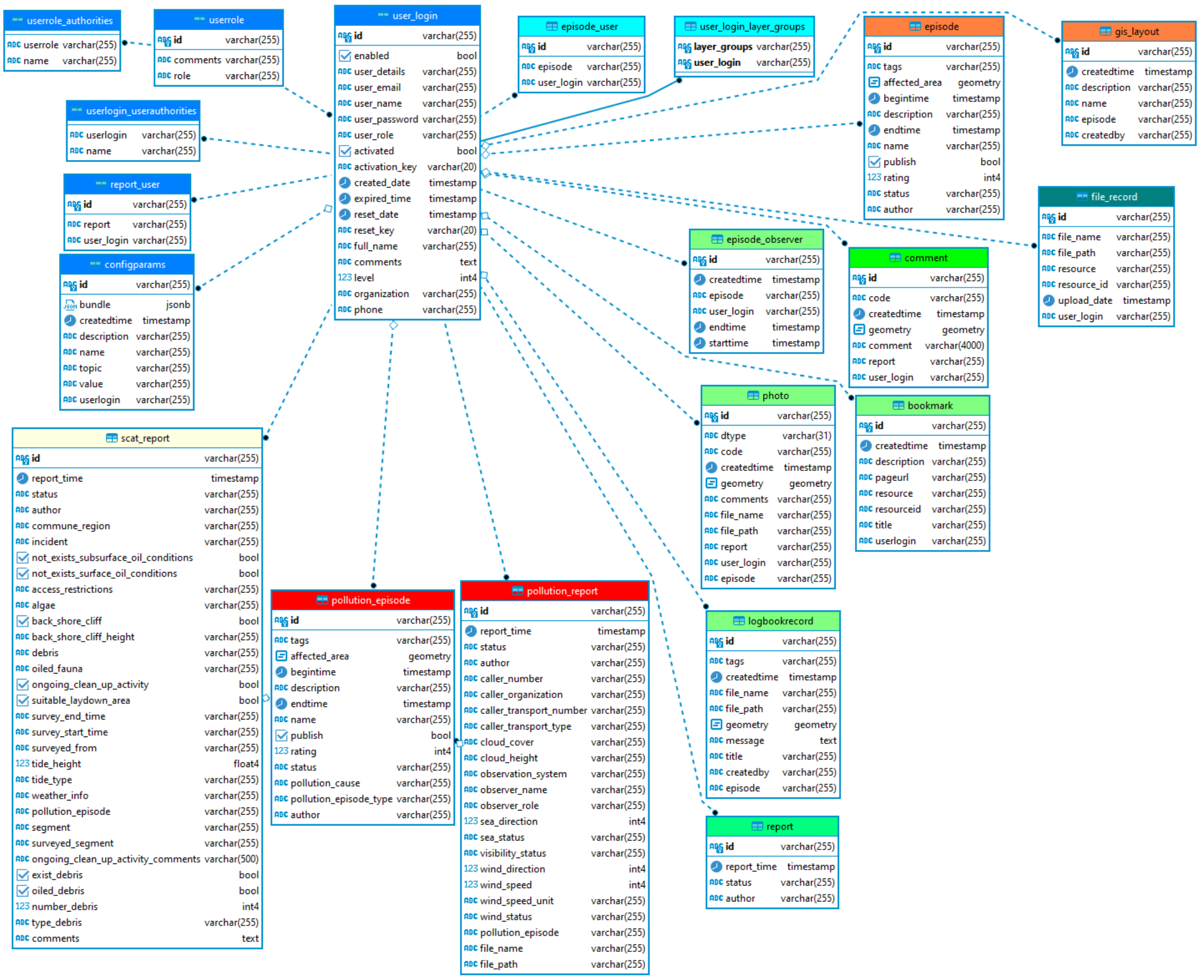

Fig. 15: Schema of User relationships in the database.

In addition to the users, the COPtool must manage the layers of information that will be visible by the different users.

When defining that the system contemplates a layer, what is done is to collect which WMS service or another must be consulted so that this layer is displayed. Therefore, a layer is defined by the name of the layer, the WMS service (or other) and a series of parameters as projection, and the coordinates of the bounding box.

To do this, keep in mind that each layer belongs to a layer tree that is structured in Panel, Group, Layer. In addition, each user can access certain episodes of which only the layers allowed for that user will be displayed. In addition, layers can be filtered by some field.

The following figure shows a simplified Relationship Entity schema.

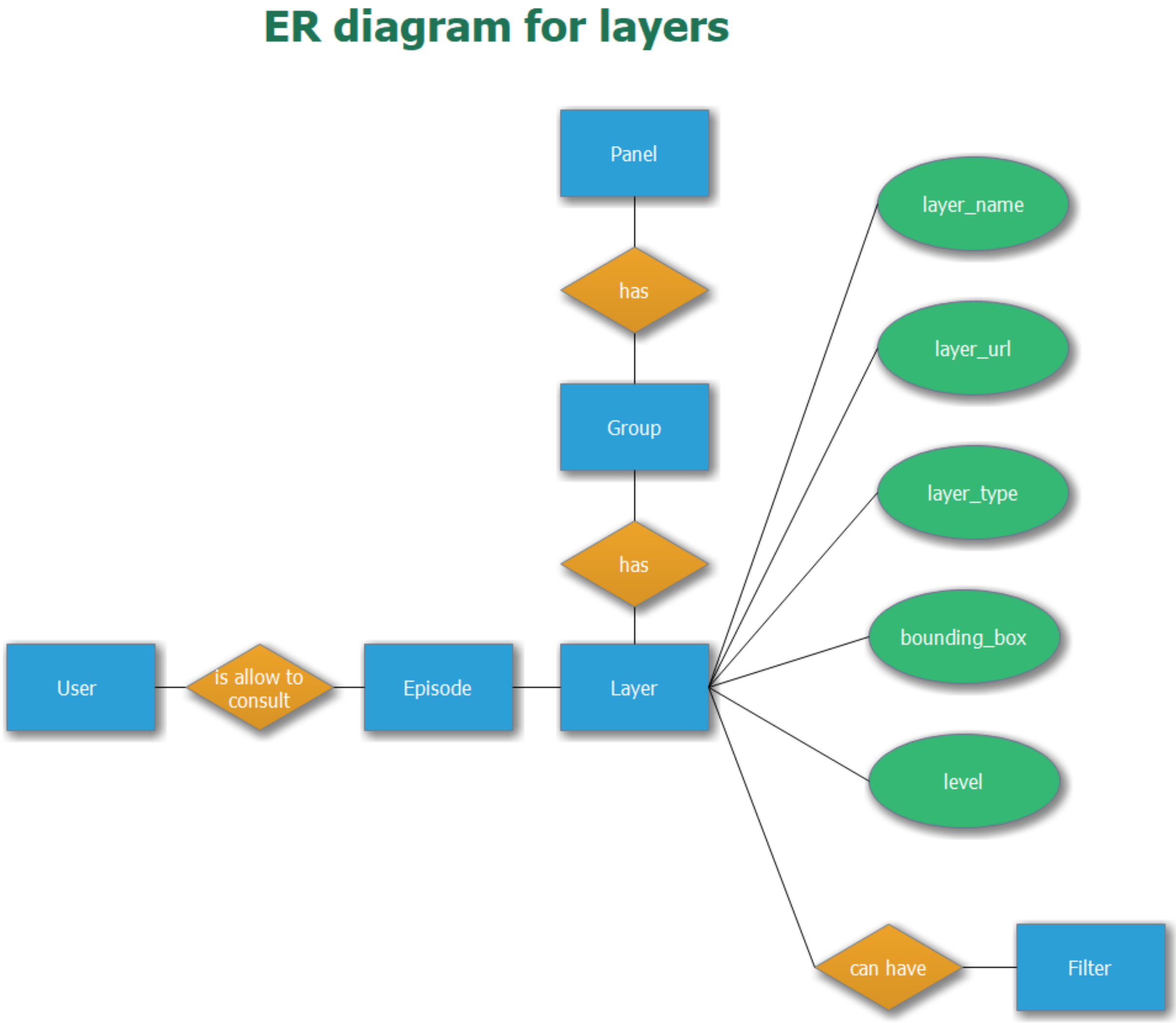

Fig. 16: Entity-Relationship Diagram for Layers16

This schema has been moved to the database as follows:

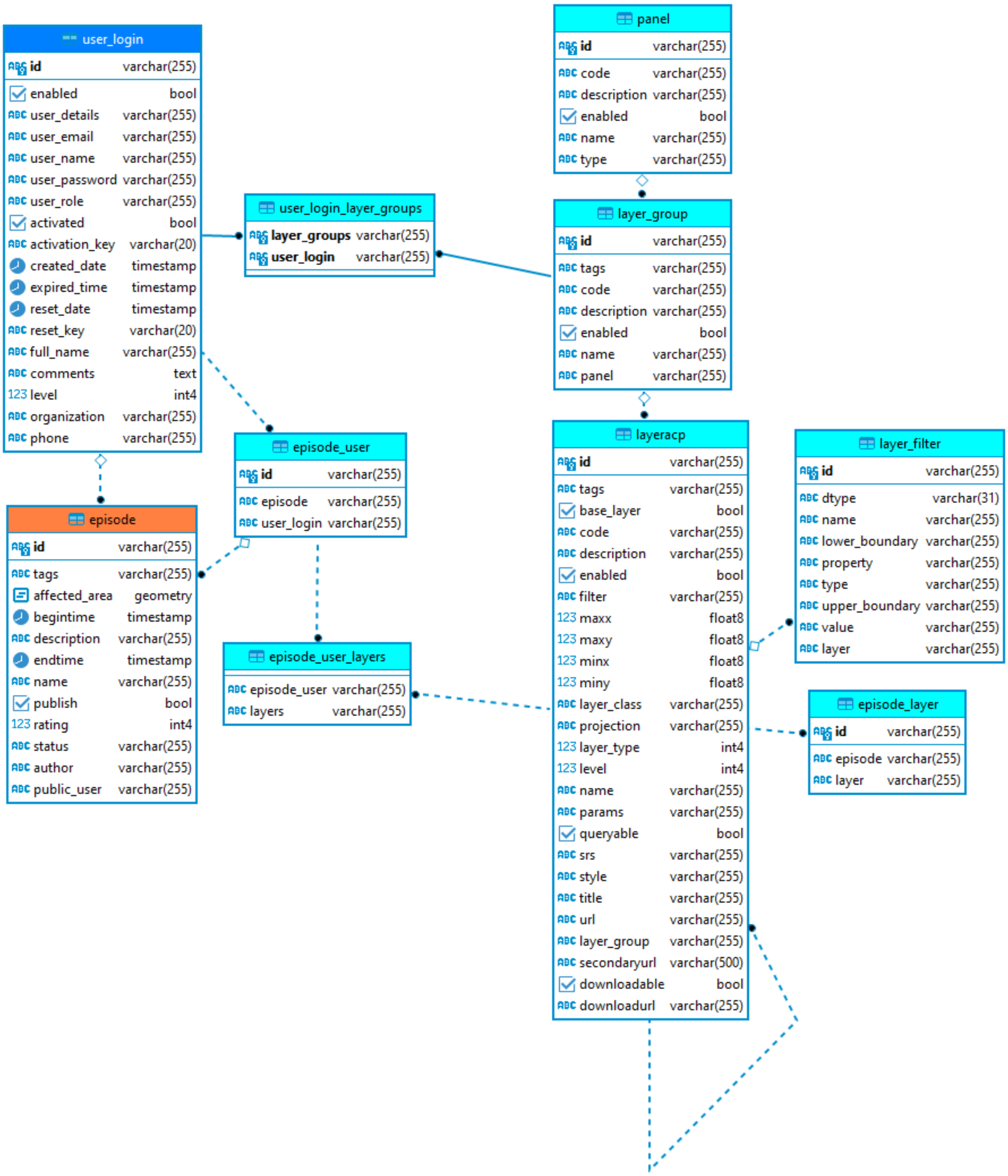

Fig. 17: Schema of the Layers relationships in the database.17

Finally, it is necessary to manage the COP with its contingencies or episodes. The term episode is used interchangeably to contingency and is maintained for compatibility with past solutions.

The following entity relationship scheme shows the different properties and relationships of a contingency COP. The contingency is created by a contingency manager, has an area and a beginning and end (which in this case refer to the associated COP). In addition, each contingency will have associated COP users, as well as others. A contingency may have associated POLREP, SCATs or other types of reports.

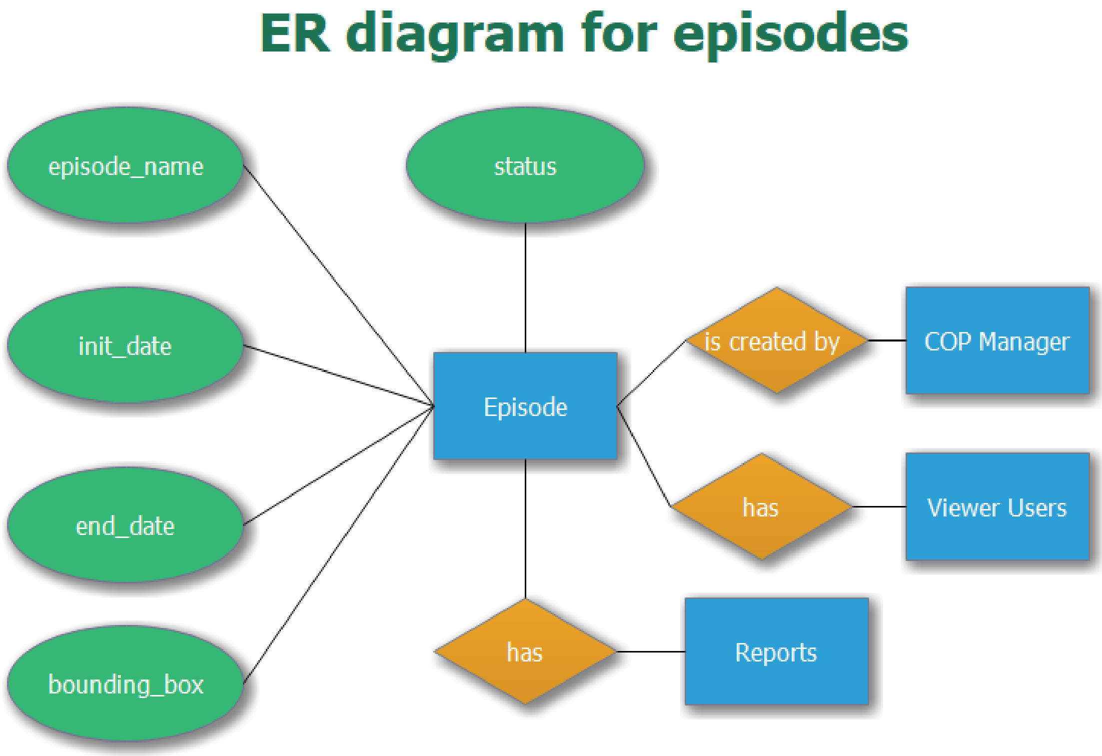

Fig. 18: Entity-Relationship Diagram for Episodes.18

This schema is represented in tables within the database as follows:

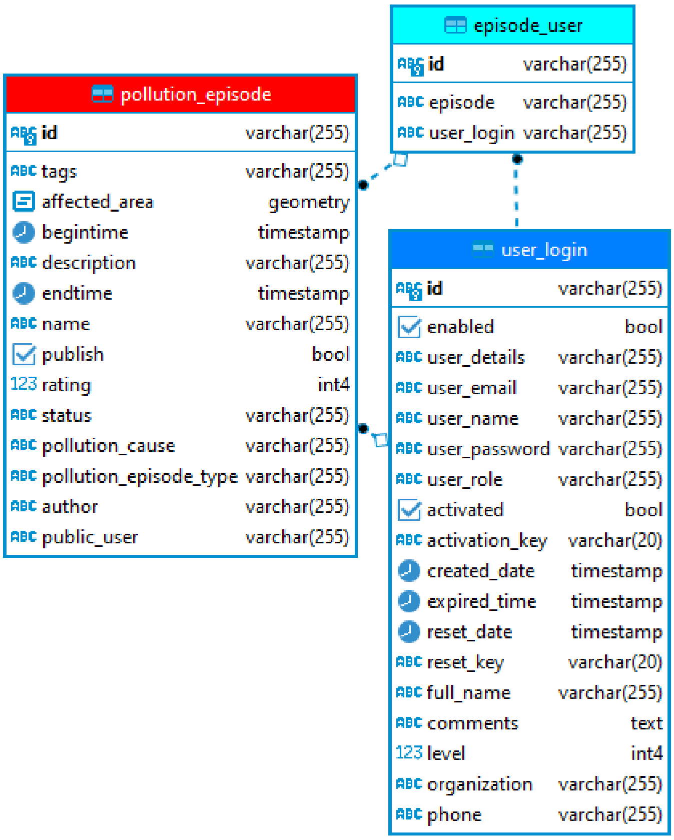

Fig. 19: Outline of Episodes relationships in the database.

5.2.2. COOPTOOL. Insertion tools

The COPtool not only allows you to manage POPs, contingencies and users, but also has the ability to allow the management of standard reports and associated information that is prepared during the contingency. These standard reports are the POLREP (Pollution Report) and the POLREP Costa (or SCAT). These reports are widely used by the international community and are based on the recommendations of the International Maritime Organization.[2]

Other associated information is the reports, or information during the contingency that may be reported by an agent or observer and that may consist of text, files and photographs or information about the disposition of the media and barriers.

[2]https://www.rempec.org/en/our-work/pollution-preparedness-and-response/emergency-response/emergency-response/polrep
https://www.rempec.org/en/our-work/pollution-preparedness-and-response/response/tools/shoreline-assessment

It has been decided that all this information (whether the reports, POLREPs or POLREP-Costa) may or may not be associated with an episode. The fact that they can be generated without having been associated with an episode allows greater flexibility when creating them, which is an advantage because much of the information could be recorded even before the creation of the COP the contingency itself.

For the insertion of any report of these, it is necessary on the one hand to be a COPtool user and on the other hand that this user has enabled the functionality of inserting each type of report.

On the other hand, the POPs manager can associate the reports that have been made to a specific contingency.

The following figures show the E-R diagrams for the POLREP and POLREP-Costa report. A new type of data ingestion will use a similar diagram.

ER diagram for POLREP

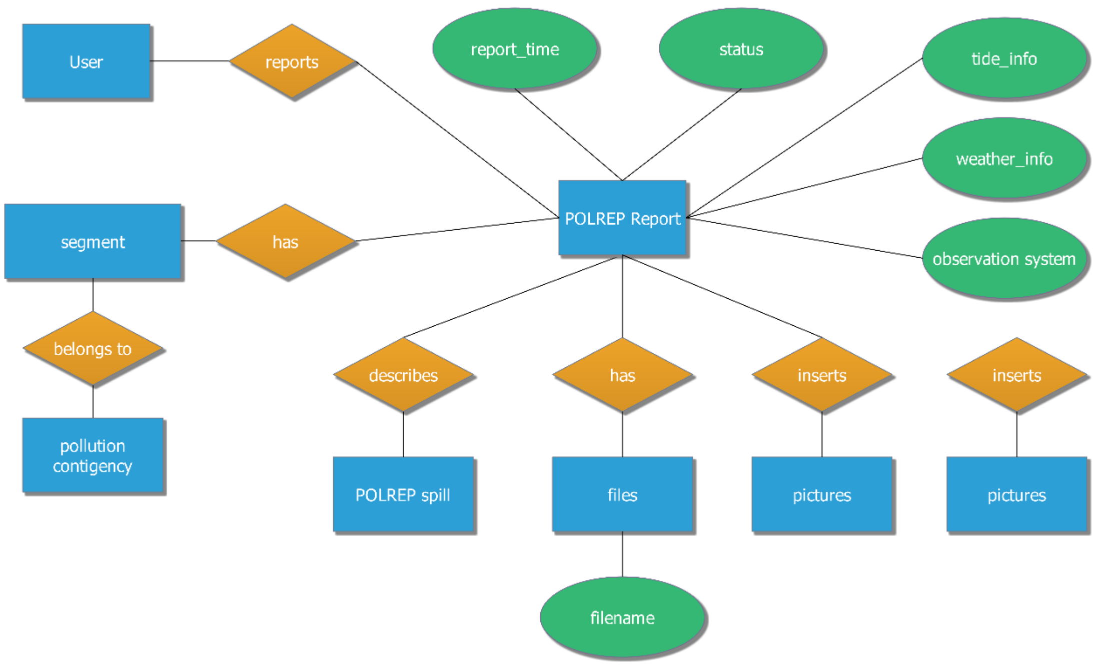

Fig. 20: Entity-Relationship Diagram for POLREP.20

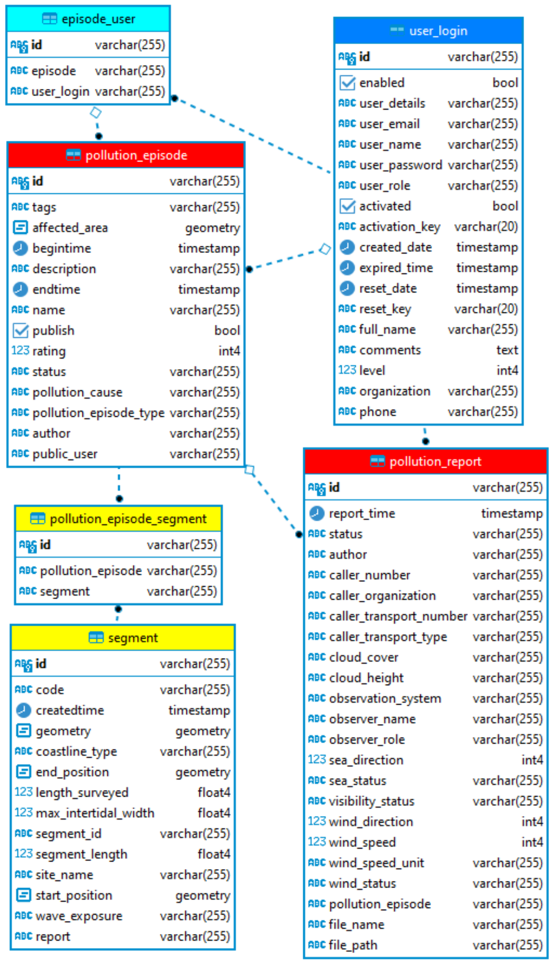

Fig. 21: Schema of POLREP relationships in the database.21

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ER diagram for SCAT

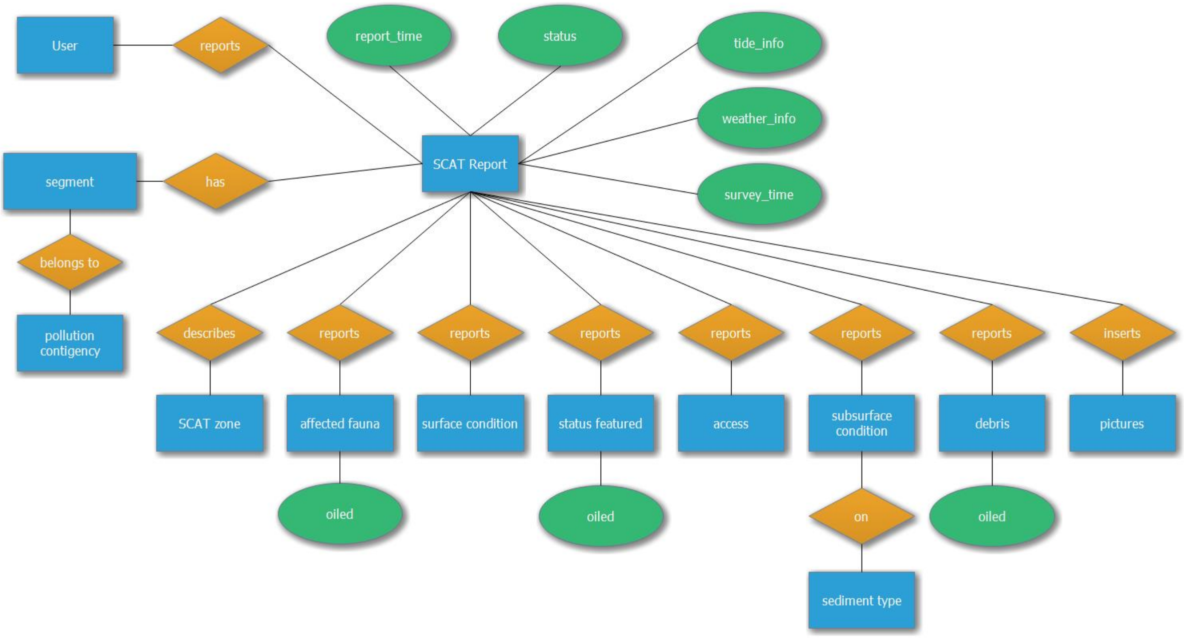

Fig. 22: Entity-Relationship Diagram for SCAT.22

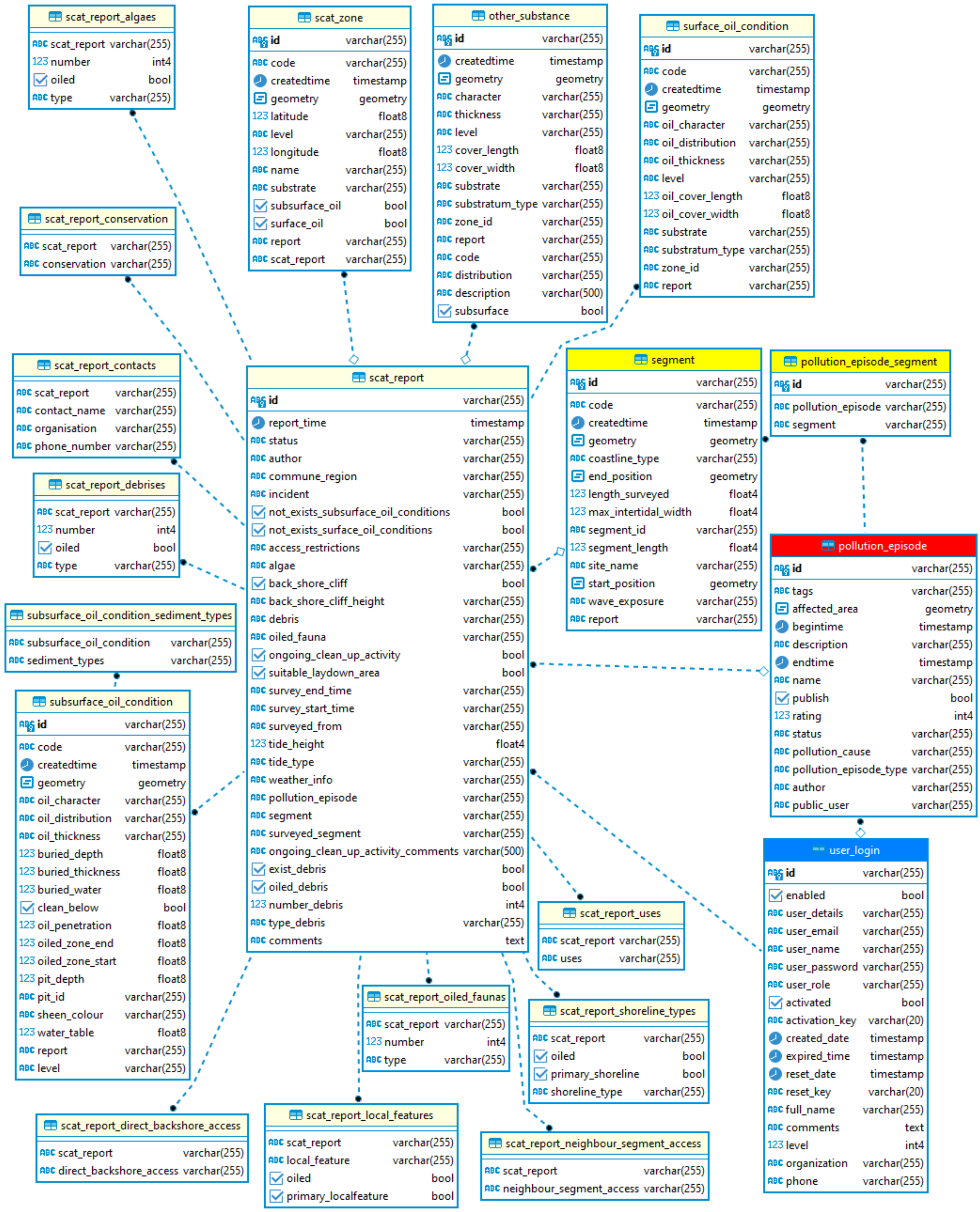

Fig. 23: Schema of SCAT relationships in the database.23

5.2.3. COOPTOOL. General outline

Once all the partial schemes are put together, the general scheme of the COPtool is formed. The following figure shows the general outline of the entire COPtool. each color in the table corresponds to each of the parts of the general database

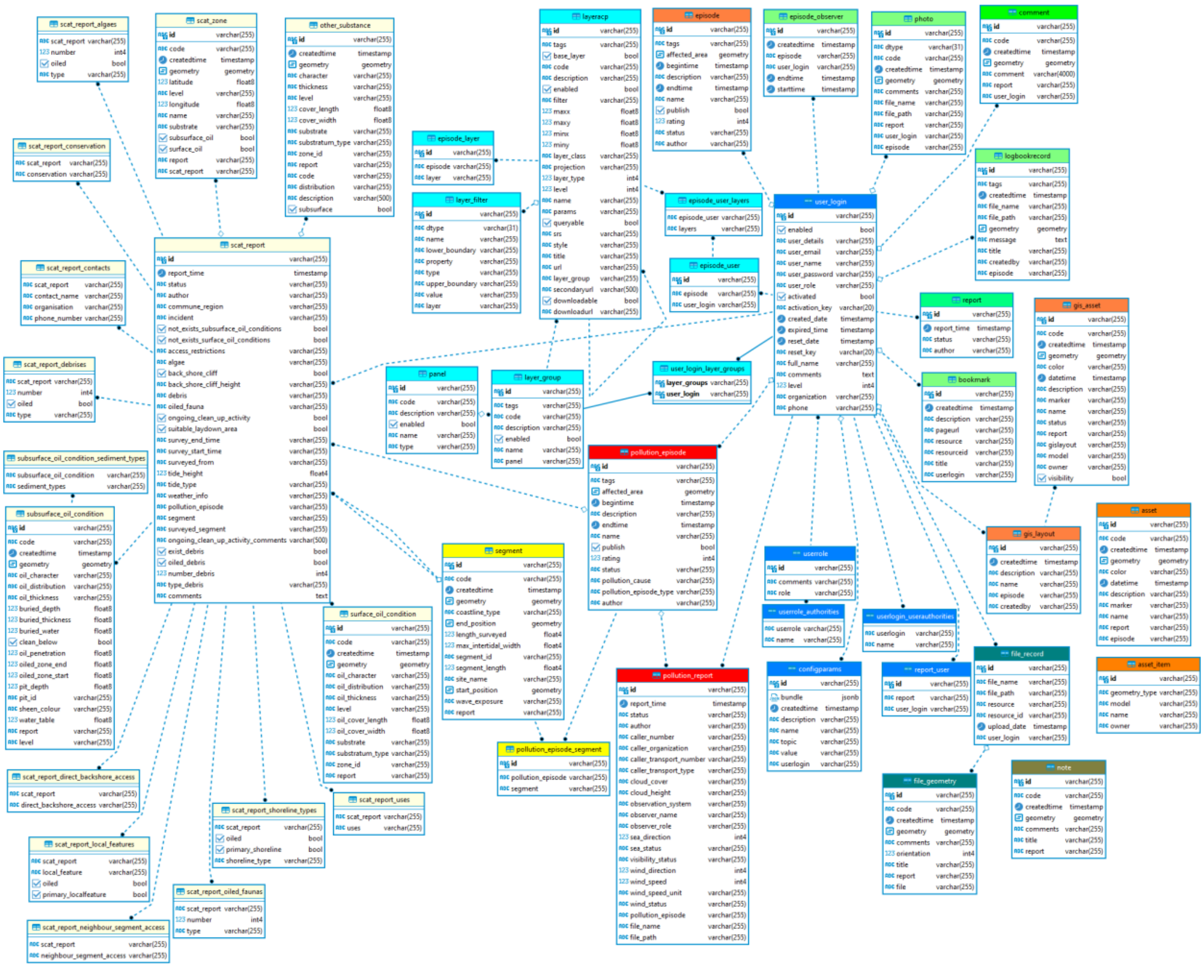

Fig. 24: Complete schema of the database relationships.24

For the access and representation of several tables, different views have been created, which give access to the data in the form of a table.

5.2.4. COOPTOOL. Auxiliary databases

As mentioned, this database depends on the needs of each agency and can be implemented in many different ways, although it must be remembered that, for this information to be displayed in the COP Viewer, queries must be able to be served through a WMS service. In our case, most of the maps served through WMS correspond to views associated with the database.

In this case, the associated database COP_AUX also used as the database engine to PostGIS. Each type of information will be associated with a schema in the database. For each layer that you want to show, a query will be built in such a way that the information appears in the form of a table with a geometry field and thus be able to serve it through the WMS service.

As an example, the following lines describe the scheme for aerial dispersion models of pollutants. In this case, the Entity-Relationship schema is as shown in the figure:

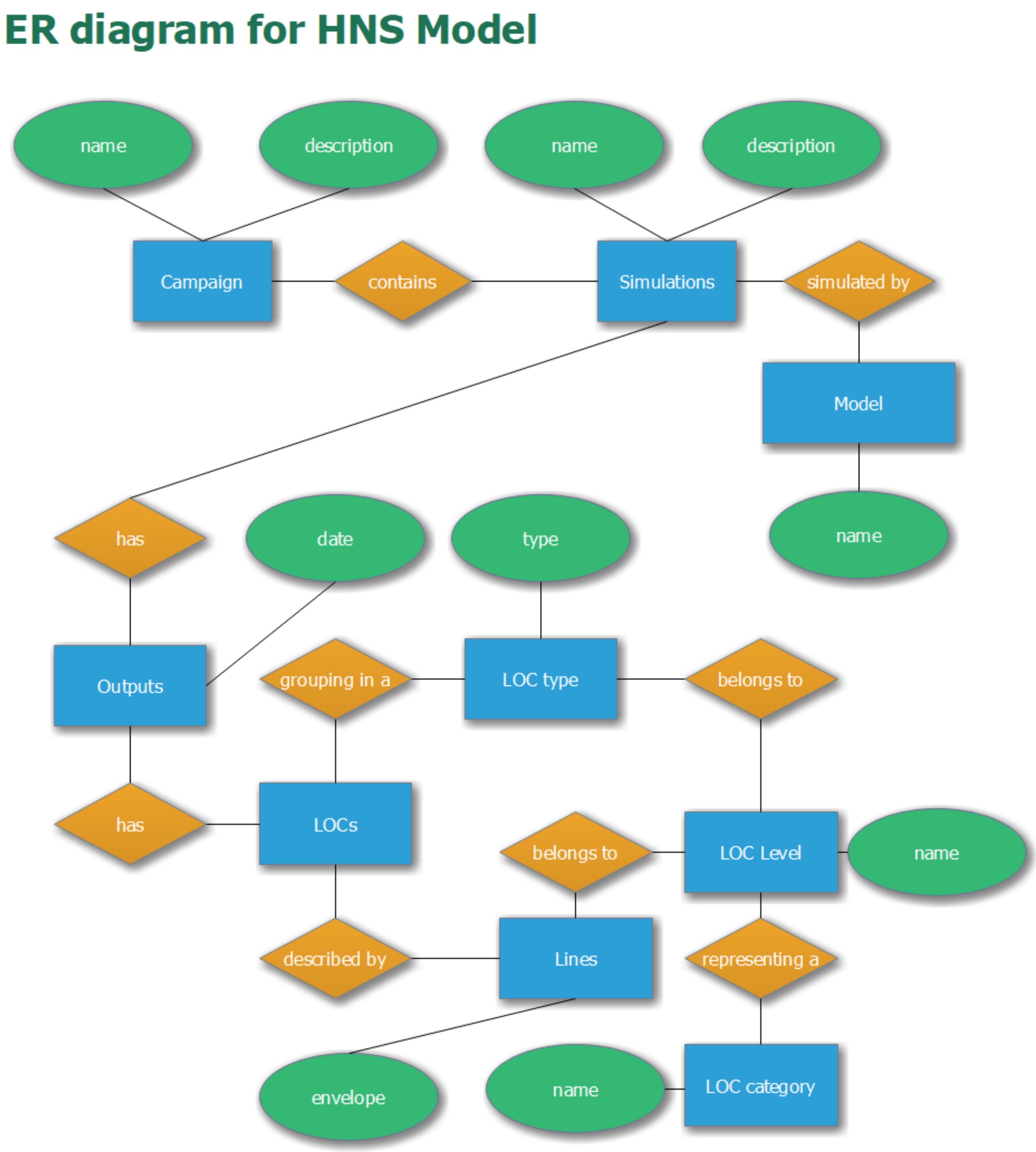

Fig. 25: Entity-Relationship Diagram for HNS Model.

This schema is implemented in the Auxiliary Database as shown in the figure.

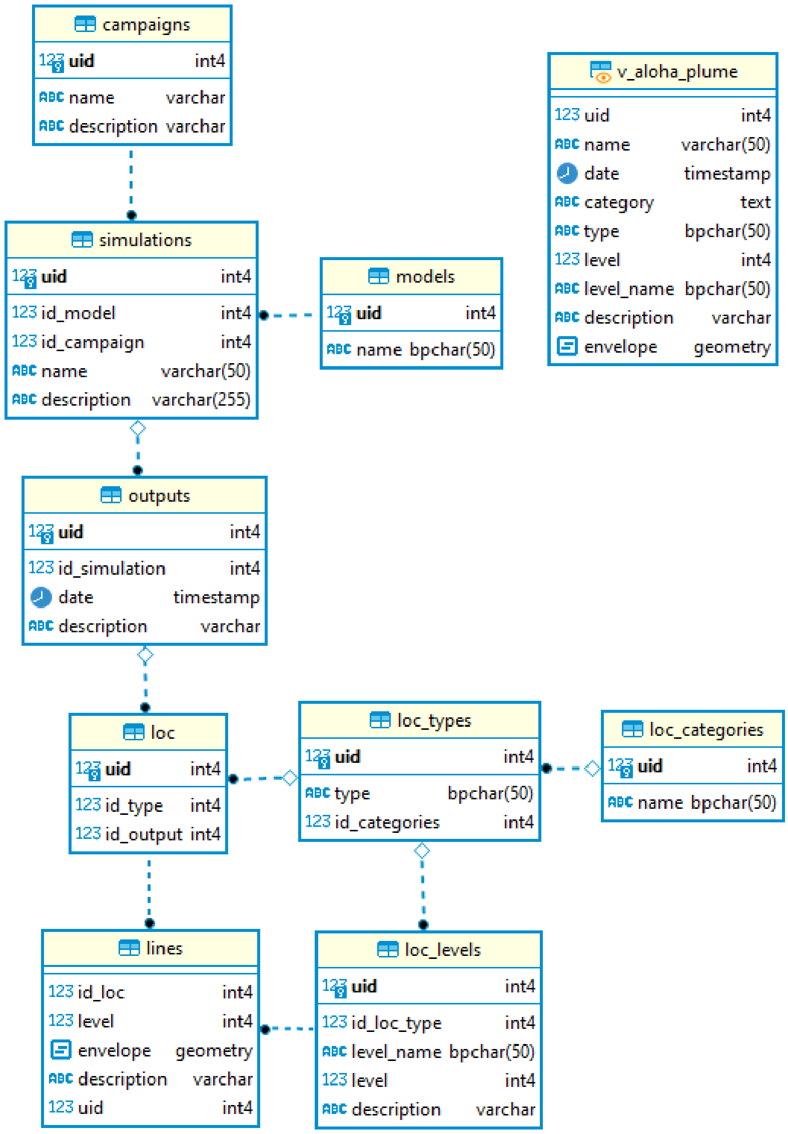

Fig. 26: Schematic of HNS Model relationships in the auxiliary database AUX_COP.26

As mentioned before, for the database information to become a WMS layer served by Geoserver, it must be a table or view that has a spatial component. That is why, accompanying the previous schemes, there are views of the data which are necessary to establish the wms layers that you want to serve.

The following table shows the required view *v_aloha_plume* to serve a LOC layer of a pollutant dispersion model from this database.

```
SELECT lines.id,
    simulations.name,
    outputs.initial_date,
    btrim(loc_categories.name::text) AS category,
    loc_types.type,
    lines.id_loc_level,
    loc_levels.level,
    loc_levels.level_name,
    lines.description,
    lines.envelope
   FROM hns_models.lines
     JOIN hns_models.loc ON lines.id_loc = loc.id
     JOIN hns_models.outputs ON loc.id_output = outputs.id
     JOIN hns_models.simulations ON outputs.id_simulation = simulations.id
     JOIN hns_models.loc_types ON loc.id_type = loc_types.uid
     JOIN hns_models.loc_categories ON loc_types.id_categories =
loc_categories.uid
     JOIN hns_models.loc_levels ON loc_levels.uid = lines.id_loc_level
  ORDER BY loc_levels.level DESC;
```

The ingestion of data in this system is inherent to each organization and its developments. In the case of the Camgal Plan, most of the insertions are done through ingestor software, developed in Python.

A series of scripts for inserting the information are listed below.

- Aloha2COP.py
- Drifter2COP.py

This software is included in the GitHub of the project, but as mentioned, most of the processes are specific to each organization and therefore, it is necessary to adapt these scripts to each instrument and / or institution.

6. Resources

The exact specifications of these applications were defined in conjunction with the advisory board, taking into account the resources and skills available. Its development is based on harmonized and/or standard formats and its source code is available in https://github.com/MANIFETS-DSS. It should be noted that, although the tools are as generic as possible, it is likely that some configuration and adaptation will need to be tailored to the purpose and specificities of the individual maritime authorities using the MANIFESTS decision support system.

The power of the MANIFESTS decision support system is demonstrated in the real example of its use by the Camgal Plan (https://www.plancamgal.gal) as well as in the transfer of this development to other members of the MANIFESTS project.

Due to its open source approach, this DSS can be replicated and adapted in any region and country.

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