ADVANCES IN FOREST FIRE RESEARCH 2022

Edited by
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VESPRA-Vulnerable Elements in Spain and Portugal and Risk Assessment

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Keywords

Vulnerable elements, Cross-border risk assessments, GIS-based platform, Extreme events, Emergencies

Abstract

The VESPRA project (Vulnerable Elements in Spain and Portugal and Risk Assessment), financed by the Union Civil Protection Mechanism UCPM-2020-PP-AG, is designed in a context of increased frequency and intensity of extreme events and emergencies, and in a current context where those responsible for the emergency often do not have sufficiently updated information on vulnerable elements. Indeed, there is cartography of these elements, but it is very quickly becoming outdated. It is therefore necessary to design a strategy that allows continuous updating of this information, and this is one of the main functionalities of the proposed solution in VESPRA.

VESPRA arises for the improvement of the risk management mechanisms for local risks such as forest fires, and also for other generic ones like those related to adverse meteorological phenomena or the dispersion of pollutants in wide areas. It is focused on the border area between Spain and Portugal and within the project, an international protocol will be defined for the collection of vulnerable elements and their characterisation regarding different hazards, and for their integration into a GIS-based platform specially designed to optimize their management and continuous updating. VESPRA will result in a system to assist decision-making in the event of an emergency in order to improve the harmonised identification and mapping of vulnerable elements and the integration of vulnerability in a joint information system for the evaluation and assessment of the transnational emergency response. The project targets three end-user groups: (I) the local authorities, (II) the general population, and (III) relevant institutions in civil protection.

Although the implementation for demonstration and validation purposes will be actually implemented as a baseline in three study cases, along the transboundary area between Spain and Portugal, VESPRA is developed with an European vocation aimed at the future adoption of the technological and procedural models in other transboundary European regions. These will be international, trans-boundary operational exercises based on the VESPRA system and on simulated scenarios in the selected study case regions. The first one will be a forest fire starting in Spain and moving towards Portugal. The exercise will evaluate the capability of the VESPRA system to help in the joint evaluation of potential risks and the coordination of responding forces, as well as the primary actions for the protection of the population and infrastructures. The second exercise will develop a combination of simultaneous nuclear and industrial emergency, one in each country, and will focus on the ability of VESPRA to provide accurate information and a channel of seamless interchange of key aspects for the ranking, evaluation and final decision making on such combined scenarios. The third one will be the simulation of an extreme weather episode, similar to the pass of Ophelia in 2017, affecting population and critical transportation and other infrastructures in both countries.

1. Introduction and objectives

We are in a new paradigm of change regarding emergencies, on the one hand due to the need for new scopes in the treatment of information across borders, and on the other hand in the context of global climate change. Most natural and man-made disasters imply risks that cross borders, due to their spatial dimension (earthquakes, forest fires, extreme weather events, floods) or their spread (pandemics, livestock epidemics, nuclear/industrial accidents).

Climate change has already led to an increase in the frequency and intensity of new extreme weather events such as the storm Ophelia, that occurred in 2017 and affected Portugal and Spain through a wave of fires never seen before. The increasing human, economic or environmental impacts of these new hazards, as well as their also increasing probability of occurrence, affect boths sides of the borders between countries. This increasing complexity and the emergence of new threats require greater intersectoral, transdisciplinary and cross-national cooperation at all stages of risk management (Benelux; 2016).

Risk analysis services and early warning systems have become basic tools in civil protection. Recent technological changes related to big-data, artificial intelligence, communication networks, and remote-sensing have created a shift in awareness of the emergency. In addition, the advances on the global and local weather forecast have led to an increasing improvement of their accuracy. Authorities and end-users of these services demand high quality, tailor-made information and solutions to their very specific problems in emergency management. To address this demand it is necessary to provide more innovative and holistic services with higher added-value, in an increasingly competitive market.

One of the main needs of emergency response services is to have updated information. They used to have vulnerable elements in cartography, but it became outdated very quickly, as changes in their location, characteristics, operating status, etc., as well as the appearance of new elements (for example, a new point of interest where visitors congregate), are very frequent. Thus, if for example an access road has been damaged last winter and is no longer suitable for emergency vehicles, or if there is a new point to protect in the event of a disaster, this information is essential for the emergency managers, and the outdated mapping is no longer useful, or may even be harmful. In this context, they need a solution allowing the constant updating of these vulnerable elements' information, and therefore allowing the assessment of the territory's vulnerability in a robust way..

VESPRA arises as an answer adapted to the new demands and offers flexible and demand-driven services that fit the end-users specific needs. Specialized end-users demand innovative solutions and bespoke system features. The main objectives of the VEPRA project are:

(I) The design, development and operationally implementation of a system for the evaluation and analysis of the transboundary vulnerability to the identified risks (forest fires, industrial/nuclear pollution cloud dispersion and extreme weather). It will be an open-source computer platform for vulnerable elements data and information exchange with a common methodology for: the harmonised collection and updating of data, vulnerability and impact assessment and assistance in operational and preventive decision-making in the emergency; and

(II) The other major objective is to improve emergency management through cross-border collaboration, taking into account civil protection and emergency management structures in each country. This requires the implementation of a network of competent authorities at national and sub-national level for the use of the platform applied to the identified risks, including: Technical specifications and protocols for the development and generation of operational vulnerability mapping to enhance cross-border interoperability and Design and implementation of joint cross-border small-scale exercises for previously identified risks.

2. Methodology

The VESPRA project seeks to establish an environment where vulnerability can be assessed prior to an emergency. To do so, it is necessary to know the vulnerable elements that could be affected, as well as current state of the art regarding vulnerability. For this purpose, available databases of vulnerable elements are reviewed along with an analysis of vulnerability in real events. These results form the basis for the establishment of a harmonised cross-border catalogue of typologies of vulnerable elements. This step is crucial for the subsequent development and implementation of a GIS system that will be fed by these typologies, and subsequently by the vulnerability models.

The system (VESPRA platform) is developed and adapted in two phases, a first phase that allows the collection of vulnerable elements (WP2) and a second phase that allows the design, development and implementation of vulnerability assessment models (WP4).

VESPRA platform is used to collect the vulnerable elements of the Spanish-Portuguese border in a database which is harmonized for both countries. In addition, the system allows the cartographic representation of all the results, so that possible cartographic alternatives can be analysed using the most modern representation techniques (WP3).

During the project, work is also carried out on the characterisation of vulnerable elements using different methodologies derived from the risks studied in the project (forest fires, industrial / nuclear accidents and extreme weather events, WP4). To this end, different models are applied according to the nature of the risk and the vulnerable element. All this is integrated in the GIS platform already developed to have a final system that allows the vulnerability assessment (WP5). This system has the following characteristics:

- Simplicity. The handling of the platform is practical and simple, as it should be used by non-technical people, without requiring any training, beyond reading the help and, occasionally, consulting the support centre;
- Flexibility. The platform allows the creation of new typologies of vulnerable elements, and new information related to each typology through its administration module without the need for software modifications. It also allows, through the administration module, the modification of the symbology and styles of the elements represented;
- Immediacy. Any change produced in the territory must be able to be immediately validated and incorporated into the system and into the systems connected to it. This is an essential characteristic, in order to allow the continuous updating of the vulnerable elements information;
- No licenses. As it will be 100% developed on free software libraries, operating system, database and languages, future maintenance costs will be limited to the maintenance of the hardware where it is installed;
- Transferability. The system is able to be subject to technology transfer, so it is easy to administer and easy to modify, with a clean and clear data model and a structured and commented code.

Once the system has been completed, it is validated by means of an operational implementation in which the results it provides, both cartographic and numerical, are evaluated. In addition, the platform is used in the three cross-border trainings in order to see its applicability and operability in quasi-real situations. Subsequently, all evaluation results are used to make adjustments in the final version of the platform(WP6).

Finally, the last work package (WP7) has as its main objective to promote the use and exploitation of the main VESPRA results ensuring their contribution to risk reduction in transboundary regions. This is done through dissemination and diffusion of technical and scientific documentation, organisation of workshops and the creation of public awareness and media working groups, among others, aimed at two relevant target groups: technicians and researchers; and different stakeholders (e.g. potentially affected populations or the media).

3. Preliminary results

The VESPRA project has achieved the objectives expected for the basic line of work of study and harmonisation of data, focusing on a rigorous analysis of the specific state of the art in the field, on which the fundamental bases of the VESPRA project have been built, searching for unmet needs in this area and technological innovation to make the most of them. Specifically, these first lines of work have been based on the following:

(I) the survey and harmonisation of the conceptual framework of vulnerability, hazard and risk and of the databases of vulnerable elements available in the regions, Member States and the Union. A total of 45 databases covering different geographical scales - global, European, cross-border, national, regional and local - have been evaluated, taking into account the data format, as well as their time frame and spatial resolution.

(II) the creation of an agreed catalogue of vulnerable elements (Annex 1), including a hierarchical classification by type and nature groups (i.e. static, dynamic), a universal definition and a preliminary description of the undesired consequences in case of exposure to hazard levels observed in real events. This catalogue includes more than 100 vulnerable elements divided into six main types related to each hazard: people, utilities, commercial and service facilities, industrial facilities, environmental elements and cultural heritage facilities and services. Each vulnerable element typology is divided into several sub-typologies with a simple attribute scheme that is used to analyse its vulnerability to emergencies.

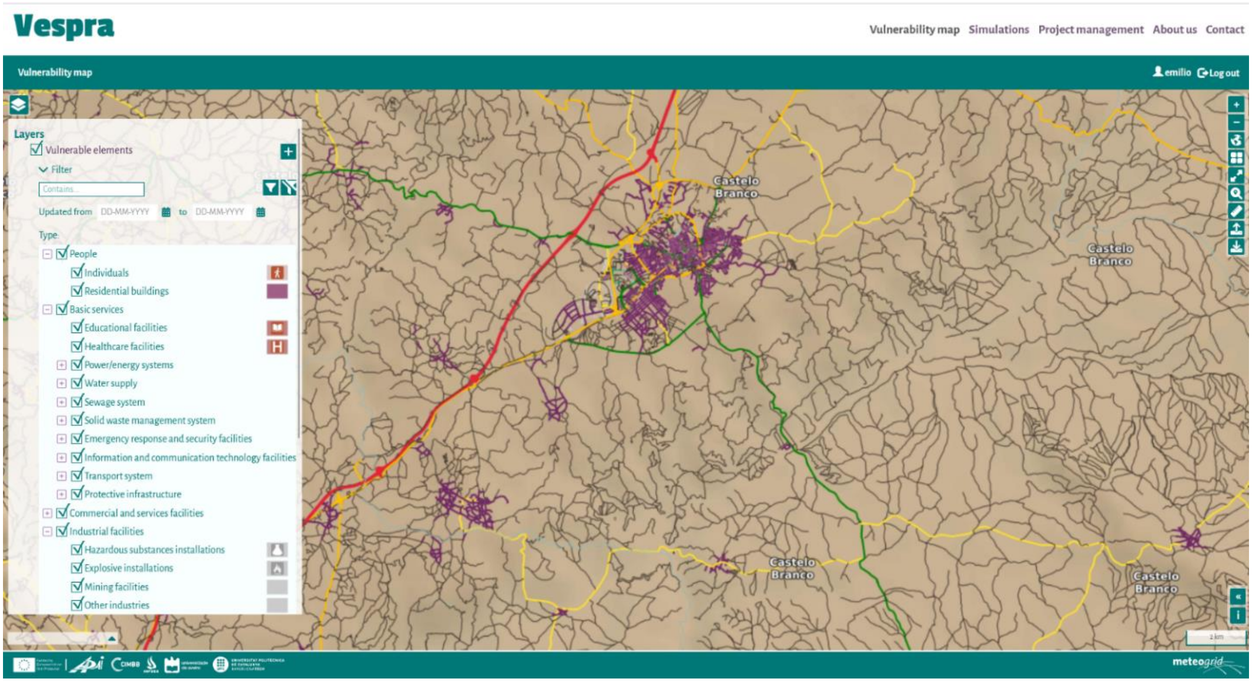

Figure 1. Overview of the system

As a result of the above it has been possible to complete a survey of the main databases of vulnerable elements and of the main hazards in the Member States, as described in the relevant Civil Protection Organisations, and to review and draw lessons learned from recent relevant events involving vulnerable elements, especially in population, infrastructures and the environment.

In parallel, the VESPRA project has devoted effort to the design, development and implementation of a data collection system and procedure linking several territorial levels. Given the trans-scalar and cross-border nature of the data collection, a special effort has been made for the interoperability of the process between Spain and Portugal, for which a multilingual graphical user interface has been developed. Portability and modularity have been at the core of the system design, including the use of mobile phones and tablets to facilitate its use down to a local level. The tools are based on a GIS-WEB with different solutions to manage the cartographic information generated with different user profiles (Figure 1). A mapping strategy has also been developed based on existing standards for the mapping coding of vulnerable elements and consistent with the rapid mapping of the Copernicus service. This makes VESPRA perfectly compatible with the products used by and for the Union Civil Protection Mechanism (UCPM).

The next step in the VESPRA project has been the study, definition, analysis and description of the vulnerability and risk models to be incorporated into the VESPRA tool. For each of the four hazards considered, the vulnerability models available in the state of the art have been studied and the most interesting ones have been selected for the purposes of the project taking into account the previous results. Once the models have been analysed and selected, the next step has been to describe an algorithm for their use and implementation in the VESPRA tool.

The risk assessment model followed in the VESPRA Project comprises several sequential steps. Each of these steps provides the user with a set of information of great operational and preventive interest, making the VESPRA tool usable in the prevention, preparedness and response phases, i.e. in the hypothesis of a future hazard event and in the course of a hazard event.

Figure 2 shows the general data flow and processing of the VESPRA approach to obtain mapping information on vulnerability and potential damage. This general approach has been specified for each of the hazards.

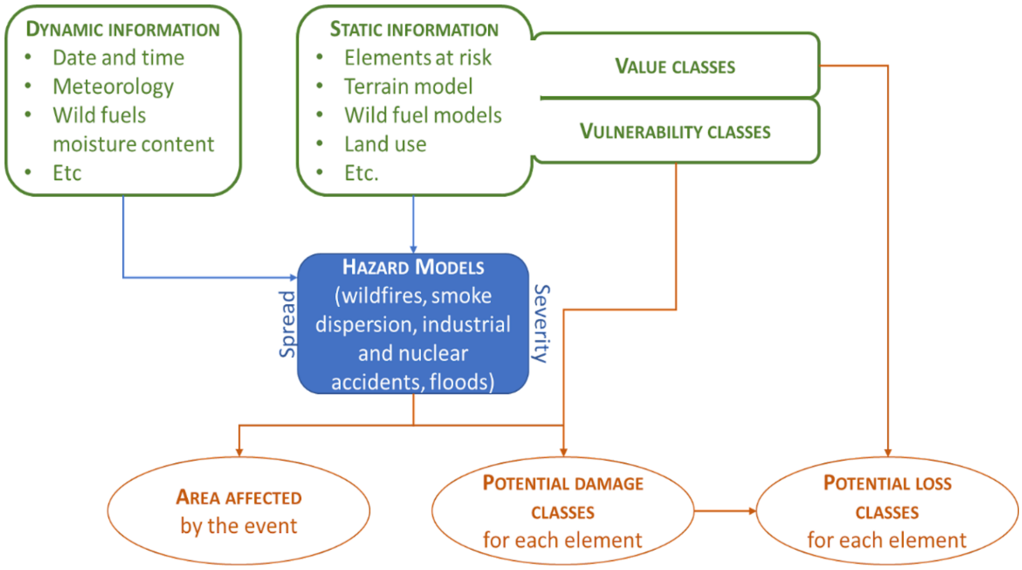

Figure 2. Data flow of the VESPRA Tool.

The VESPRA team is currently implementing these models in the decision support system (Figure 3), contributing to the specific end goal (cross-border disaster risk management through prevention and preparedness in Europe).

Figure 3. Potential Loss of the exposed elements for the demonstration area in the scenario.

4. Conclusions

VESPRA is a system based on web services that will incorporate the vulnerability geo-database, the catalogue, the weather forecasting services and the different vulnerability analysis models in diverse risk domains. This includes the capacity to project meteorological processes, the identification of possible scenarios, the estimation of possible consequences and the identification of possible vulnerable elements affected. In this sense, this last line of innovation is especially dedicated to the integration of all the components of the system under a single user interface, which will comply with the degree of interoperability required by the cross-border nature of the services. The system will be fully compatible with the existing legacy systems in the two selected countries (Portugal and Spain), but will also be fully interactive and allow information sharing in both countries.

5. Acknowledgements

This research is funded by theEuropean Union Civil Protection Mechanism (Project UCPM-2020-PP-AG–VESPRA – 101004896)

6. References

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7. Annex 1

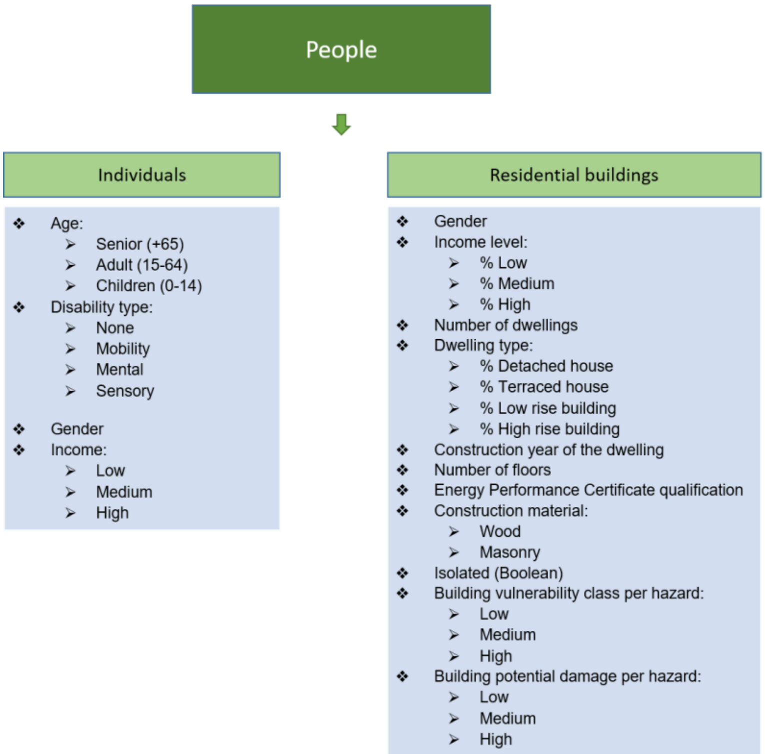

Figure 1. Specific attributes for people sub-typologies.

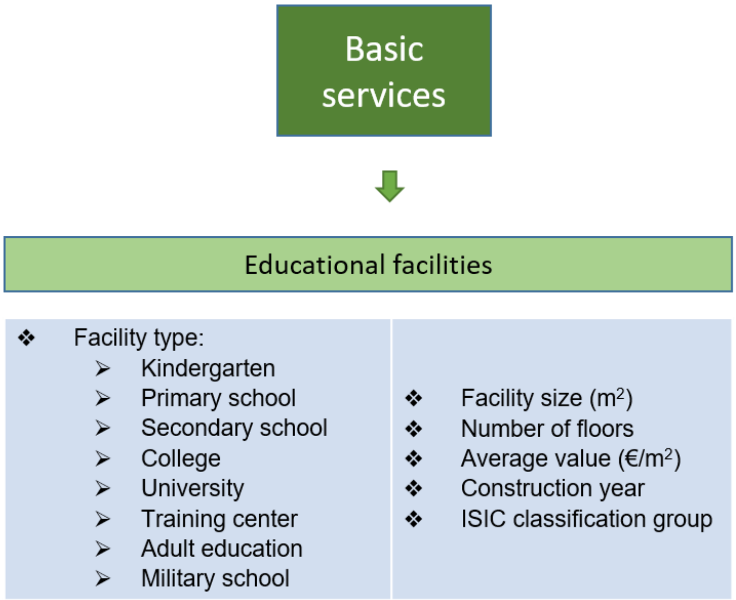

Figure 2. Specific attributes for educational facilities sub-typologies.

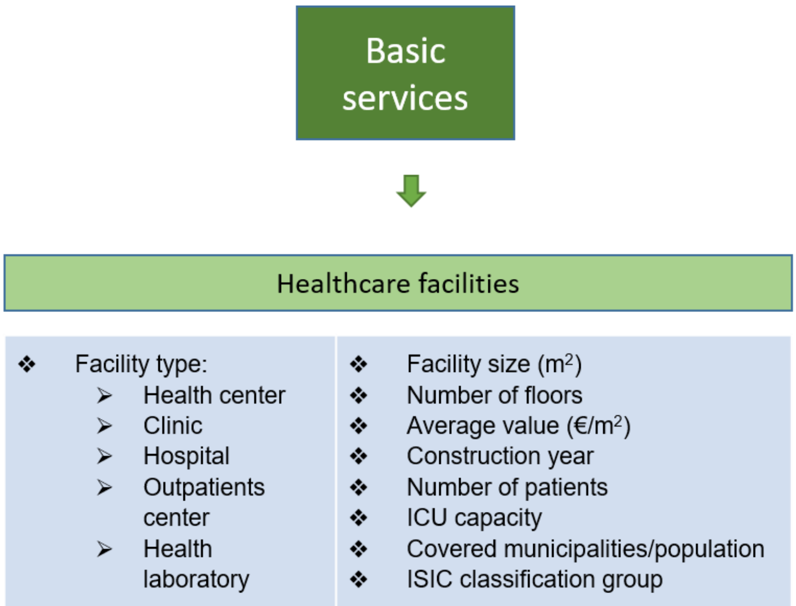

Figure 3. Specific attributes for health care sub-typologies.

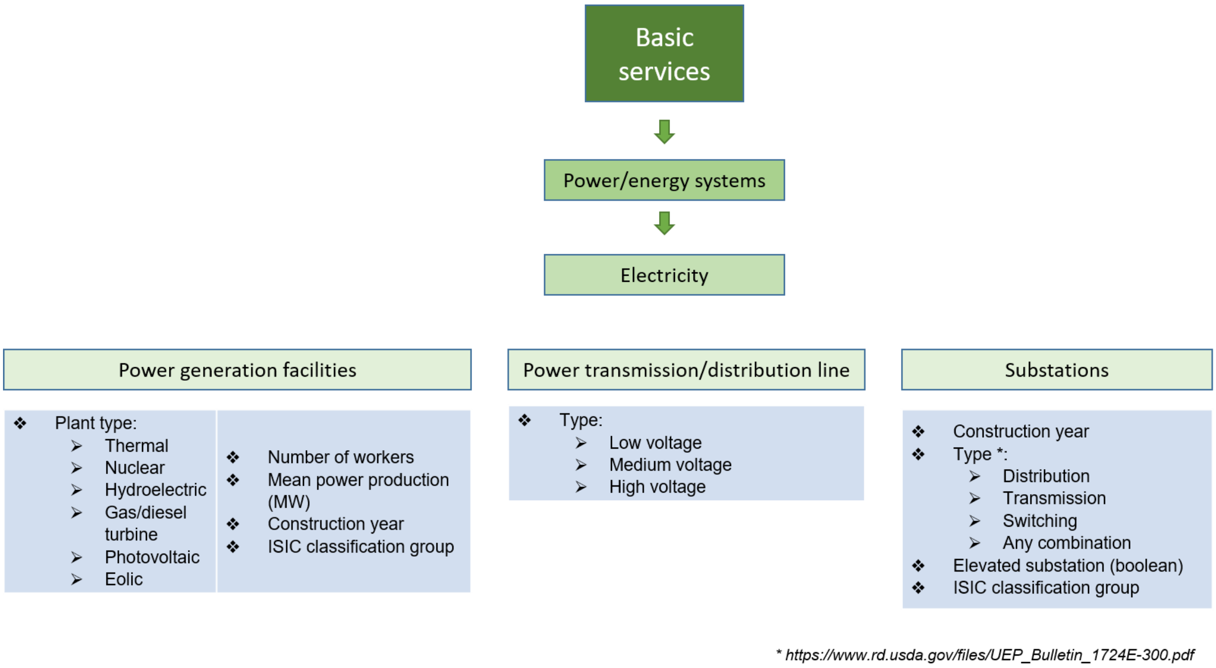

Figure 4. Specific attributes for electricity sub-typologies.

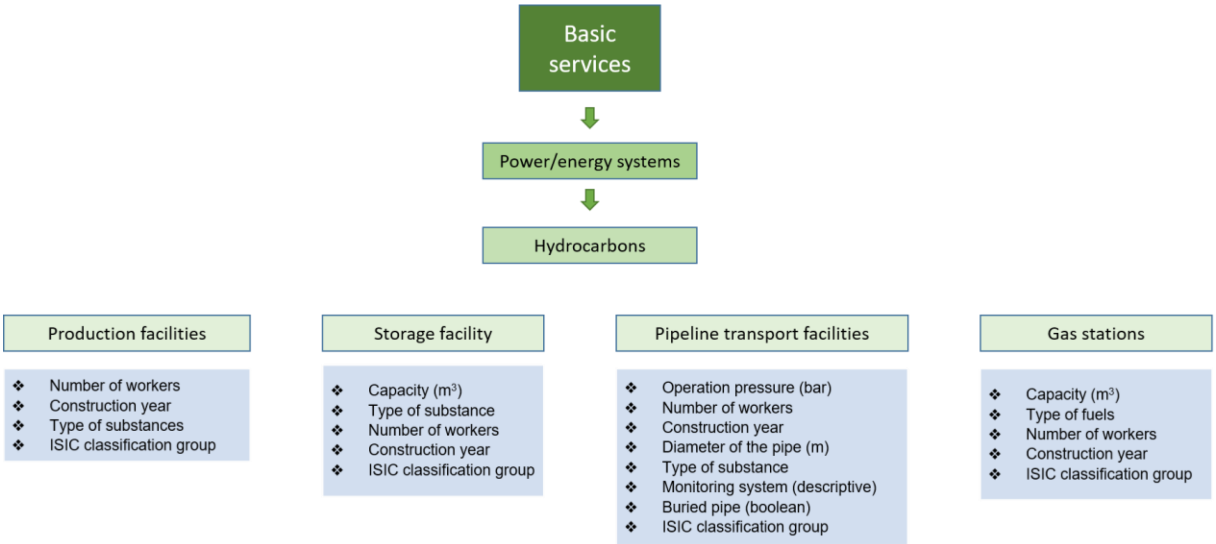

Figure 5. Specific attributes for hydrocarbons sub-typologies.

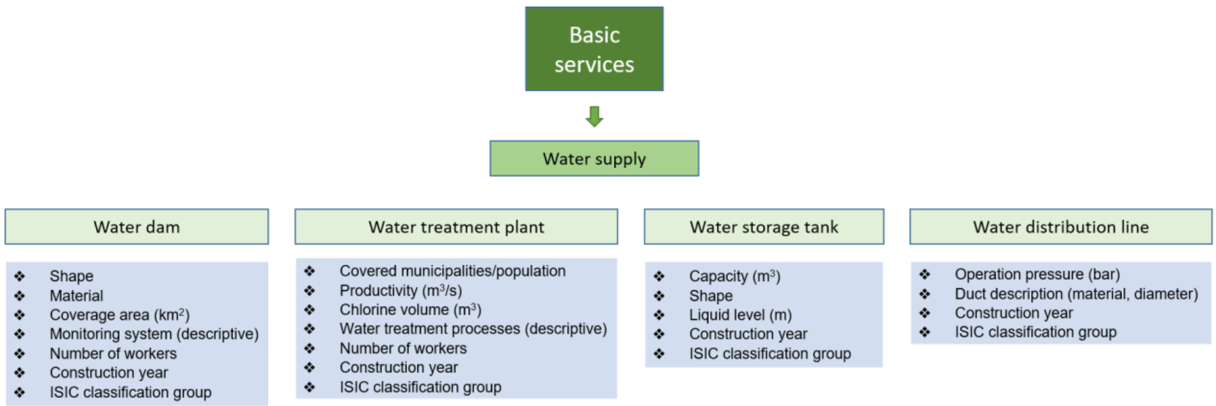

Figure 6. Specific attributes for water supply sub-typologies.

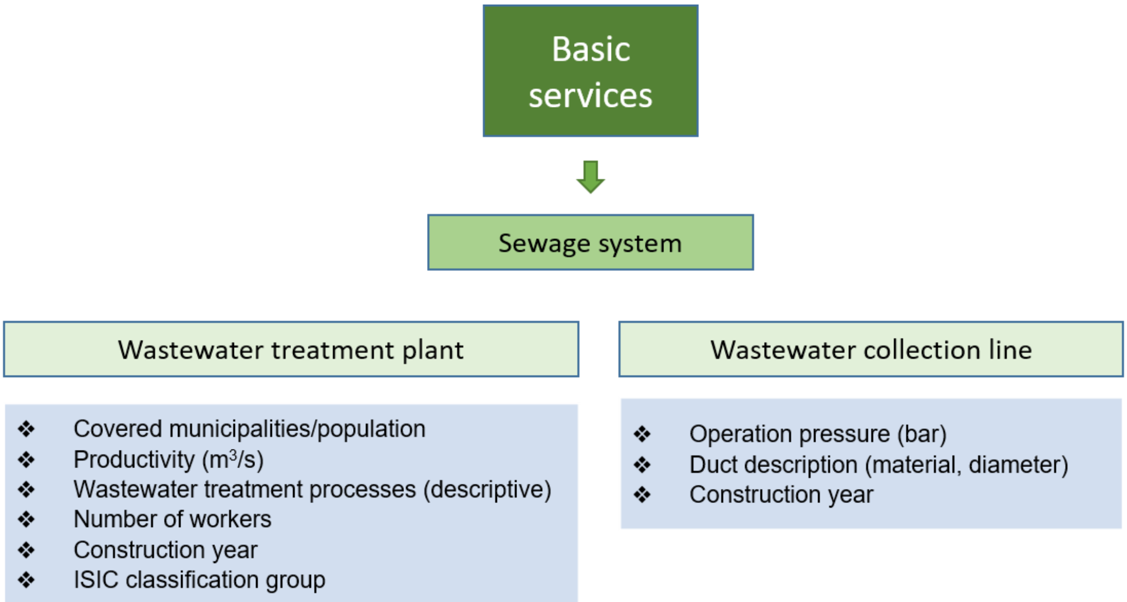

Figure 7. Specific attributes for sewage system sub-typologies.

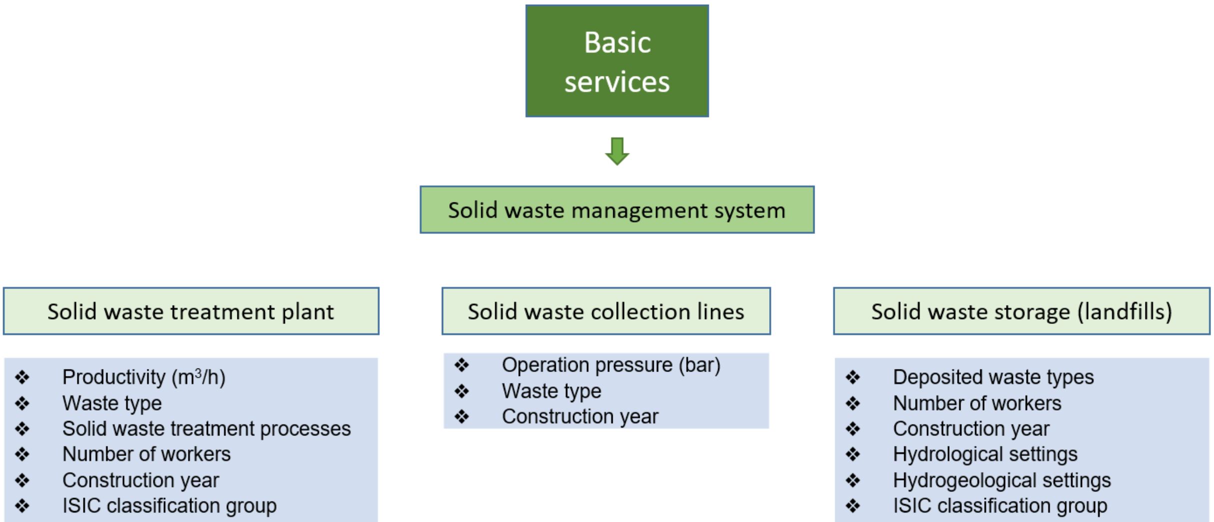

Figure 8. Specific attributes for solid waste management system sub-typologies.

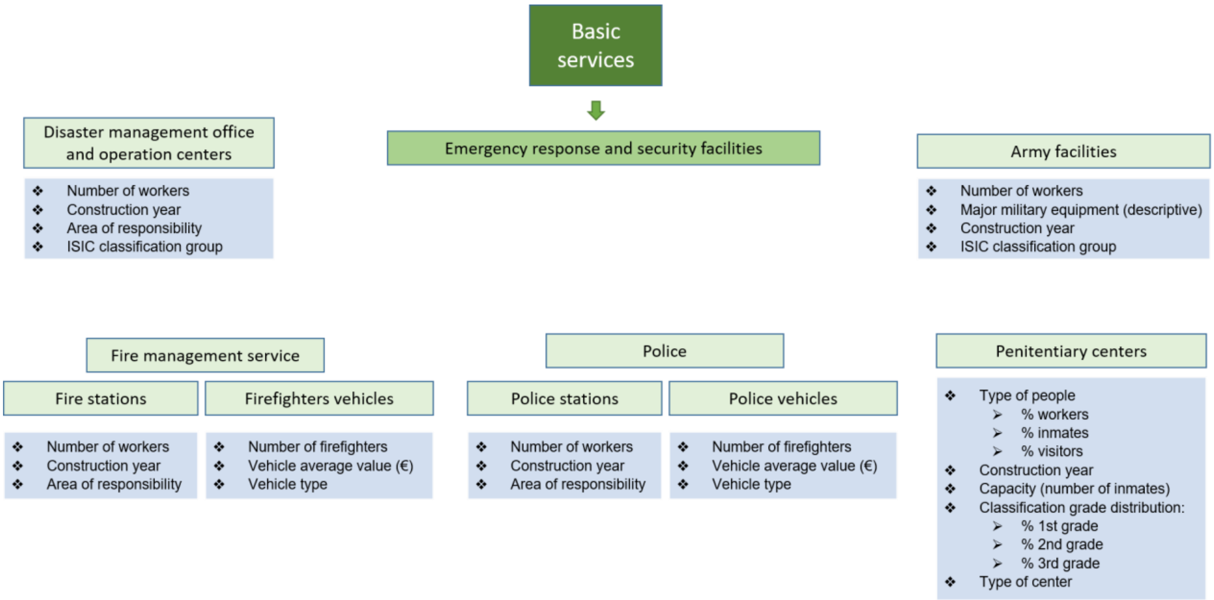

Figure 9. Specific attributes for emergency response and security facilities sub-typologies.

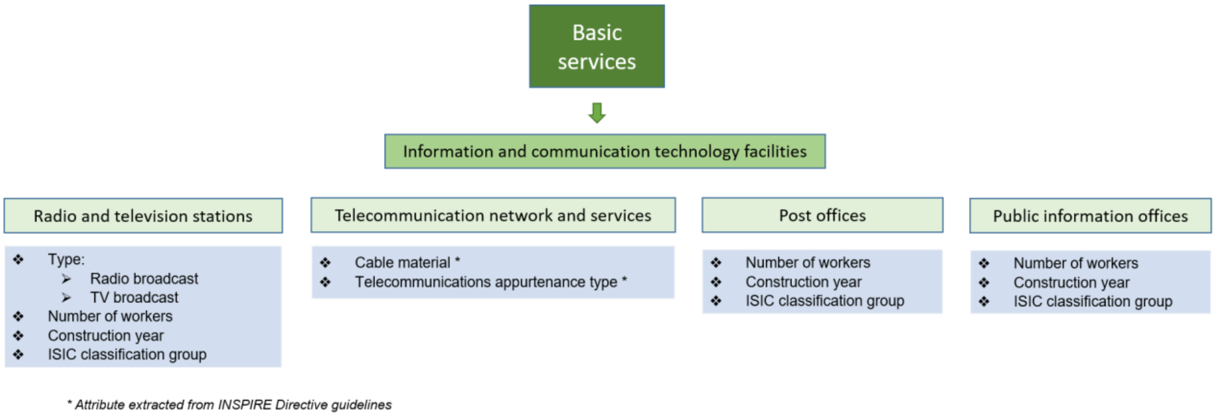

Figure 10. Specific attributes for information and communication technology facilities sub-typologies.

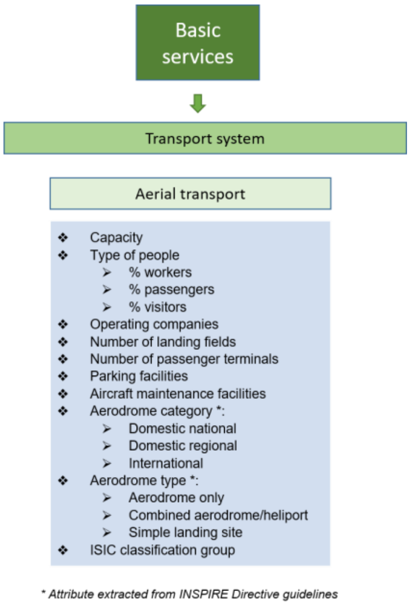

Figure 11. Specific attributes for aerial transport.

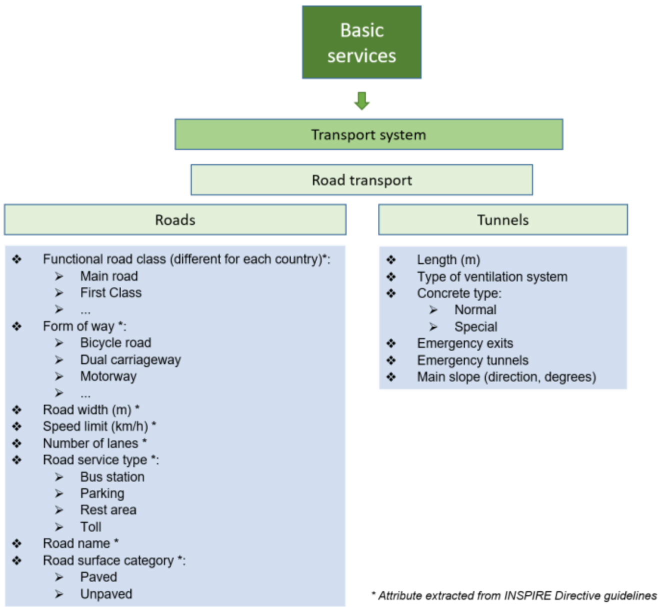

Figure 12. Specific attributes for road transport sub-typologies.

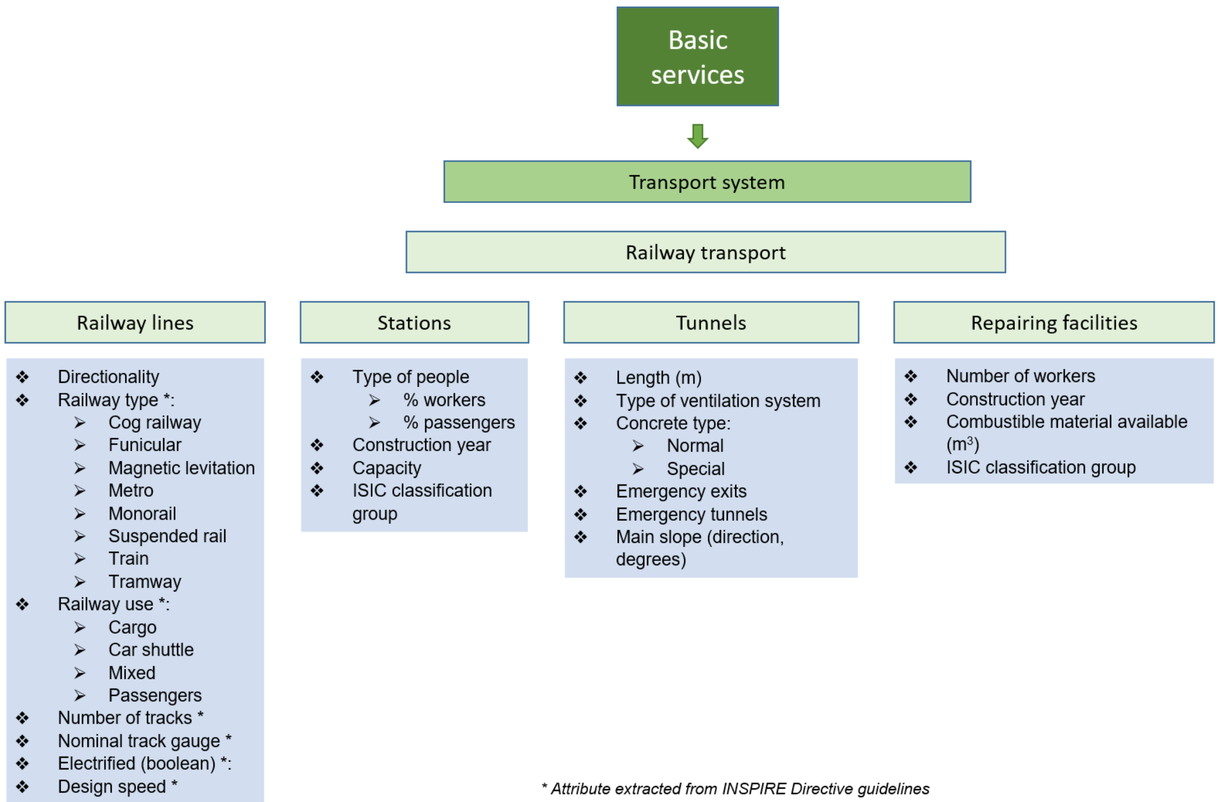

Figure 13. Specific attributes for railway transport sub-typologies.

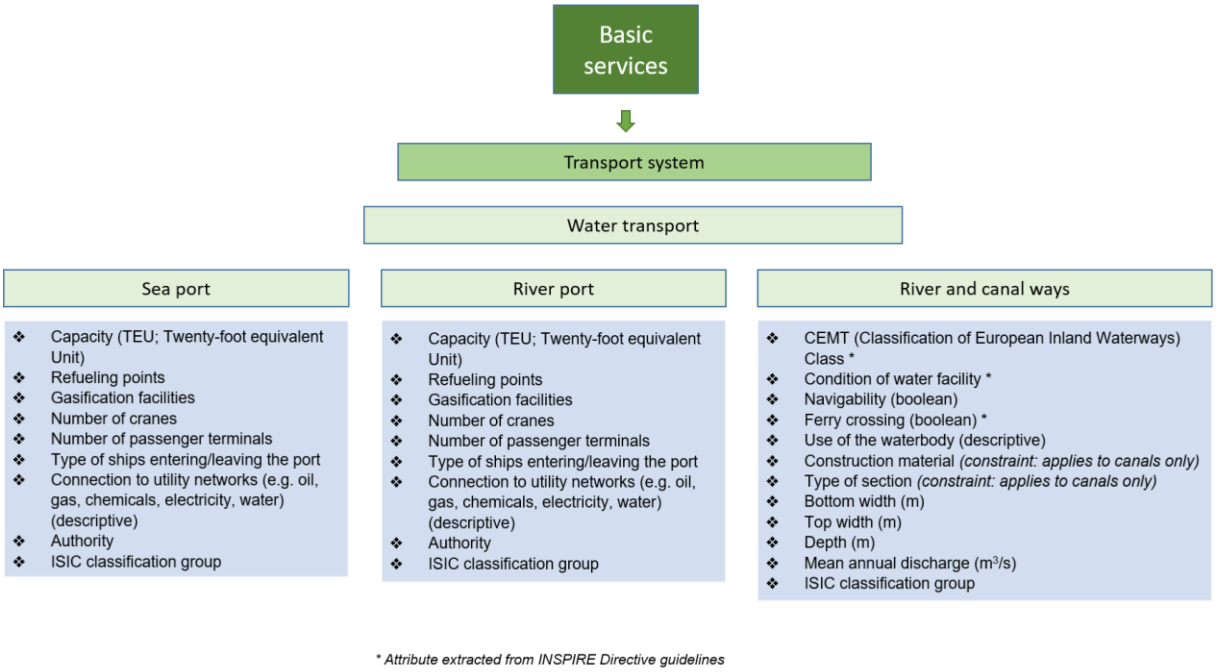

Figure 14. Specific attributes for water transport sub-typologies.

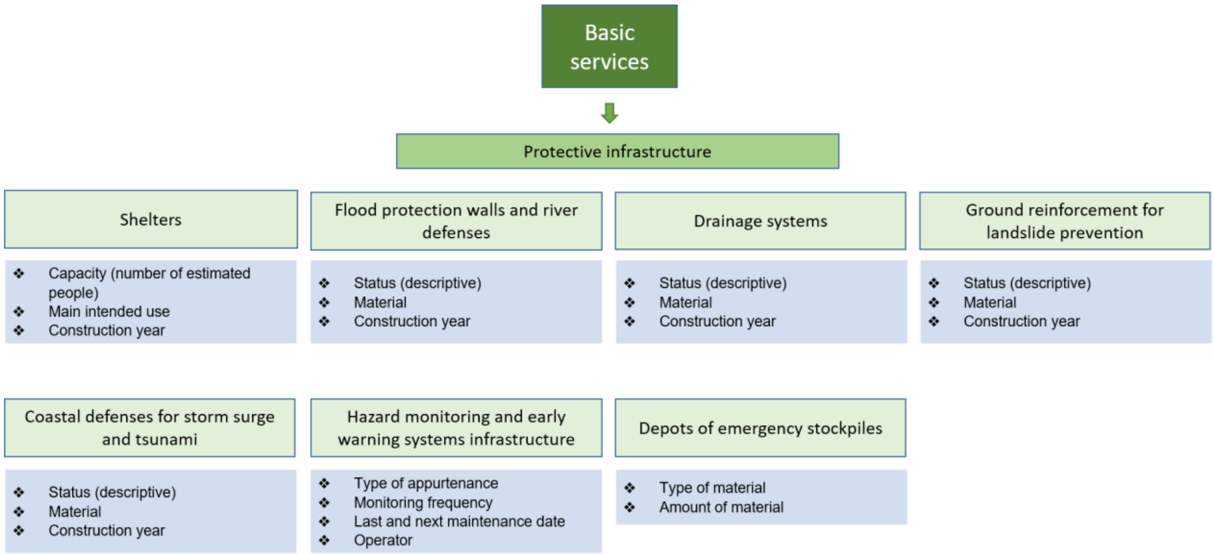

Figure 15. Specific attributes for protective infrastructure sub-typologies.

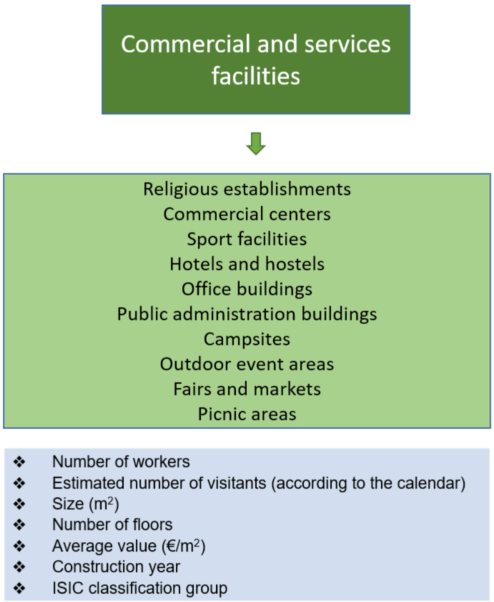

Figure 16. Specific attributes for commercial and services sub-typologies.

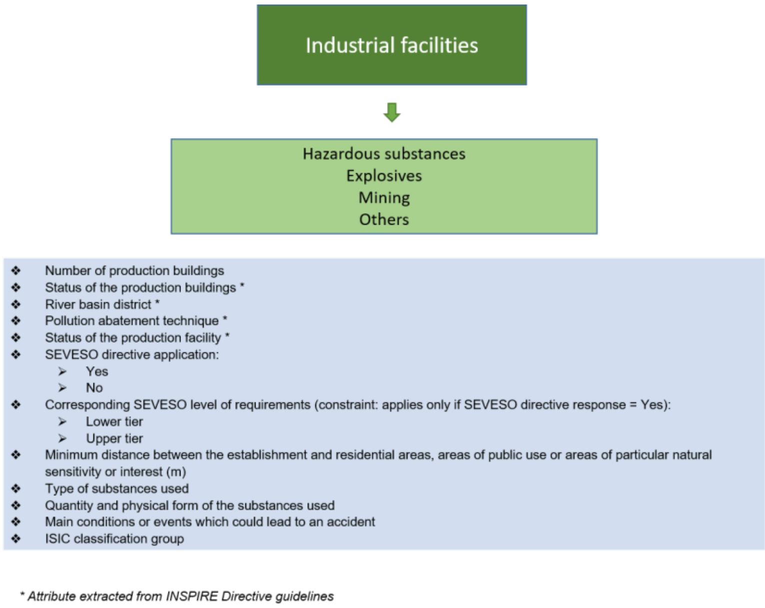

Figure 17. Specific attributes for industrial facilities sub-typologies.

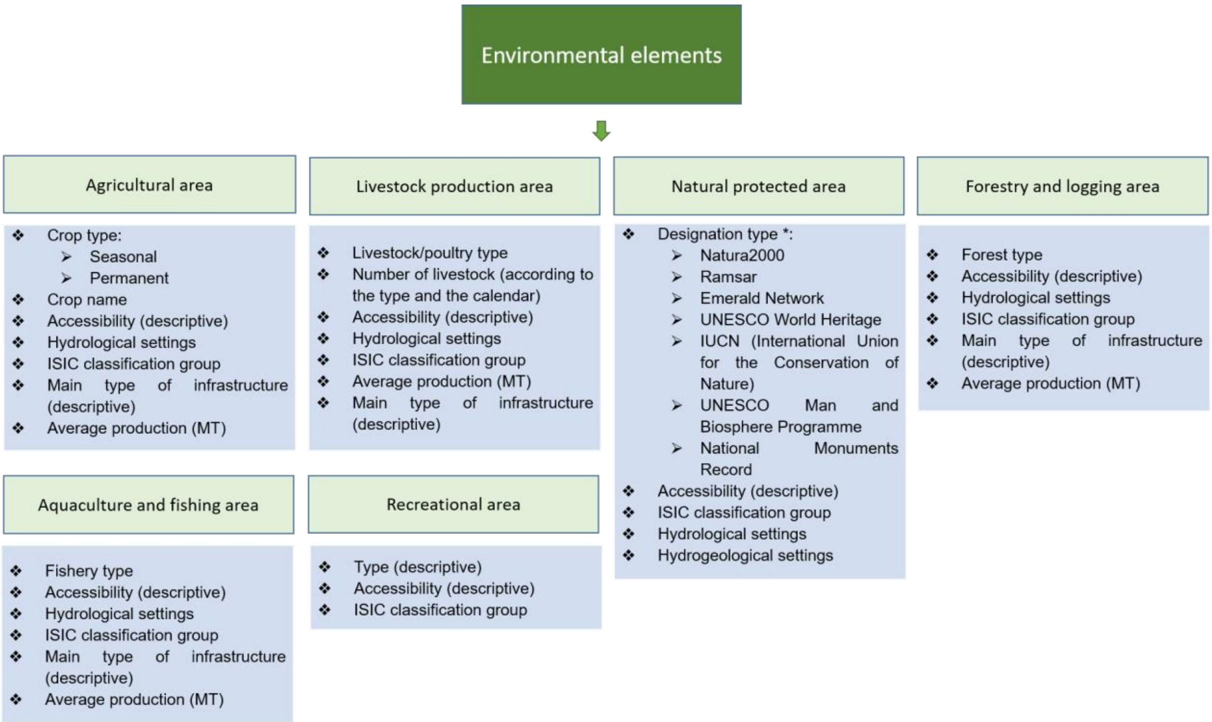

Figure 18. Specific attributes for environmental elements sub-typologies.

Figure 19. Specific attributes for cultural heritage facilities and services sub-typologies.