WORK PACKAGE 2
DELIVERABLE D.T2.1.3

GIS-based databases for municipalities – CESENA 11/2017

D.T2.1.3: GIS-based databases for municipalities

A.T2.1 Exploring energy saving potentials and potentials to reduce light pollution

Issued by: Partner Nr. 13 – »Poltegor – Institute«
Version date: 1.11.2017
Circulation RE – Restricted to Dynamic Light Partners

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D.T2.1.3 - GIS-BASED DATABASES FOR MUNICIPALITIES: CESENA

Introduction

The Deliverable describes how data were collected for the design of a Geo Database to read the energy consumption and light pollution of the public lighting network within the municipality of Cesena. All the elaborations were conducted by the municipality of Cesena, in particular by the GIS municipal department, in collaboration with Hera Luce Ltd, the public lighting manager of the City of Cesena. The goal is to provide the City with a new "Dynamic Light GIS database" that can be used as a new planning and investments tool for future public lighting retrofits projects and to plan and implement dynamic light solutions in the urban area. The GIS database will be updated during the whole duration of the project with input and output information from the other WPs, including the results of the Pilot Action (Wp3). Specific analyzes and thematic maps were created within the research area of the Cesena Urban Center District that includes the pilot area of the Ex Sugar Refinery of Cesena.

1 - Data acquisition/survey and collection of data

1.1 - Data sources and methodology used

As specified in the Deliverable 2.2.1 (Analysis of the lighting situation), the municipality of Cesena, through an agreement signed in 2015, has entrusted the management of the urban lighting network to Hera Luce Ltd a company specializes in management of public lighting installations. Within the agreement there is also a chapter devoted to the development of a GIS platform to monitor the Cesena's lighting network. The municipal GIS Department in collaboration with Hera Luce has therefore carried out a general census of the public lighting network to geo-referencing all the light spots. Positions of lighting poles and switchboards were defined by using on-site GPS and by digitizing features from maps. Then specific data were collected including: types of luminaires, technical characteristics of the individual light points, adequacy of the light points to the targets set by the current regulations, standards of technological innovation and energy saving. The census was carried out following the indications contained in the new Emilia Romagna Region Directive on light pollution and energy saving in application of the LR. 19/2003 (section 2.1 of Annex B).

Figure 1 - Example of Cesena's Geo Database with georeferenced light points.

The main source of data to build the "Dynamic Light Geo database" is the geo-database resulting from this census, that contains information of luminaires, poles, electrical lines and power supply distribution boxes (switchboards) of the Cesena's network. This Geo database is updated continuously with new data but it is currently used as a simple tool to visualize light points and asses the current maintenance, safety and operation conditions of the components of the urban public lighting system. The aim of the activity was first of all, to imagine the alternative use of the GIS as a planning tool, capable to read the energy consumption of the individual city's areas and to pass from the Geo Database to "Dynamic Light Geo Database".

Starting from the general lighting geo-database of the city, a specific Geo database was created selecting the a research area that corresponds to the **Cesena Urban Center District** that includes a total of 4.187 lights points and has an area of 46,436 km2.
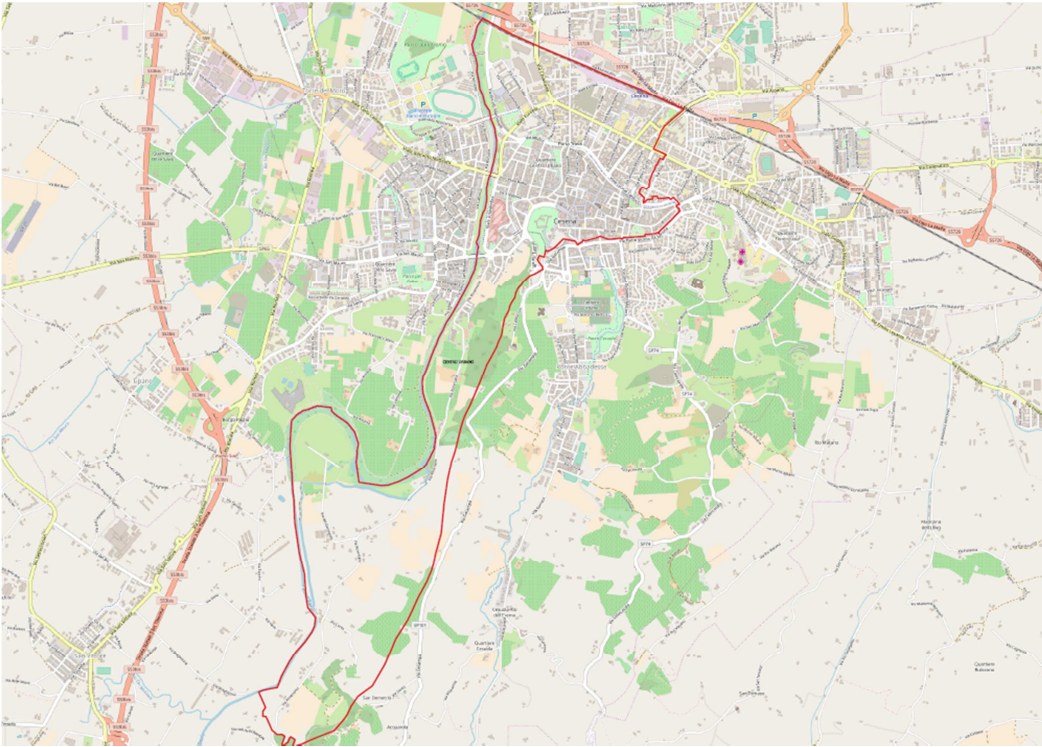
Figure - 1 - Cesena Urban Center District map.

The research area has been selected first of all because inside it is located the pilot area of the Ex sugar refinery in wich it will be tested the pilot action. In addition, the area is the most central district of Cesena that also includes the urban core of the old historic center between the fortified ancient walls. Inside there are therefore different types of public spaces with the respective type of urban lighting: we pass from the main square "Piazza del Popolo" in the heart of the historic center, to cycle paths connecting the city center to the pilot area, vehicular traffic roads and public green areas. The research area is therefore interesting because it will allow to experiment different uses of GIS as a tool to improve the quality of public spaces by acting on the type of urban public lighting. During the creation of the Geo-database, specific data were collected and in particular:

- energy consumption data were collected from energy bills of Cesena's citizens and add in the Geo Database;
- photometric data were collected from on-the-spot measures using a professional luxmeter (with calibration certificate). The analyzes were carried out within the Ex Sugar Refinery area and in particular within the 11th of September 2001 park, during non-full moon evenings, under clear or cloudy conditions, without atmospheric precipitation, following the

methodology described below. The first survey was done by evaluating the horizontal illuminance (on the walking surface) according to the following scheme:

L

PL   PL

L/8

L/4   L/4   L/4   L/4
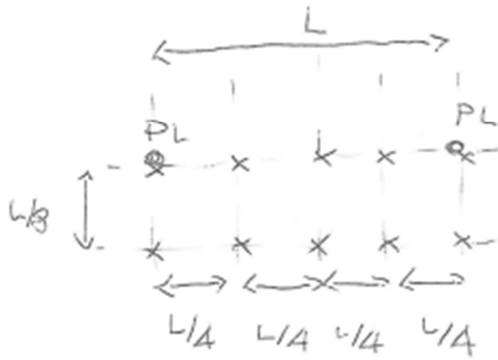
The second survey was done by evaluating the vertical illuminance (at 1.5m height) according to the following scheme:

PL   PL

L/8

L/2

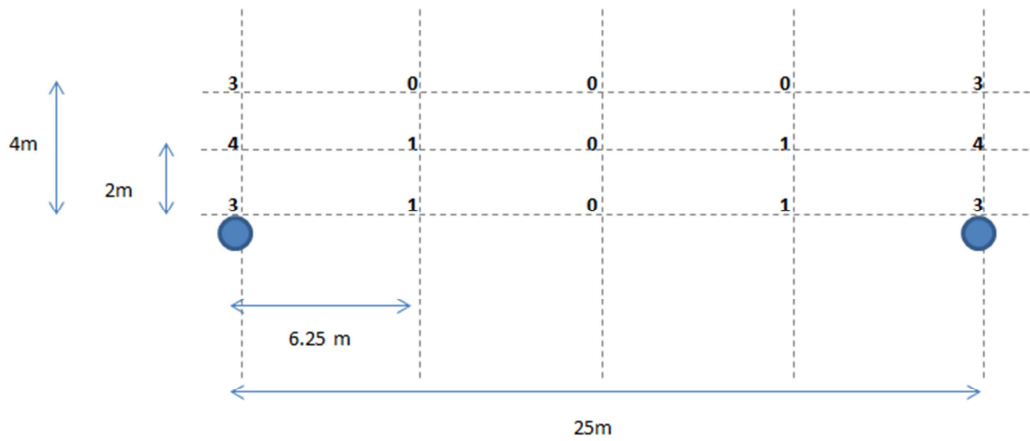↑₁ prima direzione
△ luxmetro

→₂ seconda direzione
▯ luxmetro
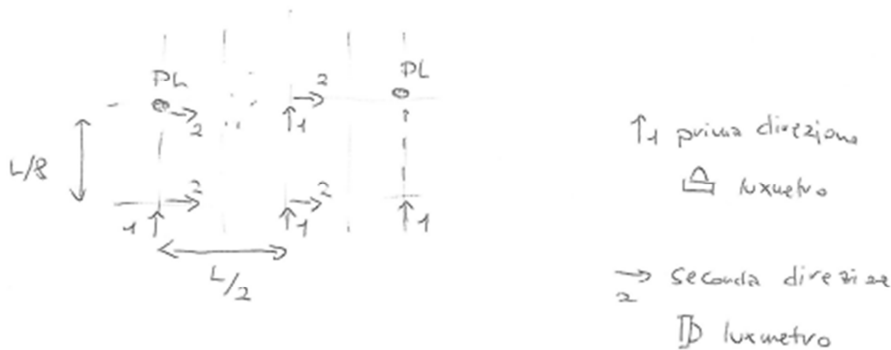
The main results of the analyzes are shown below:

SITUATION 1

Sidewalk with Siteco armor without optic (only light curtain around the lamp mounted vertically) with lamp 80w HPL H = 3.5 m.
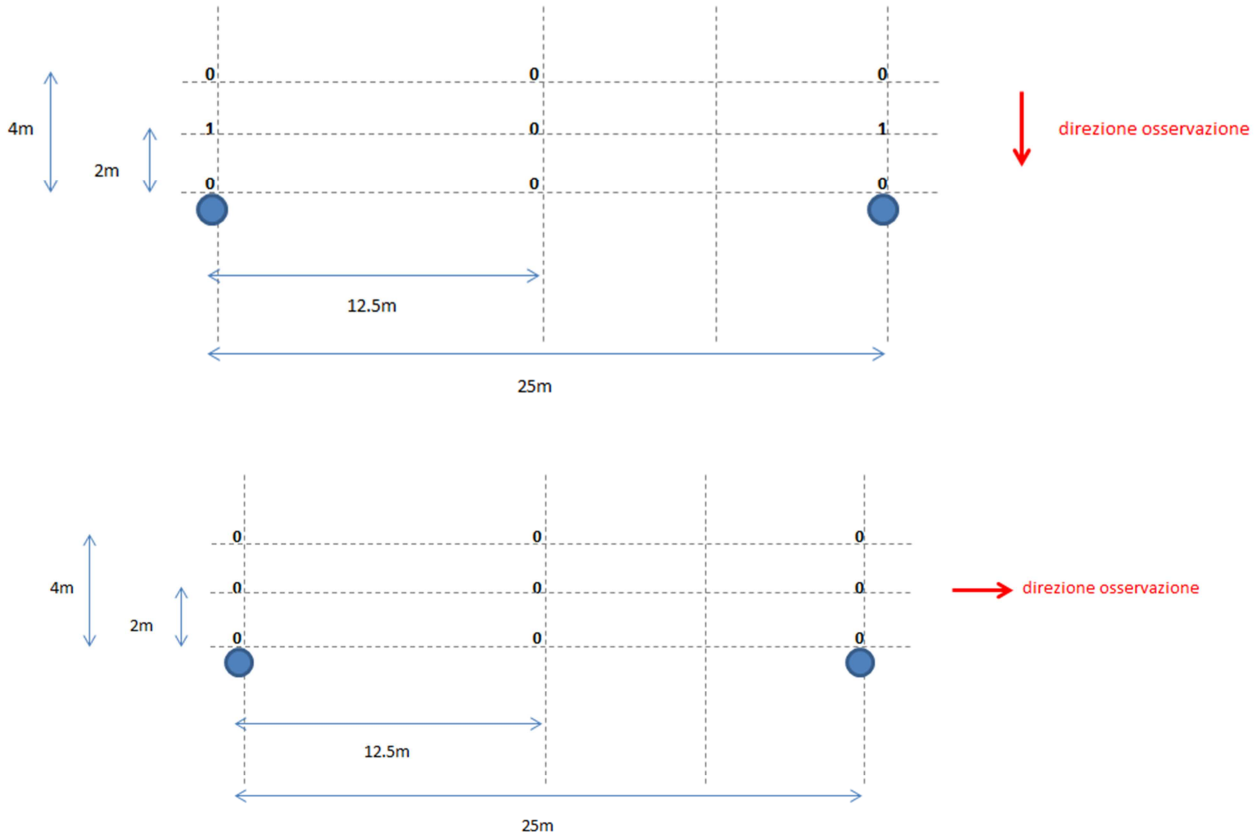
Relief of horizontal illumination
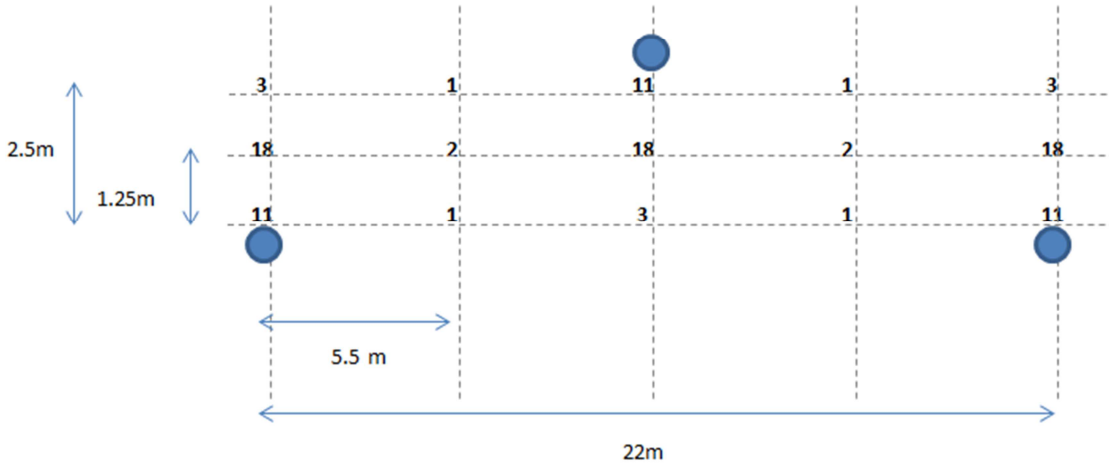

Relief of vertical illumination

SITUATION 2

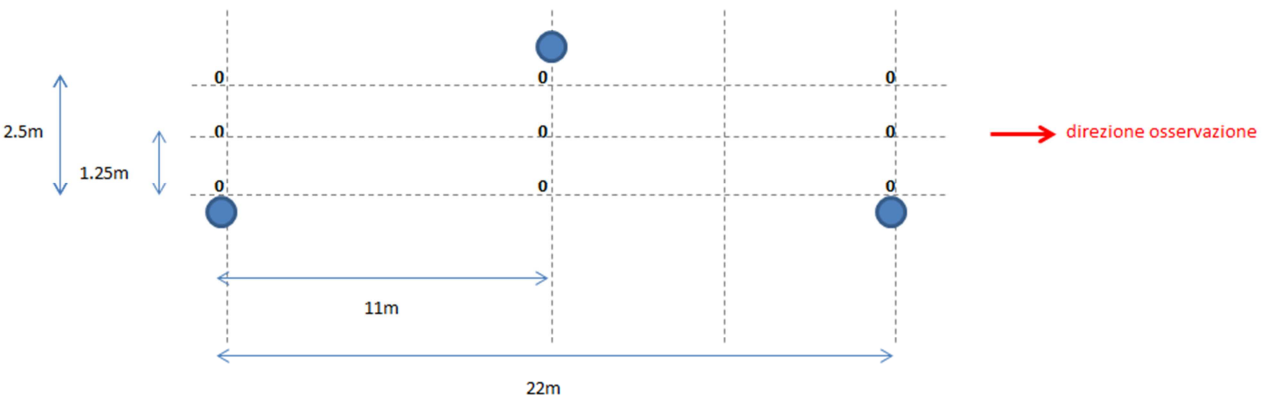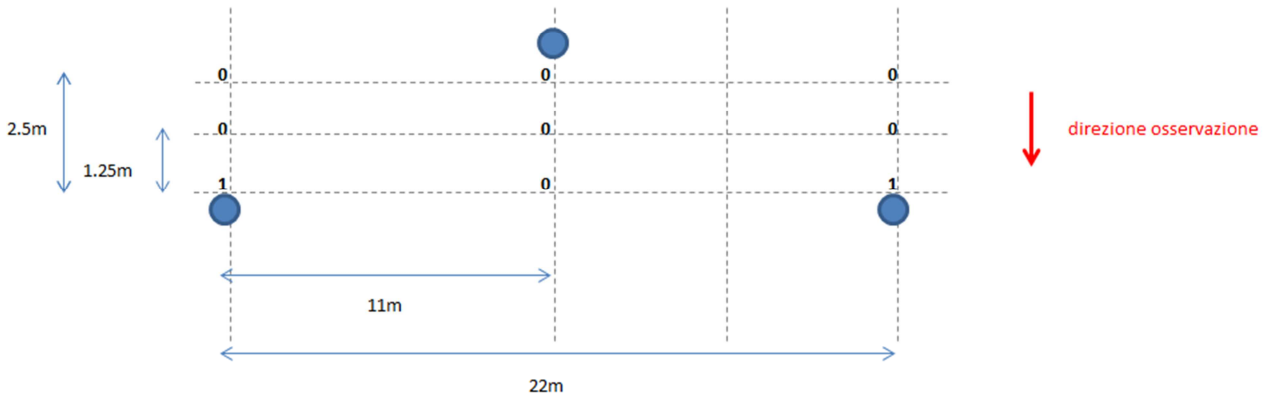Pavement with bollard without optics (only louver around the lamp mounted vertically) with lamp 50w HPL H = 1.0 m.

Relief of horizontal illumination

Relief of vertical illumination

1.2 - Structure and naming of the data

DESCRIPTION OF THE COLLECTED INFORMATION

The tables below reports the description of the specific data collected for the single lighting points that composed the "Dynamic Light Geo Database". It is specified that the data was organized within the templates provided by PP 13. In particular, the legends of the attached tables are shown.

LEGEND of the GEO_DB Luminaire

GIS Field	DATA DESCRIPTION
LAMPADE	Number of lamps per light point
COD_VIA	Univocal code combined with the street (in general name of the street)
TIPO_ARMAT	Brand and model of armor
STATO DI C	Conservation status
TYPE	Support type
CON_P_ATTU	Light point condition
CHIUSINO	Material of the cover
COLLARINO	Type of collar
DIM_CHIUS	Size of the cast iron manhole cover
Material	Support material
VER	Painting (yes/no)
T_ARM	Type of luminaire
POSE	Position of luminaire
LIN	Type of power supply line
Power-One	Presence of the Power One Control System
FORNITURA	Power panel of the single light point
IN CARICO	Light point in charge of Hera Luce

LEGEND of the GEO_DB Swichboard

GIS Field	DATA DESCRIPTION
MATRICOLA	Serial code of the electric meter
N_UTENZA	Unique identification code of the electric user
TIPO_ARMAD	Cabinet material
RECNO	Unique identification code of the electrical panel

DATA TYPE USED

The collected data are all vectorial data processed using a Web-Gis mapping system and therefore represented on a tabular basis, so that all the main data of the light points are reported, such as the type of equipment, material, height of poles and state of the support, the status of the electrical panel etc.). The data is also represented on a graphical basis so that when they are superimposed on the GIS map of the City of Cesena, they provide visual evidence of the physical location of the light spot in space. This integrated system also allows to depict elements on the map by cross-linking the various associated information and thematizing the data to have differentiated state-of-the-art projections with immediate visual impact. The use of this program (which includes the ability to implement the information to be associated with the single light point) also allows you to add new information in the database also by point to point.

1.3 – Software

DESCRIPTION

The QGIS software was used to collect and process the data and build the Geo Database.

The QGIS is an Open Source Geographic Information System that supports many raster and vector formats. QGIS is licensed under the GNU General Public License (GPL). QGIS is supported by a variety of environments such as Windows, Unix (including Linux!), OS X. This type of software is very versatile and user friendly not only for technicians but also for displaying results thanks to its graphical user interface. QGIS allows to implement spatial analysis on spatial databases and other formats supported by OGR. Currently QGIS offers vector analysis, geo-processing, geometry and database management tools. Furthermore, the software allows to export and publish maps and data on web, using a webserver with UMN MapServer or GeoServer installed.

The software allows to view and overlay vectors and raster formats of different sizes and with different projections, without any format conversion.

Supported formats include:

- ✓ PostGIS, SpatiaLite and MS SQL Spatial tables, Oracle Spatial tables and vectors supported by the OGR library as ESRI shapefile, MapInfo, SDTS, GML and many more, see the Working with Vectors section;
- ✓ Raster and images supported by the Geospatial Data Abstraction Library (GDAL), such as GeoTIFF, ERDAS IMG, ArcInfo ASCII GRID, JPEG, PNG, and many others, see Working with Raster Data;

- ✓ Raster and GRASS vectors from their database (location / mapset), see Integrating with GRASS GIS;
- ✓ Space data accessible from Web Services OGC, such as (WMS, WMTS, WCS, WFS, WFS-T).

The software also allows to edit, manage and export vectors and raster in many formats. Some of the main features of QGIS are:

- ✓ Digitizing tools for OGR formats and for GRASS carriers;
- ✓ Possibility to create and modify shapefiles and GRASS vectors;
- ✓ Georeferencing plugin for geocoding images;
- ✓ Support for viewing and editing Open Street Map data;
- ✓ Create shapefile spatial database tables with the DB Manager plugin;
- ✓ Improved spatial database tables management;
- ✓ Tools for managing the attribute tables of a carrier;
- ✓ Saving screens as geo-images.

VISUALIZATION OF THE COLLECTED DATA

Using the QGIS software was therefore possible to process and create specific maps to visualize different features of the lighting network within the Urban Center District and in the pilot area of the Ex Sugar Refinery in Cesena. Below is a list and a brief description of the main maps designed (It is specified that other specific maps will be created on the pilot area in the next project phases so that the geo-database is enriched with updated and necessary information).

1. URBAN CENTER DISTRICT MAPS

1.A – Switchboards and light sources by type of lamp

1.B – Switchboards and luminaires by type

1.C – Power supply lines

1.D – Consumption

1.E – Light poles by type of construction material

1.F – Compliance with the Regional Law n.19/2003 "Light pollution"

2. EX SUGAR REFINERY AREA MAPS

2.A – Switchboards and light sources by type of lamp

2.B – Switchboards and luminaires by type

2.C – Power supply lines

2.D – Pole height of the light fixtures

1. URBAN CENTER DISTRICT MAPS

1A. Switchboards and light sources by type of lamp

The map shows the location of the switchboards and the location of the light sources subdivided by type of lamp and in particular: LED; Compact fluorescents; Halogen lamps; Metal halide lamps; Lamps with mixed light; Mercury lamp; High pressure sodium lamp; Linear fluorescents.
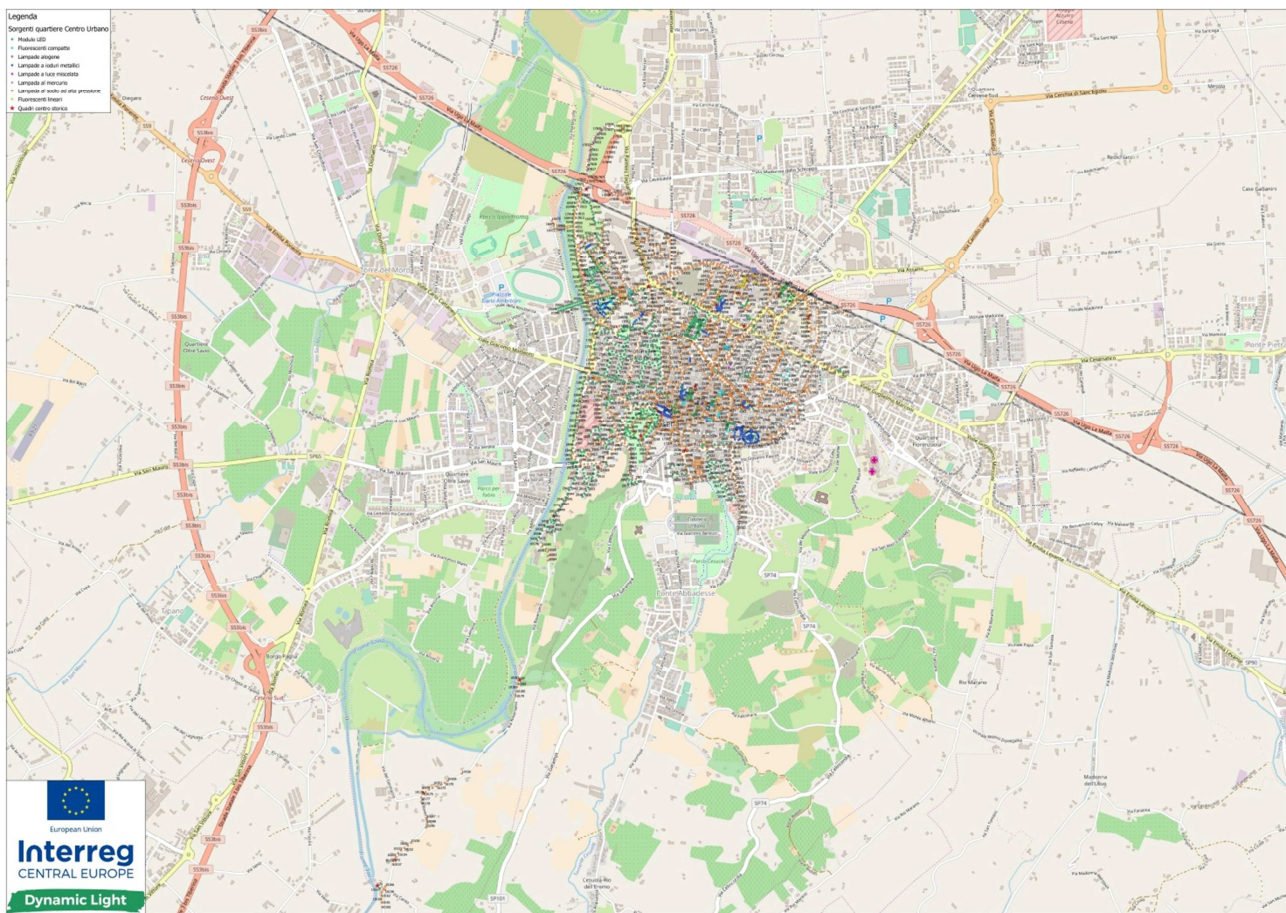

1B. Switchboards and luminaires by type

The map shows the location of the switchboards and the location of the luminaires by type, and in particular were identify 4 main types: Street lighting; Street furniture; Artistic lantern; Ceiling Light; Projector Sphere/Globe.
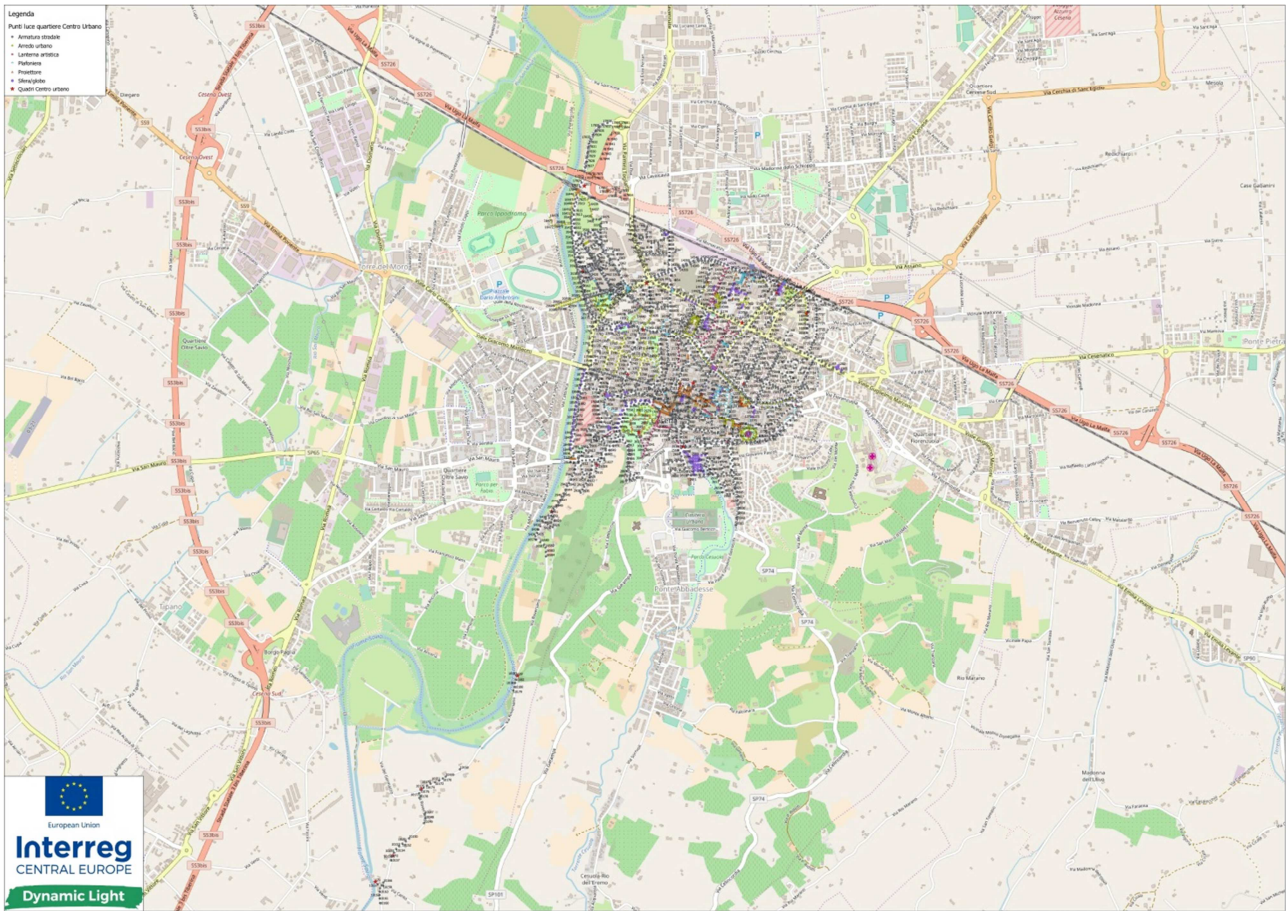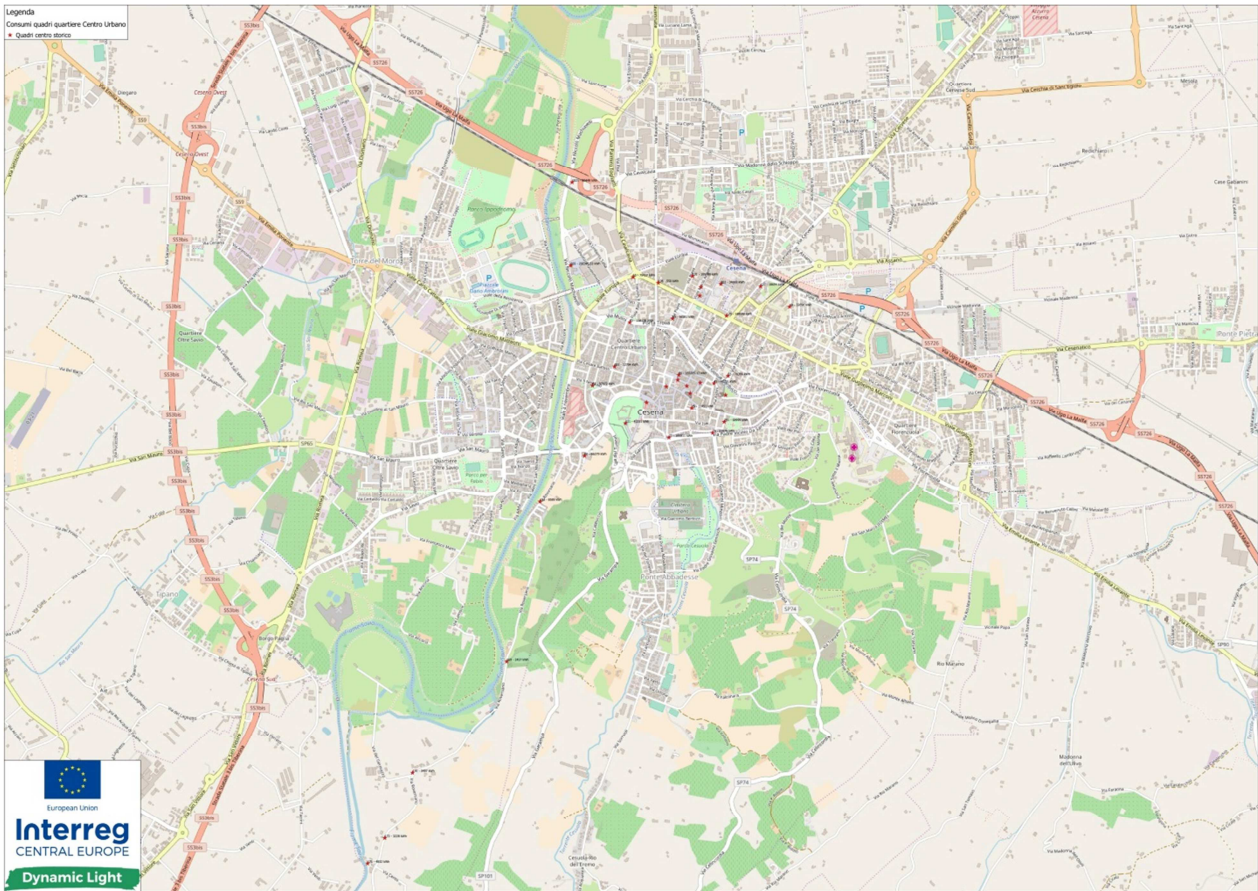
1C. Power supply lines

The map shows the location of power supply lines by type and in particular: Aerial electric line in copper; Aerial power line; In-ground power line.
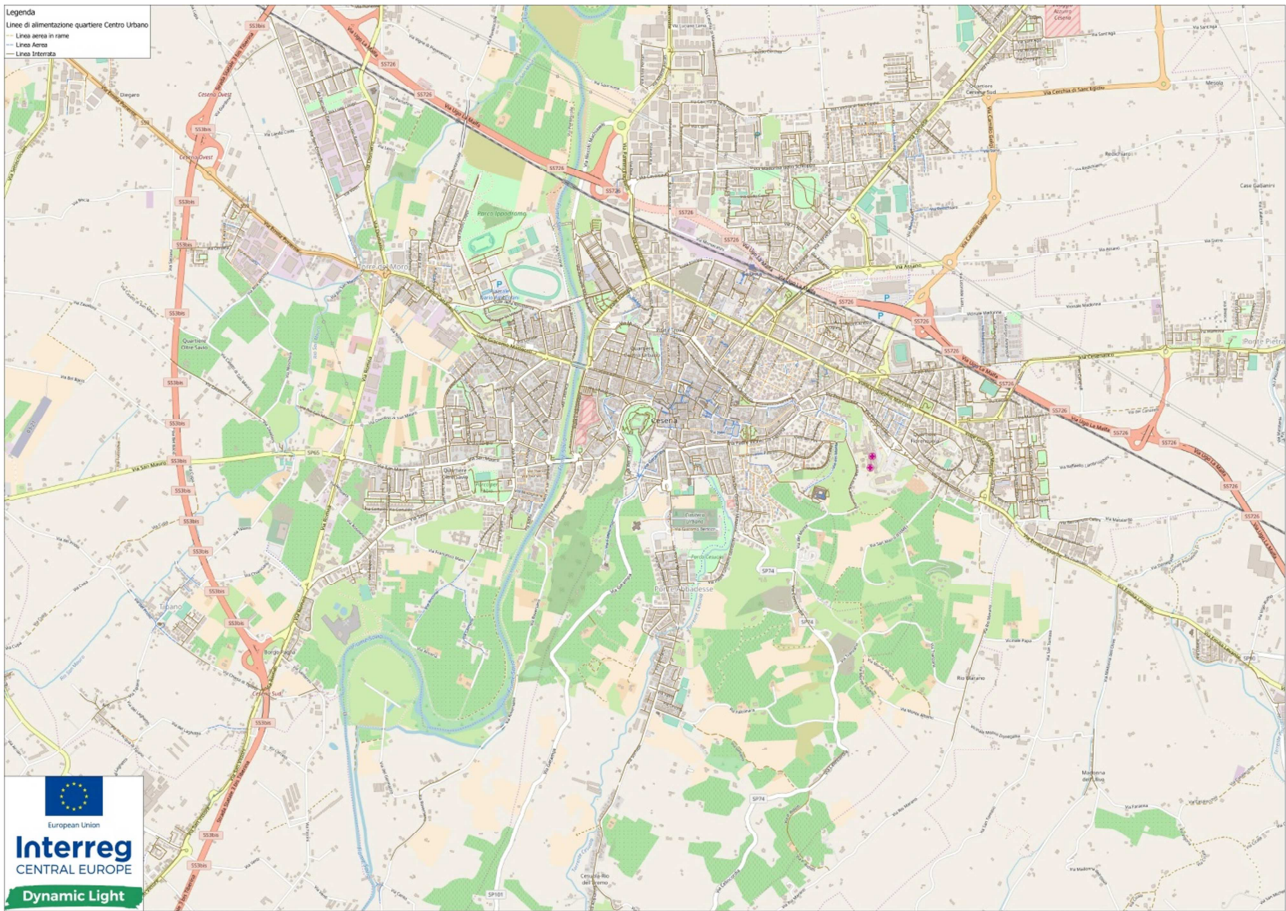
1D. Consumption

The map shows the location of the electrical panels and the respective consumptions calculated from actual meter readings and invoices.

1E. Light poles by type of construction material

The map shows the location of the light poles by type of construction material, in particular: galvanized steel; aluminum; concrete; cast iron. This information could be interesting to work on urban furniture in future redevelopment projects and to have a detail in case of breakage of the pole facilitating its replacement.
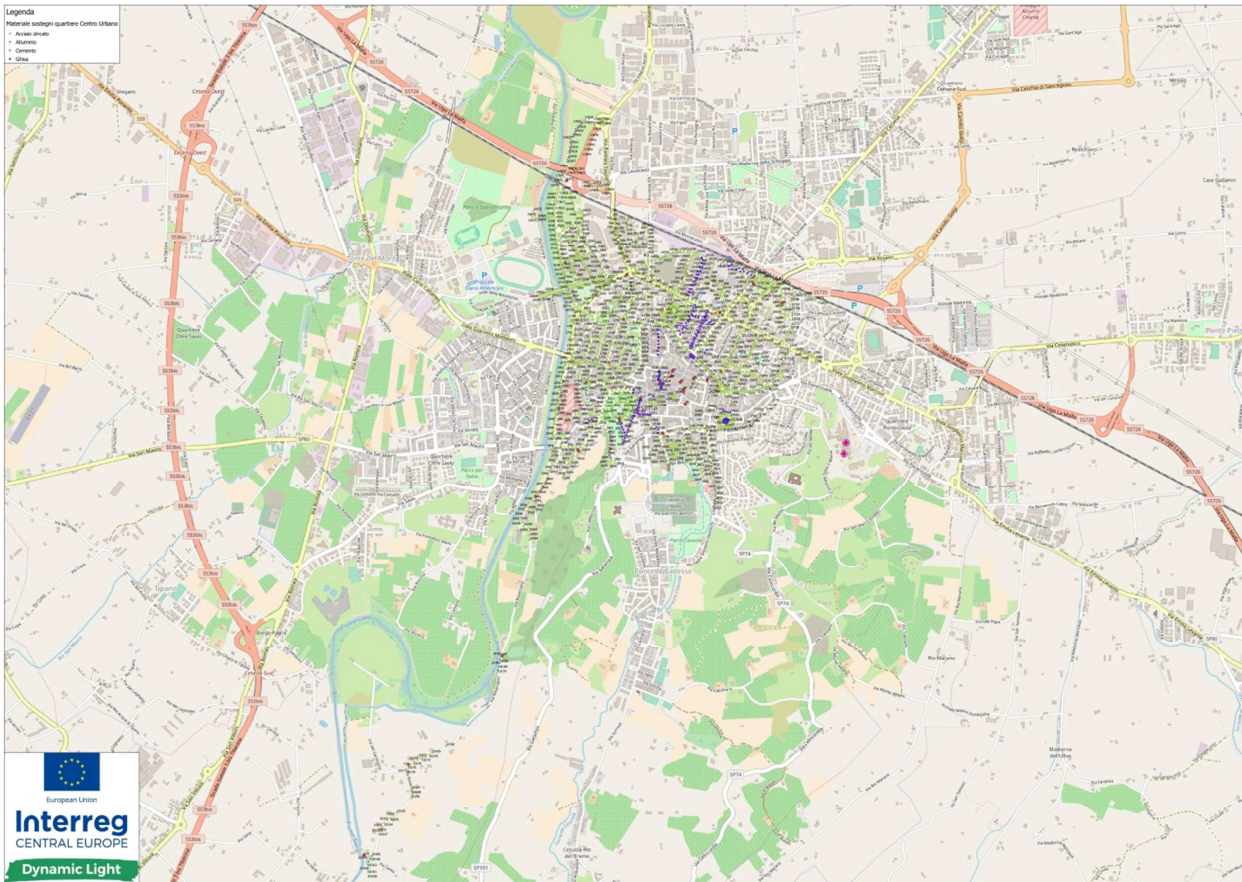
1F. Compliance with the Regional Law n.19/2003 "Light pollution"

For the future planning of the public lighting infrastructure, an interesting figure to visualize is the conformity of the lighting points with the technical standards defined by national and regional law and standards. This allows, for example, a picture of obsolete plants to prioritize future redevelopment interventions. At local level, the reference standard is the regional law of 29th September 2003, n.19 on "Regulations on the reduction of light pollution and energy saving". During the analysis a map was then created that shows the % of the light points, which are currently compliant or not, in accordance with the standards set by the Regional Law n.19/ 2003.
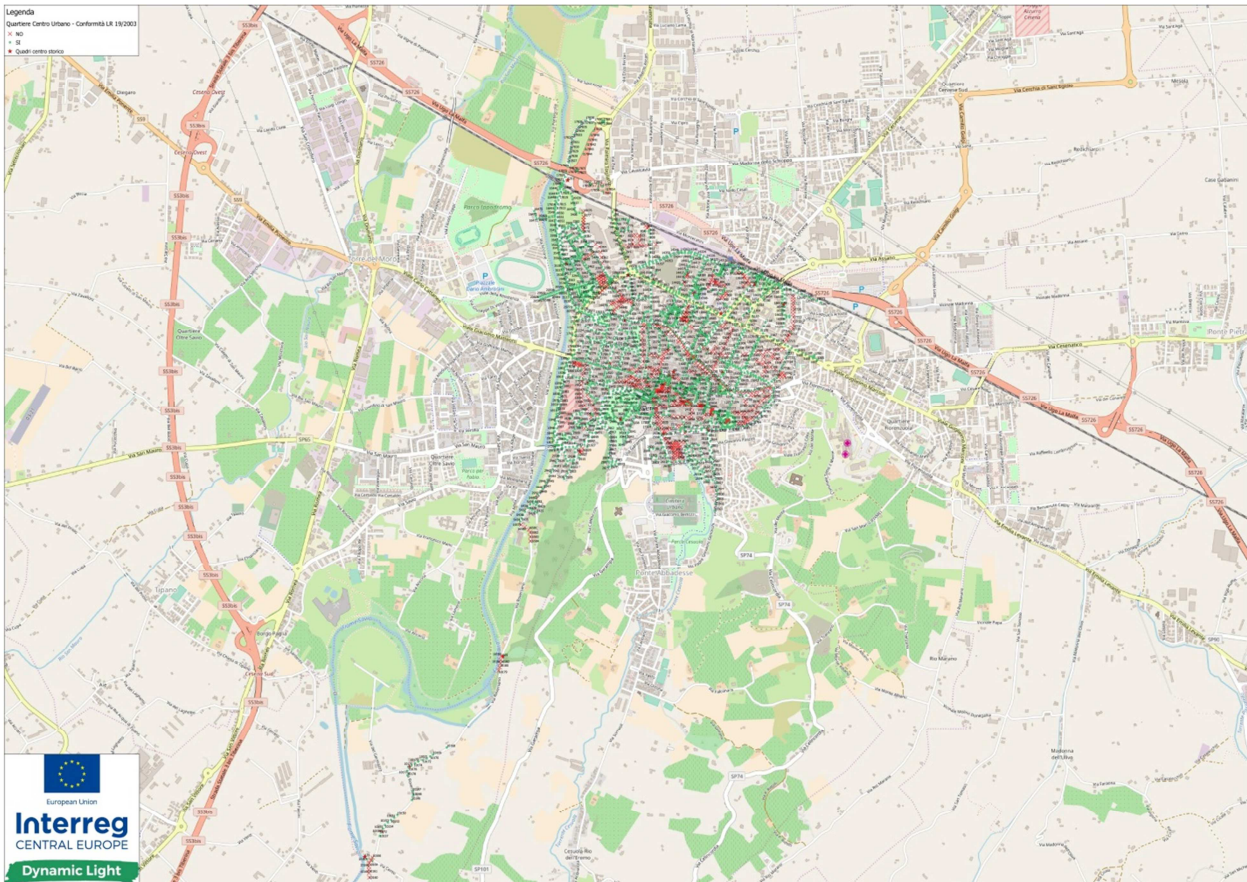
2. EX SUGAR REFINERY AREA MAPS

2.A – Switchboards and light sources by type of lamp

The map shows the location of the switchboards and the location of the light sources subdivided by type of lamp and in particular: LED; Compact fluorescents; Metal halide lamps; Mercury lamp; High pressure sodium lamp.

2.B – Switchboards and luminaires by type

The map shows the location of the switchboards and the location of the luminaire by type, and in particular were identify 3 main types within the pilot area: Street lighting; Street furniture; Recessed luminaire.
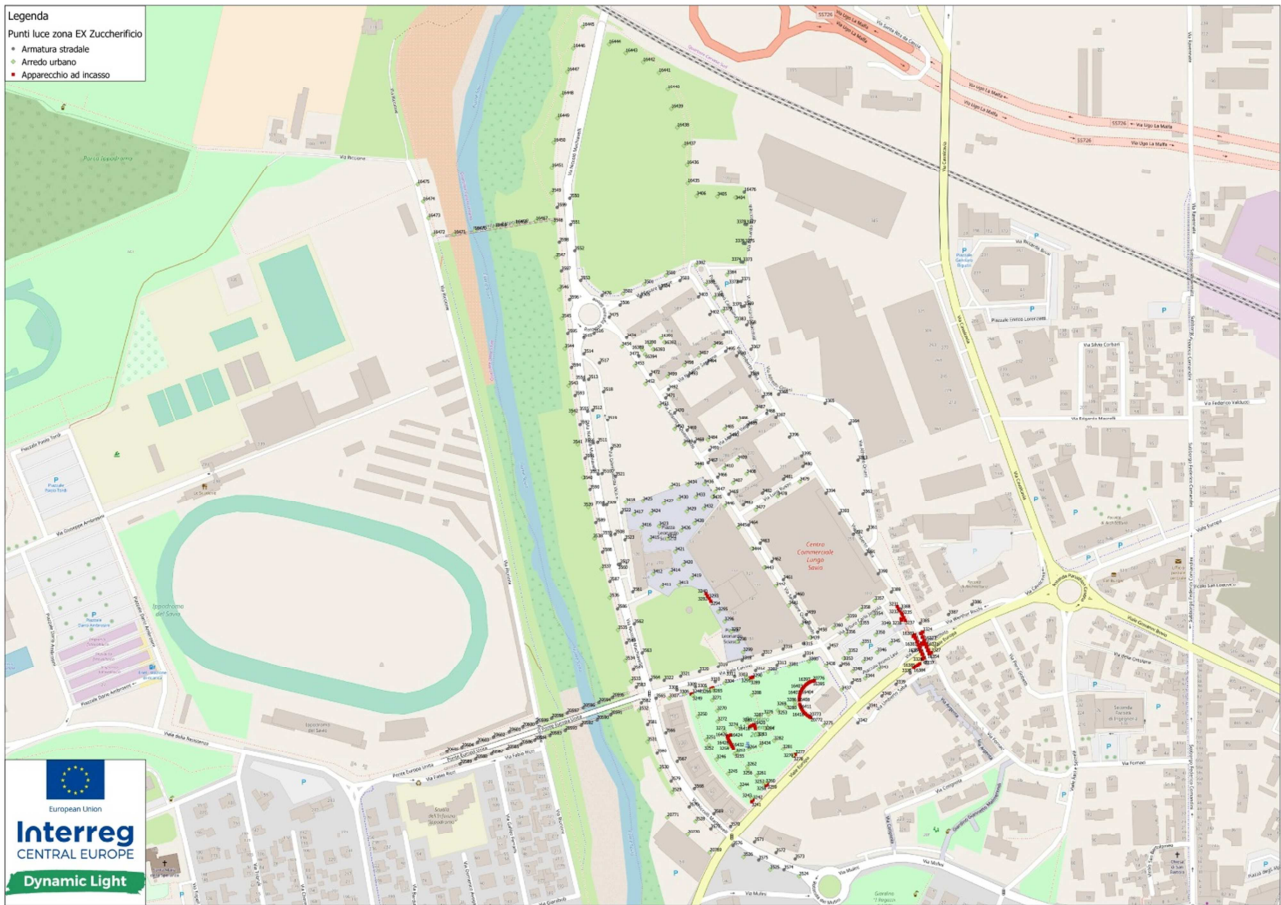
2.C – Power supply lines

The map shows the location of power supply lines by type and in particular there were 2 main types of lines: Aerial power line; In-ground power line.

2.D – Pole height of the light fixtures

The map shows the heights (in meter) of the support poles of the light fixtures, and in particular:

recessed luminaire; 3m; 3.2m; 4.2m; 5.2m; 8.2m.

2. Future use of the GIS database

As described above, currently the GIS database is using as a simple point-of-control tool for the urban lighting network of Cesena. In the future, the main aim is to implement a Dynamic Light GIS database as an effective tool for planning public retrofit interventions on lighting within the city.

A GIS tool which is contemporaneous a technical support for lighting designers and municipal technicians to plan future interventions and monitor the impact of public and private investments (for example by measuring energy savings "before and after") and a communication tool to disseminate data and policies more widely to a non-technical audience, by publishing maps on GIS open web portal. Furthermore, the GIS database presented in this Deliverable, will be the basis updated during the whole duration of the project, to visualize the main input and output information from the other WPs; in particular for collecting data from D.T2.2.2 - Strategies for city lighting and D.T2.2.3 - Action plans for municipalities and to include the results of the Pilot Action (Wp3) in particular within the workflow of the D.T3.2.5 - Pilot investment, to measure the energy savings achieved with the intervention in Cesena.

3. Expected impact and benefits of the tool for the concerned territories and target groups

For the development of the O.T2.1 and of the Deliverable, different internal meetings were organized to design the geo-database collecting shape files and additional data and implementing a common future strategy to develop this tool within the existing GIS municipal platform.

In particular the following stakeholders were involved:

- ✓ Local public authority (in particular the municipal GIS Department and Urban Development Department);
- ✓ Infrastructure and (public) service provider (in particular Hera Luce Lta that is the public lighting manager of Cesena and that is responsible for updating the shape files);
- ✓ Sectoral agency (Energie per la città, the in-house society 100% owned by the municipality of Cesena, that deals with the energy management of the public buildings and in the future will be manage the public lighting network).

The main future challenge on this issue is to promote an alternative use of GIS as a planning and monitoring tool for energy consumption in the lighting infrastructure, first of all inside the municipality. Thanks to the project and the specific training activities on this topic, the technicians will increase their expertise on how to use the GIS and read the maps of the public lighting infrastructure to prioritize the redevelopment interventions by reading consumption and recognizing the more or less illuminated areas of the city.

4. Sustainability of the tool and its transferability to other territories and stakeholders

Since January 2014 the Municipality of Cesena is leading the Union of Municipalities of Savio Valley (810 km2 and over 118.000 inhabitants) composed by 5 municipalities: Bagno di Romagna, Mercato Saraceno, Montiano, Sarsina, Verghereto. The Union of municipalities is in charge of several services such as informative services, social services, civil protection, productive activities etc. In particular, since 2 years, the Geographic Information Systems department of Cesena has been developing and updating Geo-Databases for all the municipalities of the Union Savio Valley.

A GIS open data web portal of the Union of Municipalities of Savio Valley has been created to visualize territorial maps and share thematic shapefiles with users, technicians and citizens (http://dati.unionevallesavio.it/). The GIS open data web portal is divided in different thematic

areas including Environment and Territory Protection, Tourism, Culture, Health, Population, Environmental Services. The goal will be to create a section on public lighting network of Cesena update with all the output of the project. In the future the new GIS tool implemented during the project with the methodology for data collection and analysis, can be extended to other municipalities of the Union and the maps will be published on the web open portal.

Another key stakeholder for the transferability of the GIS tool and the Dynamic project approach, is the National Association of Italian Municipalities – Emilia Romagna Region department (ANCI/Emilia Romagna). In particular the ANCI Energy sector works together with the municipalities throughout the region, to transfer good practices and innovative tools on energy efficiency and smart cities. Finally, the collaboration with Hera Luce in the development of GIS-Database will be important in transferring alternative use of this tool also among enterprises of other territories, that deal with the management of the public lighting network. For these reasons, it will be important during the project to provide training course on the alternative use of GIS for the management of public urban lighting devoted to municipal technicians of Union of Municipalities of Savio Valley and private public lighting operators of the region.

5. Lessons learned from the development/implementation process of the tool and added value of transnational cooperation

As described above, the process for the development of the Geodatabase has allowed the activation of a working table between the municipal GIS department and the GIS experts of Hera Luce, increasing the ability to exchange and process data and shape files on the public lighting infrastructure. This comparison also allowed for the first time to rethink the use of GIS as a tool for reading energy consumption and planning of future interventions in public urban lighting.

In the next phases of the project the Geodatabase will have to be implemented in this direction also through updating courses for municipal technicians and a comparison with the other project partners.

At the end of the project a Geodatabase able to measure the effects of dynamic light in terms of reducing consumption, will be an innovative tool able to guide European cities and experts in the public lighting sector in planning interventions and invest on this technology.

6. Attachments

- GIS Database

- Geospatial data

- Maps of the street light infrastructure:

1. Urban Center District Maps

1.A – Switchboards and light sources by type of lamp

1.B – Switchboards and luminaires by type

1.C – Power supply lines

1.D – Consumption

1.E – Light poles by type of construction material

1.F – Compliance with the Regional Law n.19/2003 "Light pollution"

2. Ex Sugar Refinery Area Maps

2.A – Switchboards and light sources by type of lamp

2.B – Switchboards and luminaires by type

2.C – Power supply lines

2.D – Pole height of the light fixtures