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An Open Multi-user Platform in Support of Urban Development: the DATA WebGIS

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1 ABSTRACT

One of the key features of our times is the availability of a huge amount of digital data regarding any branch of knowledge or human activity, combined with the widespread diffusion of devices connected to the web. Besides, the potential of data mining and processing offered by contemporary ICT is constantly growing.

Turning these capabilities into opportunities and advantages is a challenge involving a lot of research areas.

In the field of urban and territorial studies, free and open access to spatial data is by now a common policy for national and international institutions: an example is the INSPIRE Directive by European Union, which sets a framework for Spatial Data Infrastructures by its member states. As a consequence, georeferenced data and thematic maps concerning cities and their surrounding territory are released for public consultation by administrations and monitoring agencies.

Nevertheless, this proliferation of data is not always accompanied by an improvement of spatial planning quality: in western cities, economic crisis and functional obsolescence can take to decommission or underuse of buildings and compounds, both public and private; at the same time, a circular and environmentally-friendly vision of urban development is still struggling to gain acceptance in practices.

In order to reactivate complex urban or peri-urban areas, traditional planning shall therefore lean on different research fields in a multidisciplinary vision. Proposed scenarios should be sustainable, and take advantage of new ways of thinking and acting bred by the advancement of digital geo-information technologies.

DATA – Developing Abandoned Transurban Areas is a research project financed by European Social Funds, involving Departments of Civil, Environmental and Architectural Engineering and Industrial Engineering of the University of Padova and fitting in the framework described above. It aims to generate pilot transformation scenarios for abandoned areas awaiting regeneration. The chosen sample region is a part of the western periphery of Padova, in the North East of Italy, marked by a mix of rural and built surfaces, infrastructures and partially abandoned building complexes.

One of DATA topics is to collect and process multi-scale data related to the region of interest, for the purpose of releasing them on an open source webGIS platform, thus spreading knowledge outside the academic field and creating interactions with involved urban actors.

Collected data include base city maps, social and environmental information, historical evolution of the studied area, urban development plans. Their processing is developed through an open source workflow, from QGIS software to a GeoNode web platform, and their combination produces integrated information layers and in-depth analysis about the nodes of possible urban transformations.

This paper introduces data and GIS-based analysis feeding the platform, together with its fruition levels: the webGIS in fact addresses to different users' categories, including the research group itself, public and private stakeholders that may be interested in starting new urban projects, active citizens and associations willing to participate in the processes of development. The final goal is to keep the platform working beyond the end of the research project, as a base framework for the futures of the area.

Keywords: urban regeneration, data, WebGIS, INSPIRE, data mining

2 INTRODUCTION

2.1 Spatial data proliferation and GIScience

In XXI century the demand and availability of spatial-based services, initially driven by platforms like Google Earth/Maps, Bing Maps and OpenStreetMap, has become widespread and tens of millions of people access geographic information every day for the most different purposes.

More and more in this context, public administrations, research groups, monitoring agencies and project developers need to communicate, to spread and to share information and results with involved or interested communities. This necessity matches with ubiquity of digital technologies and pervasiveness of the internet as an everyday tool. Already in 2007, the INSPIRE directive by European Union set a framework for Spatial Data Infrastructures (SDI) supporting environmental and territorial policies by its member states, with common implementing rules on metadata, interoperability and network services.[1] A key concept is open data policy, meant to guarantee free availability of data by communities of users.

As a consequence, there is a growing diffusion of web maps, geoportals and webGIS platforms.

While web maps only allow viewing and searching geographic information, geoportals and webGIS offer other services, which may include data analysis, editing and download.

On a back-end level, Geographic Information Systems, or GIS, are a very effective tool for these purposes, because of their capacity to connect multi-scale spatial representations with tabular attributes. It means that the user of a GIS is able to realize maps with different spatial extents and to add any kind of information related to the regions of interest.

GIS-based operations don't only consist in collecting and querying data, but include density mapping of phenomena, surveying conflicts related to the impact of human activities and, detecting most suitable areas to host some functions. GIS are therefore very useful working tools for studies and activities with a remarkable spatial and relational component.

Compared to a desktop GIS software, a webGIS is released on the web and therefore accessible for online users. It has the disadvantage to allow limited processing and editing options, but the advantage to enable viewing, querying and downloading geographic data and other contents to a multiplicity of users.[2]

2.2 GIS and WebGIS in territorial and urban planning

In the field of territorial development and management, in order to provide valid, effective outputs, a solid supporting profile is more and more needed, to combine and process data with the aim to evaluate consequences of planned transformations

In urban planning and design, and especially when dealing with regeneration of peripheral and peri-urban areas, a webGIS can have multiple uses, in relation with users' communities and data categories:

- for the members of the working or research group, it is a platform for data exchange, testing and delivering results obtained;
- for stakeholders and potential investors, it gives the opportunity to access information and indications oriented to design transformation scenarios and to define guidelines and action strategies;
- for engaged or interested citizens, it stands as an open and user-friendly information and analysis repository, fostering critical awareness about the present and future of changing urban areas.

Examples in literature[3] or in practices show two major types of using webGIS: a) to spread and enquire base data, as for example in public administrations' geoportals; and b) for targeted processing and representations, linked to specific city management projects or research programmes. The latter kind is more interesting as a reference model for studying urban themes, but usually in these cases webGIS are online just till the end of the mother project, or they are only accessible by inner users.

[1] The text of the directive is available at http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=OJ:L:2007:108:TOC
[2] Veenendal, 2016; De Iaco et al., 2014.
[3] Manzke et al., 2016; Abdelhalim et al., 2016; Scanu et al., 2013

3 THE DATA PROJECT: LOCATION AND PILOT ACTIONS

3.1 Research framework

DATA – Developing Abandoned Transurban Areas involves Department of Civil, Environmental and Architectural Engineering and Department of Industrial Engineering of University of Padova. It is a research project funded by Veneto Region through European Social Funds, lasting one year.

The project has the goal to design pilot transformation scenarios for transurban areas awaiting regeneration. The last decades in evolution of Western cities, especially in Italy, have been marked by growth, often poorly planned, of urban territories. Along the fringes between settled city and surrounding countryside, that led to sprawling suburbs and proliferation of junk spaces and infrastructures, while relocation or closing of industrial, commercial or public service activities spawned lots of decommissioned or underused sites.

Such phenomena, which are still ongoing, also have environmental costs in terms of soil consumption and sealing: soil is now considered a hardly renewable resource[4], so future urban development should lean on transformations of existing spaces rather than further expansion. This raises issues about reuse of neglected buildings or places and reactivation of functions and social activities in challenging urban environments.

These processes can be regarded as systemic in contemporary dynamics of city borders. In order to understand their inner working it is possible to locate sample areas fitting the described spatial settings. Then, procedures to collect and select and analyse data can be tested, and pilot design scenarios connecting different scales can be developed.

3.2 Location of case study

he case study chosen for DATA is located in West Padova, one of the municipalities with the highest level of soil consumption in Italy. Here, beyond the tracks of Padova-Bologna railway and the neighbouring ring road, a sparse urban fabric stretches, structured along two penetration axes. A canal marks the western physical border and municipality boundary. This city part features a mix of buildings and crops and some big decommissioned and a former mental hospital, now a health complex.

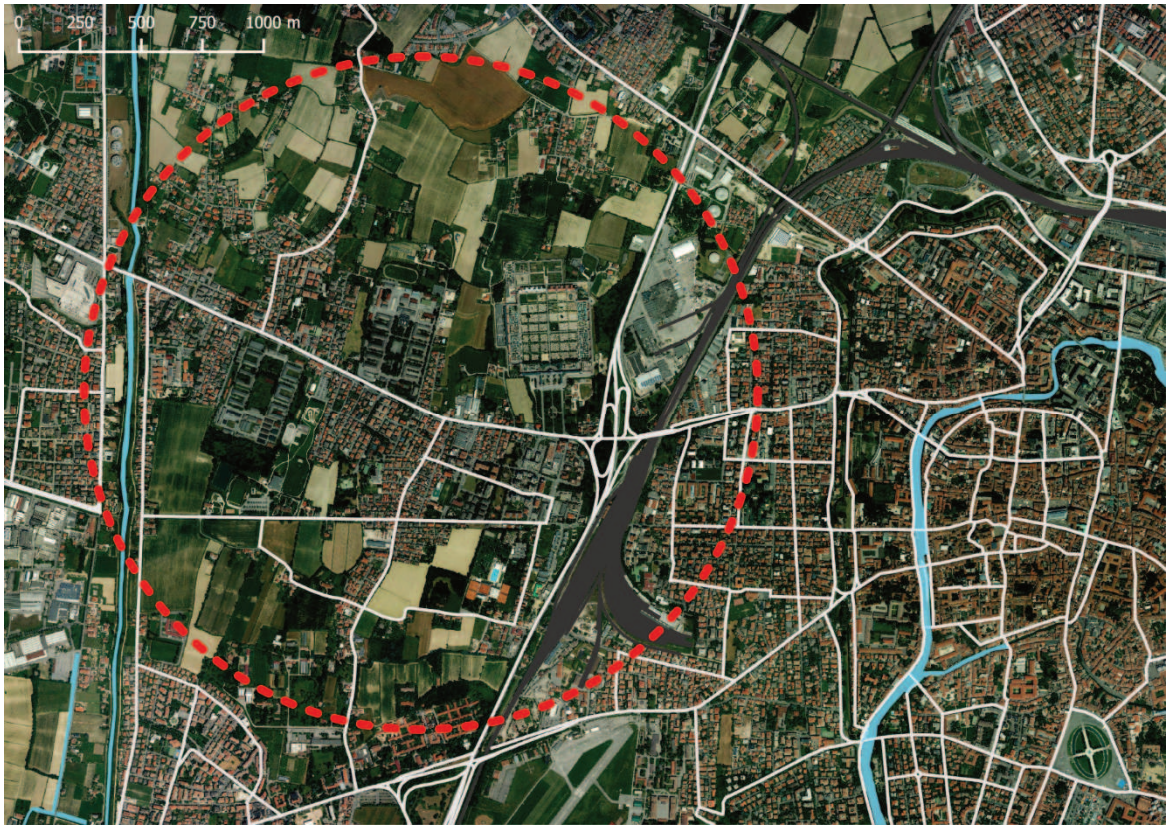

Fig. 1: Location of the area of interest in Padova. Transport infrastructures and streams are shown.

[4] Pileri, 2015.

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This zone serves as a good example for issues and potential of peri-urban environments, because of the presence of transport infrastructures, sites now underused and agricultural softscape which could be the core of sustainable urban regeneration.

3.3 Planned actions

DATA project aims to combine and mash up different skills. It is in fact organized in six topics:

- WebGIS and data mining;
- Building and Land Information Modeling;
- Pilot scenarios Design;
- Urban planning and feasibility studies;
- Urban mining;
- Data management and ICT.

One of the target is mutual exchange and update between academic field and companies on the territory, in a contemporary context where urban and territorial planning experiments the collaboration between environment studies and informatics, while public participation processes or public-private partnerships try to activate worthwhile changes.

The first stage of the project, still ongoing, has been dedicated to define targets in detail, to find and discuss analysis methods and to set interactions between involved research fields.

An early masterplan has been realized, showing transformation concepts for the study area: opening to the city the big architectural systems; connecting areas now fragmented by infrastructures; bringing the green to the foreground.

The concept of pilot scenarios means that analysis developed and actions planned for the chosen peri-urban environment may be replicated in other urban regions, in Padova or elsewhere, which show similar features.

4 BUILDING THE WEBGIS: MATERIALS, METHODS AND RESULTS

4.1 Data mining

As we claimed before, one of the key functions of a GIS is the connection between information and graphical representation. This is even more important when dealing with drawing-based disciplines like urban planning and architectural design. For this reason, an exhaustive collection of data is needed to build a common playground.

Within DATA, collected data are structured into categories to support information exchange between involved people and fields. Such categories are:

- Selected historical maps (starting from 1784) and aerial photos (starting from 1954) depicting Padova and in particular its west side, to show the evolution of the study area;
- Orthophotos representing the city in detail;
- Census data. They give information about population density, age and conservation state buildings and relevant social indexes like youth population and work mobility;
- Environmental data, taken from geoportals of public administrations or monitoring agencies. They include soil permeability, stream network, plant location and help evaluating the impact of planned actions. They also support urban mining practices;
- Land use/land cover map;
- Urban development plans concerning the areas of interest, especially the Territorial Management Plan and the Intervention Plan of Padova Municipality. They stand as a reference framework for the production of regeneration scenarios;
- Maps and data specifically concerning the built environment. They allow the exchange of information between GIS, used for urban and territorial analysis, and BIM, more suitable for architectural 3D models.

Collected data are multi-scale and multidisciplinary, as their extent goes from regional transport networks to local features of the sample area.

4.2 GIS-based analysis

The DATA project aims to generate effective, easily available tools to detect most suitable areas for transformations and to assess the consequences of alternative planned actions. Therefore, base data are combined in GIS environment, in order to build up information tables useful to understand local contexts. According to the principles of developing replicable methods, this operation is made at municipality scale.

For example, intersecting farmland category from land cover map and the Intervention Plan for Padova, a map of farmlands to be transformed was obtained. Some of them should undergo residential or service development, other will be turned into parks and gardens.

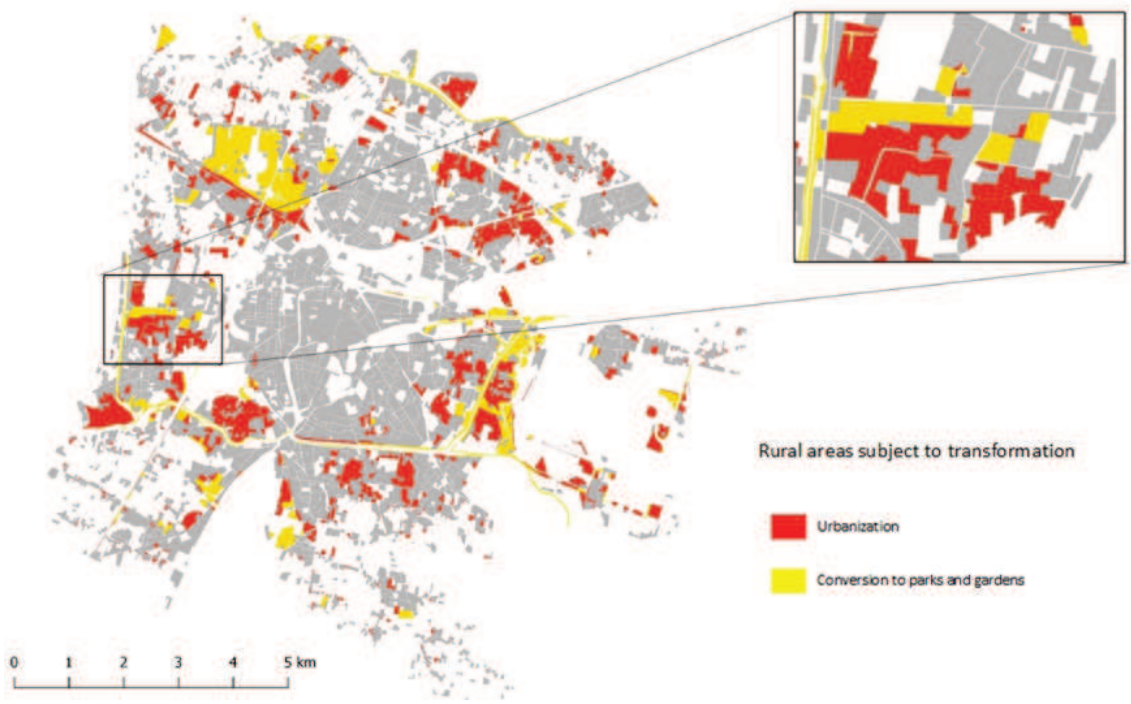

Fig. 2: Map of Padova agricultural areas subject to transformation, with a focus on DATA pilot area.

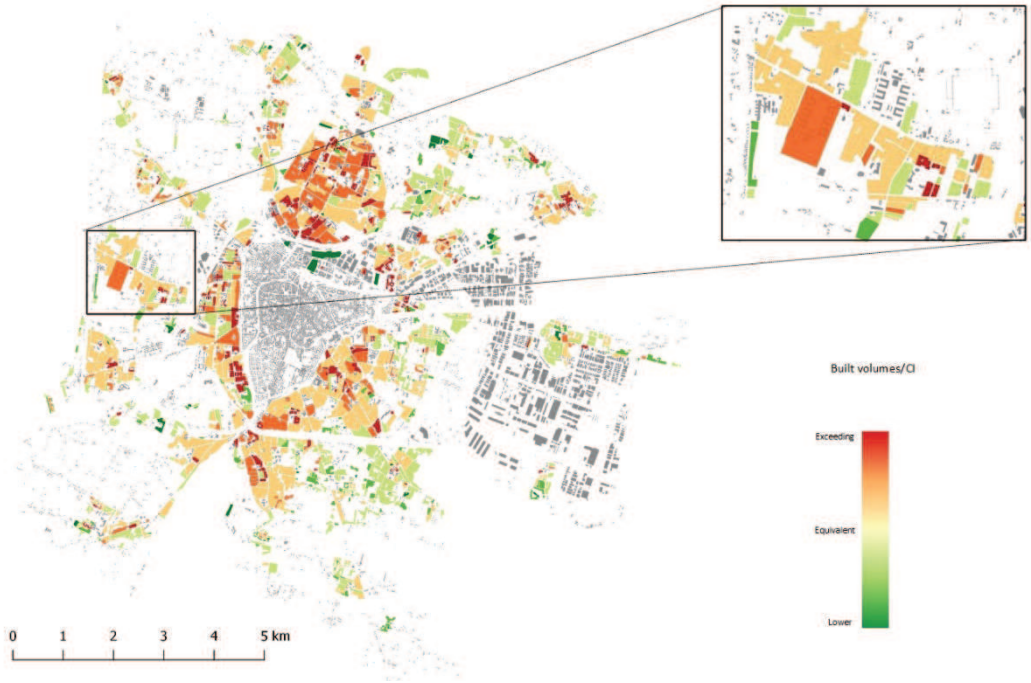

Fig. 3: Density map of Padova built volumes in relation with construction indexes, with a focus on DATA pilot area.

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This map can serve as a monitoring tool for soil consumption or support green design actions.

Another GIS processing performed is adding parameters from the Intervention Plan to the map of Padova buildings. By combining data, the relationship between built volumes and construction indexes was mapped.

The second map shows areas where such volumes are exceeding or lower than allowed thresholds. This could give indications about city evolution and sites where it is still possible to build.

In the upcoming phases of the project, feasibility studies and design scenarios will be developed starting from data collected and analysis performed.

Furthermore, data concerning buildings have been put together to test interoperability between GIS and BIM, thus feeding a 3D city model provided with significant information.

4.3 WebGIS implementation

In the field of urban regeneration studies and operations, moving from research to interaction with territorial entities requires sharing tools and results with involved actors, as a starting point for further actions.

DATA intends to spread information and materials produced within the project, taking into account different modes of reception and use of released data by platform users.

The products of research work and all the other documents that may help understanding addressed subjects and places are published on the open source webGIS platform GeoNode. It is an application for spatial data dissemination based on Django as Python web development framework and PostgreSQL-PostGIS as spatial DBMS. The platform allows to manage documents as texts and images, accompanied by metadata according to ISO standards. On GeoNode, one can publish single layers processed and stylized by GIS software, and overlap them to form thematic maps.[5]

Fruition by users' groups can be organized through different access permissions: from view-only to downloading and even editing options. Released data are gathered into categories, and their attribute table is displayed by clicking on features. To help searches by keywords, tags can be added to published layers.

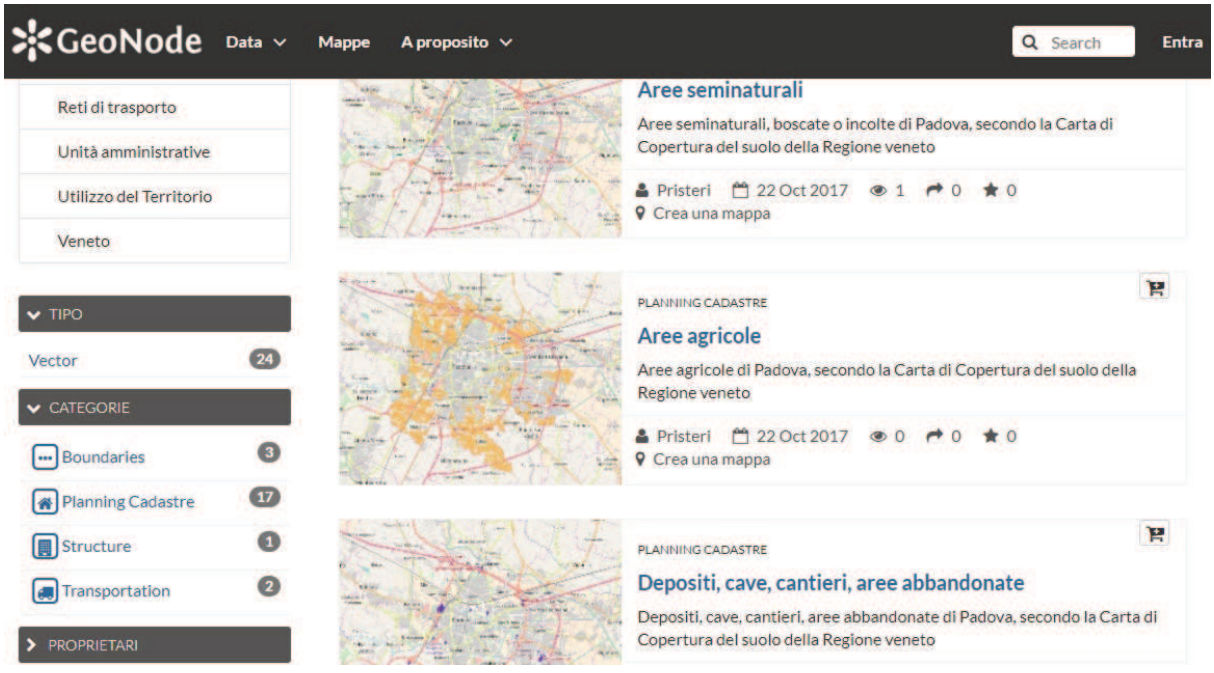

Fig. 4: Visual interface of the DATA GeoNode platform.

For the moment, there are three fruition levels, each one corresponding to an access permission:

- first or inner level gathers data that are not available for external users. Anyway, they can be viewed, downloaded and edited by the research group, whose members uses the platform for exchanging and updating materials during the working process. These data represent intermediate steps of processing;

[5] Regarding the use of GeoNode as an urban data repository, see for example Steiniger et al., 2017.

- second level is made by data that anyone can view, but only the research group can download and edit. It includes the results of operations performed on base data during the project and some public interest data subject to publishing restrictions, like the elements of the Intervention Plan by Padova Municipality;
- third level includes data that anyone can view and download, but only the research group can edit, such as data coming from open access public geoportals. However, they can be edited and stylized to fit the project's themes and purposes.

Besides, the platform addresses to different kinds of users. First of all, the research group itself, as an inner project management system. Then, stakeholders: in this case they are public administrators, with the task to direct urban development, land owners, local associations and companies, investors interested in ground-breaking urban projects. They can have access to thematic information maps at a urban scale, and to test design scenarios at a local scale (West Padova transurban area). Finally, a crowd of scholars and engaged or simply curious citizens, who can freely explore the functions offered.

Fig. 5: Layout of the platform's fruition levels.

Of course, the listed categories could actually combine one another, and unexpected ways of fruition could arise during the platform's life cycle.

5 CONCLUSION

At this development stage, the webGIS platform is still in progress and hosts base data listed above and results of the work performed on data related to buildings, land cover and urban development plans. With the advancement of the project, further data and analysis will be added, to support feasibility studies and global impact assessment of planned changes. Design scenarios will be represented as map layers, too.

As soon as an exhaustive dataset is set, the GeoNode platform, which is now used by the research group, will be released to public. Once launched, the platform will be updated when necessary and provided with new layers, maps and documents. At the end of DATA activities, the webGIS and its contents will show the final results of the project. However, since some expected products cannot be displayed as data layers, a more complete online management and communication system should be implemented.

After DATA deadline, the aim is to turn the webGIS into an independent tool supporting future transformations. Then, update and maintenance plans will be set, trying to trigger social energies and institutional processes to keep the platform in operation and to go on developing it.

Apart from possible achievements in terms of urban regeneration, anyway, this process will fulfil its tasks if, by means of digital technologies, it fosters the advancement of shared knowledge about urban dynamics and gives to communities new focuses and points of view on some neglected city areas.

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