

Open Data from Social Media as Tool for Better Understanding Complex Territory

Application through Photos Data in Calabria

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Abstract—Data are becoming increasingly important nowadays, because they represent a concrete and inexhaustible source of information, which could be transformed into knowledge. Then, knowledge is synonymous with resource, because it represents a source of personal and community enrichment and, at the same time, it allows to accomplish more aware actions and to take advantage of every moment of freedom that comes from it. Thanks to today's technology, that creates services in response to the growing needs of citizens, public administrations and companies, the value of these data is finally disclosable in simple and immediate ways. An important tool, particularly with regard to more precise issues, such as security, economy or quality of life, is Geographic Information System, since it allows not only to represent the collected data in an immediate way, but above all to provide it with georeferencing, and, then, to spread it through mappings, easily interpreted also by non-experts. In particular, research is always more interested in big and Open Data; for this reason, the present work aims to analyze a significant amount of information on geo-referenced data in order to provide a broad view on issues related to tourism flows, in a reality such as Calabria, an Italian region, which is configured as a territory characterized by complex interactions and dynamics.

Keywords—Big Open Data; collective sensing; community; territory.

I. INTRODUCTION

The meaning of Open Data can be clarified by using one of the commonly accepted definitions provided by the Open Data Manual, the “Bible” for anyone who wants to embrace this philosophy, which describes it as:

“[...] data that can be freely used, reused and redistributed, with the only limitation - at most - of the request for allocation and the redistribution of the author in the same way, so without any change.”

As highlighted above, we talk about “open” data, i.e., freely transmitted and distributed information, that is exchanged in the network in ways that provide for the total absence of forms of control (such as copyright and patents) and other restrictions that may limit the use, integration and reuse.

Starting from the concept of open knowledge as outlined by the Open Knowledge Foundation (a no-profit foundation founded on 24 May 2004 in Cambridge with the aim to

promote open content and Open Data), Open Data can also be characterized by the same principles:

- availability and access: data must be available in a convenient and modifiable form, preferably by downloading it from the Internet. Data must be available in a useful and editable format;
- reuse and redistribution: data must be provided so as to allow its reuse and redistribution, this includes the ability to combine it with other databases;
- Universal participation: everyone should be able to use, redistribute and reuse data, without any discrimination towards application areas or people or groups.

Open knowledge is a prerequisite for collective intelligence, through which it is possible to implement the main practical advantage of the opening that is to exponentially increase the ability to control, certify, explore and combine different databases and then develop new products and services [1].

The use of Open Data is also connected to the tools used for its cataloguing, processing and representation. Since most data are equipped with a system of coordinates that make the data itself georeferenced, it is logical to connect the subject with the Geographic Information System (GIS), a system designed to receive, store, process, analyze, manage and display data geographically; GIS, in fact, allows to work on maps and to show, through an endless series of layers, all the features that are highlighted in a given territory.

But why should research about urban planning be so much interested in these technologies?

1. Because, in the short period, the distance between the digital and the real world becomes shorter and shorter;
2. Because researchers have been very good in the last few years at talking about new technologies, but not as good at understanding how these technologies can actually improve our lives.

It is time to explore these issues, so, the question should be: How can we extract added value from these datasets that are constantly increasing? Everything comes together for creating abundance of data.

Collective sensing is focused on the human aspect that can be drawn from this data, and it would be quite interesting to understand how data can be representative of some

collective phenomena, such as mobility, transportation, tourism, etc.

One area that has much interest in Big Data and Collective Sensing is, in fact, tourism. As it will better explained later, tourism in Italy represents 10% of the national Gross Domestic Product (GDP). However, nobody knows how many tourists are present at a given time in a specific area of our nation. These details can be retrieved only with great expense in terms of time and costs, and after a certain period; it is the same case of a company that does not know who its users are, it is unfamiliar with its production cycles, and that, by working in this way, is bound to fail [2]. Big Data can help in this situation, providing knowledge about what happens and also analyzing it.

The work presented is divided as follows: Section II explains the importance of Big Data to analyze complex cities and to help decision makers to invest in and improve this kind of cities; Section III describes how GIS can be used as a tool to mapping Open Data, Section IV provides an example of the application is presented, and Section V concludes the work with some considerations.

II. THE USE OF BIG DATA FOR THE COMPLEX CITIES

“Big Data” is a huge collection of such complex datasets as to require the use of different tools as compared to traditional ones in all phases of the process: acquisition, also through sharing, analysis and visualization. The increasing size of the dataset is related to the need to analyze a single dataset, with the aim of extracting additional information as compared to what could be obtained by analyzing just small series of data, for example, the analysis to gauge the “mood” of the markets and trade, and thus, the overall trend of the company and the flow of information travelling and passing through the Internet.

Big Data also represents the interrelationship of data from potentially disparate sources; these are structured set of data, such as databases, but also unstructured ones, such as pictures, emails, Global Positioning System (GPS) data, as well as information taken from social networks. So, we can talk about “Big Data” when we have a large dataset which requires unconventional tools to extract, manage and process information within a reasonable time [3]. This issue is ever changing because machines are getting faster and datasets are getting bigger. According to a 2001 study [4], the analyst Doug Laney defined the growth model as a three-dimensional one (model of “3V” [5]):

- *volume*: is the size of the data set;
- *velocity*: is the velocity of generation of the data; there is a tendency inherent in making analysis of the data in real time or nearly so;
- *variety*: refers to the various types of data from different sources (structured and unstructured);

This model, summarized in Figure 1, is still valid, although in 2012 the model was extended to a fourth variable V to indicate the *veracity* of the data [6], i.e., the informative value that you can extract.

Over time the model was extended, adding the following features:

- *variability*: this feature can be a problem because it refers to the possibility of inconsistency of data;
- *complexity*: the huge size of the dataset increases the complexity of the data to be managed; the most difficult task is to link the information to obtain interesting outputs.

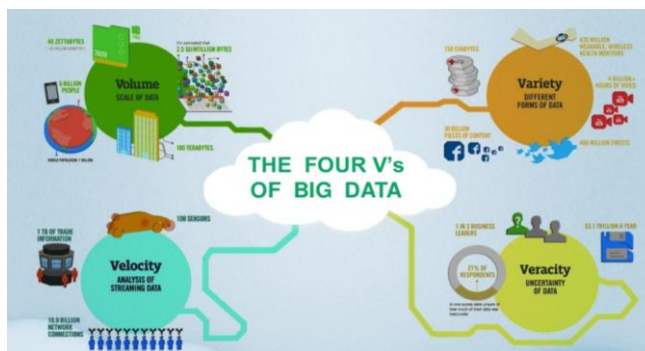


Figure 1. The four V's of Big Data, source IBM.

With 7 billion people on the planet, who access about 1.2 billion personal computers and 1.5 billion smart phones, growing at a rate of about 30% annually, the scale of data being generated by these devices is daunting [7], but it is important that Big Data are not turned into Bad Data [8]. In fact, the possibility to collect digital traces on a massive scale could be transformed from a tool of potential liberation — the fuel that drives Open Data initiatives in cities and states across the world — into an instrument of abuse, surveillance and asymmetrical control.

Yet, Big Data still hold many promises, not only for the private but also for the public welfare. In cities, Big Data is making a tremendous impact across a broad spectrum: it is helping to imagine a more efficient mobility [9], reducing pollution [10], showing humanity patterns [11]-[13], from energy [14] to waste [15]; moreover, understanding city patterns is a useful instrument for urban planning in general [7]. It is a silent tool that can promote new forms of civil engagement. Nonetheless, a new way to frame the relationship between individuals and Big Data is urgently needed, to move beyond today's pseudo-feudal system of trading personal information for a service.

The challenge, of course, is that Big Data will shortly provide new ways to analyze topical issues of the world, offering new immediate solutions.

Big Data is certainly enriching our experiences of how cities function, and it is offering many new opportunities for social interaction and more informed decision-making with respect to our knowledge on how to better interact in cities. However, it is important to use it properly and respecting everything, keeping in mind that citizens are essentially people and not only data.

III. MAPPING OPEN DATA WITH GIS

GIS is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. The acronym GIS is sometimes used for geographical information science, or geospatial information studies to refer to the academic discipline, or career of working with geographic information systems, and it is a large domain within the broader academic discipline of Geoinformatics [16]. In a general sense, the term describes any information system that integrates, stores, edits, analyzes, shares, and displays geographic information. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations [17]-[19]. Geographic information science is the science underlying geographic concepts, applications, and systems [20]. GIS is a broad term that can be referred to a number of different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport/logistics, insurance, telecommunications, and business [18]. For this reason, GIS and location intelligence applications can be the foundation for many location-enabled services that rely on analysis and visualization. GIS can relate unrelated information by using location as a key index variable. Locations or extents in the Earth space-time may be recorded as dates/times of occurrence, where x, y, and z coordinates represent, longitude, latitude, and elevation, respectively. All Earth-based spatial-temporal location and extent references should, ideally, be relatable to one another and ultimately to a “real” physical location or extent. This key characteristic of GIS has begun to open new avenues of scientific inquiry. The GIS tool allows to map the territory and to have a complete visualization of the overall situation of a determined phenomenon.

The importance of the localization component, i.e., the possibility to have geographical knowledge and information detailed up to the urban level, is often an essential element of the knowledge base of businesses, institutions, local administrative bodies, and public and private operators, providing services in many areas; moreover, with the greater interest in economic, social, political and environmental issues, the availability of data and information, that could be traced on a geographical basis, is increasing.

For example, GIS is a fundamental tool for smart cities, as explained in the book “Geographic information systems for Smart Cities” by Professor Vinod [21], focusing on how the future development of GIS will be triggered by Smart City challenges. In order to explain how GIS system performs, GIS experiences in conjunction with Smart Cities from many countries are shared by GIS experts who have designed and maintained it for several years. GIS is employed for sea erosion issues, urban resilience issues, slum rehabilitation (for example in India where slums represent one of the most important social aspects to be considered in the urban planning) and state perspective; GIS is also used for smart growth and transport planning, for land use allocation and also for community planning and so on.

The investigation about smart cities requires an integrated approach through innovative, sustainable and inclusive dimensions with knowledge across green energy, sustainable transportation, quality environment and smart building, risk and resilience and many other different domains in which geospatial data and GIS are fundamental elements.

IV. THE USE OF OPEN DATA FOR THE ANALYSIS OF TOURIST FLOWS

As discussed in Section III, the availability of digital geographic information at different scales (national, regional and urban) has produced a crucial transformation in the use of spatial data in recent years, with important benefits for organizations, institutions, governments, public and private operators in the different sectors of economy and services.

It is sensible to assume that the possibility of operating in a relatively simple way with geographically related information, i.e., “geo” information linked directly to the territory, and “graphic” information based on the effective graphical representations of digital mapping, can produce benefits in several application areas, with research or operational purposes, resulting from enhanced possibilities to integrate databases and from their use “on site” (by their direct acquisition), and/or “on line” (through the construction of databases that make information available on the web immediately accessible).

GIS applications are those traditionally used for the production and use of digital maps, such as monitoring and mapping territorial, environmental protection, urban planning, design and operation of road networks, stations and, more generally, technological networks.

Recently, the use of GIS and spatial data has become more popular and widespread; therefore, GIS applications, often integrated with simulation and visualization tools, are covering new areas, such as telecommunications, but little has been done in the cultural and tourist sector so far.

Our country is universally recognized for its great cultural heritage: 3.609 museums, nearly 5.000 cultural sites (including monuments, museums and archaeological sites), 4.000 entertainment places, 49 UNESCO sites, hundreds of festivals, traditions and cultural events.

Tourism is a key sector for our economy (10% of GDP), but beyond figures and statements about our tangible and intangible heritage, the truth is that culture is not considered as a priority in the political choices for the development of the country [22].

For several years, the cultural sector has been suffering due to a serious decrease in resources, that was the consequence of a substantial absence of active investment policies for the development of cultural, creative and artistic activities, and of a renunciation to an effective protection and enhancement of our heritage. Moreover, the interest people have in heritage and cultural activities in general, is progressively increasing, surely thanks to a medium level of culture, that has improved considerably as compared to the

past, but also thanks to an instinctive attraction to beauty, which leads us to approach, look at and understand it.

These statements are supported by data provided by the National Statistical System (SISTAN) and Statistical Office of the Ministry of Heritage and Culture (MIBAC); from the analysis, it is clear that the number of museum visitors (including also monuments, archaeological sites, etc. in this category) is steadily increasing. In fact, cultural tourism remains a key segment of the tourism industry, which accounts for about 35%; moreover, 17.6% of the Italian and foreign expenditure in our country in 2012 (i.e. 12.6 billion euro), was represented by expenses made for cultural activities.

The increasing diffusion of social networks, internet, the use of new technologies and strategies of digital communication, have generated deep changes and imposed new rules, new speed and new spaces. Essentially, we have created new ways of interaction and relationship with end-users, users themselves and between users and cultural institutions; a new communication space, made not only of exclusive content, created ad hoc, but mainly based on sharing, discussions, constant feedback and interaction with users, before, during and after the experience of enjoyment [23]. Therefore, we should reconsider everything. And we should do it fast.

Based on the data provided by Globalwebindex 2014, Figure 2 shows the daily hours spent on social media by the people who use them in different countries. Italy, with 2.5 hours / day, perfectly ranks in the middle between the minimum value of 0.7 hours / day in Japan, and the maximum value of 4.3 hours / day in Argentina and the Philippines.

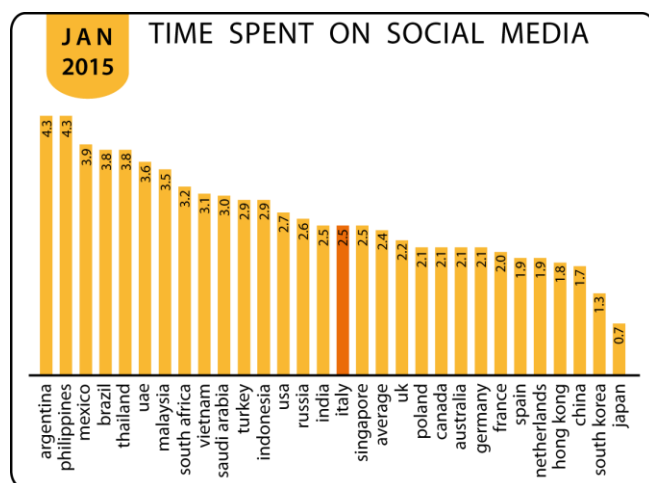


Figure 2. Average number of hours / day spent by users on social media (this figure only applies to people who use social media, not who do not use them), source Globalwebindex 2014.

Although our country has the highest concentration of cultural heritage, certainly it does not stand out for a promotion activity able to communicate with the new generations, exploiting the full potential of digital channels, starting with the name of the museum that we seek in the web. The *Uffizi Gallery*, for example, is one of the most famous museums in the world, but on the search engine Google it ranks third among the research results; first of all, the name of the website is *polomuseale.firenze.it*, the website is translated in English only, the graphical interface is not attractive, the Facebook page has only 28.794 “likes” and only 117 people who “are talking about it”, nothing as compared to the *British Museum*, that has 468.747 “likes”, and 12.057 people who “are talking about it” [24].

Heritage and cultural activities, by their nature, are perfect candidates to support an effective endogenous development, however, art can help the economy grow if a proper strategy [25] is conceived.

The convenience to invest in the cultural field, therefore, lies not in an immediate economic advantage, but in the utilities flow generated by the use, research, and propagation of the heritage and territory where cultural heritage is located.

It is clear how much social media can help promote a territory rather than another. In fact, people buy through the social and choose clothes, shoes and accessories for the car through Facebook and Twitter, and of course, they also plan their vacations by using the same media. So, we can say that by studying social network information, it is possible to have a general idea of people perceptions.

The big novelty of this study does not only lie in mapping Big Data in GIS, since there are many examples of that in the literature, but in the particular kind of data considered.

In the large variety of social networks, we have chosen Flickr, the most famous social for picture sharing. We focused on geo-tagged photos because photography is a disciplined way of viewing and investigating landscapes, able to inform about design and planning in a more “qualitative” way. Residents and visitors take photos in particular places they consider important for some reasons. It could be very useful to understand what we like in our cities, in our territories, what we are interested in, or also where residents or tourists want to go. In turn, understanding this could provide important indications for urban innovation. For this reason, photography is already considered a good mean of inquiry in architecture and urban planning, being it quite useful for understanding the landscape [26].

As we can see in Figure 3, for Globalwebindex, in 2014, Flickr has been the first social network dedicated to sharing photographs.

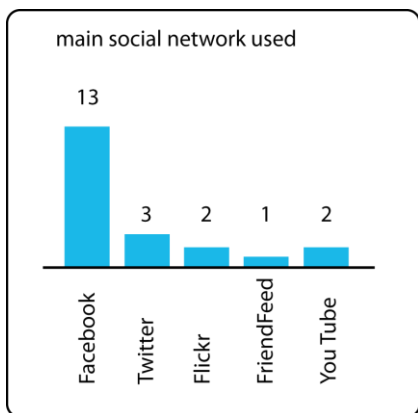


Figure 3. Main social networks used in Italy, source Globalwebindex 2014.

Flickr photos are publicly available, and there are many “Applications Programming Interfaces” (APIs) allowing the download of picture-related data. To carry out this study a tool was prepared, connected with flickr.photos.search API. Through this, we had the possibility to insert the name of the place we were interested in and download the information related to the pictures shared for that place.

Regarding the “spatial” issue, we have chosen to consider the poorest Italian region, Calabria: a land of seas, of mountains, of emigrants, of social, economical and geological problems, nevertheless a wonderful land. Regarding the “temporal” issue, we have chosen to consider data related to the last 5 years, i.e. the time-span from 2010 to 2014. Then, collecting data on pictures in Calabria related to these 5 years, we obtained a large amount of information. We have chosen to consider only spatial coordinates, i.e., the longitude and latitude of places where the picture was taken, year by year, and, for each year, month by month. Thanks to this approach, we were able to geo-localize our Big Data on a map, using a GIS tool, which can read and elaborate our files. Thanks to the GIS tool, the interaction between our cleaned Big Data from Flickr and the effective GIS in a map become possible.

The idea is to be able to describe the tourist potential of an area, and consequently its weaknesses in terms of attractiveness, through the study and revision of data collected from users who visited the territory, and to represent them through the use of GIS. In order to do it, as explained, we elaborated maps year by year, using different colors, and then we overlapped all of them in one single map (Figure 4).

Until now, in the literature, we can find studies about a particular event in a particular area of a city [27], or in three consecutive years in ten of the most famous and attractive cities of the world [13]. In this study Big and Open Data from photography is used for the first time to understand people perceptions in a poor region, so different in each of its own areas, including relatively small cities, little events, sea and mountains, and in such a large temporal range.

Referred to the Map of Attractiveness [13], we created the Map of Attractiveness of Calabria for each year, and at

the end, instead of different categories of users, we overlapped the years, comparing what happened each year, and the attractiveness evolution.



Figure 4. Calabria (Italy), representation of Open Data from Flickr - series 2010/2014, and overlapping of several years, processing by GIS.

We think that this visualization can be considered as representative of the popularity rating of people, who, satisfied after visiting a place, want to preserve the memory, and then take a picture and share it on the social.

Through the downloaded Data, the origin of the users can be traced, information for year can be classified, and the

geographical coordinates of the place where it was taken can be associated to each photograph; thanks to this approach it was simple to recognize the most popular tourist sites, the months of the year when tourist flows are greater, and to try to create attractions that enhance tourism itself; but above all, it becomes clear the need to analyze the deficiencies of the territory, which are immediately visible by the mapping of the area, and suggest strategies to overcome the gaps found.

In particular, by the analysis carried out in the years 2010/2014, shown in Figure 4, a repeated pattern for each year stands out: the predominance of the coast respect to the hinterland. This is not related to a particular period or month, even if it is clear, through the temporal analysis, that the most attractive period is summer.

The hinterland is almost completely unknown, despite the presence of three National Parks (Aspromonte, Pollino, Sila), a Regional Park (Serre) and numerous reserves. Also, as far as the coast is considered, each year the Tyrrhenian coast is more attractive than the Ionian one. These are the macro considerations relative to what happens in the whole region, considering coast and hinterland. We also want to underline what happens, at regional scale, in the different cities.

The experiment showed that out of 409 towns divided into five provinces (Catanzaro, Cosenza, Crotona, Reggio Calabria, and Vibo Valentia), the popular and well-known places are less than 70. These information indicate an isolation of some towns, a tourism flow which is limited to certain nationally known and well advertised places, probably included in the catalogues of travel agencies. But Calabria is also made of smaller and typical towns, of characteristic places full of traditions, which should be valued and handed down.

The idea was to compare the Data from the last five years to assess the possible evolution of the interest and the attractiveness of the Calabria region; overall the results indicated it as an interesting place and with a good tourism potential, in fact the tourists' interest is generally constant, although the region faces some problems, which we have already mentioned above, probably related to poor accessibility of the hinterland, and to the inadequacy of the infrastructure network and of the media system.

V. CONCLUSION

In this study, we introduced and explained two new tools that are becoming fundamental in the new approach to observation of cities and territories in general: Big Data and GIS. These tools are also mutually related, because the term Big Data also indicates Open Data, the latter are most of all georeferenced data, particularly in the cases we are interested in, like cities. With them it is possible to conduct analyses applying the complex theory that better responds to city descriptions, revealing patterns and predicting phenomena that can allow to improve everyone's life. These geotagged data can be spatially visualized on maps to have a complete and immediate vision of the situation we are talking about, thanks to the GIS.

Both tools are rapidly becoming necessary in space and territory related researches. However, we are quite at the

beginning of such explorations, therefore research has to advance more and more in order to improve and maximize the huge potential of these instruments minimizing the controversies and the problems that a wrong use of the same can generate. Therefore, it is correct to affirm that GIS and Big Data suggest a future in which experiences of common citizens, and of true tourists, can be used for better understanding people's taste. Data give a "safe surprise", i.e., information about a reality away from home. Predicting that consumers will prefer a place instead of another one, or eat more in a restaurant rather than a pub, does not sound like a Big Data issue; nevertheless, by giving exact information about the favorite places, seasons, or hours of the day, it represents a new and powerful tool for fine-tuning and maximizing the tactical brand decisions. For instance, the capacity to adjust prices, mobility, services, in a quick and competitive way and in response to an analytically predictable change in tourist vocations, is clearly a significant tactical power. Thus, also through these predictions, Big Data will greatly enhance the capabilities of travel companies, tour operators and urban planners.

Previous studies on tourism, retrieved from the Internet or from scientific articles, are mostly based on surveys and interviews with experts carried out by the Ministry of Industry, Energy and Tourism, the main public organizations, or private companies; in this particular case this indicates that the industry does not have real data about tourists and it can only take samples from the population as a whole. In contrast, the innovative approach achieved and proposed through this study, specially through the use of photos and GIS for localization, is to introduce data based on real actions of users and not on surveys. In other words, real actions have been analyzed instead of stated intentions or answers to questions, that can be interpreted through a subjective vision and can be, therefore, less useful for business and development.

This study has involved many different indicators, useful to carry out more precise contributions, such as:

- Visitors' main country of origin;
- Geographical position.

Based on the conclusions drawn from data analysis, the study ends with a series of tactical and strategic recommendations for managers. These recommendations focus on:

- Attracting more customers and pinpointing the countries where it is recommended to focus on marketing;
- Detecting areas of the city in which commercial transactions are carried out, specially, those referring to accommodation;
- Ensuring an attractive product suited to customers' true needs (ideal length of package offers, information about complementary services demanded by nationalities, etc.).

It is realistic to believe that a new frontier of social, territorial and economic retraining, could be based on open source data and geographic information, along with the use of information technology-based GIS.

The analysis of the vast amount of data produced by digital activities, opens up a wide range of opportunities for companies, for enhancing the services they offer and for the

management of their business. This study is a first step for understanding the possibilities of Big Data, especially in Calabria region, where the potential is enormous. In this specific case, we are trying to contribute and add value to what is a key sector for the Calabrian economy, underlying that there are places already discovered and appreciated by tourists, such as coasts and the Sila area, but that there are also suggestive and unexplored towns. Moreover, this kind of study could become a replicable model, useful for analyzing other economic and social sectors, or other territories.

For sure digital traces we leave every day on social media will increase, providing a very accurate representation of what we do. Social media are a kind of expression of people and crowds participation because they reveal interests, tastes and perceptions of the community. Therefore, we can use these data to know, understand and analyze our collective behavior and, as a function of them, we can imagine better spatial planning in the territories where we live, by taking into account what each of us spontaneously shares and expresses on social media every day.

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