GeoProgress Journal, Vol. 7, i.2, 2020, Geoprogress Editions
ISSN 2384-9398
DOI

RISK PERCEPTION, SPATIAL DATA, LEGAL RESPONSE DURING COVID-19 PANDEMIC: A CONCEPTUAL MODEL

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Abstract

The first European COVID-19 outbreak was identified in Italy; we present the Italian response to the crisis generated by the January-April 2020 wave using an interdisciplinary approach. We discuss the outbreak evolution tightly linked to political/legal/social responses to the epidemic. We draw considerations on the risk perception among population and decision makers, on characteristics of social behavior in this critical period, on means of communication employment. We describe (spatial) data and their instantiation in medical, healthcare, epidemiological, and socio-economic databases. Finally, we represent the Data-Spatiality-Sociality and Legal (DSS-L) response nexus conceptualizing the interplay of the responses given to the pandemic from the (spatial) data, social and legal perspectives.

Keywords: Pandemic and political, legal and social responses in Italy.

1. Introduction

Epidemics present intrinsically significant spatial, geographical, and human implications (Pyle, 1976; Kanaroglou and Delmelle, 2015) as these are occurring when a sudden disease outbreak affects a large number of people in a particular region, community, or population.
In medical and health geographies, indexes, cartography, and quantitative models are common elements and standard practices. In the initial and peak phases, generally referred to as 'phase 1' (WHO, 2020), data are considered the basic constituent for such applications. At the first level, the number of deaths and of new infected/hospitalized/recovered cases are examples of basic elements to be collected, elaborated, and communicated (Palagiano, 1996; Thompson *et al*., 2011; Crooks *et al*., 2018). Secondarily, the corresponding epidemic indexes (such as mortality,

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Authors' contributions: S.G. proposed the initial study, contributed the contents for Sections 2, 3 and 5, A.B. contributed the contents for Section 4. The authors jointly discussed and wrote the manuscript.

growth rates, and doubling time) are considered fundamental for internal/specialist analyses, for public information, and for supporting policy making. A third level of data and their elaborations is related to factors that can help to monitor and explain the related phenomena: health system response, as well as socio-economic or environmental impacts.

Nevertheless, the current times of social networks, big data and high-performance computing can potentially create an information overload, further leading to fuzzy information (Turco, 2020), rather than a linear support to decision and communication patterns. Turco (ibidem), however, argues that the intrinsic nature of the typical scientist work, recalling the Popperian theory, is based on trials and errors, research attempts that only time could soundly verify. Thus, this mechanism is creating a set of complex interconnections and feedback loops among the medical and social (that is, economic, political, and cultural) implications of a pandemic.

In this paper – in particular – we present the response to the crisis occurred in Italy in the case of the COVID-19 outbreak during the period of January-April 2020, i.e., Phase 1, discussing the relationships among data, communication, and legal response patterns interweaved with the concepts of risk perception and social behavior.

The employed methodological approach is interdisciplinary (see Figure 1). It blends classical medical geography (Pyle, 1976; Curto, 2008; Patterson and Pyle, 1991; Kanaroglou and Delmelle, 2015; Palagiano, 1998; Crooks *et al.*, 2018), health communication (Thompson *et al.*, 2011; Thompson, 2014), behavioral science in epidemics (Lombardi, 2005; Brug *et al.*, 2009) and database conceptual modeling (Chen, 1976; Batini *et al.*, 1992).

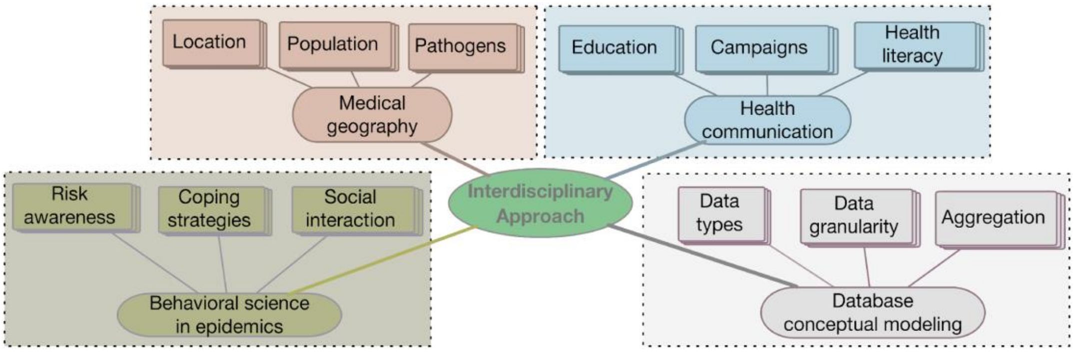

Figure 1: Interdisciplinary approach dimensions (medical geography, health communication, behavioral science in epidemics, and database conceptual modeling) described by their main determinants. Source: Authors' elaboration

To support this study, a set of elements have been considered and clustered for the conceptual analysis, starting from a chronology of facts and data reported in the official press releases, video-press conferences, and news. On a daily basis, we monitored and analyzed official/unofficial web-based GISs and dashboards (with various levels of spatial details on the outbreak); moreover, we analyzed applicable legal documents issued by the central government, ministries, regional authorities and municipalities.

The first part of the paper will address the most relevant events useful to understand the governance and main phenomena characterizing the outbreak evolution in Europe with special attention to the case of Italy; we relate political actions, social

ISSN 2384-9398
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perception, and legal response. The second part will introduce the concept of risk perception, social behavior, and communication, with a reflection on the spatiality aspects. The third part is dedicated to data, their spatiality, their generation processes, their instantiation in diverse databases (including medical, healthcare, epidemiological, and socio-economical ones), and their public communication evolution.
Finally, we assemble all the elements previously discussed with the purpose of building the conceptual model that describes the Data-Spatiality-Sociality and Legal response nexus; hence we present the DSS-L model, discussing the most interesting aspects of interactions among the model dimensions, such as the behaviors at the frontiers of the relational space.

2. Evolution of the outbreak and consequent political, legal and social response

The response to an epidemic is considered part of a country risk plan; in Italy the main governmental responsibilities and governance are under the duties of the Ministry of Health, the Civil Protection Department, the National Center for Disease Control and Prevention, the National Institute for Health, and the Regional Health Systems. The latter are the most important ones, as health policy matters are highly delegated to regional authorities, which have a significant autonomy. This institutional architecture leads to a scattered and jeopardized system ranging from regions with top worldwide performances to much weaker ones, typically in the Southern part.
After the outbreaks of A/H5N1 (avian influenza), as the risk of a pandemic was recognized as more concrete and persistent (Ministry of Health, 2006), a National plan for the preparation and response to a flu pandemic ("Piano nazionale di preparazione e risposta ad una pandemia influenzale") was developed in accordance with the WHO's 2005 guidelines; it was organized in the six pandemic phases, providing objectives and actions differentiated by phase (WHO, 2020). However, as the dissemination of SARS has been prevented and controlled in Europe without causing panic nor economic impact, the risk perception was initially significantly biased (Brug *et al.*, 2009).
In this framework, COVID-19 had its initial epidemic official manifestations in the Italian territory on January 31st, 2020, when two tourists from China were tested positive for SARS-CoV-2 virus in Rome. At the end of January 2020, as a consequence of the pandemic developments in mainland China, advanced screening measures – including body temperature detection and the active presence of medical staff – were established at Leonardo da Vinci-Fiumicino and Milan Malpensa airports. Moreover, the Italian government suspended all flights to and from China and declared a state of emergency. On February 3rd an Ordinance of the Head of the Italian Civil Protection Department set up the coordination emergency management, as well as the technical and scientific committee (Civil Protection Department, 2020). Prime Minister Giuseppe Conte said that, at the time, Italy was the first country in the EU to take this precautionary measure. These preliminary decisions divided the population in two main groups: the conscious and the skeptical ones. The first group approving the worries, seeking for further verifications and precaution measures; the second criticizing, opposing, minimizing, and considering

the taken measures as over-reactions. The same general attitudes could be observed when the outbreak of COVID-19 infections was subsequently detected inland on February 21st, 2020, starting from 16 confirmed cases in Codogno (in the province of Lodi, within the Lombardy region) increased to 60 on the following day, with the first deaths reported in the same days. It is interesting to note that the first case was found thanks to the breach of the standard protocols of the emergency room in Codogno. Unfortunately, this first case was a 38 year old person that was already at his second or third visit (and subsequent rejection) in this hospital, as his symptoms – despite being quite severe – were misinterpreted and largely underestimated. This situation created a significant group of first contagions. Unexpectedly, epidemiology studies could not relate Codogno's first patient to Wuhan exposure. On the other hand, while the first cases had shown up in Rome on tourists, this first endemic case happened in the Lombardy region, which has a very widespread and internationalized entrepreneurial system projected toward Germany and China. It has to be noted that Germany plays an important role in the system of air connections; it is known that the most widespread air transport company, both for capillarity and comfort for Italian business travelers, is Lufthansa. The Lombardy-Bayern relationship in COVID-19 was later explained through the phylogenetic study of the evolution of the virus (Zehender *et al*., 2020).
On February 21st other two people were found positive for COVID-19 infections in the Veneto region. The next day, one of them, a 78 year old man, died at the Schiavonia Hospital in Padua, becoming the first victim of the virus in Italy. The man lived in the town of Vo', which was subsequently placed in quarantine, having all inhabitants checked for COVID-19; this corresponds to a significant decision by Veneto region and Padua University, taken to collect useful elements for potential epidemic model parameters[3] (see Lavezzo *et al*., 2020). Once these first internal outbreaks were discovered, one of the first measures taken was the quarantine of municipalities in northern Italy (in Lombardy and Veneto).
As of February 22nd, new patients were identified in the northern province of Emilia-Romagna region, Piacenza, one in Piedmont region and two in Rome. The first two locations can be explained with commuting patterns as well as with the intensity of economic relations, as they are in an area that is significantly rich in firms with high internationalization rate, hence active part of global value chains. However, another hypothesis (not backed yet by any scientific study, but only reported in newspaper articles) raised to explain the spread of the virus in other regions involves a train accident occurred in the area of Lodi on 6th of February, exactly during the period of epidemic incubation; in such circumstance many policemen, technicians, politicians and onlookers assembled in the following days[4]. Similarly, two football matches are likely relevant for the explanation of the spatial spread of the virus in relation to the outbreak in Lombardy: a derby between two very popular teams and an international match between the team of Bergamo (Atalanta) and the team of Valencia, Spain.
Considering all the mentioned events, the response to the internal outbreak has been relatively fast; it followed two level of norms: those issued by the President of the

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[3] https://www.askanews.it/cronaca/2020/03/25/coronavirus-lopinione-del-virologo-andrea-crisanti-top10_20200325_192506/ (accessed online on June 11th, 2020)
[4] https://www.nextquotidiano.it/coronavirus-il-treno-del-contagio-incidente-di-lodi/ (accessed online on June 11th, 2020)

GeoProgress Journal, Vol. 7, i.2, 2020, Geoprogress Editions
ISSN 2384-9398
DOI

Council of Ministers and those issued by the single regions. In particular, on February 23rd, the Council of Ministers issued the Law Decree n. 6, which sanctioned the total closure of 11 municipalities with active outbreaks and the suspension of demonstrations and events in the same municipalities; this corresponded to the creation of the first "red zones" covering a population of about 54.000 inhabitants. In the same days, the Presidents of the Lombardy, Emilia-Romagna, and Veneto regions issued ordinances to stop schools and university activities. In numerous cases in the later days, the mayors of municipalities introduced additional restrictions (stronger than those of the regional and central governments), in response to the population general sentiment and perceived risk. This multilevel action, often criticized as chaotic and not based on clear policies, will then characterize the whole crisis period, especially up to mid of March. At this time, indeed, a stronger social and political alignment on the importance of the health crisis was reached, and only few, with skeptical positions or strong optimistic bias, remained.

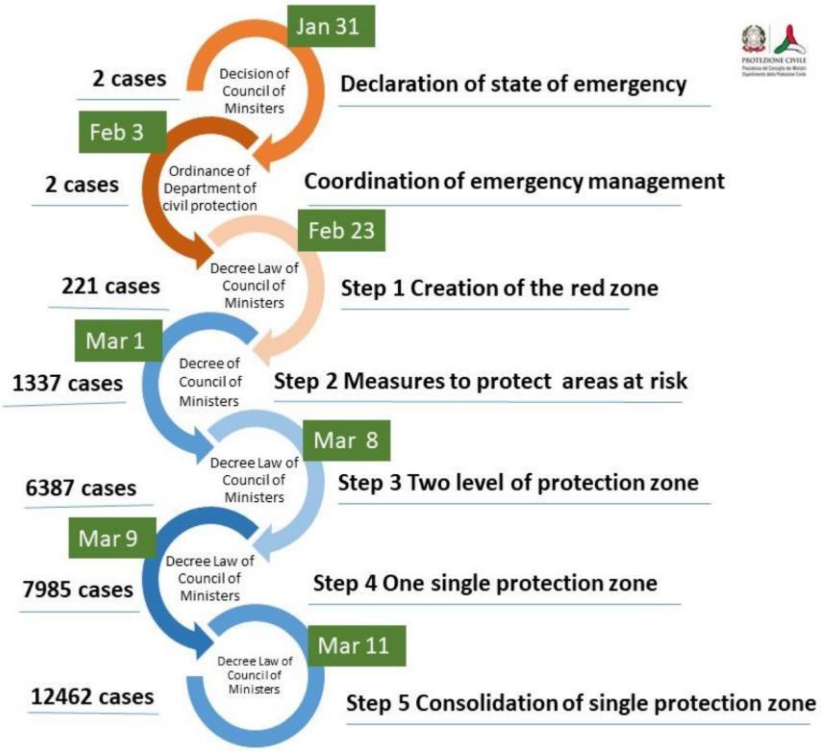

Figure 2: Overview of the evolution of the COVID-19 emergency and legal acts taken in Italy according to WHO phases. Source: Civil Protection Department, 2020

After the first set of responses, the Prime Minister issued a series of implementing decrees (DPCMs) in which the restriction measures (see Figure 2) were progressively more stringent, as well as extended to the entire national territory. The main ones are listed in the following:

(a) the DPCM of March 1st clearly set measures to contain the spread of COVID-19 provinces and regions at risk (that is, homogenizing regional ordinances issued on the preceding days) in Lombardy, Veneto and Emilia-Romagna and 2 additional provinces, thus creating "yellow zones";

(b) the DPCM of March 4th declared the suspension of all schooling and university-related activity in the whole country;
(c) the DPCM of March 8th led to the extension of the "red zones" to the whole Lombardy region and to other provinces in Veneto (Padua, Treviso, Venice), Piedmont (Alessandria, Asti, Novara, Verbano-Cusio-Ossola, Vercelli), Emilia-Romagna (Piacenza, Parma, Modena, Reggio Emilia, Rimini), Marche (Pesaro-Urbino) and of the "yellow zones" involving three regions (Lombardy, Veneto and Emilia-Romagna); instead, for the rest of Italy another set of protection level was set;
(d) the DPCM of March 11th finally consolidated a single protection zone for the entire national territory, with the suspension of retail commercial, social activities, and personal services, with the exception of pharmacies, food/agricultural/technical basic services (for example gas and electricity) and financial services (banking, insurance). A strengthened narrative and campaign on "I stay at home" was reinforced through media and police checks.

A further step of the lockdown targeted the rest of economic activities with the DPCM of March 22nd, when only a limited set of primary and industrial activities was left operational; these were considered essential up to April 4th (then extended to April 13th with the DPCM of April 1st). Finally, with the DPCM of April 10th all the measures were extended until May 3rd, allowing the reopening, from April 14th, only of shops for babies and children, bookshops, and stationers. The measures adopted in the Order of March 22nd, signed jointly by the Minister of Health and the Minister of the Interior, prohibited people from moving by public or private means of transport to a municipality different from the one in which they were located, except for proven occupational needs, absolute urgency or health reasons.
In parallel to containment legal responses, central, regional authorities and municipalities tackled socio-economic impacts according to multilevel competences. The first one was the suspension of significant fiscal deadlines for the "red zones" issued on February 25th by the Ministry of Economy and Finance. Very soon it became clear that the crisis was going to involve the whole country: the Law Decree of March 2nd – "Urgent support measures for families, workers and enterprises related to the epidemiological emergency from COVID-19" –provided legal responses to create instruments for financial support. These ranged from subsidies directed to workers and professionals losing their jobs, to tax credit on rents for retail activities, support to teleworking, suspension of significant fiscal deadlines, incentives for reconversion of industrial activities to tackle supply shortage of protective or other COVID-19 related equipment. Law Decree of March 17th – "Caring Italy" – set measures to strengthen the National Health Service and economic support for families, workers and businesses related to the epidemiological emergency. Finally, the most relevant financial provision was issued with the Law Decree of April 8th – "Liquidity Decree" – containing urgent measures concerning access to credit and tax obligations for businesses, special powers in strategic sectors, as well as measures in the field of health and work, extension of administrative and procedural deadlines. Officially, in Italy, phase 1 ended on May 3rd, 2020, when most of economic activities were allowed to reopen and the restrictions on mobility of people were strongly reduced. Other European countries followed a similar example.

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3. Risk perception, social behavior, and communication

Despite Italy had a national plan for the preparation and response to a flu pandemic (Ministry of Health, 2006) as well as high standard scientific and institutional structures dedicated to epidemic monitoring and management, the Italian political system and population were caught substantially unprepared by the COVID-19, in comparison to Asian countries like South Korea, Hong Kong or China, where SARS had previously hit more significantly in the 2003 outbreaks. Moreover, even the Swine flu or Zika had not hit in major ways Italy, nor other European countries. Before COVID-19, the perception of Italians and Europeans of a pandemic recalled imaginaries dispersed in the historical memories of the Asian flu in the late 1950s, of the Spanish flu outbreak (however without any living witness talking about it), or even of history and literature reminiscences of the plagues. Indeed, the idea of quarantine recalls the etymology: as a matter of fact, the word quarantine comes from Italian word "*quarantena*", meaning "forty days", used in the $14^{th}/15^{th}$-century Venetian language to designate the period for which all ships were required to stay isolated before passengers and crew could go ashore during the Black Death plague epidemic.

According to the Protection Motivation Theory (Rogers, 1975), the motivation to protect oneself from the disease results as the product of: i) the perception of the severity of the threat, ii) the perception of personal vulnerability, and iii) the effectiveness of the coping response in reducing the threat. Therefore, the appraisal of threat essentially consists of estimates of the probability of contracting the disease and of the severity of the given disease (Brug *et al.*, 2009).

Recalling sociology literature, Lombardi (2005) argues that the concept of risk is not – in itself – a new condition in human history. The cultural policy of the European post-war period attempted to carefully remove the risk perception in favor of the spread of a sense of security (at least in the field of health), following a hypothesis of non-vulnerability that is not actually real. In this perspective, the reassuring determination of cause-effect relations supporting a process of perceptive risk removal has been difficult to rework in the first week of COVID-19.

Indeed, the perception of the risk of COVID-19 was initially underestimated by the majority of political and economic forces, as well as by the citizens, who reacted with an optimistic bias given by two kinds of awareness of Italians: all the recent outbreaks ended to be controlled and the Italian health system is universally considered as very high-ranked. Moreover, COVID-19 happened in a disruptive framework where the lack of trust in the official media and institutions had been significant; this is a typical social reaction in a post-modern era (Lombardi, 2005) where 'over-information' and 'mediaticity' – aimed at 'spectacularization' and emphasis – tend to create a sense of bewilderment (Turco, 2020). Yet, in a relatively high number of people this form of communication leads to an attitude to conspiracy reactions that social networks spread quickly. Such situation creates strong uncertainty and disorientation (*ibidem*). Note that, in terms of health policies, for instance, up to a few weeks before the outbreak, the most prevalent discussions in politics and media had been related to the debate on anti-vax issues.

Furthermore, pandemic in Italy has also been politically timely. Whist in Germany the attention of the main news was related to the formation of new political coalitions and in France to the administrative elections, at the beginning of 2020 in Italy the government was going through a phase of strong difficulties, quickly weakening and 'bikeshedding'[5], in terms of public communication and political proposal (*ibidem*). At least, COVID-19 could be recognized as a reasonably good exit strategy to the January political impasse, reinvigorating the sense of unity of the coalition and of the whole country.
In the Italian news and political discourses, the evolution of information, communication narratives, and rhetoric largely changed overtime, according to the phases of the pandemic. The first pieces of information came from far away and seemed hardly remarkable. At the end of January, it became "a China problem", leading to some clusters of prejudice, stigmatization, and fear towards the Chinese community. These even needed to be addressed by the President of the Republic who, on February 6th, visited a school in the Esquiline district of Rome with high rate of students from the Chinese community, giving a speech and a symbolic handshake to some students[6]. Starting from mid-January to the acknowledgement of the first inner patients in Codogno, the media narrative focused on repatriation, health protocols at the borders, advanced screening measures, as well as on the discussion on the suspension of connections with China. The anxiety built up from something that was "*outside the national border*s", which suddenly turned into something "*inside the national borders*" (as of February 20th), breaching the first level of risk removal tendency. The escalation from "outside" to "inside" moved from far away to closer to individuals; in other words, from a disease that could only interest tourists, businesspeople traveling to the Far East, Italians living in the Wuhan region, or Chinese migrants, it quickly became a problem of the "red zone". Progressively, the wave moved to regions and provinces, where concerns were related to proximity and to relational connectivity (regarding events such as conferences, meetings, sport activities, *et cetera*).
Within these areas the perception of risk started to move according to relational networks (relatives, friends, colleagues, and acquaintances), hence a relational space. Direct communication leads to a stronger trust on facts and reduces the uncertainty of the message; it also aids the calibration of a problem's severity, with the aim of identifying actions by the institutions and the government and to consequently obtain a deeper acceptance of the lockdown measures by the citizen. This dynamic shows the importance of spatiality in terms of epidemiology, health and social response.

4. Data of the epidemics: types, applications, questions

[5]The term 'bikeshedding' has been popularized by the naval historian and author C. Northcote Parkinson who wrote of a fictional committee meeting during which, after a two-and-a-half minute non discussion on whether to build a nuclear reactor worth US $10 million, the members spend 45 minutes discussing the power plant's bikeshed, worth $2,350, thus conceptualizing frequent, detailed discussions on a minor issue conducted while major issues are being ignored or postponed (Mcfedries, 2017).
[6]https://www.repubblica.it/politica/2020/02/06/news/mattarella_visita_a_sopresa_una_scuola_con_molti_bambini_cinesi-247790974/ (accessed online on June 11th, 2020)

GeoProgress Journal, Vol. 7, i.2, 2020, Geoprogress Editions
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From the aspects so far discussed, related to risk perception, social behavior, and communication, the question of *where* COVID-19-related events happen arises with increasing importance and needs to be answered. A multitude of different data are available to track such information. We consider a number of categories: i) the most specific kind of data, related to genetic aspects of both the virus and the host organism (or patient), is typically produced in sequencing laboratories, collected by big genomic consortia (Bernasconi *et al.*, 2020a), and described by conceptual models such as the Genomic Conceptual Model (Bernasconi *et al.*, 2017) or the Conceptual Schema of the Human Genome (Palacio *et al.*, 2018) for human genomic data and the Viral Conceptual Model (Bernasconi *et al.*, 2020b) for viral sequences; ii) clinical data are collected from medical institutions, including admission symptoms, risk factors, exposure information and hospitalization course; iii) epidemiological data include all the heterogeneous categories that serve for the unique purpose of modeling disease-diffusion waves (a first comprehensive set of methods for this data is given in Cliff and Haggett, 1988); iv) health data generally includes the information on quality of life, causes of death, health conditions of population; v) socio-economic data include a very broad set of datasets (regarding, among others, social media, mobility and transportation, employment, financial). All such categories are clearly orthogonally related to a spatial component: genetic and clinical data are connected to the location of the infected organism or medical patient; epidemiological and health data only make sense when properly set in a defined geographic area; socio-economical ones may be georeferenced (Grandi and Bernasconi, 2020).

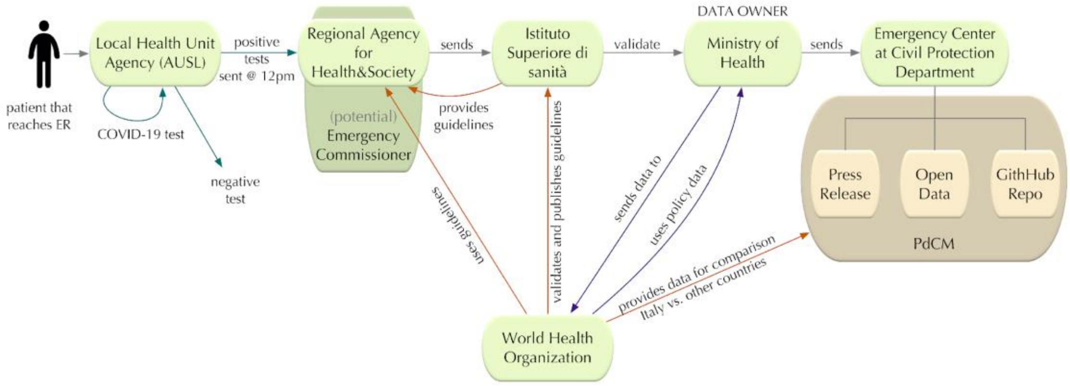

Figure 3: Process of data collection and consumption from the first contributor (the patient), through a series of data players, up to the communication of data (in their raw format or, most commonly, in a first-level elaboration), to press release or public repositories. Source: Authors' elaboration

Conceptualizing these data types, understanding their order and importance, with the aim to drive a spatial approach, is extremely critical as parameters are too many; this issue has been discussed in the past (Pyle, 1976; Crooks *et al.*, 2018). We propose an order that is strictly related to the process of data collection. For ease of understanding, we describe the typical process of data collection performed from databases that contain data describing all the mentioned categories within the scope of the Italian system. Figure 3 shows, step by step, the course of data; they are first generated from local health agencies that collect patient information and their symptoms. Every day, at noon, they are communicated to regional agencies (that, in

the exceptional period of the pandemic, are often run by Emergency Commissioners). Data are then sent to the Italian National Institute of Health (*Istituto Superiore di Sanità*), which is in charge of their validation (according to guidelines that are inspired from the WHO and adapted for the national context). Validated data are then transmitted to the Ministry of Health that communicates directly with the WHO (which imposes its own policies); data arrive also to the Emergency Center of the Italian Civil Protection Department; it is in charge of communicating the appropriate content to the general public. Typical means are press conferences, press releases, open data, and GitHub repositories.
During the COVID-19 epidemic, data have been used horizontally for all kinds of applications. In the following we discuss two uses that are expected to be predominant in the context of any epidemic outbreak: the first, involving the use of web-based dashboards, is original for this specific epidemic as it leverages information technologies characteristics that have not been available until now (such as wide accessibility of internet, visualization techniques, fast servers for dashboard upload, update and world-wide sharing), whereas the second, including forecasting and scenario models, is typical of all the past epidemics.

4.1 Geographical dashboards and infographics

Internationally, as a reaction to the outbreak, the main public institutions of countries, as well as private citizens, considered the opportunity to design and publish online explanatory data visualization tools for the communication of disease data supported by a spatial dimension. They responded to the need for instant information of the broad research community, of public health authorities, and also of the general public (embodying the principle of transparency, as well as curiosity, socialization of emotions in a period of crisis). In parallel, the evolution in time and space of the disease has been paired with a need of awareness and of effective visualization of the dynamics of the epidemic patterns. In the current times, information and communication technologies, web geographic information systems and social networks are reaching new levels of maturity and spread every day; this has led to a growing diffusion of web-based dashboards and infographics, which blend geographical, graphical and statistical representations (Grandi and Bernasconi, 2020). Experience of geographical studies and altlas of Covid-19 could be found too (Casti and Adobati, 2020). This general trend was corresponded also in Italy: public data and their visualization have been firstly proposed by national newspapers and the initial main reference has been the COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU). Next to published data in the form of dashboards, information communication followed more traditional trajectories: to report on data and major happenings, social networks were used in an official way as well as traditional TV channels. As of February 19th, official press releases and press conference were organized and curated by the Ministry of Health jointly with the Civil Protection Department. For two full months, until April 19th, the main official updates were given daily at 6PM from the symbolic place of the press room of the Civil Protection Department; from April 19th onwards, the conferences happened only twice a week. Moreover, as of March 7th, an ArcGIS web-GIS map with a basic dashboard has been published on the official Web site dedicated to COVID-19 of the Civil Protection Department. Few days after open data were shared through GitHub on a

ISSN 2384-9398
DOI

daily basis, thus creating the possibility to better track data evolution possibly producing self-elaborations. The geographical level of this open data reaches the detail level of provinces, whilst each region (and often each health district) provided a daily press conference and press release with further data, typically with a finer granularity (for instance of infrastructure capacity growth). The learning curve of citizen and political decision makers has been growing relatively fast and the habit of checking and understanding data stabilized in one month, around March 22nd when the full lockdown was decided and socially accepted. Another interesting element to be considered is that forecasting curve was not published until March 31st: this was made available by a private Think Tank (Peracchi, 2020)[7], while it was not an official information yet.

4.2 Forecasting and scenario models

Clinical and health data are also used together in many epidemiological studies, or SIR models (S for the number of susceptible, I for the number of infectious, and R for the number of recovered, deceased or immune individuals). As indicated in the survey (Shinde *et al.*, 2020) many epidemiological studies have analyzed the current Italian COVID-19 situation and have proposed forecasts to assist the Government in designing better strategies and in taking productive decisions, leveraging many open data resources, mainly from big data accessed from WHO or National databases and from social media communication (Alamo *et al.*, 2020). Many works (Perone, 2020; Giordano *et al.*, 2020; Traini *et al.* 2020) forecast the number of COVID-19 patients, some also comparing the Italian situation to the Chinese one (Caccavo, 2020; Wangping *et al.*, 2020). Parameters used in such studies belong to different categories (we defined them as data types earlier); more specifically: *clinical data* include underlying disease and available medical facilities; strictly *epidemiological data* include transmission rates and report times; *health data* report daily death count, number of carriers, and incubation period; all other parameters, related to awareness about COVID-19, social distancing-quarantine-isolation numbers, mobility, most and least vulnerable population, government policies, and environment, could be placed under the broad category of *social and economic data*. Differently, parameters such as geographical location, age and gender of population are orthogonal to all these categories.

4.3 Open questions

Alongside a greater understanding of the phenomenon and a collective reading of the data, statistical methodology gaps have begun to emerge in the detection of new cases, undeniably also linked to the protocols by which the swabs were performed. For example, we observe that a first missing information is related to pauci-symptomatic or non-symptomatic cases; this undeniably leads to significant underestimation of the infection process and diffusion. After the peak of infections, estimated around March 30th, other substantial elements have begun to emerge; interesting questions on January-April 2020 time frame are still unanswered by open data and public communication: where are the remaining outbreaks still generating? Are there

[7] https://www.corriere.it/cronache/20_marzo_31/coronavirus-quando-finira-italia-fine-a7fd34a2-72c0-11ea-bc49-338bb9c7b205.shtml (accessed online on June 11th, 2020)

epidemic motivations that make some categories of workers more exposed? Data to answer these kinds of more complex inquiries are not available openly yet; the Italian Data Protection Code (Legislative Decree 196/2003) is clearly making this process more complex, as full anonymization must be guaranteed.

5. The Data-Spatiality-Sociality and Legal response nexus: the DSS-L conceptual model

The collected elements and observations, overviewed in the previous paragraphs, show that the spatial and, more broadly, geographical dimension of the COVID-19 is relevant and acts in multiple aspects of the pandemic course. We have a *geography of the diffusion of the disease* as well as *a geography of the social responses*. The risk-perception-model can be extended to explain and correlate the legal responses of the governmental system that acts in a multi-level governance fashion. In addition, data plays an intriguing and correlated role. The analysis of the case of COVID-19 leads to the definition of a conceptual model relating spatiality, sociality, data, legal response and time.

First of all, in terms of relational/spatial modeling, from a perceptual point of view, we can consider the following interweaving dichotomies: (a) a spatiality proximity wave, where "outside" and "inside" move in space from the rest of the world towards the person, as the virus is perceived as closer in physical terms (thus medical-health terms); (b) a sociality proximity wave, ranging from "far from the self" to "close to the self", from unknown foreign people to colleagues, friends , and family. The Cartesian space hereafter created considering spatiality and sociality (Figure 4) configures a general relational space. Moreover, we highlight some potential frontiers (dotted lines) that are significant in changing the perceptions of people responses, as well as communication, social, political, and legal responses.

The first frontier is the top 'inside-outside' one, that can be generally considered as set by the national borders. Nevertheless, every administrative level became a potential frontier zone during COVID-19 pandemic, especially in a multi-layered administrative system like the Italian one, but to avoid over-complexification this is not plotted.

The second frontier depicted ('inside - relational inside') includes all the real frontiers set between the daily life space and the mid-level spaces (such as city, provinces, and regions). This frontier sets the difference between the "relational inside" and a generic "inside" in term of spatiality. Across this frontier, information can be exchanged with direct contacts among people, enhancing trust of information, diffusion of better/worse perception of risk. Clearly, this kind of frontiers are to be considered as approximate, as the range of movement of citizens changes significantly according to professional activities, lifestyles, and routine patterns.

In a further development of the model, one could include the social network and virtual space extent. This extension would open up to another set of analytical dimensions, as in a virtual space information exchange and related risk perception follow different rules.

Frontiers can be identified also along the social axis, from left to right. The third frontier we consider is where the "relational inside" ends (corresponding to acquaintances), whilst the fourth frontier, "inside-outside", is set with the sense of

GeoProgress Journal, Vol. 7, i.2, 2020, Geoprogress Editions
ISSN 2384-9398
DOI

otherness, that is, when a person does not know nor has the likely chance or the interest to know someone.
In this model, implicitly, we can observe the area where politics, policies and legal frameworks develop, namely in between the described frontiers, that is in the "inside" space. From this central area, the effects permeate towards the 'relational inside', influencing daily life and relational spaces of people. For instance, the legal response to the crisis, such as a lockdown, limits individuals in an inner spatiality/sociality, affecting their relationships with family, friends, and colleagues as well as creating psychological effects on the self. Similarly, from this central area, effects of legal response could permeate towards the 'outside'. As an example, the restrictions applied to flights change the possibility of tourism.

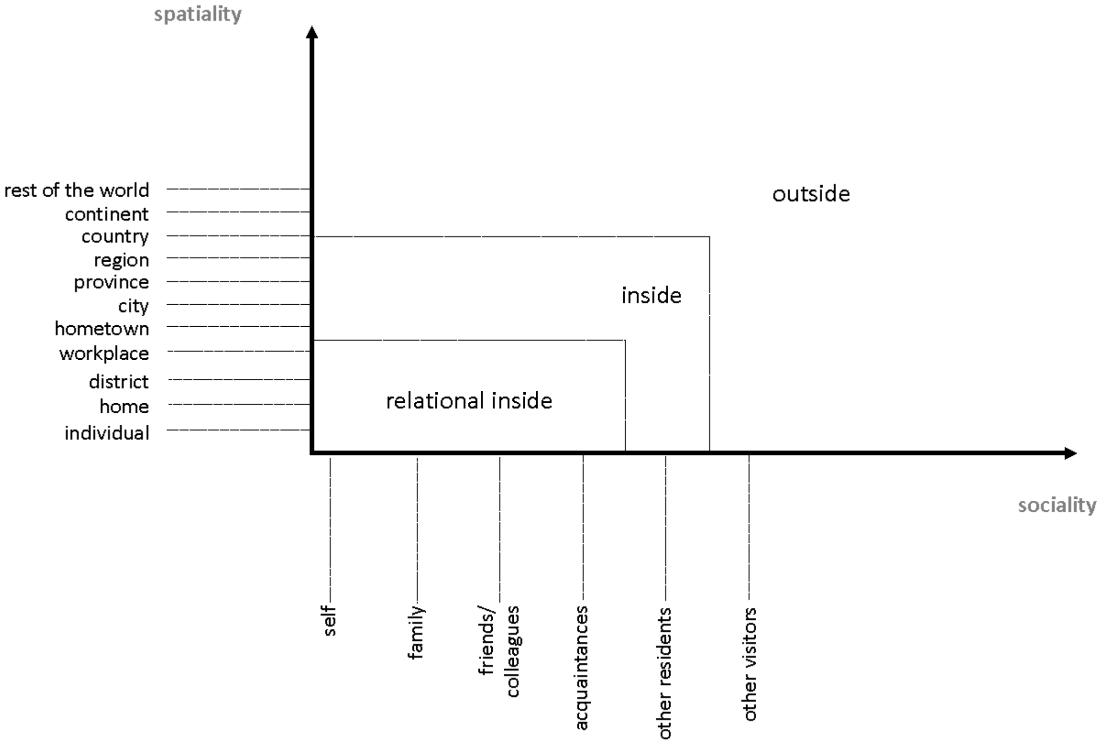

Figure 4: Sociality-Spatiality relation in epidemics and inside-outside frontiers. Source: Authors' elaboration

After analyzing the Social-Spatial relation, identifying the legal response area, we moved our conceptualization focus towards the relationship among legal response, data, and communication evolution in time. In Figure 5, we plot the main COVID-19 indicators made available (new daily confirmed cases and daily deaths); we represent, in the form of rectangles pointing to specific dates, the evolution of the main national Legal Decree issued by the Presidency of the Council (as described above); the information and communication patterns are also indicated. First, it can be argued that the "inside-outside" model sets a significant frontier in media communication. The gradual nature of the legal response seems to be strongly correlated with data. However, data are not independent from legal response, since the data of the day after are function of the legal responses chosen the days before. Data trends influence political and legal strategies, but epidemic response reacts to them creating a circular causation, potentially a virtuous cycle. At least in Italy, probably due to the fact that it was the first European country facing the hotbed outbreaks, the decision-making choices in phase 1 seemed to be following this semi-chaotic or trial-and-error pattern.

GeoProgress Journal, Vol. 7, i.2, 2020, Geoprogress Editions
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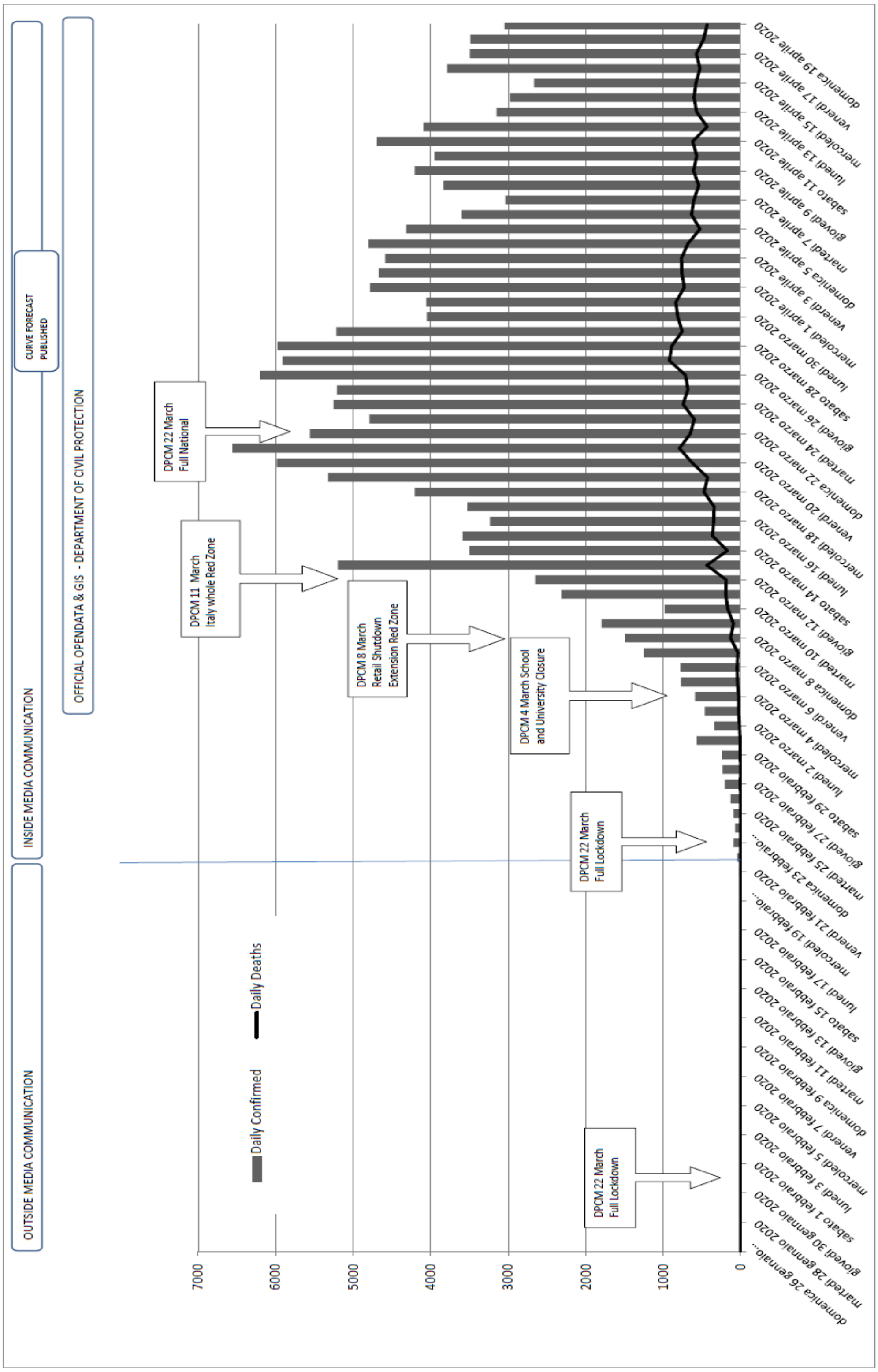

Figure 5. The timeline of the main epidemic indicator of COVID-19 and control measures implemented in Italy, from January 2020 to April 2020. At the top part of the chart the milestones on public communication are reported. Source: Authors' elaboration; data: Italian Civil Protection Department, 2020

In conclusion, the case of COVID-19 led to the construction of a conceptual model where Legal response (L) is function of Data, Spatiality and Sociality (DSS); these variables set frontiers called 'relational inside-inside' and 'inside-outside'. As data change over time, legal response becomes a time-dependent variable too, affecting social response and spatiality of people. Especially during an epidemic, when legal responses to crisis are sudden and stout, individuals or collectivities change significantly their behavioral patterns, thus, affecting their relational space. We call this conceptualization the DSS-L model (Figure 6), which provides a comprehensive view of the dynamics of an outbreak crisis.

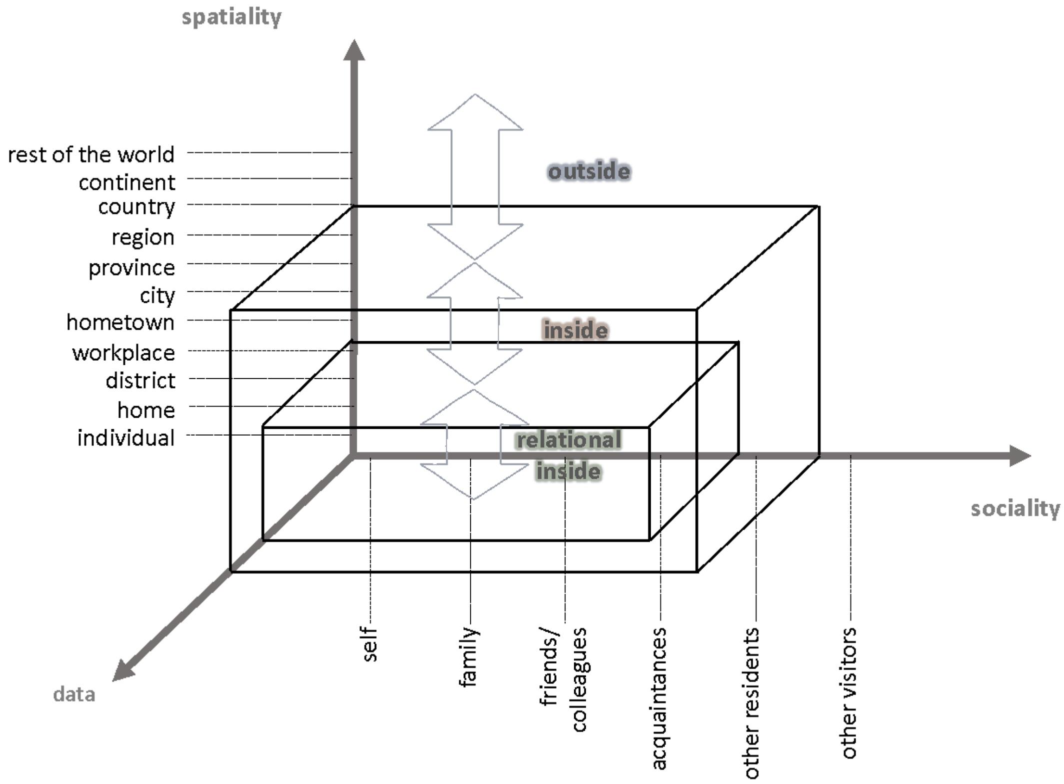

Figure 6: The DSS-L (Data-Spatiality-Sociality and Legal response) conceptual model. Source: Authors' elaboration

6. Conclusion

This paper has analyzed the case of the Italian response to the crisis generated by the COVID-19 epidemic from the earliest information to the 3rd of May, corresponding to the date of the end of phase 1 in Italy, the first country in Europe discovering an inner outbreak, thus suffering from an undeniable 'surprise effect' that increased its impact. The theoretical framework that seemed to be more appropriated is an interdisciplinary approach as, recalling McGlashan (1966) and Pyle (1976), medical geography is a "borderline discipline" with conceptual overlaps between geographical, spatial, social, political, health and medical aspects. In particular, blending classical medical/health geography elements with behavioral science aspects and conceptual modeling guidelines, appeared essential in order to model the geography of an epidemic.
The initial phases of the COVID-19 pandemic outbreak in Italy offer a significant case study on the multiple connections among spatial, social, and relational aspects as well

as on how these are associated to the political and legal geographies of responses to a crisis. These variables vary in time and space creating a dynamic model. The creation of geographical "red zones" is a classic example on how geography of COVID-19 is related to the medical, epidemical, and health spheres of the phenomena, along with the political and legal responses. However, risk perception, communication and social response also emerge as important factors to be considered moving the center of the investigation from a factual to a perceptual spatiality, driving decision making processes. These relational dynamics led to the design a conceptual model, called the DSS-L model, which describes the relations between Data, Spatiality, and Sociality connected to communication and Legal response, thus creating an interweaved con-causal system. This multidimensional model highlights the existence of space-relational frontiers (namely 'relational inside-inside' and 'inside-outside') and of areas of action where legal and political response are acting according to data, perceived risk and communication patterns.

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