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Understanding the *Geospatial Factory*

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1.1. Introduction

The issues addressed by geomatics and geographic information science are often perceived as essentially technical. They do indeed require a certain level of expertise in topography, mapping, computer science, data processing, statistics, etc. The manipulation of geospatial information follows precise methods and models and uses rigorous and specific protocols and formats. To practice it, it is necessary to master fairly complicated specialized software and have at least a basic knowledge of computer coding. However, this multifaceted and evolving technical dimension is only one element of a broader assembly designed to process geospatial information, which can be called the *geospatial factory*. It brings together men and women with a wide range of specializations from various organizations (public institutions, private companies, associations, informal groups, etc.). They have skills often acquired in universities and schools, which renew them through research. All their activities are regulated by bodies that produce laws, rules, standards, etc. This factory has been gradually built up over more than 50 years to carry out an almost continuous process of digitalizing geographic information, which we will call *geodigitalization*. It is heterogeneous, riddled with conflicts of interest and disagreements over methods and priorities. It has no clear boundaries. It has changed significantly over time in response to technical innovations and societal transformations, and along with the

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increasing scope of geodigitalization. It would take several books to present this digitalization process of geographic information in any depth. But it is possible, as we will attempt to do in this chapter, to reconstruct retrospectively what constitutes, behind a multitude of more or less coordinated initiatives, the core of its project: the systematic digital transcription of geographic information covering the whole world. The presentation is in three sections. In section 1.2, we restore a sense of history to the geodigitalization process by isolating a few major milestones that marked the deployment of geomatics and geographic information science and systems. Section 1.3 focuses on the powerful but little-discussed driving force behind this process: the temptation to replicate the world through computer simulation. Finally, in section 1.4, we seek to show that geodigitalization is not just a matter of representing the world (material and unmaterial). It must be seen as an operating matrix that not only contributes to changing perceptions of reality but also interferes with the spatial structure of social interactions and behaviors, and materializes in the physical environment. Examples from three areas illustrate these effects: the role of digital geolocation data in sports, mixed reality gaming and management of Covid-19 pandemic; the use of big data in transportation; and the geospatial logic of social interactions at the hyperlocal level.

1.2. The making of the *geospatial factory*

The steps below are milestones in a complex story that correspond to key moments in the geodigitalization process.

1.2.1. *GIS*

Until the late 1980s, digital geographic information technologies were confined to university laboratories, mainly (but not exclusively) in the United States, where researchers developed geographic information systems (GIS) (Foresman 1998; Chrisman 2006). These research tools were then transformed into standalone software sold by private American companies, which quickly conquered the market of businesses, local authorities, administrations and research centers. Their rapid adoption by researchers led to a heated debate in English-language geography at the time, which contributed significantly to shaping the future field of research in geographic information science (Schuurman 2000). In France, these new tools have also triggered hostile reactions from geographers on two historically opposed sides (Joliveau 2004). On the one hand, traditional geographers criticize the excessive importance given to technologies that they consider to be nothing more than geographical engineering, distracting users from true geography, which is conceptual and discursive. On the other hand, proponents of a new theoretical and quantitative geography already use computers and have often developed their own programs to implement formal modeling and a nomothetic approach. The latter are also highly critical of this new software, which they see as tools without theory, ignoring the foundations and recognized models of spatial analysis and the established semiological principles of cartography, and offering only simplistic geometric combination operators with an essentially idiographic purpose (Rimbert 1989; Groupe Dupont 1994). Both sides agree that these trendy "GIS software" programs are suitable for operational issues but not for fundamental conceptualization. The operational dimension of these computer technologies contributed to their success in the 1990s in what has been known in France since the 1960s as "applied geography" (Philipponneau 1960). Between 1960 and 1980, and even beyond, this form of geography, which was geared toward solving practical issues, led many geographers to pursue careers in town and country planning. Therefore, it was in the departments responsible for land management and environmental planning that GIS quickly became established as a means of automating a number of tasks, mainly cartographic ones. GIS were also quickly adopted in ecology, hydrology and environmental sciences as a complement to specialized digital tools.

1.2.2. *Geoinformatics*

At the time, it was not widely understood that this wave of computerization was not limited to the adoption of software for automating certain repetitive and tedious mapping tasks and visualizing the new images captured by the first Earth observation satellites. All these data, painstakingly entered by hand on A0-size tables or retrieved from magnetic tapes, formed a system, as the name GIS indicated (Joliveau 1996). It constitutes a systematic, organized and generalized transcription in the form of information on facts, observations and knowledge concerning all phenomena detectable on the Earth's sphere.

This ongoing computerization has led to the creation of large databases for analysis. Contrary to George's (1978) assessment at the time, these data have increasingly being used to support decision-making in all fields. GIS represent only the geographical aspect of this general process of recording and using computer data. Certain fields of primary interest to geography have remained generally wary or even hostile to this computerization process, such as urban planning and landscape management, where human expertise in contact with the field and stakeholders has remained the benchmark for information gathering.

1.2.3. *Geomatics*

What has been called geomatics or geographic information science since the 1990s actually refers to the gradual reorganization, through the concepts and methods of computer science, of the knowledge and techniques related to the acquisition, storage, processing, analysis and dissemination of spatially referenced data. Previously, these tasks fell under related but distinct disciplines, such as topography, cartography, geodesy, photogrammetry and remote sensing. These disciplines did not merge because they correspond to different professions, skills and needs. However, as geographic information becomes more digitalized, it becomes easier to connect the various activities and applications related to this information. Geomatics links together all the technical systems related to geographic information. These systems are becoming increasingly numerous and diverse as the concepts and methods of GIS and automated cartography begin to circulate more widely among experts interested in their use in an increasingly varied range of fields: archaeology, ecology, transportation, the environment, urban management and planning, archaeology, etc. (Joliveau 2007).

1.2.4. *Geoweb and neogeography*

The emergence of the Internet in the mid-1990s completely transformed digital forms of access to geographic information (Scharl and Tochtermann 2007). The creation of online map portals reversed the traditional relationship between data and maps. Databases are no longer queried to produce maps; instead, cartographic interfaces are used to navigate an increasingly rich universe of data, leading to the harmonization of formats and the structuring of forms of cooperation between data producers and holders (Joliveau 2011). This networking of databases, applications and users gives the general public access to an enormous volume of geographic information: base maps, satellite imagery, thematic data, etc. It is transforming the processes of map production, distribution and use (Mericskay 2016). Spatial indexing of all types of digital content is becoming widespread to organize access and enable data retrieval. The techniques used are georeferencing, geocoding and geographic indexing. Mapping methods on the Internet are also changing, increasing the ability to navigate at different scales and select and aggregate information (Guérois and Madelin 2024). A whole new world of interactive, dynamic and animated geovisualizations is emerging (Cunty et al. 2017). The so-called Geoweb is neither unified from a technical nor from a usage standpoint. The technical process of acquiring, storing and consulting geographic data is made up of numerous protocols. And geographic information has become a significant market, with multiple services seeking a competitive advantage, or even a monopolistic position.

It is also the moment when new global players, such as Microsoft and, above all, Google, enter this market.

In the mid-2000s, computer technologies evolved, and the Internet transformed from a medium for finding information to a medium for self-expression, through comments on websites, contributions in forums and blogs creation. Personal mapping applications accessible on the go are emerging, initially with Wi-Fi-enabled laptops, then with connected smartphones. The web became cartographic following the success of Google Maps/Earth, which allowed users to view search engine results, navigate freely on a single world map and create personal maps. OpenStreetMap[1], created by Internet users, can be considered a free version of Google's proprietary map or the state maps produced by national mapping agencies. This contributory shift in geographic information is changing the public's relationship with geographic information. It was quickly proclaimed a major revolution called "neogeography" by some of its players (Turner 2006). In fact, it turned out to be a redistribution of the economic and industrial system around the production and exploitation of geographic information, which placed large web companies, particularly Google, at the center of the field (Joliveau 2010). This cartographic effervescence resulted in the emergence of a new form of mapping that is more fragmented and scattered (Noucher 2017). In research, this contributory dimension of geographic information was theorized very early by Goodchild under the name VGI (Volunteered Geographical Information), which invites us to understand how individuals and citizens participate in the creation of geographic information (Goodchild 2007).

1.2.5. *Social (geo)media*

This desire among Internet users to contribute was quickly picked up by the social media platforms that were emerging at the time. Facebook (created in 2004) and Twitter (created in 2006) were the leading examples, but many others have followed since: Instagram, Snapchat, TikTok, etc. These platforms have become the preferred channels of communication for billions of people around the world, at the expense of forums and blogs, which have lost their appeal. They constitute information spaces of unprecedented size and intensity, which have become genuine geopolitical objects. Under the guise of a horizontal connection tool, social networks organize and filter access to information through algorithms. These are geared toward capturing and maintaining the user's attention, imposed by an economic model based on free service in exchange for the provision of personal data that feeds

1 See B. Mericskay's analysis of OSM as an example of digital commons in Chapter 3.

personalized profiles sold to advertisers. The location of users is quickly perceived as an important feature of these profiles by social media applications. At the end of the 2000s, social networks were created specifically around sharing geographical location: Google Latitude, Foursquare and Gowalla, among others. This led to predictions of the emergence of a new type of “geomedia”, which would allow individuals to continuously share their experience of immediate environments and places visited using geolocated and multimedia information such as texts, images and sounds[2]. In fact, these new social networks do not last. Dominant social networking platforms, such as Facebook (which bought Gowalla) and Snapchat, incorporate the social sharing function of geolocated information. Foursquare continues to develop geolocation-related technologies but in 2014 transformed itself into an urban guide for peer-to-peer recommendations of interesting places. As Nova (2009) notes, the emergence of autonomous geomedia is short-lived. However, this episode leads researchers to wonder whether GIS should be theorized as media as much as information systems (Sui and Goodchild 2003; Crumplin 2007). The interpenetration of geospatial technologies and social media also invite us to cross-fertilize geography, which is opening up to communication issues, with communication sciences, which are negotiating a spatial turn. Sui and Goodchild point out a number of concepts that geographic information science should re-examine in light of this encounter with social networks. This project is still ongoing: it includes visualizing interpersonal networks, exploring the multimedia dimension of data and better conceptualization of what a place is in GIS models initially built to account for space (Sui and Goodchild 2011).

Several other milestones could be added to this short history of the geospatial factory including satellite imagery, big data, the Internet of Things and, more recently, artificial intelligence. The proposed markers clearly outline the stages of the digital transcription process of geographic information.

1.3. Geodigitalization as replication

Since the mid-1960s, Geomatics and geographic information science have therefore been at the heart of the geodigitalization. This process employs various computerized methods and direct or indirect georeferencing techniques to systematically transcribe all objects, beings, phenomena, activities, artifacts and creative works. This process, which seems essentially technical, has taken on different forms over time. But it has mobilized and continues to mobilize dreams and fantasies, utopian goals and fundamental concerns, which are worth revisiting.

2 Quesnot tackles this issue head-on in Chapter 2.

1.3.1. *Replicating the physical world*

Geodigitalization initially involved transferring existing maps, aerial photographs and satellite images of concrete objects of the physical world – roads, rivers, houses, terrain, etc. – to computer media with ever-increasing precision and detail. Intangible objects such as property boundaries, which are particularly important in Western societies, were also digitally transcribed from the outset. These concrete objects have been associated with characteristics related to their nature (type of road, building, etc.), their use (number of vehicles passing on a road, etc.) and their functioning (flow rate of a watercourse, etc.). As it expanded and became more precise, this digital description came to encompass industrial devices and entire urban organizations. This georeferenced description of the world is constantly expanding and becoming increasingly detailed and up-to-date. It includes natural atmospheric, geophysical, terrestrial and oceanic phenomena, natural environments, and surveys of living organisms, plants and animals, as well as measurements of demographic, economic and social phenomena. The geomatics project has gradually emerged as the most faithful reproduction possible of the physical world – a replica of it, but always in the form of explicit, formalized, documented and shared models.

Admittedly, the multiplicity of sources, technical devices and operators means that this digital double is not an exact, seamless copy of its physical model. The replica is imperfect, cracked, irregular and uneven. But since its inception, geomatics has strived to coordinate initiatives and promote the interoperability of formats and tools to give coherence and continuity to this digital copy of the world. This is despite ongoing competition between stakeholders and differences linked to the monopolistic tendencies of the large companies involved, as well as the fierce determination of institutions to protect their turf.

1.3.2. *Georeferencing unmaterial and mental objects*

Hill (2006) was one of the first to point out that the ongoing systematic georeferencing was extending beyond the material world to include immaterial entities such as cultural and artistic works, media content, images and texts, and everything related to heritage[3]. Geodigitalization now encompasses all human communications, fundamentally changing the status of geospatial technologies. Until then, these technologies were a separate domain, a well-defined field of expertise derived from highly specialized professions and disciplines responsible for

3 Chapter 6 of Hautdidier and Morel clearly illustrates the conceptual and theoretical renewal produced by the convergence of geomatics and digital humanities.

providing a robust and documented description of the state of the world. In digital mode, they have become part of the most intimate and everyday aspects of life through social media and ambient computing technologies with their ever-increasing number of sensors and connected objects.

1.3.3. *When cyberspace reverses itself*

A major shift in this geospatial world can be seen at the turn of the 2000s, when computer technology had already advanced enough to raise the question of its visual representation. This was the moment when visualization techniques, driven for 20 years by the rapid development of video games, became mature enough to render this mass of computer data in three dimensions. The renderings were sufficiently convincing and realistic, even on standard computers, to raise fears or hopes that this digital world would compete with the physical world. The visual similarity between the replica and its model coincided with the release of realistic open-world video games such as *Grand Theft Auto*, which digitally recreate[4] real locations. These were also the years of the launch of Second Life, the first persistent virtual universe where participants could interact through their avatars. It may come as a surprise to learn that Second Life still exists in 2025, while Meta's ambitious attempt to create the Metaverse ended in spectacular financial failure in 2023. However, the emergence of this gesospatial world, topographically aligned with the physical world, seems to be, in the words of novelist William Gibson[5], as if cyberspace were no longer "a specific elsewhere, one we visited periodically, peering into it from the familiar physical world. Now cyberspace has everted. Turned itself inside out. Colonized the physical"[6]. Several researchers have attempted to conceptualize this reversal, which directly links physical locations to resources on the web and, conversely, web "sites" to real locations. Zook and Graham (2007) proposed calling *Digiplace* this hybrid place, both digital and physical, which we inhabit or visit today. The local, physical environment of a place is complemented by a fluid, constantly updated "cloud" of information that refers to and describes it. We can explore a place physically and/or digitally and use georeferencing to match the cloud of information with the physical space. Digiplace is always constructed by a computer program that queries the data available on a place. Visiting the *Digiplace* is interactive and individual, as it depends on the code/program used, the user's skills and their personal interest. Not all digital spaces are equal, either in terms of their physical or social characteristics

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4 By significantly altering the topography of the area (Joliveau 2012).

5 Creator in 1982 of the name and first imaginary description of cyberspace in his novel *Neuromancer*.

6 http://www.nytimes.com/2010/09/01/opinion/01gibson.html. See Chapter 8.

or in terms of the accuracy, completeness and detail of their translation into data. It is important to note that this cyberspace, which has become ambient, is not virtual in the common sense of being unreal. According to Vial (2014), inspired by Turkle (1995), it is a "computer-simulated" space, a digital space that is added to and combined with physical space. As Vial writes, geodigitalization is gradually leading us to change our perceptual structures. We now are present to things and beings also as digital interfaces show them to us (Vial 2014).

1.3.4. *Digital twins of territory*

In recent years, the creation of a geospatial replica, a "computer-simulated" version of the world, has continued to develop in a new technopolitical context: the digital twin. This concept was imported from industry in the context of the smart city. The aim is to digitally reproduce an object, process or system as accurately as possible to simulate how it functions. After 3D models of a territory, which focused on replicating the visible dimension, the goal is now to create digital replicas of the territory "as it works". A digital twin of a territory can be defined as:

> A dynamic and intelligent digital model of the city that integrates static and dynamic (real-time) data, both public and private, into a single reference environment. It is a consolidated information system that integrates business tools (mapping, planning, e-administration, etc.). The 3D visualization offered by the digital twin facilitates the contextualization and understanding of urban data. (Banque des Territoires 2021)

The digital twin theory is very much a product of the smart city. It shares some of the same beliefs and assumptions, which are sometimes paradoxical. The digital twin is based on a functionalist approach that treats the territory – an anthropic, organizational, social and political entity – as a complex technical system. It considers that centralizing data will resolve the separate siloed approaches that are believed to be the main source of territorial dysfunction. It presupposes that intensifying real-time data collection and artificial intelligence technologies, a kind of local geo-engineering, will make cities more sustainable and frugal. The concept of digital twins is not limited to the city scale. The European Commission's "Destination Earth" project, for example, aims to develop a digital twin of the Earth "to model, monitor, and simulate natural phenomena, risks, and related human activities".[7]

7 See: https://destination-earth.eu/.

The digital twin appears to be the ultimate utopia of successful geodigitalization. Not only will all the necessary data needed to model all processes be collected, but it will be possible to model and simulate all these processes and their systemic relationships by integrating complexity sciences (Arcaute et al. 2021).

Lucas (2022) clearly highlights the imaginary dimension of the digital twin of the territory through the many myths it revives: Pygmalion, Narcissus, Prometheus, Faust, Babel, Sisyphus, Gaia, etc. Apart from the dizzying dream of merging the object and its representation, there is still the risk of granting more power to experts and engineers. They are the only ones able to understand the models that lead to decisions.

Furthermore, our social interactions are already driven by algorithms and our itineraries calculated by navigation systems. We know in real-time whether a place is busy and what time it will stop raining. An artificial intelligence tool can now write a novel set in the places we love or draw maps of the landscapes we dream of living in. The ambient and ubiquitous "digital twin" that would orchestrate this utopia takes on a "Big Brother" air.

1.4. Geodigitalization as an operating matrix

The geodigitalization of the world cannot be assessed solely in terms of data and representation. The widespread adoption of geodigital technologies and data is transforming the way we represent the world – but its impact is broader than that. In subtle yet fundamental ways, it is changing how we explore, understand, experience, talk about and critically engage with the world to transform it. Geospatial technologies are now an integral part of contemporary social life, having assimilated and even reinforced existing forms and structures. They have also created a new way for people to access the world, leading to new behaviors and uses as well as new opportunities and risks. We must consider the implementation of geospatial technologies as *operations* to use the term employed by Besse and Tiberghien (2017) in relation to cartography. These operations transform the ways we do, act, and think.

The process of geodigitalization is widespread. Its effects are subtle but affect virtually all domains. Here are a few examples of these geospatial operations and the transformations they facilitate and accompany. Some are global and massive, others seem more modest and innocuous, but all appear to be irreversible. These are just a few highlights; each issue would need to be addressed in greater depth.

1.4.1. *Digital geolocation, from entertainment to control*

Real-time geolocation functions have become the building block of many applications based on what Beaude (2012) calls “synchorization”, that is, the synchronized spatialization of actions. These applications are used to connect people most often by turning them into users of a private digital service that acts as an intermediary. The implementation of these synchorization services has greatly transformed many aspects of daily life in wealthy countries and elsewhere: travel route planning (Google Maps, TomTom, Waze), individual transportation organization (Uber), tourist accommodation rental (Airbnb), dating (Grindr, Tinder), access to healthcare (Doctolib) and so on. The economic, social and spatial effects of these highly popular services have already been widely documented. What is less well known, or often omitted, is that the geolocation data collected is used for other purposes. We have deliberately chosen two examples of use that relate to very different situations, but both have global implications: sporting and leisure activities on the one hand, and the Covid-19 pandemic on the other hand. The contrast between individual activities and centralized coordination at the national level illustrates the extent to which digital geolocation technologies have become ingrained in our lives.

1.4.1.1. *Geolocation of sports and recreational activities*

A first example of a recreational application is Strava, a social network linked to GPS, widely used by runners and cyclists who record and share their journeys online to compare their performance with other users. It became very famous beyond the sports world in 2018 when an Australian student revealed that soldiers’ geolocated Strava tracks were freely accessible online in the form of a heat map. This allowed other users to locate US military bases in Syria and Afghanistan. In densely populated areas, individual anonymized tracks were aggregated into the most frequently used routes, but in desert or less frequented areas, they were clearly visible. It then emerged that the Strava website gave access to users’ public profiles, allowing them to be identified, and their home locations to be deduced from their tracks. In 2024, the French newspaper Le Monde revealed that many bodyguards of heads of state continued to publish their running routes on Strava with a public profile under their real names, making it easy to locate where these world leaders were staying (Untersinger 2024). Strava pointed out that users could limit the visibility of their profile and activity to their friends, or even make them private. However, subsequent investigations showed that these “sensitive” users had neglected to do so.

Mixed or alternate reality games are another recreational use of geolocation, made famous by the global success of *Pokemon Go* in 2016, where players capture digital Pokemon by exploring their surroundings using their smartphone screen. The game was developed by Niantic, a Google subsidiary that became independent in 2015. It is based on the same computational and spatial architecture as *Ingress*, Niantic's previous game. In Ingress, players worldwide are divided into two teams and compete for "Portals" via their smartphone's digital interface. These portals are associated with physical locations, many of which were created by players. Launched in 2012, the game was integrated into Google's geospatial ecosystem alongside Google Maps, Google Earth and Google Street View. It enabled the company to collect on-site data about places and geographical features that are meaningful and emotionally significant to users. *Pokemon Go* took over *Ingress's* geographic database, with Portals becoming PokeStops. In March 2025, Niantic sold *Pokemon Go* to Scopely, a smartphone video game company owned by a Saudi investment fund. Niantic's artificial intelligence division became Niantic Spatial, an independent company in which Scopely invested. Niantic Spatial used *Pokémon Go* data to train a "large geospatial model (LGM)" based on large language models (LLM) on textual data, which is intended to "help computers perceive, understand, and navigate the physical world" (Brachmann and Prisacariu 2024). Players had not anticipated this use of their geolocation data: contributing to the creation of a private company's database, which the company then uses to train artificial intelligence. It is also an original illustration of the economic value of geographic information through gaming (Odobašić et al. 2013). Incidentally, given the problems of LLMs trained on biased data, we can anticipate issues with this future LGM. Colley et al. (2017), for example, found that in 2016, Pokestops were significantly more numerous in urban, white, affluent neighborhoods in the United States.

Geolocation data is collected by applications for which knowledge of a geographical position is essential, such as dating apps (Grindr), peer-to-peer goods sales apps (Leboncoin, Vinted), and weather forecast apps (Météo et Radar). Many other personal apps that are indifferent to location also record this data, opening up privacy and security breaches similar to those seen with Strava. This geodata can also be purchased through data brokers, companies that control this highly opaque market (Sénécat et al. 2025). Even more worrying, a tool provided by the company Babel Street is indicative of the advent of a society of pervasive control and surveillance. This tool called *Locate X* uses a polygon-drawing function on a map of any location in the world to list and visualize the advertising ID of the mobile phones that have entered a specified area in the previous days. It is then possible to identify the home address of these individuals by searching for the night-time locations of their phones or by directly purchasing files that link the mobile advertising ID to the name, address, email and phone number of its owner (Kebs 2024). The legality of this type of software tool is being debated in the United States, but there are growing concerns that it could be used in an uncontrolled manner by private organizations or police forces for individual surveillance purposes.

1.4.1.2. *Geolocation and Covid-19*

The Covid-19 pandemic in 2020 was a global phenomenon that led several countries to discuss the advisability of using individual geolocation data to control the epidemic, through tracking the contacts of infected individuals and monitoring people's movements (Boudreau and Caron 2022). There were significant differences between countries in their adoption of this type of policy. In South Korea, the authorities very quickly set up a technological platform called the Epidemic Investigation Support System (EISS) adapted for epidemiological purposes from a pre-existing system developed as part of a smart city project. This platform centralized individual data from multiple sources: credit card transactions, cell phone geolocation, health records, public transportation travel, surveillance cameras in public spaces, etc. Its purpose was to identify and notify people who had been in contact with an infected person and who had not worn a mask or respected physical distancing and to request that they self-isolate. The platform cross-referenced, analyzed and mapped all these data in a very short time. France, Canada and Quebec opted to develop applications for use on a voluntary basis. These applications were designed to anonymously track Bluetooth connections with other users, so that anyone who had come into contact with someone who had reported the disease could be notified. These apps were based on the principles of non-centralization, non-identification and non-localization. To function effectively, they needed to be adopted by a significant portion of the population. In none of these three countries did these applications play the expected role. Determining the relative effectiveness of the two systems is not easy. A thorough investigation into the reasons why a country has or has not opted to track individuals during the pandemic would be necessary (Guillaud 2021). A number of factors may explain the choice between these two approaches such as the more or less individualistic nature of the societies in question, the degree of digitalization of individual practices, the level of deployment of ubiquitous computing and smart city projects, the nature and age of the relationship with democracy. For our purposes, this is a real-life demonstration that geospatial technologies are already being widely used and are not merely limited to a simple collection of geolocation data. A comprehensive system of spatial data information and analysis can be mobilized for the purposes of state surveillance and control of individuals. The absence of a systematic and uniform geospatial control framework in the context of the Covid pandemic highlight the importance of the political and cultural dimension in this domain. It underscores the challenges associated with democratic oversight of the use of these technologies, which authoritarian states may exploit for purposes that undermine freedom. Another risk stems from the fact that digital technology companies have become as powerful as, if not more powerful than, governments. They are opposed to the regulations that states are trying to impose. At the same time, the market for personal geographic data, whether legally obtained or not, is growing very rapidly without real control.

1.4.2. *Material effects of geolocation in transportation*

The ability to remotely and in real-time geolocate individuals and objects can have significant impact on individual behavior and social relationships. It also influences concrete actions and infrastructures in various ways, as demonstrated by three examples from the transportation sector.

1.4.2.1. *Planning*

The first example describes a purely potential effect, when geolocation data are used to plan physical infrastructure. With more than 135 million claimed users in 190 countries, the geolocation data available on the Strava app mentioned above provides a basis for analysis by researchers and planners. These data can be used, for example, to better understand the practices of cyclists in cities and plan appropriate amenities. Battiston et al. (2023) examine the reasons why fewer women than men cycle and attempt to understand whether this could be due to physical conditions and cycling facilities. Using Strava data, they calculate a ratio of female to male cyclists and statistically compare it with indicators describing the local physical environment. The local physical environment is defined by factors such as road network structure, types of intersections, speed limits, presence and types of bike lanes and air quality. This comparison is conducted at the city and street levels in various American and European cities. The study's findings highlight discrepancies among countries and validate most of the hypotheses concerning safety, opening up a new interrogation on women's perception of safety in cycle lanes that are not physically separated from traffic. However, the authors conclude that the main limitation of their study is the non-representative nature of Strava data. Strava users tend to be sports and leisure cyclists, whereas the facilities are primarily intended for people who cycle to school and work on a daily basis. The bias in geolocation data from big data may therefore limit its use in planning.

1.4.2.2. *Infrastructures*

The second example in the field of transportation concerns the effective impact of geolocation on urban planning through the use of geofencing techniques for free-floating bicycle and scooter sharing platforms in the Île-de-France region, as highlighted by Mangeart (2023). Free-floating vehicles do not have a station where they can be picked up and dropped off. Geolocation is therefore essential to enable customers to easily find a vehicle in public spaces and for the company to maintain them. Both customers and technicians use smartphone apps to manage the vehicles. In Paris, several platforms have been offering this type of service since 2016. They initially took advantage of the regulatory uncertainties at the time to launch their services without seeking authorization from local authorities. The presence of these new vehicles quickly became controversial and led the city of Paris to introduce "codes of conduct". In 2019, the "Loi d'orientation des mobilités" (Mobility Orientation Act) provided the regulatory framework for negotiating two major issues: the occupation of street space and the sharing of digital data collected by platforms.

In fact, these two issues go hand in hand, as a significant portion of the data is geospatial and describes the space traveled by vehicles, which is the central focus of the negotiations. Geofencing functions have been the means by which scooter platforms have developed a strategy for managing this space. Geofencing consists of drawing on a digital map in geographic information software the areas where, by computer programming, scooters must stop, slow down or be dropped off. For example, the City of Paris wanted to reduce the maximum speed of scooters from 20 to 10 km/h in certain areas of the city but was unable to impose this on the platforms. However, the platforms did eventually agree to the gradual introduction of dedicated parking spaces for scooters, outside of which users could not end their journey and leave the scooter. The platforms resisted the introduction of a feature limiting the maximum number of parked scooters, fearing that it would discourage users who might not be able to return their vehicles to their desired location. The physical space of the street is therefore subject to negotiation through its digital transcription, which becomes directly performative at the level of the scooter itself. In this situation, the community's prerogative over physical space is balanced against the power that geospatial data, which only the platforms possess, gives them. However, as Mangeart (2023) points out, the forces are not balanced, especially in small communities. Geospatial skills and tools are on the side of the platforms, which spread their investment across several cities, while communities do not have the means to equip themselves with geofencing tools. It is therefore the platforms that communicate to local authorities the boundaries of the parking areas entered into their system. They also have data on the spatial flows of scooters and on rule violations. They refuse to share this data, citing reasons of cost and underuse by local authorities. However, confidentiality with regard to competitors also plays a role. In practice, free-floating vehicle platforms are in a situation of quasi-self-regulation: "Thanks to their mastery of digital tools, they can take liberties with regulations that local authorities do not have the means to enforce" (Mangeart 2023). This example of Parisian scooters may seem isolated and anecdotal, however, the report by Hansen et al. (2021) shows that the implementation of geofencing measures is spreading across Europe. We can see how digital geolocation translates into both a physical parking space and direct digital control of behavior. Without prejudging future developments, these solutions could become widespread with the growth of shared or autonomous vehicle fleets in the context of traffic regulation in high-risk situations (congestion, pollution, flooding, etc.) or in other situations where access is restricted.

1.4.2.3. *Simulation*

The third example concerns the Waze navigation system, which results in hundreds of cars driving through quiet residential areas in search of the fastest route. Waze is a GPS-based smartphone navigation system developed by the Israeli company Mobile and acquired by Google (Alphabet) in 2013. It claims to have 140 million users worldwide, including 20 million in France. Its unique feature is that it relies on a road network provided by users who can report events or problems during their journeys, which are then received by all connected users in the vicinity. The route is recalculated instantly and very quickly based on traffic conditions. As a result, in the event of traffic jams or roadworks on major roads, Waze tends to redirect traffic to smaller roads or quiet residential streets nearby. For years, groups of residents have been mobilizing against Waze in various ways. The first was digital, reporting on Waze false traffic jams or non-existent incidents on the street concerned. This did not work because more drivers confirmed the new route, and Waze ended up blocking residents' accounts for bad behavior (Furno 2016). The reactions took a physical turn with anti-Waze signs at the entrance to villages. Then the municipalities introduced speed limits, which could work, not necessarily because drivers respected the limit, but because once the maximum speed for the segment was integrated into Waze, the algorithm no longer suggested the route. A one-way system or speed bumps on the road could also work. These are all physical responses to a geospatial problem.

Courmont (2018) explains the nature of the problem very clearly. Waze calculates road traffic based on geolocation and real-time reports from millions of drivers connected to the app across the entire network, from highways to small streets. Traditional methods used by road network managers measure traffic flows at fixed points on their network. These two models differ in their logic but also in their objective. Road managers regulate traffic flows across their hierarchical network so that, collectively, overall traffic flows as smoothly as possible. Waze aims to optimize the individual travel time of each connected driver. In addition, unlike road network managers, it has real-time information on the entire network traveled by connected cars. In the event of a problem on the main road network, it distributes traffic to the secondary network, including residential roads. These two models are actually complementary, as the new route suggested by Waze may not ultimately result in the time savings expected by the driver, given changes in overall traffic flow. Furthermore, Waze does not have information about roadworks or events that block or slow down traffic before its users discover them. In fact, with its Connected Citizens program, Waze offers local authorities access to its traffic data, obtained from the geolocation of its users, in exchange for information about roadworks and street closures. As Courmont (2018) points out, this exchange of data is also an exchange of legitimacy. Local authorities strengthen their ability to regulate traffic by integrating data that they cannot produce themselves. Waze strengthens the trust of its users and becomes part of the official public decision-making system. This example also illustrates how geolocation data always refers to a state of the physical environment that it gradually helps to transform if the data can be aggregated.

1.4.3. *The geospatial logic of local information*

What role do geospatial technologies play in the way individuals manage their local information online, with regard to their living space and place of residence? Numerous tools handle this abundant and highly diverse information. The first local websites to find a wide audience were those offering classified ads between individuals, such as Craigslist in the United States, created in 1996, or Leboncoin in France. To share more regular and diverse local information online, many digital tools also offer solutions: social networks (Facebook, Instagram, Twitter/X), messaging services (WhatsApp), forums (Reddit) and networks specializing in neighborhood connections (Nextdoor, AlloVoisins, etc.). This technological proliferation demonstrates the importance of information exchange on a local geographic basis. It also highlights the difficulty of understanding its scope and nature, given its dual compartmentalization by territory and platform.

1.4.3.1. *Facebook groups and Nextdoor neighborhoods*

Two examples are particularly significant: Meta's Facebook with its local groups, and Nextdoor, the hyperlocal social network run by the company of the same name. In 2010, Facebook gave its members the option to form groups based on shared interests, which led to the creation of local, geographically based groups. There is a total of 10 million Facebook groups worldwide, but there are no figures or definitions for specifically local groups. Herdağdelen and Adamic (2023) were able to use Facebook's internal data to show that the distribution of Facebook groups (local or otherwise) differed regionally in the United States in relation to major sociocultural parameters. According to Zahnow et al. (2024), local Facebook groups in the Brisbane region of Australia are also more numerous and active in affluent, ethnically homogeneous neighborhoods and along the more touristy coastline. At around the same time as local Facebook groups, Nextdoor was created, the first and largest hyperlocal social network focused on neighborhood connections. In 2025, it claimed to have 340,000 neighborhoods and more than 100 million neighbors in 11 countries, including France[8]. Thirteen percent of Americans were reported to be using Nextdoor in 2021 (Auxier and Anderson 2021). According to Iqbal et al. (2023) and Brown et al. (2024), American Nextdoor neighborhoods also tend to be areas where the population is wealthier than average, whiter, more educated and more likely to own their homes. Local Facebook groups and Nextdoor neighborhoods are therefore very similar. They are both owned by large American digital technology companies and aim to meet broadly the same local needs: information sharing, commercial and non-commercial exchanges of goods and services, mutual aid and assistance, neighborhood watch, etc. This similarity likely explains Meta's decision to create Neighborhoods in 2021 in the United States and Canada, a specific feature dedicated to neighborhood relations similar to Nextdoor[9].

1.4.3.2. *Two spatial logics*

However, the two companies operate differently. Creating a local Facebook group is free and its geographical scope is not limited. The group is located using a name freely chosen by its creator, and membership is voluntary. Nextdoor, on the other hand, is based on a predetermined network of areas. The company sets the names and boundaries of neighborhoods, which are displayed on a map. Members are assigned to a neighborhood based on their address, but they also have access to information about adjacent neighborhoods. As a result, while several Facebook groups may coexist in the same space, all services offered on Nextdoor are centralized in the user's Nextdoor neighborhood, including the creation of specific interest subgroups similar to those on Facebook. This difference in organization may explain why the US counties dominated by highly local Facebook groups, studied by Herdağdelen and Adamic (2023), are characterized by a strong presence of local organizations: schools, libraries, scout groups, churches, volunteers, etc., each of which likely has its own Facebook group. In his survey of the Ain department, Trably (2024) confirms for France this link between local Facebook groups and associations or organizations that operate in the area and are the main sources of consultation and dissemination of local information.

In contrast to this plurality of perspectives on an undefined space, the Nextdoor model takes a more territorial approach, as illustrated by the example of San Francisco in 2016 (Payne 2017), when users were able to determine the boundaries of their own neighborhood. Amidst large neighborhoods with historical

8 See: https://about.nextdoor.com/.

9 Meta has said little since then about this feature and how it has been received. It does not appear to have been rolled out to other countries.

or toponymic names (Tenderloin, Lafayette Park, etc.), two tiny "neighborhoods" were added, each corresponding to a luxury apartment building. It was indicative of a small group of wealthy people who aspired to maintain a sense of exclusivity and distinction from their surroundings. This territorial demarcation may also explain the significant controversy surrounding Nextdoor and the prominence of issues such as insecurity, crime and racially based reporting of suspicious activity in the United States and Canada (Kennedy and Coelho 2022; Nextdoor 2024). These issues have led to Nextdoor neighborhoods being described as "digital gated communities" (Kurwa 2019). The reality seems more nuanced, as shown by Brown et al. (2024) for Nextdoor neighborhoods in the United States and Zahnow et al. (2024) for Australian Facebook Local Groups dedicated specifically to neighborhood watch. In addition to the logic of segregation, the minor yet systematic role of surveillance in these digital neighborhood exchanges, and above all the visual and direct nature of its exercise, once again reveal the practical, material and concrete nature of the information shared in these hyperlocal communal spaces[10].

1.4.3.3. *Imprecise geolocation*

There is no need for precise real-time geolocation on this type of geosocial network. On Facebook, geotagged posts or photos mainly concern unfamiliar vacation destinations and very rarely local areas (Trably 2024). On Nextdoor, messages of all kinds are exchanged and filled with topographical indications, but these often remain somewhat vague. Neighborhood, metro station, bus stop, landmarks, etc., are all locational references but do not identify specific locations. Personal addresses are normally only shared by phone or private message. As Trably (2025, p. 347) writes, these local networks form a "local Internet where attachment to the area and mutual acquaintance frame interactions". For her, this "local Internet" is less an expression of a strictly geographical link than of "attachment to the territory through its associative and leisure practices and the mutual acquaintance that characterizes it (...)" (Trably 2024, p. 388). Participants must navigate between two types of hybridized mutual acquaintance: the concrete acquaintance of people who meet in the same places, and the digital acquaintance of local information exchanges. But here again, we find it difficult to separate attachment to a territory from the material and concrete topographical space formed by streets, squares, buildings, fields and forests, which concretely support local activities.

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10 Since 2018 in the United States, the hyperlocal neighbors network has been connecting all owners of connected video doorbells from Amazon subsidiary Ring, enabling them to remotely monitor their doorsteps, send alerts and share videos of suspicious activity with neighbors and police. Visual surveillance is becoming natively geospatial.

While precise geolocation is not necessary on Facebook and Nextdoor, it should be remembered that both companies' business models are based on selling user data and targeted advertising. They have users' IP addresses, email addresses and phone numbers, as well as their geographical location at the neighborhood level and, in the case of Nextdoor, even their postal address. User profiles are all the more valuable to advertisers because they include details of daily activities in the living space. There is a clear contrast between the global scale of the companies that manage these networks and the "localized self" (Trably 2024, p. 375) that they help to generate among their users. These users devote time and energy to building collective local resources that are also useful to isolated individuals or those who have recently arrived in the area. As Trably (2025) notes, the movement calling for people to leave large local commercial networks in favor of tools that are less predatory in terms of data does not currently offer an alternative solution for people who, for a variety of reasons, depend on these large local social network operators.

1.5. Conclusion

In this chapter, we have described geodigitalization as a continuous process. However, certain stages of this process are marked by sociotechnical milestones linked to a series of innovations that are inseparable from companies marketing them, groups disseminating them and users finding uses for them – or not. The utopian project that inspires it is the creation of a computer-simulated replica of the material and mental world. Its purpose and consequences must be questioned. Nevertheless, geodigitalization also takes the form of multiple geospatial operations that change individuals' perception of reality, establish new regulation through the space of interactions and social behaviors and also result in concrete changes in the material environment. However, what we have described concerns only part of the information collected. Alongside computers and smartphones, a growing volume of information comes from what is known as the Internet of Things, that is, all those geolocated sensors that collect various data on their immediate environment: connected speakers, surveillance cameras, environmental sensors, access terminals to buildings and transportation, etc. In addition to all these static devices that directly inscribe computer code into space (Kitchin and Dodge 2011), there are also mobile sensors built into phones and connected vehicles. That said, the informational net that geodigitalization casts over reality is far from being seamless and homogeneous. Furthermore, its density varies greatly depending on the territory (Noucher 2023). It is more like a superimposition of irregular and incomplete grids, with different resolutions. However, mobilizing and combining the grids produced by geodigitalization requires specific engineering expertise, which is only available to large public bodies (and intelligence agencies), as well as large international digital information companies, which also have access to their gigantic proprietary databases. This raises significant concerns for an effective political and democratic regulation.

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