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## Position on urban research and innovation

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# THE FRENCH NATIONAL INFORMATION POINT ON THE CITY

*Position on urban research  
and innovation*

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october 2018



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## PREAMBLE

Urban issues are becoming an increasingly important part of the European agenda. There is a wide range of European programmes that address the urban domain (H2020, URBACT, Urban Innovative Actions, JPI Urban Europe, LIFE, ESPON) and most of them advocate an integrated approach and strong partnerships. Calls for projects thus reach out to a wide variety of stakeholders (researchers, companies, local authorities, developers, architects, urban planners...) to set up collaborative projects. All these actors are strongly in need of an overview of European initiatives, programmes and calls for projects relating to different degrees to the urban sphere. There is also demand for initiatives that promote the emergence of stakeholder ecosystems conducive to the development of partnership projects.

Given these expectations and the complexity of the context, the purpose of the National Information Point on the CITY<sup>1</sup> (NIP CITY) is to reinforce the combined and coordinated participation of French public and private actors in European initiatives, programmes and projects relating to urban affairs, by providing them with a summary of European policies and funding opportunities, and by fostering mutual understanding and cooperation between stakeholders. Its mission is also to contribute to European policies and programmes by helping to promote French positions in the European institutions. NIP CITY's activities are conceived to take place in synergy and in concert with existing national initiatives. NIP CITY brings together national structures and networks of researchers, companies, local authorities and urban planners, as well as the Ministry of Ecological Transition and Solidarity (MTES), the Ministry of Higher Education, Research and Innovation (MESRI), the Ministry of Territorial Cohesion (MCT), and the General Commissariat for Territorial Equality (CGET).

This "Position on urban research and innovation" has been prepared within the framework of NIP CITY'S CITY working group. The members of this working group are French representatives of national research alliances (environment, energy, ICT, social sciences and humanities), of the H2020 Programme Committee, of European programmes (URBACT, UIA, LIFE, ESPON), of professional networks (companies, architects, urban planners), of local authority associations (cities, conurbations, metropolises, regions), of European Initiatives, of competitiveness clusters, of national agencies (ANR, ADEME).

This document was produced through the following process:

- Forecasting documents (see appendix) were collected by the CITY working group;
- The analysis and the summary of these forecasting documents, the preparation of the document plan and the proofreading were carried out by a sub-group: Gérard Hégron coordinator of NIP CITY (IFSTTAR), Jean-Pierre Lévy (CNRS), Denise Pumain (University Paris 1 Panthéon-Sorbonne), Alain Zarli (CSTB), Marie-Claude Dalibard (Club Ville Aménagement);
- The draft document was discussed with the CITY working group;
- The document was written by Gérard Hégron (IFSTTAR) and Jean-Pierre Lévy (CNRS);
- The document was translated from French by John Crisp.



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# 1 - INTRODUCTION

## Background

Most prospective programmes or studies on urban research and innovation in recent years have introduced their subject by reference to the big global changes (climatic, environmental, technological, demographic...) that heavily influence territorial and urban dynamics and give this field of investigation a new and very distinct importance. Not only is this global context still relevant, but the level of intensity and urgency has become much greater: the delay in implementing measures to limit greenhouse gas emissions makes the IPCC's forecasts regarding future climate conditions increasingly inevitable, biodiversity continues to decline and certain resources, such as arable land and water, to become scarce, digital technology has gained a foothold in every field of human activity, producing profound changes, migrations driven by economic, climate or political factors continue to expand (by 2.4% a year on average), etc. The targets and approaches formulated in response to these global changes in the big international agreements (2010 Nagoya biodiversity protocol, COP21 in 2015, Habitat III on housing and sustainable urban development in 2016) therefore remain a frame of reference.

## The problems of change

These targets produce changes that are both necessary and different in nature, steering research and innovation in quite different directions:

- **Transition:** Transition implies perceiving the next state of the system and the pathway needed to achieve it, by planning the technical resources required and devising appropriate forms of governance for them; this seems to be true of energy transition, where quantitative targets can be set (e.g. the proportion of renewable energy in energy production), or decisions made on the measures to be taken in response to climate change (e.g. percentage reduction in greenhouse gas emissions).
- **Transformation:** In the social sciences and humanities, where goals are more difficult to put into quantitative terms, the European Commission proposes the term transformation, which concerns the observation and description of social impacts in the sphere of political, social and economic organization, as well as in historical and cultural heritage and the arts.
- **Disruption:** This term refers to innovation that represents a phase shift, by opposition with incremental innovation that improves existing solutions. It is also a term used by Audacities in reference to the incursion of the new digital operators into the domains of activity of local authorities, emphasising the urgency of the need to revise methods and governance. It is also governance that the European Commission emphasises in tackling the recurrent problems of inequalities and democratic crisis, by encouraging innovations that would make the public sector more agile and citizen focused, and upscaling to efficient and inventive social services.

## Concepts and methodologies

Whether the objective is acquiring knowledge, identifying and solving problems, or designing and implementing innovative solutions, the study of urban systems requires appropriate methodological approaches:

- Different **paradigms** are used to analyse and understand the phenomena at play in urban territories and to resolve the problems inherent in their operation and development: sustainable city, smart city, resilient city, green economy, frugal city, etc. While these concepts offer additional perspectives, analytical frameworks and working methodologies, the goals they serve sometimes differ in their consequences. For this reason, work needs to be done to compare (efficiency, objectives) and harmonise these concepts. Moreover, the question remains whether these paradigms are always commensurate with the challenges, which seem to demand not so much changes as metamorphoses (mutations) in our models of development, of production and consumption, in our values, in our organizations, in our practices and in our lifestyles.
- Cities are objects that connect multiple dimensions – physical, ecological, technical, human and societal – and therefore demand multidisciplinary approaches. However, the hoped-for transitions and transformations will only happen with the development of a **radical interdisciplinarity**, connecting the humanities and social sciences with the environmental sciences, engineering and modelling. Our societies will only become sustainable through a combination of technical and social innovations.
- Growing urbanisation has gradually but radically transformed societies across the planet. Moreover, it is occurring in close interaction with global change (Anthropocene) via multiple networks (urban clusters, cities, multinational companies...), thereby shifting the boundaries of the city and urban issues from the local to the global scale. In addition, the city operates on a variety of timeframes: days, seasons, generations, centuries... The transition and transformation processes will therefore only harmonise through a **multiscale approach**, which connects the different scales, both spatial (from the individual to the local, regional and global levels) and temporal (urgent short-term needs, medium-term planning, and long-term strategies).
- An understanding of urban realities and the transition from knowledge to action cannot be achieved without the engagement of all stakeholders: academics, territorial actors, experts (contractors, developers, architects, urbanists, civil society organizations, consultants...), residents, etc. This **intersectoral approach** also calls for new mediation processes for the governance and coordination of the actors involved.
- While experiments, innovations and projects need to be widely disseminated as models to the cities in order to accelerate the advent of the necessary global changes, it is nevertheless important to take into account the contextual realities of cities and the need for the approaches and solutions conceived and developed by the global players to be adapted to the local context. Every city has its own specific conditions and historical trajectories, which need to be taken into account in order to avoid counterintuitive outcomes from the application of solutions that are perceived as generic and replicable.

## Observation and modelling of urban systems

Most urban research and innovation work requires access to data and results from modelling and digital simulation. The reasoned acquisition of data requires the establishment of proper observatories of urban systems and their associated flows, as well as the development of platforms for storing and processing these data. Facilitating this are developments such as nanotechnology-based microsensors that can be distributed extremely densely, digitally connected objects (Internet of Things or IoT) and the large-scale production of participatory data, whether active or passive. The corollary will be an exponential growth in the volume of data to be exchanged, saved and processed, which raises the question of the quality, design and governance of the network and server architectures that will carry these data streams.

As regards the modelling and simulation of urban systems, there are significant and persistent issues concerning both knowledge production, in particular when it comes to understanding social phenomena and behaviours, and implementation (ex ante and ex post evaluation of urban innovations and projects, decision support...). In this domain, the use of artificial intelligence (AI) systems based on data and automatic learning raises specific problems and ethical questions:

- What part of society is genuinely included? What biases, notably relating to ethnic, economic, social and geographical segregation, are perpetuated, or even amplified, in supervised or unsupervised learning systems?
- What articulation is there with public policies and urban planning? What implicit political choices are embedded in urban infrastructure optimisation tools founded on learning systems?
- What existing legislation frames the deployment of the services and the associated data? Does it need to be changed?

More generally, as the French Technologies Academy recommends, “a frame of reference for Artificial Intelligence would ensure that it incorporated the notion of responsible AI from the very start, by including ethical dimensions and the complex issues of control, certification and testing. This frame of reference could be linked with an Artificial Intelligence watchdog, supervised by a European agency, tasked with tracking and referencing the practices and uses of AI in our society”.

## The priority themes

Eight main priority themes have been identified:

- ***Urban lifestyles: past and future***

The urban lifestyles of today are the outcome of a long historical process on which we can draw to analyse how they mould the spatial organization and practices of the city and are in turn moulded by them. Moreover, they are a major factor that will influence the success of the ecological transition and in particular of the energy transition. In consequence, the digital modelling of individual and collective practices is an essential step towards the development of relevant energy consumption models.

- ***The material and immaterial city***

The material stuff of the city, with its buildings, its infrastructures, its natural spaces, its flows of goods and materials, seems to be the dominant factor in its development and future. However, this is to ignore its immaterial side, comprising information, cultures, values, representations, standards, regulations, digital tools and services, for which the material stuff acts as the medium. It is therefore important to better understand how these two realities interfere and mutually shape each other.

- ***Urban metabolism and resilience***

Cities utilise, consume and process large quantities of goods, materials and energy, which they produce, import or export. The understanding and regulation of all these processes, together called the urban metabolism, are of primary importance in responding to the different associated issues: the degree of autonomy of cities, the circular economy, integrated flow management, the resilience of cities in handling any type of disruption to these flows, logistics and the methods of flow management.

- ***Access to the city and its services***

The location (or relocation) of human activities within a territory, land values, mobility services, the deployment of information technologies and the associated digital facilities, the cognitive, economic or physical limitations of the inhabitants, have a big impact on the development of sustainable mobility practices, on energy consumption, on socio-spatial inequalities, etc. In order to limit the negative effects, the urban planning process would need to take account of all these issues, mobility provisions (including low-energy and/or autonomous vehicles) would need to be coordinated and encourage shared modes, digital inequalities could be attenuated by appropriate training and mechanisms.

- ***Nature in the city, urban biodiversity and ecosystems***

The development of nature in the city represents a response to a range of priorities, which can sometimes be a source of problems and tensions. The first priority is to maintain biodiversity, which requires more preliminary study on assessment methods and on the conditions of its development and adaptability to urban morphology and metabolism. The second relates to the multiple uses and ecosystemic services it affords. And finally, linked with the overall quality of the urban environment, biodiversity is one of the primary determinants of health for city residents. More generally, there is a need to develop and then to implement a fully socialised and politicised ecology (regulation of conflicts over use, management and land ownership).

- ***Governance and economics of urban systems***

Cities are home to different levels of territorial administration and interact with numerous other territories (metropolitan regions, urban clusters) and networks (networks of cities, multinational companies...). These multilevel interactions are therefore an invitation to explore the coherence of urban public policies, to design more democratic forms of governance involving all stakeholders, to identify and exploit opportunities to create new values, to reduce conflicts of competition through better quality of information... Moreover, the development within cities of citizen initiatives, of digital platforms, of community coordinators, etc., requires the development of innovative modes of governance based on citizen participation, social network services and new legal and economic

models.

- ***Governance of innovation***

The ecological emergency requires innovative solutions, arising out of cooperation between operators, managers, politicians and the scientific world. It demands close collaboration between the people who devise these solutions, those who test them, and those who produce and manage them. The technical, urbanistic and social innovations produced through this cooperation entail rethinking the modes of collaboration between these different players and developing real mediation between actors, from the forward assessment of solutions to their ex post evaluation. Moreover, the increasing rapidity with which innovations become obsolete raises governance problems over the balance between modernity and longer term evolution.

- ***Population patterns and energy transition***

The term population patterns refers to the processes and dynamics through which populations are spread across a territory. Residential mobilities are motivated by professional or economic reasons, and by factors associated with housing and neighbourhood quality, household life cycles and social status. By understanding these mechanisms, it should be possible to anticipate and limit neighbourhood gentrification or decline and the concentration of poverty in old buildings (exacerbation of fuel poverty). Inflation in land and property prices in urban centres, notably as a result of interurban and international competition, drives people to live outside employment catchments (urban sprawl, increase in travel distances and car use). Periurbanisation is an issue that affects all cities, regardless of size, by incorporating former outer zones into increasingly socially mixed urban areas, though without reducing social distances. How to bring about an energy transition by population patterns (new options for mobility, housing, subsidies, relocation of jobs and services, etc.) in an urban system that is difficult to monitor, remains an ongoing problem.

## 2 - URBAN LIFESTYLES: PAST AND FUTURE

The term lifestyles refers to the day-to-day behaviours of groups and individuals. These behaviours are related to social position, income and gender, but also reflect the acculturation to models that arise from cultural and family milieus. They very largely depend on technical changes, which are generating new societal demands. The concept therefore relates to a variety of attitudes that develop on the basis of experience and material, social and economic resources. It also possesses a complex temporal depth, in so far as it reflects both the social life of each historical period and the new needs that emerge during the life phases of individuals. Moreover, it includes a day-to-day dimension, because individuals have to adapt their behaviours to the social imperatives of their different living environments, from the workplace to the neighbourhood.

In urban conditions, lifestyles first of all reflect the way that individuals and groups make use of city spaces. The task is therefore first to understand the degree to which spatial organisation influences practices, and second to find ways to adapt this organisation to the lifestyles of citydwellers. This latter question is particularly relevant in the sphere of architectural and urban design, especially as individuals always retain a degree of autonomy and a certain leeway to pursue their preferred practices and to bypass spatial constraints.

More recently, with the imperative of the ecological transition and, above all, the energy transition, lifestyles have once again become a very topical issue. There is a broad consensus that individual behaviours represent an energy cost that needs to be understood and quantified in order to move towards Factor 4 energy efficiency and a zero-carbon city. The issues go beyond spatial practices in the strict sense, extending to residential choices and urban sprawl, travel and modal choice, and alternative transport systems.

Lifestyles are also central to research on biodiversity in the relations between City-Nature and Ecosystems. They are also key to questions about the capacity of individuals to change their mobility behaviours and adopt new modes of transport. Among all these issues, the question of the energy consumption of buildings appears to be one of the thorniest and most urgent, with possible solutions coming through new design techniques and through the renovation of a large proportion of the existing building stock in order to reduce its energy demand.

In all these domains, most experiments show that the current technical responses are inadequate, in particular because of the difficulty of quantifying different social behaviours. The technical models reduce energy practices to a few discrete indicators, which do not reflect the overall logic of social practices by incorporating them as an adjustment variable. On the other hand, although qualitative studies on household energy behaviours are able to describe the processes comprehensively in all their complexity, they are difficult to model numerically. More broadly, combining inductive, deterministic and statistical approaches with mathematical, deductive and stochastic approaches is no easy matter, bringing into play as it does the social sciences and economics, urban ecology and urban engineering in the broad sense.

In this respect, the co-construction of new concepts and new methods to model the causality of practices numerically is essential in order to theorise, simplify and test energy consumption models. This research field is more important than ever. However, it remains largely open and will have to overcome a number of obstacles in its development.

The first is the availability of data, since we do not currently possess qualitative and quantitative databases relating both to the technical characteristics of material objects (from buildings to transport) and to energy-related behaviours. The second is the static nature of the approaches, which means that the models fail to incorporate the impact of the flexibility of household practices on consumption. The third obstacle is the disconnect between heuristic models and models that focus on design support, which brings in the crucial issue of global generic models and their failure to take into account the diversity of local contexts.

### 3 - THE MATERIAL AND IMMATERIAL CITY

Long approached as a material reality made up of continuous built spaces, of voids and solids, the city is now conceived more in its immaterial dimensions because of the rapid development of digital networks that are profoundly altering its production, its management and its uses. The cities that have gone the furthest in introducing networks are sometimes called "smart cities". Innovative technologies are being extensively used to promote new ways of approaching the sustainable city through ecological urban design. One of the central goals is to use these digital infrastructures to achieve efficient and rapid energy regulation with the aim – under the Horizon 2020 programme – of reducing cities' greenhouse gas emissions. Eco-neighbourhoods act as laboratories for this new ecological and digital urbanism. The intention is that these experiments should be extended to urban planning in the broad sense, in particular as applied to public spaces, new buildings and renovated structures. They have the benefit of driving the emergence of innovative projects, while at the same time alerting the scientific and operational communities, as well as citydwellers, to the risks of overreach in the digitised production and management of the smart city.

Here, new technologies are used to monitor the urban metabolism, in order to reduce the quantity of natural resources consumed by urban activities and the discharge of toxic substances into the city and its environment. Managing waste, monitoring water resource systems and reducing fossil energy consumption are among the priority areas for the use of digital technologies. In other words, the new digital infrastructures contribute to the production of resources and their maintenance through urban recycling. Their spread undeniably support the ecological transition by helping to fight the loss of urban biodiversity. Nonetheless, the endogenous and artificial reproduction of large metabolisms by the integrated digital management and recycling of waste (water, solids...) raises certain questions. These projects often seek to emphasise the presence of nature through the introduction of green and blue networks, sometimes supplemented by urban farming systems sustained by the re-use of the resources consumed by city residents. At the same time, however, they construct a doctrine around the symbolic values of an artificialisation of nature in the city, while contributing to a growing uniformity of urban spaces.

In addition, the drive to develop a smart environment is profoundly altering the way buildings are now produced. Complex models are used to develop standards that dictate the materials, structures and shapes of buildings needed to fulfil the imperatives of low-energy consumption. The new buildings thus contribute to energy transition and the reduction of greenhouse gases. Yet on the other hand, architectural design is placed under increasingly strong constraints that erase the aesthetic and contextual specificities of the built environment. The demands of low consumption also apply to existing buildings, which need to meet the new energy regulations, raising the question of the position of architectural heritage within the smart city. What is the future of old buildings in a city subject to the rapid development of digital networks? Given the inertia of urban renewal, what can be done to preserve a legacy that cannot adapt to these new technologies? And what can be done to manage a composite city characterised by the coexistence of eco-designed and energy-intensive buildings?

Moreover, this energy management also encourages into the domestic space, where the aim is to improve the regulation of heating and household appliances. This in itself implies acceptance of and

social adaptation to this new environment. However, the immaterial city can only work through the physical infrastructures that carry the digital networks. This implies both that households have the financial resources to acquire the new technologies and the acculturation to their use. Which means that smart cities introduce a degree of discrimination, still to be quantified, in access to urban modernity. It also implies the need for new legal rules to protect privacy, given that digital networks can be used to monitor multiple different aspects of the everyday lives of individuals. This is already an issue with the obligation to install domestic smart meters, a process that has already raised fears and tempers, as well as expectations of better energy regulation by the utility companies. It also applies to CCTV cameras in public spaces, where questions over anonymity arise in the event of a major public risk. There is a conflict between, on the one hand, the imperative need for an energy transition to secure the future of humanity and of the city, managed partly at local level by digital infrastructures and, on the other hand, their negative impact, real or imagined, on the health and privacy of individuals.

The immaterial city is therefore synonymous with the rapid spread of new digital technologies that challenge the functioning of the current urban system. In the coming years, the introduction of these technologies into the urban production chain will affect all urban professionals: architects, developers, builders, managers, politicians... The use of digital infrastructures running on algorithms designed by engineers indirectly raises the key question of who makes the modern city. What will tomorrow's city be like, organised by a shifting set of actors, which includes the engineers who develop the digital tools, the operators and designers who use them, politicians, but also citydwellers themselves, who will be required to adapt to the use of the new technologies at the risk of seeing their individual freedoms undermined?

## 4 - URBAN METABOLISM AND RESILIENCE

### Urban metabolism

Societies, and in particular cities, are major consumers of goods, materials and energy, whether directly on their territory or indirectly through the materials, goods and services they import or export. The term urban metabolism thus refers to all the processes whereby cities marshal, consume and process these resources. These processes relate to the inflows of construction materials, water, food products and fuels, but also the outflows of finished products, emissions and waste, part of which is discharged in the form of solid, liquid and gaseous emissions into the water, the air and the soil, thereby contributing to the emergence of biogeochemical cycles. These flows of materials and goods are essential to the functioning of the city, while at the same time generating severe problems (pollution, congestion). In addition, they are usually managed separately.

The underlying challenges relate not only to understanding how cities function and their interactions with the biosphere, but also to action for the future, for example: the spatial and temporal relations with the sources of supply (tracking inflows and outflows, the city's autonomy/dependency with regard to the resources it uses), flow circuits (the circular economy), interlinked models of flow governance such as those associated with the convergence of energy sources and networks (nuclear, fossil, renewables...) and with the sharing of energy consumption points (transport, buildings, industry...), urbano-agro-industrial synergies, the relations between inequalities and the vulnerability/resilience of territories, short supply chains, conflicts over the use of space (new models of urban planning: residential, commercial, logistics), etc.

### Resilience

The study of urban metabolism is of great help in the analysis of the environmental role of cities and their resilience. Whether disaster-related (short-term episodes such as heatwaves, storms, coastal flooding, supply interruptions...) or more gradual (medium and long-term processes such as climate change, economic crises...), any event that disrupts the dynamics of these flows makes the city vulnerable, with increasingly graver consequences in terms of economic costs or social breakdown. The vulnerability of cities and the associated risks need to be studied systemically, at the same time taking into account the city's physical, functional and socio-economic vulnerability, and the interactions and feedback loops operating at different spatial and temporal scales. In particular, the growing dependency of urban trajectories on population patterns determined by remote actors (economic, financial, political) requires systematic observation and modelling, applied to changes occurring in groups of cities differentiated by their size, functions and locations in different territories, over the short, medium and long term.

Resilience is a way of thinking about the trajectories of urban systems as the combined outcome of long-term processes and often unforeseeable – or at least unforeseen – shocks. It is particularly necessary in this context to study the development of a governance and an engineering of transformation and of adaptability that accepts fail soft modes, particularly with respect to the

existing legacy fabric (buildings, networks, infrastructures) and the social and health risks associated with food, energy or environmental crises.

## Logistics

The study of urban metabolism also casts light on logistical challenges by considering the activities that generate them in terms both of the materiality of the city and of the productive activities that form it. The transition from an economy that is highly resource intensive and largely linear (“extract-make-consume-discard”) to a more frugal and circular economy (“reduce-reuse-recycle”) is a major goal. The associated logistical issues relate therefore to the volumes and distances of flows, to the location of the city’s supply sources (e.g. local services to encourage short supply chains) or waste sorting or recycling sites. They also relate to the methods of managing these flows, to the optimisation of travel routes and loading, but also to the pooling of flows of materials or products, the integrated management of the flows of materials in the city, or else the hybridisation of freight and passenger flows. These issues also call for a change in citizen behaviours and support for professionals in making the necessary alterations (e.g. expanding circular economy practices). They need also to be analysed in terms of the introduction of the new digital services, which are significantly altering the itineraries of goods flows: the uberisation of freight transport which disrupts the collaborative principle, e-commerce, the Physical Internet...

## 5 - ACCESS TO THE CITY AND ITS SERVICES

### Day-to-day mobility and spatial practices

The social and spatial practices of urban residents are closely linked with residential location and therefore with the land and housing markets, with the location of economic and social activities, with the configuration of transport infrastructures and services, and with the explosion of information and communication technologies and services. The latter, associated with the advent of “sustainable practices” are helping to transform mobility services and user practices: sharing modes (ridesharing, car sharing...), active modes (walking, cycling...), combined modes (intermodal), tele-services (e-commerce, teleworking...).

Despite these virtuous trends, the private vehicle use continues to grow and travel practices often remain resource intensive. Efforts are therefore needed on understanding and regulating this phenomenon and, more generally, on the future of mobilities in connection with changes in transport modes, in user behaviours and lifestyles, notably with reference to ICT and social networks, population ageing, new attitudes to the car, etc. Particular attention needs to be paid to peripheral and low-density urban areas. The energy efficiency of vehicles and transport systems is still a line of research where the focus is on vehicle economy, whatever the technology (hybrid vehicles, electric vehicles, gas, hydrogen...), on transport networks and their interconnections, on the new digital infrastructures for mobility management (smart roads and transport infrastructures, fifth generation roads...). The advent of autonomous vehicles, a hybrid of individual and service mobilities, will ultimately lead to a new logic of mobility regulation. Further study will be required regarding its mode of governance (public/private, coordination of mobility services) and deployment zones (prioritisation of dense urban areas, connections with lower density areas...).

### Access to services

Land and property prices place constraints on residential location choices, usually distancing people from their places of work. The relocation of companies, public offices, shops or any other private or public service also produces the same effects. The spatial inequalities that result from this are reinforced by the increase in the duration and cost of transport. Urban planning processes need therefore to be updated to take account of the issue of the relocation of housing, transport infrastructures, and industrial and service zones (use of diagnosis and evaluation methods).

In addition, we are witnessing an explosion in digital services that notably help to attenuate these spatial inequalities (teleworking, e-commerce, online public services...). This raises the question of designing digital systems and services that are accessible to as many people as possible. What efforts should be made for the illiterate, for the blind, for those who are culturally on the other side of the “digital divide”? This requires the development of an in-depth understanding of the cognitive and physical barriers involved and of the mechanisms at work in using the services (ergonomics) and in representing information (understanding and interpretation of data, especially sensitive data such as those connected with health or environmental risks).

The first corollary to the previous point is the need to think about the development of instruments of basic and continuing instruction, of universal education and scientific and technical support. This is also a democratic issue, to do with providing everyone with the necessary intellectual tools to grasp the political and ethical questions associated with digital technology: the limitations of digital tools and artificial intelligence, the question of data ownership and privacy protection, etc. The second corollary is the capacity to develop spaces for cooperation between research and urban practitioners on the co-creation of values and innovations.

### **Residential mobility**

Residential mobility (household or individual changes of residence) is a field of study in itself, which needs to be explored against a background of change, as evidenced by demographic shifts (in particular population ageing and migration), by the growing complexity of life trajectories, by the diversification of lifestyles and by different economic crises. It can be seen as an indicator that helps us to understand other problems, such as day-to-day mobility, urban transformations (periurbanisation, gentrification...), regional disparities, regional development policies (the presential/residential economy) and the different urbanistic models (attractiveness of neighbourhoods arising from urban densification or regeneration operations, impact of urban morphology on mobility practices, etc.).

## 6 - NATURE IN THE CITY, BIODIVERSITY AND URBAN ECOSYSTEMS

Nature in the city, which in some cases espouses and in other cases shapes the urban fabric, represents a valued resource (legacy and recreational value, a factor of sociability, attenuation of the effects of heat islands, agro-ecology, etc.) or conversely a source of problems or even of major tensions (urban management, health issues, land conflicts for developers wanting building land or residents wanting accommodation, etc.). It is therefore a vehicle of differing representations and interests (conflicts of use, of management, of land), which says much about urban society and its practices. Apart from the recording and tracking of species (flora and fauna), this is a fully socialised – not to say politicised – ecology that needs to be brought to light through the identification of ecosystemic uses and services, the establishment of a typology of urban practices, the definition of the land status of the sites concerned, and the necessary articulation between the different political levels and the public and private actors of urban projects.

While some of the roles played by “nature in the city” are beginning to be better understood, significant gaps remain. The first concerns how animal and plant species adapt to urban conditions. Recent studies have shown, for example, that the size of certain insects evolve in response to the dispersal of areas of vegetation or to higher temperatures (heat islands). Such research therefore needs to be pursued to further understanding of how fauna and flora acclimatise and adapt to urban conditions (air, water and soil pollution, light pollution, noise, etc.), to rising temperatures, to the fragmentation of natural spaces, etc. The second gap concerns our understanding of the interactions between urban ecological networks at different spatial and temporal scales, and the often limited connectivity between the components of these networks to allow the movement of species. Little work in this domain has been done on the permeability of the urban milieu to biodiversity, although this question has serious implications for planning at both local and regional scale. One of the major issues concerns the link between land-use and biodiversity. In particular, the central and multifunctional role of urban and suburban farming needs to be better studied and measured, and compared with other forms of land use.

Other important research fields include:

- The classification and comparison of methods of assessing (measuring) biodiversity, and the sensitivity of the results to the quality and volume of data available;
- Exploration of the role of collective engagement in the production of biodiversity, the revival of collective action at local and metropolitan scale thanks in particular to the pooling of local initiatives;
- The development of urban ecological engineering, founded in particular on the production of new data regarding plant and animal species (biodiversity legacy), on their adaptation to urban conditions and on the functioning of urban socio-ecosystems, and the development of innovative methods;
- Ecosystemic services as a component of the well-being of urban residents, and therefore the question of access to these services (and inequalities of access). Ecosystems, which provide human societies with many services, are an object of growing scientific interest. However, the research is often sectoral and fails to consider the different interactions and feedback loops between the

main categories of services: supply, regulation, social, cultural, sensory (urban ambiances) and landscape-related... New approaches in this field are therefore needed for the threefold purpose of knowledge, evaluation and collective action.

- The development of crosscutting approaches that seek (i) to support the necessary development of more formal consensus between actors on what is “valuable” in terms of biodiversity legacy, landscape aesthetics, history, services, economics... and (ii) to confirm the relevance of territorial contributions, in particular local initiatives, to the global objectives.
- The environment is one of the main determinants of individual and community health (a quarter of illnesses and deaths are attributable to environmental factors). Some disorders are more specifically linked with urban milieus (cardiovascular conditions, allergies, obesity or stress) and characterised by significant spatial disparities. Moreover, cities are primary focal points for the spread of illnesses (vector-borne diseases, epidemics), in certain cases linked with planetary environmental changes and the growing globalisation of exchanges. On the other hand, in the poorest countries, the presence of health facilities in cities tends to make urban health conditions superior to those in the countryside. Health in the city therefore represents another important field of investigation. In a context of growing urbanisation, it would seem to be essential to explore the relations between urban interdependencies, urban ecosystems and health. Such studies should be able to draw, in particular, on large-scale epidemiological surveys.

## 7 - GOVERNANCE AND ECONOMICS OF URBAN SYSTEMS

### Governance of urban systems

The canonical forms of regulation as broadly understood (rules, incentives, evaluation...) rely on a conception of nested spatial and institutional scales running from the local to the global or vice versa. This picture has been altered by the rise of environmental concerns within our societies, in at least three ways: by the rescaling of the phenomena, by the lack of coherence in the public environmental policies conducted at different levels of territorial administration, by the perceptions and representations of citydwellers. There is therefore a need to explore the different aspects of multilevel forms of democratic governance that largely remain to be invented, with particular emphasis on the diversification and proliferation of stakeholders (or their spokespersons): public and private actors, civil society, residents, future generations... One of the fundamental questions inherent in this mode of so-called participatory governance, where strategies of influence or pressure are often present, is to know who really governs and makes the decisions.

### Networked cities

In calculations of urban metabolism, in the quest for technical solutions for ecological transition, as well as in reflection on the governance of cities, one picture tends to dominate the debates, which is the idea of the isolated city, in charge of its choices and of its future. Yet in the modern world, swarming as it is with networks (city clusters and metropolitan regions, networks of cities, an urban-suburban-rural continuum, multinational corporate networks...) that generate interactions and influences at all scales, as well as competition between cities and territories, research is needed to improve our understanding of these multiscale interactions and influences. Whether it be multinational corporations, big digital platforms, or else geopolitical agreements or epidemic, ideological and cultural contaminations, the effects of networks on the future of cities are still very poorly understood and greatly underestimated. Yet these interactions and influences act not only as constraints that allow urban decision-makers less room for manoeuvre, but also as opportunities that could be grasped in order to create more values, of all kinds, by better exploiting the resources of these networked cities.

### Innovative governance

Territorial authorities need to develop new skills in order to assume their role as mediators and interfaces between the different urban stakeholders, as designers of platforms for the acquisition and storage of urban data, as managers of the community.

Civil society and citizen organisations are taking on numerous issues (adaptation to climate change

such as the Transition Towns movement, urban farming, local commerce, integration and social bonds, adoption of public spaces, et cetera.) and producing alternative solutions based on local forms of reappropriation.

Citizen participation requires not only digital social networks, but also in the longer term the construction of collectives (networked local initiatives) to imagine and construct change, collectives that research can help to create. In fact, these initiatives usually originate in users and consumers, whereas a much higher value could be placed on the legitimacy and capacity of citizens to intervene in the urban future. The priority is to support and build upon these citizen initiatives, without necessarily institutionalising them, so that they can realise their full potential...

### The governance and economics of the new urban systems and services

New urban systems or services are gradually emerging, such as urban data management platforms, circular economy practices, tertiary real estate, multimodal mobility, etc. However, the question of the governance and economics of the systems remains open.

For example, what measures can be taken to support the emergence of urban data operators? This role encompasses data collection (mostly operators of IOT networks), then data storage (mostly data centres) and finally processing choices (High Performance Computing, grid). The proliferation of competing actors is not conducive to efficient data handling. For collection this is clear, since there are several networks that operate on the same frequency bands without coordinating. For storage and processing, it is the lack of control of data quality, the lack of standardisation, notably with open data, the different storage locations, which limit the potential for these data to be processed and cross-referenced. Moreover, it is very difficult to regulate a heterogeneous set of actors, particularly on matters of data privacy. Reflection on the convergence of technical and administrative solutions, bringing together public authorities, private organisations and citizens, is a major objective, since it should encourage:

- the establishment of both legal and political entities that are subject to data law, capable of maintaining data integrity, security and long-term viability;
- the orchestration of access to data and efficient data handling, in order to give free rein to research, innovation, the sharing economy and planning. Among the different processes possible we can cite different levels of digital design and simulation, real-time or ex-post urban management and supervision (mobility, security, energy...), services for citydwellers and city users.

Without answers to these questions, these activities will become concentrated in the hands of a few digital actors (e.g. the GAFA) with an obvious loss of the European countries' economic and political sovereignty.

Concomitant with the question of the governance of urban systems or services, there is the issue of their economics and their viability. What new values do they offer (service offering)? What sources of revenue do they generate (who pays whom, and how much)? What is their target clientele (service users)? What are their consequences in terms of ecological sustainability, social cohesion?

The issues around business models and political decision-making processes should not be neglected and postponed for subsequent consideration, disconnected from the ongoing technological R&D.

## 8 - GOVERNANCE OF INNOVATION

The damaging impact of human activities on the biosphere means that urban governance activities need to be embedded in the frameworks of ecological and energy transition. The task now is to develop and devise forms of eco-design in urban planning, i.e. in the production of public spaces, large infrastructures or new neighbourhoods.

This new type of planning largely takes place under the pressure of ecological emergency, which forces leaders, technicians, researchers and engineers to come up with rapid and inventive solutions to reduce the damage caused by the city to its environment. The innovative techniques proposed are therefore not simply laboratory products: they need to meet the needs of operators and be tested so that their real effects can quickly be assessed. As a result, urban research ceases to be pure investigation, and becomes the outcome of a necessary cooperation between operators, managers, politicians and the scientific world. This shift alters the status of innovation and experiment in the approach to research. A new process develops, a sequence of ecological imperative/innovative response/disparity with demand.

The effects of certain innovations can be assessed through real-world experiments. In eco-neighbourhoods, for example, the impact of selective waste collection and recycling, ecological heating methods, mobility systems, energy consumption measures, can be assessed as soon as a project is completed... The effects of new infrastructures, new domestic appliances and ecological urban design on a project's overall energy and environmental footprint can be evaluated: fossil fuel consumption, impact on fauna and flora, CO<sub>2</sub> emission rates... If there are significant disparities between the estimated outcomes and the real impact of the innovations, improvements can quickly be made.

On the other hand, some innovations cannot be tested in situ and require periods of laboratory study. This is the case, for example, for new buildings or heat islands. Here, the use of models is unavoidable. They can be seen as tools of mediation between the operators who set the project objectives and the researchers and engineers charged with finding the means to meet them. This method is particularly appropriate in the field of eco-construction. Here, the models are based on deductive approaches, and the hypotheses are developed in concert with engineers, designers and producers in the broad sense (architect, promoter, urban planners and sometimes politicians). In addition to the buildings themselves, consumption models are also used to develop standards for low-energy construction. It is only once construction is completed that the real impact of the model will appear. If there are differences between the predictions of the model and actual consumption, their causes will need to be identified in order to adjust the variables and coefficients, or to introduce other factors into a new model. Then, however, the standards – and above all the buildings produced from the initial model – will seem obsolete in the urban landscape in relation to new proposals that are more innovative than their predecessors.

The pursuit of ecological innovation at all costs thus disrupts the whole chain of urban production. A new urban governance is gradually being established, in response to ecological emergency and societal pressures. Urban production, in an instantaneous continuum between research/experiment/materiality is transforming all the urban professions, imposing collaborations between the actors who produce the city, those who manage it and those charged with inventing it in response to

the environmental emergency. How can we ensure the success of the technical and urbanistic innovations co-produced by the different urban professions and resulting from new forms of collaboration? What working methods, what vocabularies, what crosscutting practices will help these different actors to achieve mutual understanding? Within this new framework, can real or virtual experimentation genuinely mediate between the different actors and is it enough of a solution on its own to produce consensual innovation? Finally, what kind of governance will work for an ecological city exposed to the accelerating pace of technical and urbanistic innovations? Especially if we recognise that novelty is, by definition, ephemeral and inevitably left behind. In this sense, is not the governance of an innovative ecological city simply a matter of accepting a choice – paradoxical and insoluble – between modernity and its corollary, ever faster technical, formal and material obsolescence?

## 9 - POPULATION PATTERNS AND ENERGY TRANSITION

In its broadest sense, population patterns refer to the processes whereby populations are distributed in space. These processes are always a mix of mechanisms of stability and mobility. By measuring these two factors together, it is possible to understand and anticipate the construction and rhythms of change of social, demographic and, indeed, ethnic characteristics on a given territory. It is therefore a dynamic notion in so far as the distributions are always part of a process, although maps provide a snapshot of a given state of affairs.

In any case, the notion changes according to the scales at which it is applied. Population patterns can relate to a country, or a region, a metropolis, a city, a neighbourhood or of a building. Each of these scales relates to demographic dynamics, but above all to attractions and repulsions that entail specific mobilities. For example, national population patterns are determined by distinct migratory phenomena for different countries of origin or destination, but population structure essentially evolves through natural balance effects. It is at the lower levels that the impact of mobilities is most visible. For example, trends in regional population patterns are very sensitive to the effects of so-called long-distance mobilities, generally motivated by employment factors. On the other hand, within metropolitan areas, cities or neighbourhoods, most households undertake short distance changes of residence motivated by housing-related factors: quality, neighbourhood, size, etc. Residential mobility is also associated with the big stages of household lifecycles: couple formation, births, deaths, etc. At each of these stages, dwelling size is adapted to household size.

In addition, there is a connection between residential position and social position, in so far as the home neighbourhood or the quality of the dwelling represents a status. Population patterns are therefore a tricky social issue because of unequal spatial spread. Forms of social coexistence produce concentrations of rich or poor households that raise direct questions for urban governance. The political sphere is interested in the development of research into how poverty or wealth become embedded, in order to anticipate or even limit neighbourhood gentrification or decline resulting from events such as economic booms or crises.

The notion of population patterns is also associated with the ecological and energy transition. From the environmental perspective, the distribution of populations in space is part of the problem of residential encroachment into natural areas. Urban sprawl raises the question of why households move away from urban centres. Here, property developers share the same objectives as first-time buyers. The commodification of the city leads to inflation in land and property prices in urban centres, making city centre homes unaffordable. As a result, estates of detached family homes have proliferated in peripheral zones, right up to the rural margins. This dynamic of metropolitanisation brings former peripheral zones – sometimes impoverished – from the outskirts into the ambit of the city. It is a process that is happening in large and mid-size cities, as well as smaller towns, in each case reflecting the specificities of the location, but nevertheless leading to a homogenisation of urban forms, with a multiplication of residential and commercial centres. It is therefore no longer unusual to see estates of middle-class and executive houses, rundown apartment blocks and ageing secondary hubs standing side-by-side in urban space. This apparent social mix does not, however, lead to a mixing of populations through spatial practices, because of social inequalities in access to mobility and the difficulty of enjoying urban resources for people who do not have access to their own vehicle.

So households no longer hesitate to move outside employment zones. Population patterns then become a strictly residential problem, unconnected with job policies. It would therefore seem pointless to try to limit urban sprawl by housing policies focused on the “return to the centre”. How can residential and job location be brought closer together in a context of insecurity, where homeownership is a safe investment? Is there not a mismatch between the stated desire of developers and politicians to prevent metropolitan sprawl, and the means available to them to counter job insecurity, rising city centre property values, and promotional practices that feed aspirations for residential autonomy? In a word, how can ecological transition be achieved through population patterns in an urban system that is hard to control and characterised by an interplay of complex social, financial and economic factors?

In some ways, urban sprawl links the problem of ecological transition to that of energy transition. The withdrawal of households from zones of employment, the distancing of residential locations from shopping areas, encourage the use of the car for commuting and more generally for day-to-day activities. In this respect, population pattern practices raise questions about mobility and mobility modes. The issue here is to encourage alternative forms of transport that emit less CO<sub>2</sub>. However, it is also about planning: given the impossibility of effectively controlling residential withdrawal from the centres, can one anticipate the introduction of peripheral infrastructures that will reduce the need for car travel?

However, it is above all in the concentration of poverty in ageing buildings that population patterns and energy transition come together. Socio-residential distributions are determined by the property market and the possibilities available to households to find decent living conditions. Yet the housing system pushes the poorest households towards the oldest and most energy-intensive segments of the housing stock, combining social exclusion with energy poverty. Indirectly, the existence of these buildings constitutes a “security valve” in the property market, by offering alternatives to people without access to the ordinary housing stock. However, their presence contributes to the persistence of these buildings in cities. Public policies thus find themselves facing a twofold constraint, needing to provide financial support to poor households to help them manage the energy costs associated with old housing, while at the same time seeking to eradicate the buildings that provide them with homes. Within the question of energy, therefore, the problems of population patterns, housing and poverty come together.

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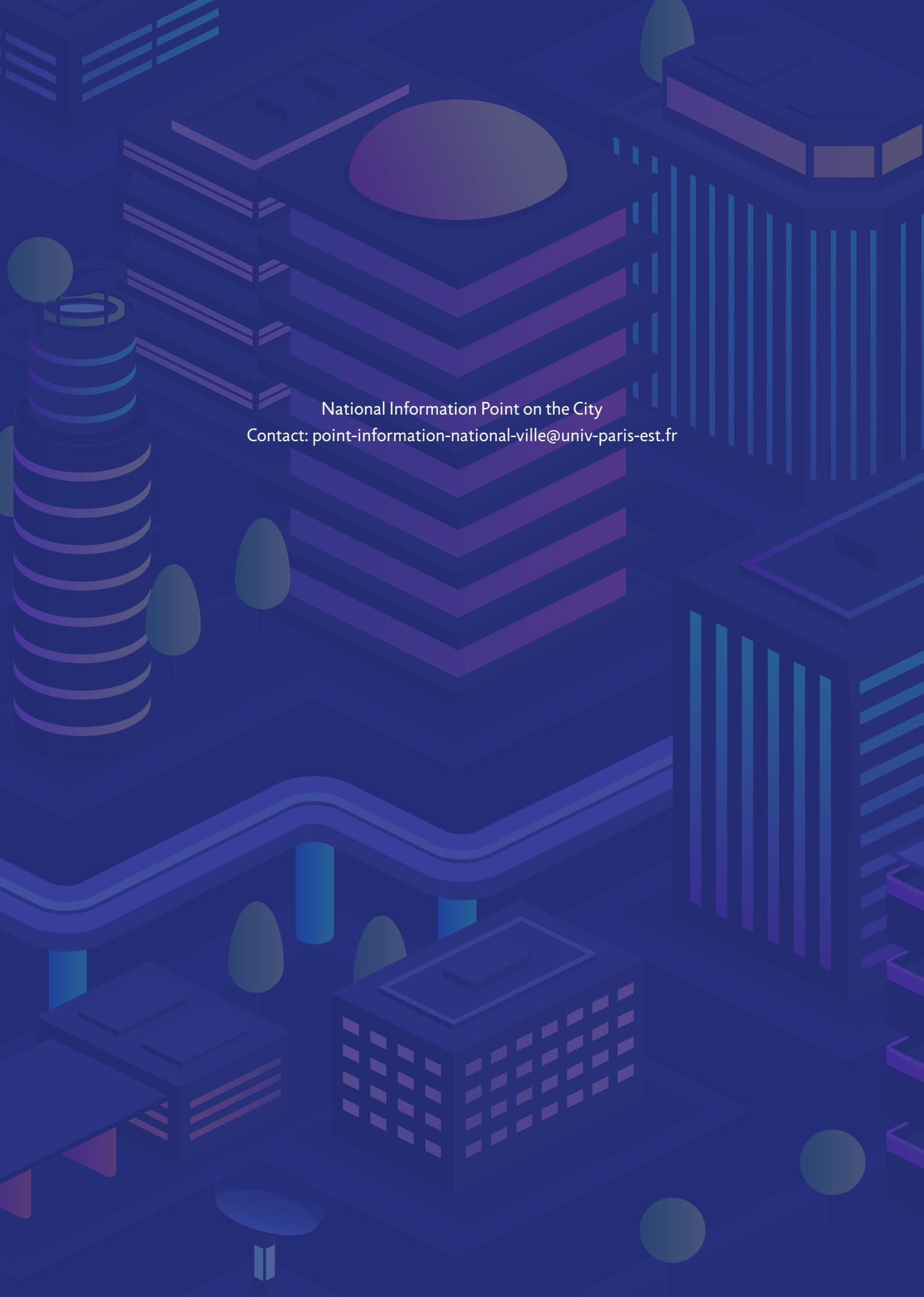
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An isometric illustration of a cityscape in shades of blue and purple. The scene features various buildings, including a tall cylindrical tower with horizontal bands, a large multi-story building with a grid of windows, and several smaller rectangular structures. Stylized trees and a large circular shape are also visible. The overall style is clean and modern.

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