85TH SESSION UNECE GLOBAL FORUM FOR ROAD TRAFFIC SAFETY (WP1)
Agenda item d (iii) - Road Traffic of the future: Challenges and perspectives in the cities

Geneva (CH) Thursday September 22, 2022

Urban fragilities and prospects in the 21st century

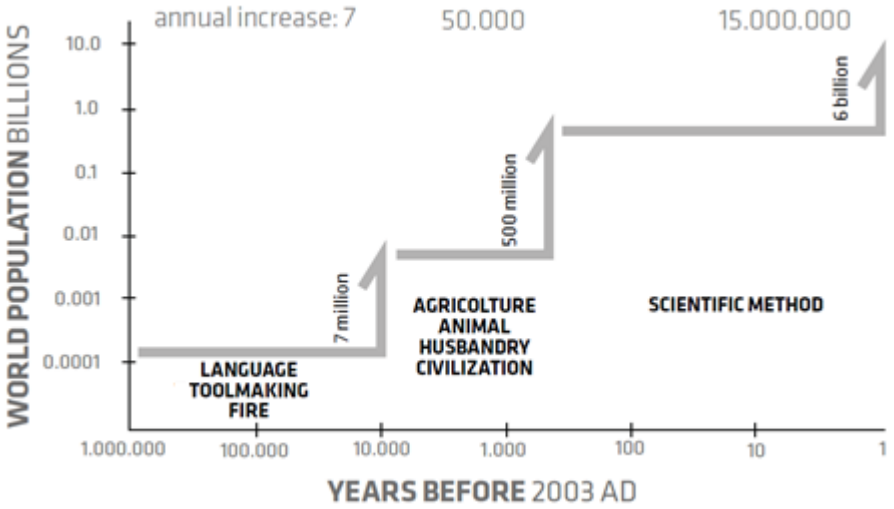
Federico Cinquepalmi (Ph.D.)
Full professor of Project Management

SAPIENZA
UNIVERSITÀ DI ROMA

According to the United Nations demographic statistics service, 2010 marked a real turning point in human history. That year the number of people inhabiting urban areas (3.42 billion) surpassed that of those living predominantly in rural areas (3.41 billion). In 1950 only 30% of humankind lived in urban areas, while projections for the year 2050 predict that 68% of the world population will live in cities, indicating an increase of 84%, passing from 3.4 billion at the end of 2009 to 6.3 billion in 2050.

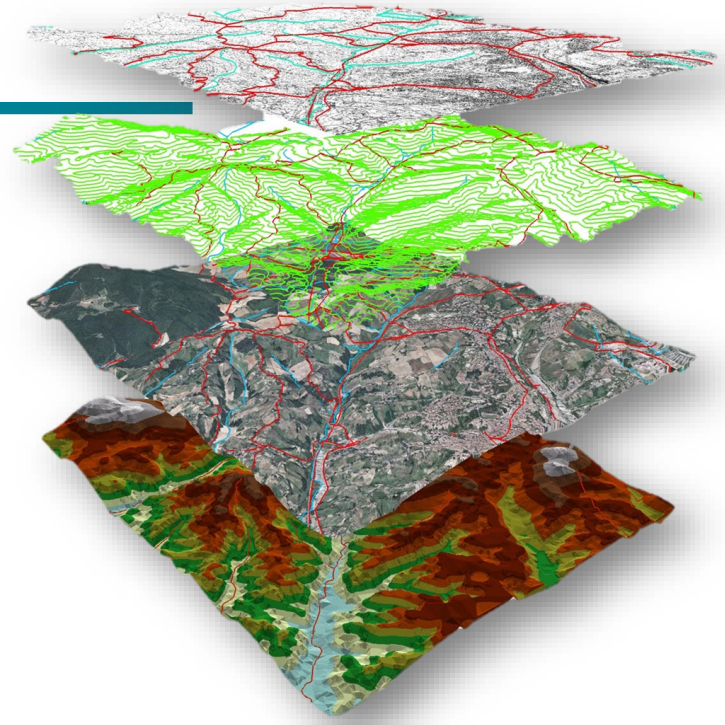
THE WORLD'S TEN LARGEST CITIES IN 2018 AND 2030

City size rank	City	Population in 2018 (thousands)	City	Population in 2030 (thousands)
1	Tokyo, Japan	37 469	Delhi, India	38 939
2	Delhi, India	28 514	Tokyo, Japan	36 574
3	Shanghai, China	25 582	Shanghai, China	32 869
4	São Paulo, Brazil	21 650	Dhaka, Bangladesh	28 076
5	Ciudad de México (México City), Mexico	21 581	Al Qahirah (Cairo), Egypt	25 517
6	Al Qahirah (Cairo), Egypt	20 076	Mumbai (Bombay), India	24 572
7	Mumbai (Bombay), India	19 980	Beijing, China	24 282
8	Beijing, China	19 618	Ciudad de México (México City), Mexico	24 111
9	Dhaka, Bangladesh	19 578	São Paulo, Brazil	23 824
10	Kimki M.M.A. (Osaka), Japan	19 281	Kinshasa, Democratic Republic of the Congo	21 914

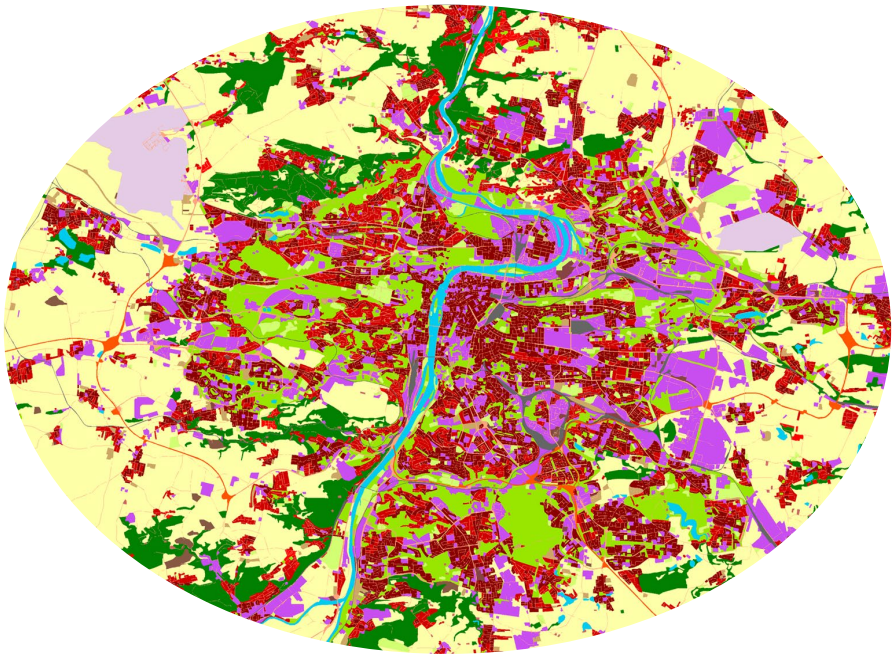


Annual increase in human population (estimated) from the Neolithic period to the present day

(2003 data) Deevey, E. S. (1960). Graphic revision from source: The human population. Scientific American CCIII: 195-204.



Cities in the XXIst Century are the focal point of complex problems ranging from the adverse effects of global warming, climate change, and the consequent aggravation of physical and psychological health problems, inequality, and alienation, reduction of economic opportunities, social fragmentation, and conflicts.



Cities are nowadays living laboratories, experimental sites for co-producing innovative solutions to contemporary global challenges, transforming emerging problems into opportunities, in order to define a model of urban development consistent with the objectives of the Smart Growth of Society

In line with UN Goal 11 of the 2030 Sustainable Development Goals (SDGs)2, stating that there is the need of: "Making Cities Inclusive, Safe, Resilient and Sustainable"3.

Urban metabolic approach

Urban metabolism is an approach describing and analyzing the in and out flows of materials, energy and waste of the city

Using a metabolic approach to analyze an urban system, in other words looking at the city as a living organism, and therefore approaching the urban growth using the logic and analytical tools applicable to living beings, seems to be a valid starting point, not only to understand the complexity of contemporary urban dynamics, but also to be able to mitigate the negative impacts generated and/or connected with cities.

The application of the integrated urban metabolism model is aimed at identify and quantifying the flows of inputs such as water, energy, materials, nutrients and outputs, namely heat dispersion, pollutants and waste.

URBAN METABOLISM	
Categories	Description
NATURAL FACTORS	These include the geographical location of the city and the spatial and climatic characteristics associated with it, including the type of natural resources present and the geomorphology of the city. These factors have a major influence on energy consumption.
FUNCTIONAL ROLE OF THE CITY	For example, the type and intensity of the main economic activities. Industrial cities tend to have higher metabolic flows than financial or political centres.
INCOME LEVEL	Which also affects the quality and quantity of urban metabolism.
URBAN POLICIES AND MANAGEMENT PRACTICES	They have the potential to make a difference. Cities have also been identified as important reservoirs of strategic materials such as copper and iron, and the literature on industrial ecology has examined the potential of urban extraction in relation to the consumption of natural reserves of these resources.
URBAN PLANNING AND DESIGN CHOICES	That is, the importance of the spatial distribution of buildings and infrastructure, the influence of which directly impacts on choices related to transport systems, the energy efficiency of buildings and the heat island effect.

Urban Fragilities, an overview

- **Extreme climate events**
- **The demographic issue and the challenge of the ageing society**
- **The challenge of migrations**
- **The challenges of pandemics in urban societies**

Global changes intended broadly as demographic transformations, climate change, extreme weather events, health crises and energy challenges must be assessed taking into account the need to ensure the management of urban metabolic functions, while at the same time ensuring the preservation of the quality of the urban environment.

Scientific community, predict an increase in the average global temperature between 2 and 3 degrees within the 21st century, which implies that the Earth will experience global unprecedented changes, at least considering the last 10 000 Years.

CLIMATIC PHENOMENA	MAIN IMPACTS EXPECTED ON URBAN AREAS
Increase in daytime and night-time temperatures	- Reduction of energy demand for heating - Increased energy demand for cooling - Decrease in air quality - Impact on winter tourism
Increase in heat waves	- Reduction in the quality of life for people in warm areas
Increase in heavy rainfall events	- Disruption of settlements, trade and transport due to flooding - Impact on urban infrastructure and real estate
Increase in drought-affected areas	- Water shortages for inhabitants, industries and services - Reduction in energy production potential, especially hydroelectricity, but also nuclear and fossil fuels - Potential increase in migration phenomena
Increase in tropical storms	- Damage due to flooding and high winds - Disruption of public water supply - Potential increase in migration phenomena
Sea level rise	- Flooding in coastal areas - Decrease in freshwater availability and saltwater intrusion - Potential increase of migration phenomena

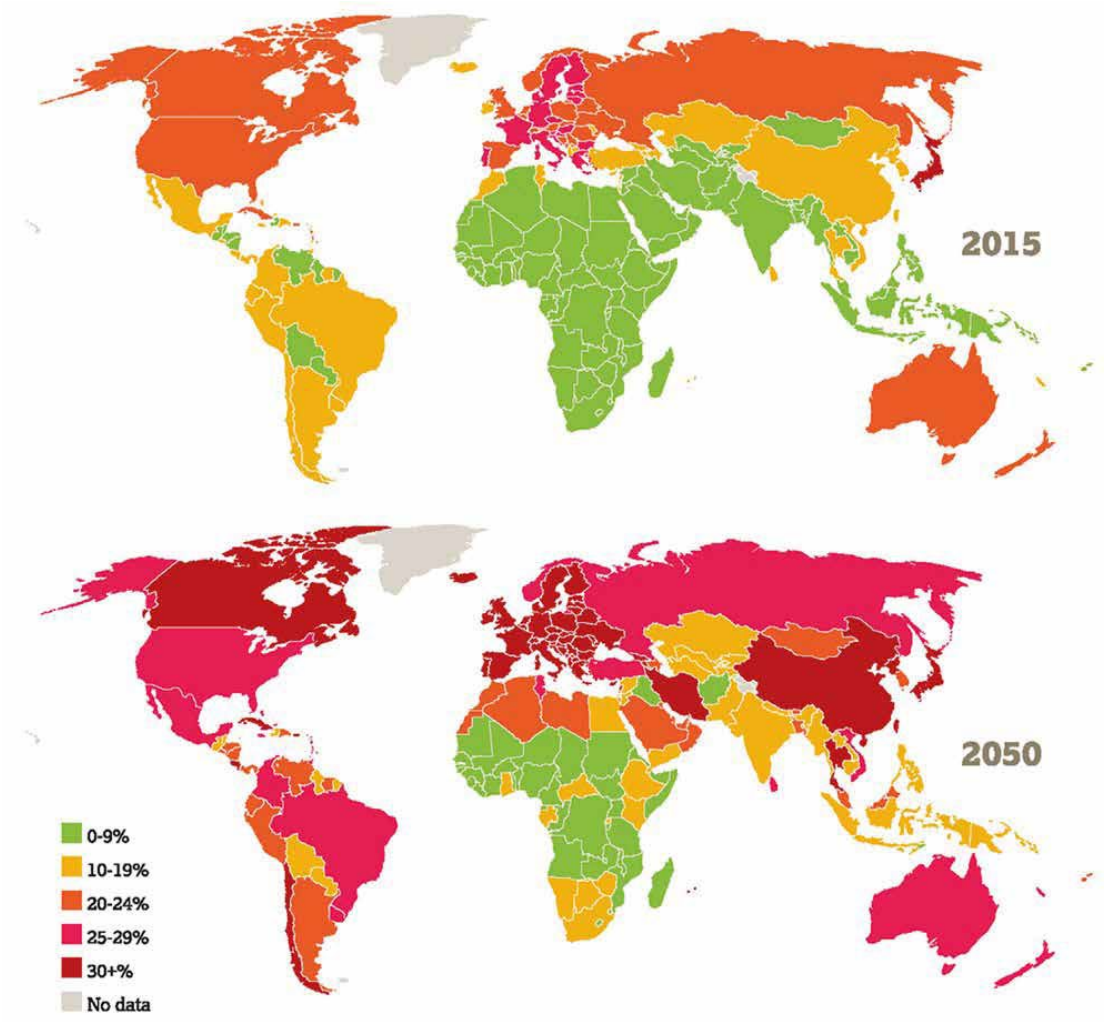
Urban Fragilities, an overview

- **Extreme climate events**
- **The demographic issue and the challenge of the ageing society**
- **The challenge of migrations**
- **The challenges of pandemics in urban societies**

	LIFE EXPECTATIONS AT 65							
	male				female			
	2016	2060	2070	prog.	2016	2060	2070	prog.
EU27	18.1	22.6	23.4	5.3	21.5	25.8	26.6	5.1
IT	19.1	23.0	23.7	4.6	22.5	26.3	27.0	4.5
	LIFE EXPECTATIONS AT TIME OF BIRTH							
EU27	78.3	84.9	86.1	7.8	83.7	89.2	90.3	6.6
IT	80.7	85.9	86.9	6.2	85.3	90.0	90.9	5.6

Comparative projections (EU27 and Italy) on life expectancy at birth and at 65 years
Source: Commission services based on Eurostat 2015-based population projections (European Commission, 2018 ®).

The demographic decline of mature economies is counterbalanced by Africa's demographic explosion, will ensure that Europe continues to be a major destination for migrants in the future



Evolution of the population over 60 in 2015 and 2050. (The World Population Prospects: 2015 Revision)

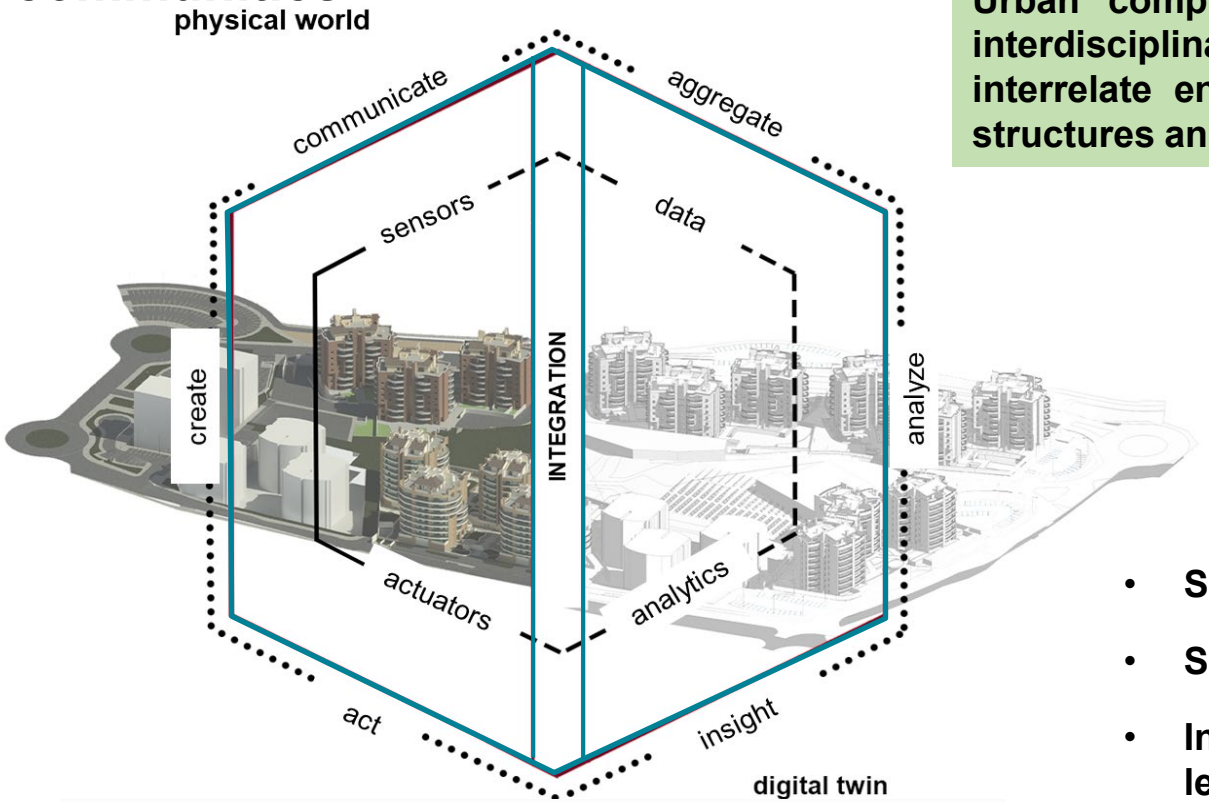
Urban Fragilities, an overview

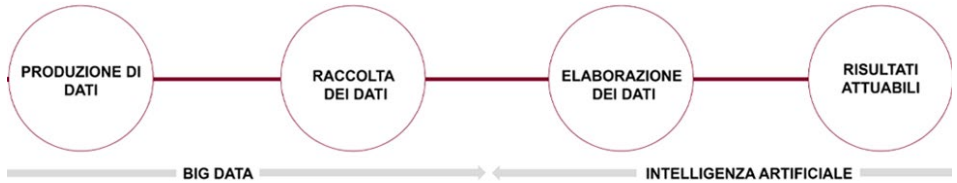
- **Extreme climate events**
- **The demographic issue and the challenge of the ageing society**
- **The challenge of migrations**
- **The challenges of pandemics in urban societies**

SUB-THEMATIC CATEGORIES	MAJOR ISSUES REVEALED BY THE PANDEMIC	MAJOR RECOMMENDATIONS/IMPLICATIONS FOR POST-COVID PLANNING
1. Smart cities	1.1 Smart solutions have contributed to developing more effective and efficient response and recovery measures (e.g., identifying and isolating infected individuals, reducing human-to-human contacts in service delivery, etc.)	1.1.1 Public access to real time and geo-referenced data enables better response and recovery from adverse events
		1.1.2 Techno-driven approaches should not undermine privacy issues and be misused to reinforce power relations
	1.2 Techno-driven approaches have been successful in containing the virus, but have raised concerns regarding privacy protection and transparency	1.2.1 Human-driven approaches are more suitable for citizen empowerment
		1.2.2 Combined approaches are better suited for containing the pandemic, dealing with privacy concerns, facilitating coordination and information sharing, and controlling the spread of misinformation
2. Transportation	2.1 Increased transport connectivity is a risk factor that may contribute to the diffusion of infection diseases	2.1.1 Smart mobility restrictions, based on the transmission risk of different transportation modes, is essential for containing the spread of the virus
	2.2 Public transportation may increase the risk of transmission during pandemics	2.2.1 More attention to minimizing potential public health risks of public transportation is needed
	2.3 The pandemic may increase negative attitudes towards public transportation	2.3.1 Modal shift to cycling and walking offers a unique opportunity to further promote active transportation
3. Urban design	3.1 Density alone is not a key risk factor contributing to the spread of the virus	3.1.1 Better access to amenities and public health infrastructure make high-density areas less vulnerable to pandemics
	3.2 Some cities lack appropriate levels of green and open spaces to meet outdoor exercise and recreation demands of their citizens while fulfilling social distancing requirements	3.2.1 Considering multiple other benefits of compact urban developments, planners should continue promoting them
		3.2.2 More space should be allocated to pedestrian areas and open spaces

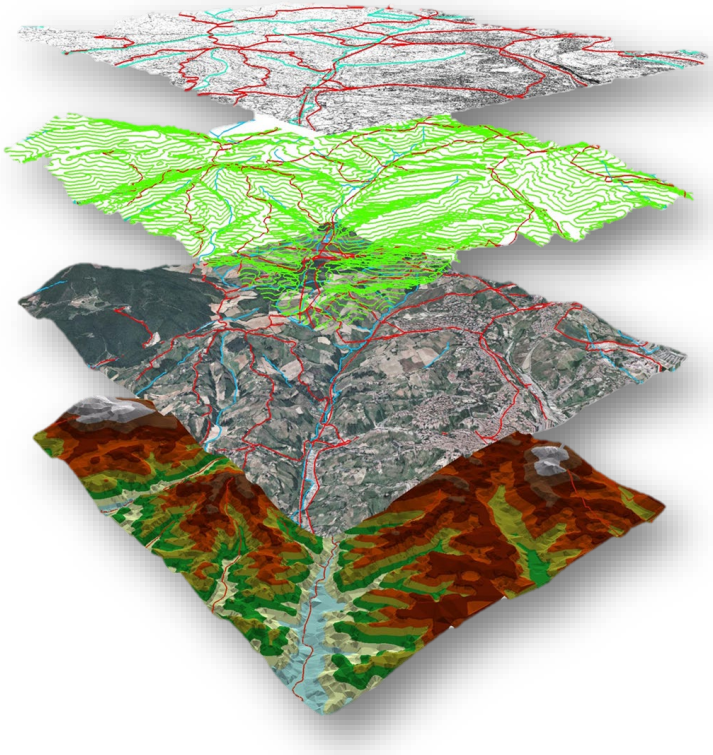
Major issues revealed by the pandemic and Major recommendations/implications for post-COVID-19 planning (Sharifi A., Khavarian-Garmsir A. R. 2020) .

Technological systems, digital tools, and smart grids serving urban communities





Urban complexity forces us to adopt an interdisciplinary approach, in order to interrelate environmental quality, quality of structures and services, and quality of life.



- **Smart grids and microgeneration**
- **Sustainable mobility technologies**
- **Information management systems for teleworking, e-teaching and e-learning and telemedicine**
- **Managing urban environments with Digital Twin models**
- **Earth observation: the EU Copernicus programme**

DI ARCHITETTURA E PROGETTO
SAPIENZA UNIVERSITÀ DI ROMA

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

The most promising path to ensure that citizens remain on board and actively engaged in the present urban mobility and digital transformation seems to be to promote new attitudes towards the interactive digitalization of mobility.

Technological systems, digital tools, and smart grids serving urban communities

Sustainable mobility technologies

Cities and metropolitan areas are today also considered major driving forces for national economies, and competitiveness is also measured by assessing the efficiency of services (mostly those connected to mobility), livability, and opportunities offered by major cities. Those sectors have direct influence on the quality of life in urban areas, as well as on air quality, road traffic and general accessibility to services. Cutting-edge infrastructural policy must start from a few basic objectives:

- **strengthening** and integrating local, regional and national public transport systems, particularly promoting **rapid mass transit rail systems** (metros and trams);
- **creating the conditions for cycling and walking**;
- **making available innovative digital tools** applied to urban and extra-urban mobility in order to **promote shared mobility services**.
- The availability of **accurate and timely information**, together with information and communication technologies, makes possible the application of increasingly effective and comprehensive **predictive and control models**.

The most promising development concerns the Internet of Things (IoT) as most modern vehicles, both public and private, can provide traffic data (Extended Floating Car Data) continuously and at low cost. They can also interact with each other, as well as with public transport systema and overarching control infrastructures, in order to increase safety, security and efficiency.

Intelligent Transport Systems (ITS) are recognized as **key tools to address transport safety, emissions, and congestion,** and the integration of existing technologies can be important in boosting jobs and growth in the transport sector. Work is already underway to implement the next generation of ITS solutions through the **development of Cooperative Intelligent Transport Systems (C-ITS).** C-ITS are systems able to share data through wireless technologies, connecting each other, as well as with road infrastructures or with other road users. These systems when able to realize full digital connectivity will be fundamental for improving road safety, traffic efficiency, and driving comfort. Connectivity, cooperation and automation, growing synergically and reinforcing each other, will in time reach full integration.

The most promising path to ensure that citizens remain on board and actively engaged in the present urban mobility and digital transformation seems to be to promote new attitudes towards the interactive digitalization of mobility.

Technological systems, digital tools, and smart grids serving urban communities

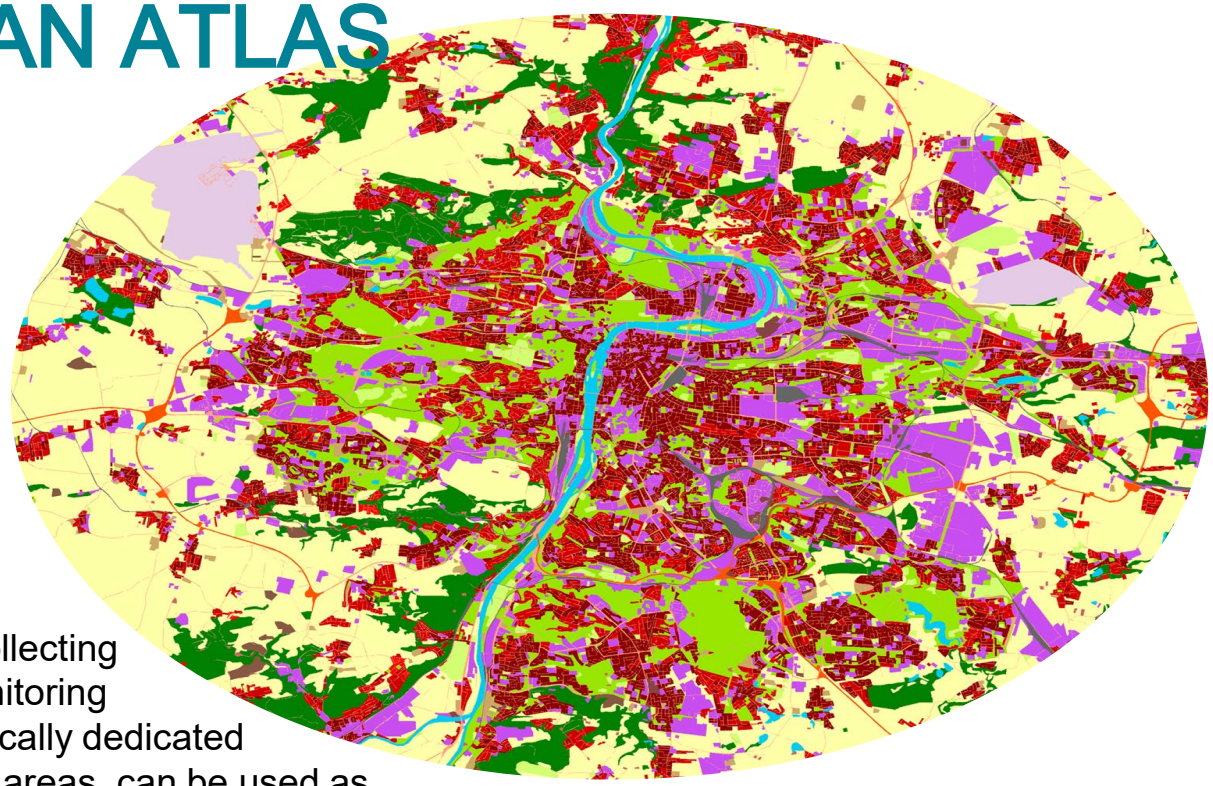
Sustainable mobility technologies

Cities and metropolitan areas are today also considered major driving forces for national economies, and competitiveness is also measured by assessing the efficiency of services (mostly those connected to mobility), livability, and opportunities offered by major cities. Those sectors have direct influence on the quality of life in urban areas, as well as on air quality, road traffic and general accessibility to services.

Intelligent Transport Systems (ITS) are recognized as **key tools to address transport safety, emissions, and congestion,** and the integration of existing technologies can be important in boosting jobs and growth in the transport sector. Work is already underway to implement the next generation of ITS solutions through the **development of Cooperative Intelligent Transport Systems (C-ITS).** C-ITS are systems able to share data through wireless technologies, connecting each other, as well as with road infrastructures or with other road users. These systems when able to realize full digital connectivity will be fundamental for improving road safety, traffic efficiency, and driving comfort. Connectivity, cooperation and automation, growing synergically and reinforcing each other, will in time reach full integration.

The potential benefits of a strategic approach to Smart Mobility are clear, **but the real advantages for cities will be significant only if Smart Mobility involves all city mobility actors and infrastructures, as well as a large part of citizens' movements**.

EU URBAN ATLAS



The European Commission's URBAN ATLAS project monitors urban systems in Pan-European space. In 2020, the Copernicus Sentinel Data Access System supported over 380,000 registered users, a daily publication rate of over 38,700 products/day and an average daily download volume of 405 TiB. A total of 405 million products have been downloaded by users since the start of data access operations in 2016 for a total data volume of 240 PiB (82.8 PiB of which were downloaded in the year 2020 alone).

Land Use – Minimum scale 1: 750,000

- Continuous Urban Fabric (S.L. > 80%)
- Discontinuous Dense Urban Fabric (S.L. : 50% - 80%)
- Discontinuous Medium Density Urban Fabric (S.L. : 30% - 50%)
- Discontinuous Low Density Urban Fabric (S.L. : 10% - 30%)
- Discontinuous Very Low Density Urban Fabric (S.L. < 10%)
- Isolated Structures
- Industrial, commercial, public, military and private units
- Fast transit roads and associated land
- Other roads and associated land
- Railways and associated land
- Port areas
- Airports
- Mineral extraction and dump sites
- Construction sites
- Land without current use
- Green urban areas
- Sports and leisure facilities
- Wetlands
- Arable land (annual crops)
- Permanent crops
- Pastures
- Complex and mixed cultivation patterns
- Orchards
- Forests and semi-natural areas
- Water bodies

Functional Urban Area – Maximum scale 1: 750,000

- 2012 data available
- 2012 data not yet available

Nomenclature of Units for Territorial Statistics (NUTS) Level 3

- Minimum scale 1: 3,000,000
- Maximum scale 1: 750,000

The Urban Atlas, collecting data from Land monitoring services and specifically dedicated to monitoring urban areas, can be used as a basis for several further uses, such as monitoring air quality over the cities as well as evaluation of the prior and post conditions of buildings, infrastructure and transport, after disastrous events (earthquakes or extreme climatic events)

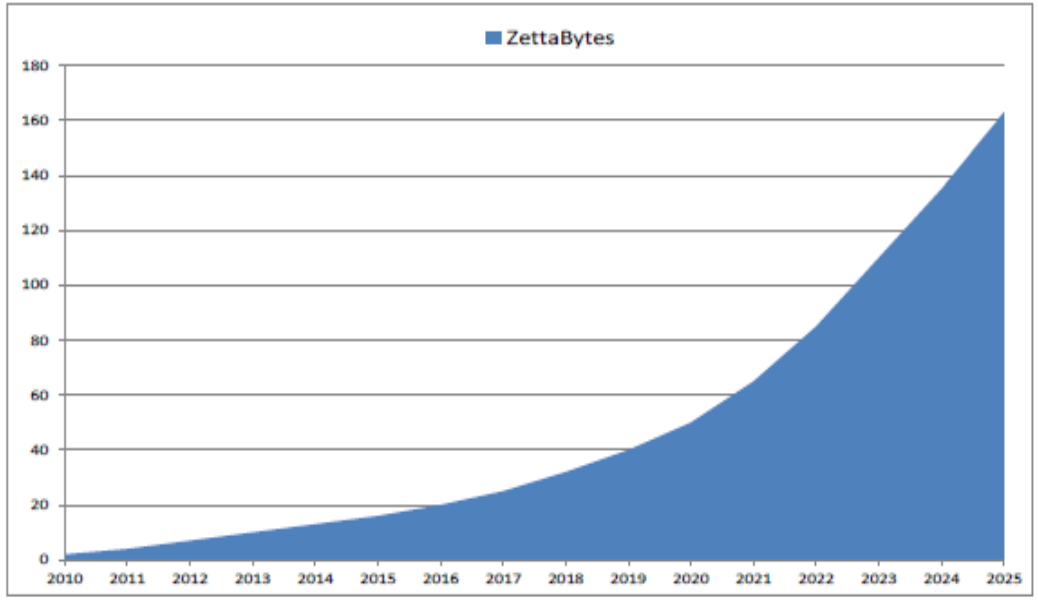
Discover the Copernicus Services:

Marine Atmosphere Security Emergency Climate

more about our partners

Dipartimento di Architettura e Progetto
Sapienza Università di Roma

The only limitation to the development of a DT in the built/urban environment is the data collection and storage capacity and of course the relative computing capacity. AGCM calculates that the flow of networked data will grow to 163 ZB by 2025 from 53 to 98 Petabytes per day in 2020. and 11.57 billion connected devices to date



Digital twins are therefore not only descriptive, but thanks to the continuous flow of data and the support of artificial intelligence algorithms, they become predictive models with the same operating logic as meteorological forecasting models. Within this framework, smart grids play an essential role. The smart grid can be an energy or transport network, but also a water supply or waste disposal network.

The New Frontier of development for urban civilizations certainly **includes digital and technological evolution**, but it does not consider technology to be the final answer to all contemporary cities' problems. The formidable challenges of the COVID-19 pandemic have thrown existing urban fragilities into stark relief. At the same time however they have highlighted the potential of digital solutions for reaching a new level of interconnected civility.

Cities **must evolve by adopting the principles of the circular economy** in the higher interest of their citizens' well-being: they must consume therefore without devouring, recycle as much as possible what they metabolize, limit the effects of their ecological footprint and ultimately lead their inhabitants, with maternal guidance and care, to a new idea of citizenship. The citizens of (R)evolving cities will abandon their predatory approach, reaching a higher stage of integration (R)evolving cities are above all 'polite' cities, or rather cities whose citizens are consciously educated in the principles of sustainable development, the essential basis for contemporary civil coexistence.

DIPARTIMENTO
DI ARCHITETTURA E PROGETTO
SAPIENZA
UNIVERSITÀ DI ROMA

My research activities in the field of built environment management, led to several scientific publications and, in particular, to a book (published in Italian in 2019 and re-edited and updated in English in 2021), dedicated to the analysis of urban fragilities and the integrated digital tools of their management. Within the framework of such research, embedded in the metabolic approach to the urban environment, a new paradigm for defining the urban built environment has been developed, namely the (R)evolving city.

Both publications are fully available online and free of charge at the following addresses:

La Città Fragile:

https://issuu.com/dida-unifi/docs/la_citta__fragile_cinquepalmi

Toward (R)evolving Cities:

https://issuu.com/dida-unifi/docs/towards_revolving_cities___federico_cinquepalmi

Dipartimento
di Architettura e Progetto
Sapienza
Università di Roma

UNITED NATIONS
ECONOMIC COMMISSION
FOR EUROPE

Thank you for you attention

Grazie per l'attenzione

Dipartimento
di Architettura e Progetto

Sapienza
Università di Roma