

**PROCEEDINGS**  
of the  
**INTERNATIONAL CONFERENCE**  
on  
**CHANGING CITIES VI**  
*Spatial, Design, Landscape, Heritage & Socio-economic Dimensions*

**CHANGING  
CITIES**



**Changing Cities VI, Rhodes, 24 - 28 June 2024**

Edited by  
**Prof. Aspa Gospodini**  
*University of Thessaly, Volos, Greece*

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*Rhodes Island, Greece, June 24-28, 2024*

**Organised by**

Research Unit of Urban Morphology and Design,  
Department of Planning and Regional Development, Faculty of Engineering,  
University of Thessaly, Greece.

**in collaboration with**

Department of Mediterranean Studies, School of Humanities,  
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**Prof. Aspa Gospodini**  
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## PREFACE

The series of international conferences on *CHANGING CITIES* aspires to bring together urban planners and designers, architects, landscape designers, urban geographers and historians, urban economists, urban sociologists, and urban policy makers, and investigate new challenges concerning cities and their future. The conference aims at becoming an international forum of transaction of ideas on cities' transitions. We have so far organised six conferences, with peer-reviewed Proceedings, taken place always in June, in venues with unique urban and natural landscape, built heritage and place identity.

- *CHANGING CITIES I: Spatial, Morphological, formal, and socioeconomic dimensions, 18-21 June 2013, Skiathos Island, Greece.*
- *CHANGING CITIES II: Spatial, Design, Landscape and socioeconomic dimensions, 22-26 June 2015, Porto Heli, Peloponnese, Greece.*
- *CHANGING CITIES III: Spatial, Design, Landscape and socioeconomic dimensions, 26-30 June 2017, Syros Island, Greece.*
- *CHANGING CITIES IV: Spatial, Design, Landscape and socioeconomic dimensions, 23-28 June 2019, Chania, Crete Island, Greece.*
- *CHANGING CITIES V: Spatial, Design, Landscape, Heritage and socioeconomic dimensions, 20-25 June 2022, Corfu Island, Greece.*
- *CHANGING CITIES VI: Spatial, Design, Landscape, Heritage and socioeconomic dimensions, 24-28 June 2024, Rhodes Island, Greece.*

All Changing Cities conferences have been welcomed by the academic community worldwide, usually attracting about 300 presenters from many countries - Greece and Europe, USA and Canada, Latin America, Middle East and North Africa, Asia, Far East, and Oceania. On this basis, we believe the 6th Changing Cities conference will also be a successful academic event.

The 6<sup>th</sup> Changing Cities conference puts an emphasis on the transformations of cities related to climate crisis; the main theme is '*Climate Crisis. Cities' transitions towards smart & green development*'. Cities are on the front line of climate change. First, cities are the main contributors to climate change due to concentration of population and various human activities such as industrial activities, people's everyday mobility and transportation of goods, etc. – all of which increase the flow of heat-trapping greenhouse gases into the atmosphere. Second, the impacts of climate crisis on cities are dramatic; Cities need to cope with the unprecedented challenges of climate crisis such as wild wood fires, floods, extreme weather conditions such as heat waves, heavy rainstorms, land drought, etc. Thus, cities as 'guilty' constituents to climate change, must also become vital protagonists in mitigating climate crisis. In this framework, the 6<sup>th</sup> Changing Cities conference welcomes the academic discussions on specific measures and policies of green and smart development of cities.

This year, about **350 abstracts have been submitted** from universities, research institutes, governmental organisations, and Ministries of environment from all over the world. In the conference, **will finally be presented 265 papers**. Among them, **54% of the papers have been authored by foreign academics** while **46% by Greek academics**- indicating the international character of the conference. For the first time the 6<sup>th</sup> Changing Cities Conference includes about 60 remote presentations organised in last day of the Conference mainly involving young researchers, PhD candidates, postgraduate students who faced difficulties to cover traveling expenses. The Conference Program includes **20 special sessions** that have been pre-organised by distinguished researchers enriching the academic discussion on portraying the impacts of climate crisis on cities and

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highlighting green and smart urban actions and policies to mitigate the negative effects of climate crisis.

I would like first to thank the Organising Committee, the keynote speakers, and the members of the international scientific board who supported enthusiastically the academic organization of this conference – and especially those colleagues who have also pre-organized special sessions in this conference.

I would like to show our gratitude to all the academic supporters – **University of Thessaly, University of The Aegean**, and **IsoCarp** (International Society of City and Regional Planners).

I would also like to express our gratitude to the sponsors of this conference - namely **The Green Fund** politically supervised by **the Greek Ministry of Environment and Energy; The Secretary General of the Aegean and Island Policy in The Greek Ministry of Maritime Affairs and Insular Policy**; and **the elected Regional Authority of Thessaly**.

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## Methods and techniques for the governance of resilient territories: the case study of the City of Matera.

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### Abstract

The new challenges related to climate change invite us to reflect on the choices to be made in urban areas. Technology and new scientific advances can not only be used to make the city function better, but also to achieve sustainability goals. To do this, new technologies must be added to 'ancient' knowledge, confirming that the objectives set must be able to exploit all available knowledge. Urban sustainability cannot ignore the recognition of the city as a public and social good, activating urban, infrastructural, and resource distribution policies aimed at consolidating density and intensity between physical space and the space of flows. The city is not just 'nature', which is why the urban ecosystem is assumed to be similar to 'an ecosystem in transition', the dynamics of which are determined by human action, the reaction of natural elements and mutual conditioning. The green and digital transition is based on sustainable development principles and should become an activator in enhancing the attractiveness of territories, also affecting the tourism sector worldwide. Tourism resilience implies providing unique cultural and natural experiences and digitally facilitated booking and travel planning, avoiding an imbalance in the tourism ecosystem. In 2022, the European Commission presented the 'Transition Pathway for Tourism', a plan jointly created with the tourism ecosystem players that details key actions, objectives, and conditions to be realised with the involvement of the tourism community. In this way, tourism and business development opportunities can be revealed in territories that contain, in their very marginality, new resources to bring about lasting change. Matera is known as the city built into the stone, an example of historical resilience, a UNESCO heritage site, and European Capital of Culture in 2019. In this area, humans have been able to adapt the territory according to their needs, exploiting the workability of tuff (Gravina calcarenite), a calcarenitic sedimentary rock that characterises the entire Murgia plateau and the Murgia Materana. However, the transformations of the territory combined with new climatic emergencies and large tourist flows entail risks to which it is necessary to respond with innovative targeted techniques. The surveying, mapping, and monitoring of the built environment are indispensable for understanding phenomena that develop on an urban scale such as water management in the light of climate change. A smart vision of the city is proposed inspired by the Sustainable Development Goals (SDGs), in particular the protection and eco-sustainable promotion of the territory (SDG 15), the availability and smart management of water resources (SDG 6), and the promotion of actions to combat climate change.

**Keywords:** resilient city; risk mitigation; sustainable and digital transition; smart tourism; Matera

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## 1. INTRODUCTION

The theme of the city is gaining more and more importance in the political debate because of the renewed planning attention imposed by urban policies, for their capacity to open up to the processes of European integration, and as far as the cities of the South are concerned, for their capacity to propose themselves as an anti-crisis factor investing themselves with an essential role in the success of territorial and social cohesion policies. Culture penetrates the life of the city and the social sphere, and discussions are held on the knowledge of space as a project of social anticipation, moulding sensitivities and thoughts on the city and the territory, as has happened in the past in the laboratory of the city of Matera.

Today, the relationship between city and territory is once again being discussed in Italy. Every time the structure of the economy and society changes, the urban issue returns to the foreground. Matera is an interesting observatory for studying several phenomena: it is a creative city, a destination for fast-growing national and international tourism and, therefore, continually subject to human action, but at the same time a city with a serious infrastructure deficit and a geomorphological conformation that is particularly exposed to hydrogeological risk. Matera can once again become a laboratory of policies to help understand what the role of a medium-sized European city can be at a time when the values of urbanity are being tested by the overwhelming force of global metropolises and post-metropolises: whether the heritage of a city's histories still has the capacity to structure larger territories, whether urban space can once again become a form of citizenship, an incubator of the city's civic value, and whether this value can be made visible in urban design and its forms [1].

The orientation of the ecological, digital and tourism transition in European programmes considers the fragility of our territories and the effects of climate change, adopting climate mitigation measures and investing in improved energy infrastructure.

Digital modelling can contribute to the creation of more resilient and adaptive cities, while recognising the challenges and limitations of implementing it in complex scenarios such as the one analysed. Urban resilience represents a crucial topic for the achievement of the Sustainable Development Goals (SDGs) proposed under the United Nations (UN) 2030 Agenda [2].

For the proposed case study, we examine available cartographic products and digital models from diverse sources and spatial scales, exploring their significance and discussing their role in achieving resilient sustainability.

## 2. SPATIAL POLICIES AND RESILIENT TOURISM

As cities rapidly expand, more infrastructure is increasingly needed. Considering it as an opportunity, the scale of global infrastructural development will be an unprecedented opportunity to reorient and rethink the urbanisation process from one that is inherently destructive to one that is sustainable and resilient [3]. This is the promise and challenge of smart cities as a key idea for building resilient urban structures. The vision and mission of smart cities are inspired by SDG 11 to "improve inclusive and sustainable urbanisation and the ability to plan and manage human settlements in a participatory, integrated and sustainable manner", such as the protection and eco-sustainable promotion of the territory (SDG 15), and the availability and smart management of water resources (SDG 6).

To overcome these challenges, the EU has adopted the European Green Deal, the new growth strategy that will transform Europe into a modern, resource-efficient, and competitive economy. The European Green Deal aims to make Europe climate-neutral by 2050, boost the economy through green technology, create sustainable industries and transport, and reduce pollution. In this way, opportunities for tourism and business development can be unveiled in territories that contain, in their very marginality, unprecedented resources to bring about lasting change. The approach known by the expression 'place-based' or 'place-oriented development' corresponds to the articulation of real phenomena and it is up to the local level to make concrete proposals to enhance the supply of services and identify development paths, overcoming the limits of both the top-down approach – the unreality

of a project established without involving local communities – and the bottom-up approach – the illusion that places have all the economic and cognitive resources required to implement effective development strategies [4]. The development potential that many areas of the country possess is largely under-exploited, consisting of significant natural, cultural, and human resources, whose activation could make an important contribution to growth. In fact, the abandonment of these areas or 'predatory' exploitation, i.e. exploitation that consumes local natural resources without creating significant benefits in terms of employment, income, and innovation, not infrequently produces negative outputs and, therefore, social costs for the entire nation, related to hydrogeological instability and the degradation of the cultural and landscape heritage [5].

The concept of resilience appears more and more in risk management strategies, specifically with the new European policy aimed at developing local-scale resilience plans by 2030. Risk-based approaches provide a rational method for weighing mitigation costs and adaptation measures. By contrast, starting from the uncertainties associated with natural hazards, resilience focuses on the ability of an affected system to absorb extreme shocks, restore good levels of functionality in the short term and plan improved services for the next phase [6].

The practices of sustainable urban tourism along the lines of the 2030 Agenda following Matera European Capital of Culture in 2019 look at temporary residences, management of public space and the old town, mobility for the fair distribution of tourist flows, and mitigation of natural hazards. Therefore, tourism is directly related to environmental and social safety and security, as well as to the importance of technological innovations for risk monitoring.

### **3. METHODS AND TECHNIQUES FOR RISK MITIGATION**

Urban areas, particularly those with historical significance, face a range of risks, including natural disasters, environmental degradation, urbanisation pressures, and cultural heritage preservation challenges. According to Varnes' risk concept, the spatial and temporal probability of occurrence of potential damaging events, as well as the distribution of the elements at risk in space and time, considering also changing vulnerabilities, collectively, contribute to an elevation in overall risk levels. As climate patterns become more unpredictable and extreme, the susceptibility of urban areas to natural hazards amplifies [7, 8]. Moreover, the ageing infrastructure, which may not have been initially designed to withstand contemporary environmental stresses, becomes increasingly vulnerable. The rapid expansion of urban settlements further exacerbates the situation by exposing more people and assets to potential risks.

Therefore, it is imperative for urban planners, policymakers, and stakeholders to integrate comprehensive risk management strategies into urban development plans to mitigate these escalating risks effectively. This integration involves various aspects, such as incorporating resilient infrastructure designs, establishing early warning systems, promoting sustainable land use practices, and enhancing community preparedness and response capabilities. In this context, the surveying, mapping, and monitoring of the built environment are essential for the understanding of phenomena that develop at urban scale such as the management of historical sites in view of climate change. The current era provides us with important digital tools and the opportunity to test innovative workflows for sustainable city development and building resilient cities. The surveying of urban spaces is constantly increasing due to new technologies that have emerged for participatory planning such as drone mapping, photogrammetry, 3D modelling and digital twin construction. Aerial vehicles such as drones or Unmanned Aircraft Systems (UaSS), equipped with sensors such as cameras, LiDAR (Light Detection and Ranging), represent a fast-developing approach for urban context monitoring [9].

Recent developments in cartographic applications are leading not only to the implementation of accurate, up-to-date map bases with shared specifications, but also to new ways in which the traditional cartographic medium is now used. These include interactive maps and mobile applications

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that can provide real-time information to visitors, such as recommended routes, trail conditions or sensitive areas to avoid, as well as to educate visitors about the importance of conservation. Cartography plays a major role in setting strategies for sustainable tourism, helping to balance the needs of visitors, environment, and local communities [10]. The key points are listed below:

1. **planning and management:** cartographic media provide detailed information about the area, helping organisers to better understand the natural and built environment, guiding tourism planning, helping to minimise environmental impact and maximise benefits for local communities;
2. **accessibility:** maps can show access routes to tourist sites, helping to manage visitor flows and reduce wear and tear on sensitive areas;
3. **education:** cartographic bases can be used to educate visitors about the importance of historical and cultural preservation, increasing awareness and appreciation for the environment and local communities, and promoting more respectful and sustainable tourism;
4. **monitoring and evaluation:** mapping techniques, through Geographic Information Systems (GIS), can be used to monitor changes over time, such as soil erosion or vegetation growth, helping to assess the effectiveness of sustainable tourism strategies and plan necessary changes.

#### **4. MATERA, AN INTERESTING CASE STUDY**

##### **4.1 The urban context between present and past**

Matera, the oldest urban settlement where life has been going on uninterruptedly since prehistoric times to the present day, a great little jewel in the deep South of Italy that has decided to defy time, winning its challenge by becoming a UNESCO World Heritage Site and European Capital of Culture in 2019. On 17 October 2014, Matera was designated to be European Capital of Culture in 2019, a historic achievement that represents the consecration of the city to culture and tourism.

The urbanised area of Matera comprises cores that arose at different times, such as the original Sasso Barisano and Sasso Caveoso, the plain, the consolidated city, the villages La Martella and Venusio, and the urban expansion areas. Each core retains structural and urbanistic characteristics specific to its historical development context. However, each has undergone transformations.

The first core of the built-up area of Matera, called the Civita, was built on a rocky spur jutting out with steep walls into the ravine and located at an altitude of about 400 m asl. The earliest settlements of the city were dug-out dwellings in which the limestone blocks removed by digging were used for the front parts of the housing units. As the years went by, a network of narrow streets and dwellings made up of housing units, neighbourhoods and hanging gardens began to stratify.

The layered terracing system ensured good surface water regulation, allowed the collection of outflows, the interception of drainage water and the accumulation of condensation water.

The ancient quarters, Sasso Caveoso and Sasso Barisano, are located within two small catchment areas in which a low-ranking hydrographic network is developed, with the two main river courses resting on V-shaped valleys, once used as real open-air sewers until their reclamation in the 1950s, and now drained (Figure. 1).





**Figure 1.** The main features of the Sassi Districts from OpenStreetMap (OSM).

The urbanisation of the modern city has obliterated the natural hydrographic network of the two creeks, whose main courses are morphologically recognisable only in their lower reaches, in correspondence with the roads Via Fiorentini and Via Buozzi. Nowadays, these roads serve as the primary destinations for tourists, hosting numerous activities catering to tourism and street furnishings. Other hydraulic works, mainly built to collect and store rainwater for self-consumption, are the cisterns carved out of calcarenite. The larger ones are located upstream of the Sassi at the boundary with the overlying clays. One of these is the Palombaro Lungo cistern, with a capacity of 5 million litres of water, built starting at the end of the 18th century in today's Piazza Vittorio Veneto. The complex system of cisterns and canalisation works ensured the storage of water resources and the fulfilment of the sanitary needs of the population of the time. In addition, these systems ensured good surface water regulation and protection from sudden runoff phenomena [11, 12].

Currently, the cisterns and the old drainage channels known as “grabiglioni” have lost their role in regulating the hydraulic flow. The cisterns have been diverted to other tourism-related tasks, whereas the “grabiglioni” coincide – as mentioned – with two roads, which nonetheless still serve as valley floor for the two creeks, with a consequent hydro-geomorphological hazard factor for the numerous tourist activities. More in general, for a large part of the urban area the issue of channelling rainwater during intense events is particularly relevant to mitigate hydraulic risk, also due to the insufficient outflow offered by the sewer network [13, 14].

#### 4.2 Available cartographic products and potentiality

The available dataset of Matera city includes information provided by Basilicata Region on a geotopographic regional database (RSDI). Topographic data from a regional survey consist of a Digital Surface Model (DSM) and a Digital Terrain Model (DTM) with a resolution of 5 metres × 5 metres and dated 2013 for the whole region [15]. This regional aerial survey has been combined with building boundary polygons and street segments from OpenStreetMap to create a 3D model, augmented with varied semantic annotations [16].

Recently, with a view to equipping itself with adequate cartographic tools, to improve the functioning of the 'municipal machine' and at the same time provide the territory with a cognitive base that meets the changing needs of society, the Municipality of Matera has recently implemented a project to produce an evolved cartographic base of its territory, through services for optical photogrammetric and LiDAR acquisition.

The project involved the production of the Numerical Technical Map of the urban centre (scale 1:1000) and of the entire municipal territory of Matera (scale 1:2000), including 5 cm and 10 cm

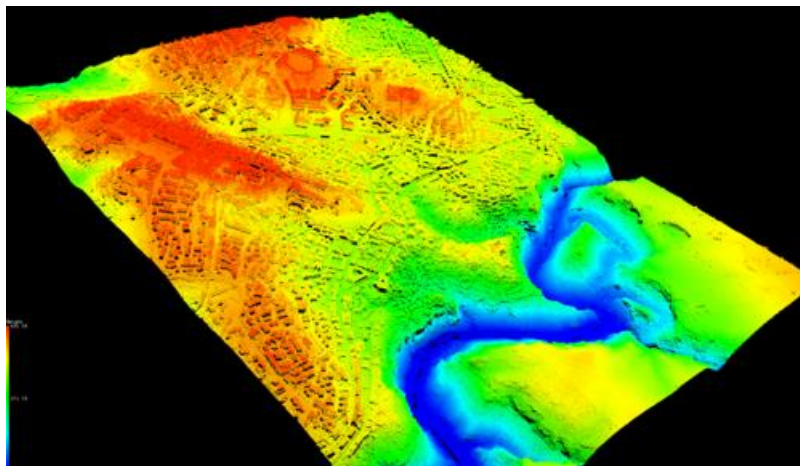
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orthophotos, point clouds and numerical terrain models, with the intermediate products required for the purpose. The aerial imaging was carried out with a Leica DMC III camera by flying with 8-10 cm ground pixels over the entire territory and 4-5 cm over the urban centre.

The LIDAR was carried out with a RIEGL VQ-580 II sensor with a density of approximately 40 pts/sqm over the entire municipal area, while for the urban area the density was approximately 130-140 pts/sqm (Figure 2). The rendering involved the punctual application of the Shared Specifications in accordance with Italian Ministerial Decree 10/11/2011, which establishes the reference standards for cartographic productions at various scales.

Below are provided:

1. an example of a Digital Surface Model (DSM) extracted from the LiDAR point cloud in the Sassi area, where the density of buildings and the depth of drainage can be seen;
2. the optical image imprint acquired with the positioning of Ground Control Points (GCPs) used in the Aerial Triangulation phase.



**Figure 2.** Elevation view of the LiDAR cloud of the spatial portion of the “Sassi” Districts.



**Figure 3.** Detail of the aerial photogrammetry mosaic with indication of the Photographic Points of Support, denser in the central area

The knowledge base created by the municipal administration is undoubtedly an extremely positive achievement, necessary for the understanding of territories and the proper management of urban and suburban spaces. However, the understanding of territories gained from aerial platforms produces a representation of the territory that is no longer considered sufficient today.

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In fragile and complex territories such as the one in question, it is now necessary to implement a "Digital Twin" that models not only the terrain and the built blocks (external changes and roofs) as in traditional cartography, but the modelling extends, if necessary, to include the parts not reached by photogrammetric surveys with exhaustive "exterior/interior" models [17].

The implementation of a digital twin, extended to at least the Sassi area, would achieve the following objectives:

improvement of hydraulic modelling, including not only the terrain and the rooftops but also all water collection and regulation works both belonging to each unit and for collective use, even reaching the modelling of underground conduits;

visibility analysis starting from significant points in the context, up to creating virtual reconstructions of monuments, offering immersive experiences for research, education, and tourism while preserving the original structures;

analysis for predicting phenomena related to sunlight exposure, such as the presence of light/shadow on various days of the year and the prediction of heat islands, a phenomenon emphasised by the rocky nature of the territory and the intensification of issues related to global warming;

establishing the basis for continuous monitoring of monuments, providing real-time data on structural integrity, environmental impact, and potential threats such as erosion or vandalism, allowing for timely interventions and conservation efforts;

the production of "virtual tours" that allow immersive paths accessible remotely;

For the production of such databases, optical and LiDAR sensors are required, which can essentially be listed as follows:

Oblique cameras, which are photographic sensors integrating up to 5 appropriately angled cones, now available to be mounted on aerial drones.

Optical cameras with 360° lenses, for the creation of virtual tours.

LiDAR devices that utilise SLAM (Simultaneous Localization and Mapping) technology for accurate georeferencing of the shots: essentially, each position is estimated based on previous positions, thus obtaining the possibility of modelling even in environments where the GNSS signal is not available (inside buildings, caves, underground channels, etc.).

These aforementioned sensors can be mounted on unconventional supports (backpacks, robots, underwater and amphibious drones), ensuring the possibility of acquisition even in special contexts like the one under examination.

## 5. CONCLUSION

The city lives thanks to its inhabitants and over time space is shaped by human activity and natural processes. But along with this comes the invisible dimension of new technologies that pervasively influence the perception and accessibility of places.

The success of a European Capital of Culture is not only measured by what happens in the fateful year, but rather by whether it contributes to a significant and sustainable change in the development trajectory of the city and its territory.

The alteration of hydrological forcing due to climate change raises important questions about the availability of future water resources and the frequency of extreme events. In this highly uncertain context, it appears useful to reconsider the model of Matera as a resilient city in the past, through the recovery of the city's ancient catchment, storage, and transport infrastructures to rebuild the important land protection functions of ground and surface water regulation.

Therefore, the utilisation of innovative technologies in risk management represents a paradigm shift towards more proactive, efficient, and resilient approaches to safeguard cultural heritage.

The critical analysis of the different experiments highlights the heterogeneity of the topics dealt with and the countless points of view to be developed on the issue of city and landscape through the lens of complexity and digitalisation, with tools and methodologies that can be replicated in different

contexts to involve local communities in structuring and enhancing the territory according to the needs of residents and temporary inhabitants.

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