Lecture Notes in Networks and Systems 906

Mohamed Ben Ahmed
Anouar Abdelhakim Boudhir
Rani El Meouche
İsmail Rakıp Karaş *Editors*

Innovations in Smart Cities Applications Volume 7

The Proceedings of the 8th International Conference on Smart City Applications, Volume 1

Springer

Lecture Notes in Networks and Systems 906

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Mohamed Ben Ahmed ·
Anouar Abdelhakim Boudhir · Rani El Meouche ·
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Editors

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Editors
Mohamed Ben Ahmed
Computer Science and Smart systems
Laboratory, Faculty of Science
and Techniques of Tangier
Abdelmalek Essaadi University
Tangier, Morocco

Anouar Abdelhakim Boudhir
Computer Science and Smart systems
Laboratory, Faculty of Science
and Techniques of Tangier
Abdelmalek Essaadi University
Tangier, Morocco

Rani El Meouche
École Spéciale des Travaux Publics
Paris, France

İsmail Rakıp Karaș
Computer Engineering Department
Karabük University
Karabük, Türkiye

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Preface

The content of this Conference Proceedings volume comprises the written version of the contributions presented at the 8th International Conference on Smart City Applications 2023.

This multidisciplinary event was co-organized by the ESTP in the partnership with Mediterranean Association of Sciences and Sustainable Development (Medi-ADD) sponsored by the digital twins' chair of construction and infrastructure at ESTP.

The contents of this volume delve into recent technological breakthroughs across diverse topics including geo-smart information systems, digital twins of construction and infrastructure, smart building and home automation, smart environment and smart agriculture, smart education and intelligent learning systems, information technologies and computer science, smart healthcare, etc.

The event has been a good opportunity for more than 110 participants coming from different countries around the world to present and discuss topics in their respective research areas.

In addition, four keynote speakers presented the latest achievements in their fields: Prof. Jason Underwood "Imagining a digital competency management ecosystem approach to transforming the productivity of people in the built environment", Prof. Isam Shahrour "Smart city: why, what, experience feedback and the future/challenges", Dr. Ihab Hijazi "Integrating system dynamics and digital twin for the circular urban environment", Prof. Mohammed Bouhorma "Challenges of cybersecurity in smart cities", Prof. Filip Biljecki "Advancing urban modelling with emerging geospatial datasets and AI technologies", Prof. Ismail Rakip Karas "Background of Smart Navigation".

We express our gratitude to all participants, members of the organizing and scientific committees, as well as session chairs, for their valuable contributions.

We also would like to acknowledge and thank the Springer Nature Switzerland AG staff for their support, guidance and for the edition of this book.

We hope to express our sincere thanks to Pr. Janusz Kacprzyk and Dr. Thomas Ditzinger for their kind support and help to promote the success of this book.

November 2023

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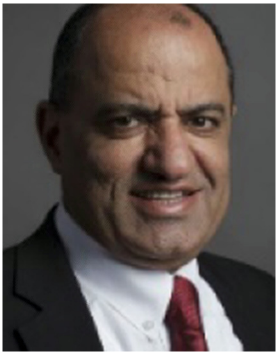
Keynotes Speakers

Smart City: Why, What, Experience Feedback and the Future/Challenges

Isam Shahrour

Lille University, France



Prof. Isam was a graduate from the National School of Bridges and Roads (Ponts et Chaussées-Paris); he has been strongly involved in research, higher education and partnership with the socio-economic sector. During the period of 2007–2012, he acted as Vice President "Research and innovation" at the University Lille1. He is a distinguished professor at Lille University with about 35 years of intensive academic activity with strong involvement in the university management as well as in both socio-economic and international partnership. His research activity concerned successively: geotechnical and environmental engineering, sustainability and since 2011 Smart Cities and urban infrastructures. Associate Editor of Infrastructures Journal (MDPI).

Imagining a Digital Competency Management Ecosystem Approach to Transforming the Productivity of People in the Built Environment

Jason Underwood

University of Salford, UK

Prof. Jason Underwood is a Professor in Construction ICT & Digital Built Environments and Programme Director of the MSc. in Building Information Modelling (BIM) & Digital Built Environments within the School of Science, Engineering & Environment at the University of Salford. He holds a BEng (Hons) in Civil Engineering from Liverpool John Moores University, a Master's in Psychology from Liverpool Hope University and a PhD from the University of Salford. His doctoral thesis was on "Integrating Design and Construction to Improve Constructability through an Effective Usage of IT". He is a Chartered Member of both the Institution of Civil Engineering Surveyors (MCInstCES) and The British Psychological Society (CPsychol) and a Fellow of the Higher Education Academy (FHEA). He is actively engaged in the digital transformation of the UK construction industry. He is the present Chair of the UK BIM Academic Forum and Director of Construct IT For Business, an industry-led non-profit making collaborative membership-based network.

Challenges of Cybersecurity in Smart Cities

Mohammed Bouhorma

UAE University, Morocco

Prof. Bouhorma is an experienced academic who has more than 25 years of teaching and tutoring experience in the areas of information security, security protocols, AI, big data and digital forensics at Abdelmalek Essaadi University. He received his M.S. and Ph.D. degrees in Electronic and Telecommunications from INPT in France. He has held a Visiting Professor position at many Universities (France, Spain, Egypt and Saudi Arabia). His research interests include cyber-security, IoT, big data analytics, AI, smart cities technology and serious games. He is an editorial board member for over dozens of international journals and has published more than 100 research papers in journals and conferences.

Advancing Urban Modelling with Emerging Geospatial Datasets and AI Technologies

Filip Biljecki

National University

Prof. Filip is a geospatial data scientist at the National University of Singapore where he had established the NUS Urban Analytics Lab. His background is in geomatic engineering, and he was jointly appointed as Assistant Professor at the Department of Architecture (College of Design and Engineering) and the Department of Real Estate (NUS Business School). He hold a PhD degree (with highest honours, top 5%) in 3D GIS from the Delft University of Technology in the Netherlands, where he also did his MSc in Geomatics. In 2020, he has been awarded the Presidential Young Professorship by NUS.

Integrating System Dynamics in Digital Urban Twin

Ihab Hijazi An-Najah

National University and Technical University of Munich

Dr. Hijazi is an associate professor of Geographic Information Science at Urban Planning Engineering Department, An-Najah National University in Palestine. Also, he is a senior scientist at the chair of Geoinformatics at Technical Uni of Munich. He worked as a postdoc scholar at the chair of information architecture, ETH Zurich. He was a researcher at ESRI–the world leader in GIS and the Institute for Geoinformatics and Remote Sensing (IGF) at the University of Osnabrueck in Germany.

Background of Smart Navigation

Ismail Rakip Karas

Karabuk University, Turkey

Prof. Ismail Rakip Karas is a Professor of Computer Engineering Department and Head of 3D GeoInformatics Research Group at Karabuk University, Turkey. He received his BSc degree from Selcuk University, MSc degree from Gebze Institute of Technology and PhD degree from GIS and remote sensing programme of Yildiz Technical University, in 1997, 2001 and 2007, respectively, three of them from Geomatics Engineering Department. In 2002, he involved in a GIS project as a Graduate Student Intern at Forest Engineering Department, Oregon State University, USA. He has also carried out administrative duties such as Head of Computer Science Division of Department, Director of Safranbolu Vocational School of Karabuk University. Currently, he is the Dean of Safranbolu Fine Art and Design Faculty in the same university. He is the author of many international and Turkish publications and papers on various areas of Geoinformation Science.

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Smart Cities

Connections Between Smart City and Flood Management Against Extreme Weather Events

Fanny Josse[1(✉)], Zhuyu Yang[1,2], and Bruno Barroca[1]

[1] Lab'urba, Université Gustave Eiffel, Champs-sur-Marne, France
fanny.normand.josse@gmail.com
[2] LATTS, UMR CNRS 8134 Université Gustave Eiffel/Ecole des Ponts ParisTech, Marne la Vallee, France

Abstract. Flooding is a highly dynamic phenomenon, and can occur due to several natural and anthropogenic causes, including flash floods, rising groundwater, gradual sea level rise, and coastal storm surges. With increased flood risk in urban areas, more and more studies suggest an integration of flood management and the concept of Smart City. This paper aims to discuss the connections between Smart Cities and flood management against extreme weather events potentially occurring in the future caused by the growing climate change. Flood prediction and warning are crucial for flood management, and their improvement could rely on the digital technological systems highlighted in many Smart City strategies. Moreover, the installation of technological equipment could benefit from flood maps that indicate high-risk flood zones in the short, medium, and long term.

Keywords: Smart city · Flood management · Flood prediction · Flood maps · Digital data

1 Introduction

Environmental changes, combined with the concentration of property and persons in urban territories foretell devastating events in the coming years. The consequences of the frequency and severity of climate extremes will lead directly to the possible occurrence of various recent heat waves and other damaging extreme weather. For example, increasing heat extremes develop into a key hazard due to their multifaceted damage, like a number of health risks, disturbances in urban activities (in the production and consumption of energy, water, supplies, etc.), and ecological imbalances. Of almost all natural hazards, floods are the natural hazard with the highest frequency and the widest geographical distribution worldwide, and the hazard that causes the most economic damage [1]. A flood is defined as the overflowing of the normal confines of a water body or the accumulation of water in areas normally without it. Floods can occur due to a variety of causes such as river floods, flash floods, heavy rainfall, storm surges in coastal areas, or failure of the sewerage system in urban areas [2].

Although flooding cannot be fully predicted, flood management can significantly reduce damage to people and infrastructure. This goal could be achieved by various

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practical measures, such as flood prevention, flood mapping, flood prediction, flood warning, etc. The main current challenges for disaster management can be summarized according to the four disaster phases, preparation, response, recovery, and mitigation [3], which, according to Josipovic and Viergutz [4], smart city solutions could address. More and more studies argue that an integration of flood management and the concept of “Smart cities” should be considered for sustainable urban development [5–8]. The concept of the smart city appeared in different forms before taking on its definitive name. A smart city could be defined as a place where traditional networks and services are made more efficient with the use of digital solutions for the benefit of its inhabitants and business [9].

As smart city strategies, apply mainly to big data applications, their main improvement to conventional flood management stems from the integration of different data streams to improve flood prediction [4]. However, little research has been conducted to discuss the connections between flood management and Smart cities with a perspective of inter-complementarity. This paper aims to figure out reinforcing measures for better urban management by presenting the connection between flood management and Smart city from different perspectives. These connections could be improved for better operationalisations of both two sectors, in particular for Smart City which is still at a theoretical stage and whose application to extreme events management from pure theory to reality is recently a significant challenge.

Section 2 will present the concept of Smart Cities from technological and data resource dimensions, based on which, it suggests the contribution of smart cities to flood prediction and warning. Section 3 shows how to identify urban zones that need smart technological systems through flood hazard maps with an example, a French district in coastal areas (Bocca district in Cannes). The variety of development and application of smart city features in coastal disaster management is recently required [8].

2 Smart Data Resources for Flood Management

The literature review on the origins of the smart city [10] observes that in 1987 the notion of "wired cities" made its appearance, that of “cyber cities” emerged in 1999 and the following year it was the turn of “digital cities”. From 2002 onwards, the "intelligent cities" approach became more widespread, and Hollands in 2008 [11] developed the term "smart cities". These different names refer to a digital city based on the exchange of information. Sustainable strategies for integrated urban flood management are considered crucial for smart city planning and development [6].

The smart city is a collection of data that is processed in real-time by ICT (Information Communication Technology), with applications providing a visual representation of this information base for greater visibility and are analysed to develop action plans based on the results obtained. Understanding the nature of the data is essential, as are the applications according to requirements. Based on a preview of the work on strategies to collect data and then implement them in smart cities that suffer from different types of flooding, a number of strategies are developed in different articles, some of which are evoked and others explored in more depth. This work studies the diversity of technical solutions that can be promoted.

Before analysing the strategies employed, a non-exhaustive study was carried out to understand what data and information were injected into the digital containers. Two types of data emerged from this work: dynamic data and static data. It is important to note that not all data is structured in the same way and comes from different sources. The sheer number of different types of data and the differences in their structure raises questions about their improtability and reliability.

Regulations, norms or standards are considered as static data to assess different types of conformity. This category also includes geospatial data such as Geographic Information Systems (GIS). The institutions share data relating to demography, the geography of the territory (relief, soil typology, location of infrastructure, etc.) and the geography of the area. Two- and three-dimensional cartographic models are used to support applications for visualising data sets. Static data can be updated in the event of modifications but does not require continuous monitoring. The Internet of Things (IoT) is defined by Sarker [12] as a connected network of heterogeneous components that detect, collect, transmit and analyse data for intelligent systems and services, introducing the notion of dynamic data.

City management uses information fromweather conditions and air and water pollution studies. Two articles, from Loftis et al., [13], and from Jon Derek et al., [14], present the monitoring of water levels using IoT sensors with an alert threshold that triggers emergency processes. As far as infrastructure is concerned, intelligent transport systems (ITS) technology presented in more than one study [15, 16] to assess transport occupancy rates. Other connected objects such as passenger cars can also be used as detection systems, as shown in the work in the article [15]. Ha et al. [17] propose a framework for using unmanned aerial vehicles (UAVs) to monitor urban roads, and this concept of camera surveillance is covered in the study of Gabbar et al. [18], which combines it with satellite scanning. Kurte et al., [19] present a semantic model called Dynamic Flood Ontology (DFO) that can be used to represent partially or fully flooded road segments, enabling targeted intervention. With regard to buildings, the guide of Kitchin et al., [20] suggests setting up building management systems, networks of sensors on equipment or intelligent appliances controlled by applications to control water and energy consumption in normal times, but also to respect protocols in the event of an emergency (power cuts, disconnection of urban systems, etc.).

Many businesses are offering different tools to contain, manage, process and visualise all this data. The work of Pettit et al. [21] suggests that the use of dashboards for the analysis of city data would allow consolidating of the information on a web page offering the public decision-makers a global view. For example the new Dublin district of the Docklands relies on this strategy to obtain reports and adjust their flood policies [22]. The information is also freely available to citizens, making it possible to set up intelligent digital spaces for discussion and consultation. Surveillance systems using cameras, drones and sensors are used to diagnose events and adjust intervention protocols. Communication systems are used by the authorities to communicate with residents and also to process their data in order to estimate specific needs in terms of functions. Event data is also collected for better anticipation and to adjust procedures. The smart city generates data that can be used to make this information more reliable.

3 Flood Maps: Basis for Smart Systems Planning

A smart city is made by a set of fundamental factors: technology (infrastructures of hardware and software), people (creativity, diversity, and education), and institutions (governance and policy) [23]. Smart City is also called Digital City [24], as recent smart urban plannings relate to digital content and services and incorporate pervasive computing [25]. Mondschein et al. [26] consider smart cities depending on large technological systems, which are immense, interconnected systems that consist of technological equipment. To build a smart city, advanced technological systems are required to provide citizens and enterprises with a powerful platform to connect city elements and let them interact effortlessly with each other and with their administration through electronic means. "Stable sturdy infrastructures, from optical fiber networks covering the city acting as a backbone to the installation of sensors, are the key for the development of intelligent solutions in cities" [27].

Evolving the concept of Smart City from pure theory for practice flood management requires the services of relevant technological systems (monitoring and warning systems). The location of technical equipment needs to be correctly identified to ensure the proper use of technological resources. For example, machines used to monitor railways inundation should be installed in vulnerable and high-risk areas, while public warning systems should be set up in schools and hospitals that are occupied by vulnerable people, or in industrial buildings that are important for economic development. Flood maps, involving various types like hazard maps, depth maps, event maps, damage maps, etc., can help recognise the more dangerous and sensitive areas. The installation of technology systems in these key areas will ensure that intelligent technology systems are used effectively. Plans for the installation of technical systems, such as water monitoring systems and alarm systems, can be added to or modified as the disaster area expands in the short, medium, and long term. The map of future flood hazards at different temporal scales is therefore significant to predict disasters and preparation.

The increasing disasters caused by climate change can be presented through a number of scenarios with different temporal phases. For instance, to analyse smart city strategies and their impact on different temporalities, Raven [28] suggests Arc 3.2 methodology [29], based on a prototype intervention aimed at mapping different scenarios (Current time, business as usual and Best Practices). This methodology implemented by UCCRN and NYIT since 2018 allows for bringing more concrete evidence to public and political decision-makers to argue in a spatiotemporal way [28]. The scenarios are allocated into three simulations:

- Current time (short term) that represents existing elements, considering current trends and events in the analysed environment;
- Business-as-usual (middle term) refers to a simulation of future scenarios that prolongs current trends without changing behaviour, which may even be accentuated if decisions are not taken.
- and Best practice (long term) based on the strict application of the recommendations of the various institutions.

This paper takes the Bocca district in Cannes as an example and explains the identification of critical zones appropriate for smart technological systems installation based

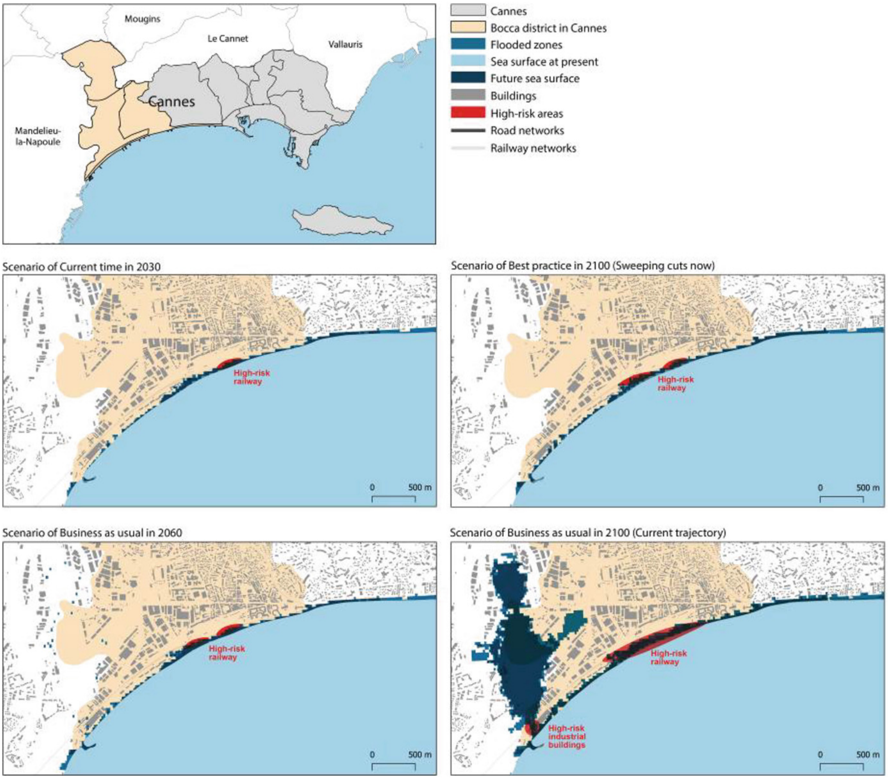

Fig. 1. Flooded zones in four scenarios and high-risk infrastructure in the Bocca disctrict (Cannes, Frence)

on flood maps in different scenarios. More and more publicly available flood maps exist online, for example, the web Géoportail [30] of the French government, the US federal agency NOAA's service [31] specifically for coastal areas, and Climate Central [32]. This paper decides to apply the map of "Land projected to be below annual flood level", produced by Climate Central and based on peer-reviewed science in leading journals. It has been chosen because the parameter of "Pollution Pathway or Sea Level Scenario" in this tool could be changed in corresponding to the requirement of the "Arc 3.2" scenarios. The "Current trajectory" option in this tool, signifies that Global emissions of heat-trapping pollution continue to rise, with annual emissions approximately doubling by the end of the century, which is suitable for the scenario "Biasness as usual" in "Arc 3.2". The "Sweeping cuts now" option, which means that Global emissions of heat-trapping pollution immediately begin to decline steeply, reaching net zero by mid-century, serves as the scenario of "Best practice".

Cannes, located on the French Riviera, is known for its association with the rich and famous, its luxury hotels and restaurants, and for several conferences. The Bocca district, to the west of Cannes, is now an industrial and touristic area following improvements to its economic and social structures. Cannes is a city facing the challenge of flood hazards, due to the flooding caused by river flooding, urban run-off, and marine submersion. Meanwhile, Cannes is a territory that has never considered building a smart city. This paper believes that the smart city concept could strengthen the city's flood management capacity in the future. According to Climate Central, the threat of sea level rise and coastal flooding to the Bocca district will rise and expand the flooding area and sea surface every year. Figure 1 shows the coastal flooding caused by sea level rise and annual floods in 2030, 2060, and 2100. The circumstances in 2030 and in 2060 could present as "Current time" and "Business as usual" in "Arc 3.2" respectively. Moreover, since the "Best Practice" scenario in 'Arc 3.2' is designed for sustainable climate management, two circumstances in 2100 illustrate respectively the scenario of "Business as usual" (Current trajectory) and the scenario of "Best practice" (Sweeping cuts now). In all scenarios, the railway networks in Cannes have flood risks, so that monitoring equipment for them is necessary. The flood risk for industrial buildings exists only in the scenario of "Business as usual" in 2100, and both monitoring and warning systems could be taken into account for better emergency management.

4 Conclusion

In the flooding risk management process, mitigation/prevention, and preparedness are before the events, whereas response and recovery are during and after events [3]. The connections between flood management and the concept of smart cities could contribute to the prevention, preparedness, and response phases. Gathering significant data, provided by smart monitoring systems, can effectively predict flood events. Then, intelligent communication and alarm systems could quickly and automatically transmit hazard information to managers and related populations. On the other hand, the planning for smart technological benefit from flood maps that clarify the urban areas more vulnerable. In identified high-risk areas, monitoring systems could be planned and set up to collect data to predict flood events and warning systems can be put in place for better warning and communication.

To go further in implementing the scenarios developed in this document, future work could explore the new emerging technology of the smart city, the digital twin [33]. This idea will enable to study this exact digital representation of the urban environment and how it will continuously enrich the prediction and simulation of natural hazards for an ever more resilient and dynamic smart city.

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