ISOCARP
REVIEW 14

CLIMATE CHANGE PLANNING

ISOCARP

The International Society of City and Regional Planners (ISOCARP) is a global association of experienced professional planners. It was founded in 1965 in a bid to bring together recognised and highly-qualified planners in an international network. The ISOCARP network brings together individual and institutional members from more than 80 countries worldwide. As a non-governmental organisation ISOCARP is recognized by the UN, UNHCS and the Council of Europe. The Society also has a formal consultative status with UNESCO. The wealth and diversity of professional expertise, knowledge, and experience in the ISOCARP membership is unmatched in the planning field.

Although ISOCARP members work in many different fields they share a common interest in the spatial and environmental dimensions of urbanisation. They advise key decision-makers, proposing and supporting projects for intervention in a spatial context through general or specific actions.

The objectives of ISOCARP include the improvement of planning practice through the creation of a global and active network of practitioners. ISOCARP encourages the exchange of professional knowledge between planners, promotes the planning profession in all its forms, stimulates and improves planning research, training and education and enhances public awareness and understanding of major planning issues at a global level.

The association's main event is the annual **ISOCARP Congress**, which focuses on a globally-significant planning theme and which takes place in a different country each year. Since 1965 ISOCARP congresses have taken place in all parts of the world on cutting edge topics and have always promoted knowledge creation and sharing in the planning profession.

Prior to the congress **Young Planning Professional** Workshops are organized. This YPP programme seeks to bring together emerging young planning professionals from all over the world to tackle 'real-world' planning projects.

All ISOCARP activities are covered in **publications** such as the ISOCARP Review, the International Manual of Planning Practice (IMPP), Congress proceedings and special project reports.

ISOCARP recognises excellence through the Society's **Awards programme**.

ISOCARP **Urban Planning Advisory Teams** (UPATs) assists sponsor organizations by offering the extensive experience and expertise of ISOCARP members to work on important local or international planning projects, programs and policy initiatives.

In response to specific requests for ISOCARP assistance with research and consulting services, ISOCARP forms **Technical Assistance Teams** consisting of members who volunteer their expertise and experience. In 2016 ISOCARP officially established the **Institute** as a "**Centre of Urban Excellence**" and formal body for generating, documenting and disseminating knowledge for better cities.

The Institute's core function is to design and deliver capacity building and continuing education programs; conduct research and promote knowledge transfer; as well as offer advice and short-term consultancy services to government, non-government and international bodies worldwide.

ISOCARP Head Office
International Society of City and Regional Planners
Gaby Kurth, Programme Manager
Monica Ornek, Office Manager

Laan van Meerdervoort 70
2517 AN The Hague, The Netherlands
Phone: + 31-70 346-2654
isocarp@isocarp.org
www.isocarp.org

Saltstraumen strøm (Saltstraumen Maelstrom), the strongest tidal current in the world

ISOCARP
Knowledge for Better Cities

Review 14

ISBN: 978-94-90354-53-4

Cover and colophon images are both courtesy of Per-Inge Johnsen, Bodø Municipality

Order online at: www.isocarp.org

The city of Bodø, Norway, is the location of the 54th ISOCARP Congress, 2018

SMART SUSTAINABLE CITY
WHITE PAPER OF THE INTERNATIONAL SOCIETY OF CITY AND REGIONAL PLANNERS

RIC STEPHENS, IRENA ITOVA,
MAŁGORZATA HANZL, BENJAMIN SCHEERBARTH

↑↑ TOC

The authors acknowledge the invaluable assistance of the speakers and attendees at the World Urban Forum 2018 "Smart Sustainable Cities" networking event in developing this paper. Further contributions came from the panelists of "International Smart Cities" session at the American Planning Association 2018 National Planning Conference in New Orleans and from the specialists and professionals gathered and collaborating with ISOCARP .
Some of those who assisted are shown and identified in group photographs below. The individual contributions can be viewed on the ISOCARP website in the publications section, their contributions are also listed in the Appendix in the end of this paper and referenced in the text.

FIGURE 1: ↑ ISOCARP organised the World Urban Forum 9 "Smart Sustainable Cities" networking event to focus on concrete examples of implementing the New Urban Agenda. Panelists included: ICLEI Deputy Director **Soumya Chaturvedula**, Royal Town Planning Institute Chief Executive **Trudi Elliott**, ISOCARP Vice Presidents **Małgorzata Hanzl** and **Daniele Vettorato**, Malaysian Institute of Planners Honorary Secretary **Datin Khalid**, Canadian Institute of Planners President **Eleanor Mohammed**, International Federation for Housing and Planning Strategic Director **Morten Nielsen**, UN-Habitat Strategic Planner **Javier Torner**, International Union of Architects President **Thomas Vonier**, and ISOCARP President **Ric Stephens**, moderator. PHOTO BY: Ric Stephens

FIGURE 2: ↓ International Smart Cities" session at the American Planning Association 2018 National Planning Conference, New Orleans, April 24. Panelists: front row: Canadian Institute of Planners President - **Eleanor Mohammed**, RPP, MCIP, EP; Royal Town Planning Institute President - **John Acres**. Back row: APA International Division Chair - **Timothy Darby Van Epp**; Brookhaven National Laboratory Policy Advisor - **Vatsal Bhatt**; ISOCARP President - **Ric Stephens**; Planning Institute of Australia President - **Brendan Nelson**; Georgia Tech Associate Professor - **Perry P Yang**; UniverCities Innovation Project Developer - **Irena Itova**.

INTRODUCTION

The term "smart city" has recently become a popular buzzword with as many taints and shades of meaning as urban life itself. Not only does it describe the applications of technology to urban infrastructure and service provision, it has also become an umbrella containing all manner of innovative management and organization. It attracts stakeholders coming from different branches of industry, who perceive it as a chance to develop and sell products and services. Because of this successful marketing, the concept of smart city will continue to develop and be adopted, whether we as urban planners and designers, support this growth or not.

Smart city implies a systematic approach to the urban economy using telecommunication, information and communication technologies [01]. Smart City as a concept is currently understood as authorities using technology to better manage the city. Smart cities initiatives around the world are driven by the pressure on public financing, climate change, production of energy, limits of resources and rapid urban population growth. Wirz Schneider [01] lists Smart Economy/stakeholder management, Smart Buildings, Smart Mobility, Good Governance, Smart Grids and Technologies and Scarcity of resources and energy production as some of the key factors of the urban assets of smart city initiatives.

ISOCARP has been involved in "smart cities" for many years, and this is reflected in Society programming and articles in previous issues of the Review. Former ISOCARP President Alfonso Vegara was a leader in this movement. In 2004, he authored the book Territorios Inteligentes describing the Spanish national program for a regional system of smart cities. More recently ISOCARP collaborated in many global events that focus on smart cities. At the May 2016 Metropolitan Solutions conference in Berlin, ISOCARP coordinated with public and private sector organizations on smart city planning. In October 2016, Habitat III in Quito had several sessions devoted to this topic, and ISOCARP was engaged in many of these as a partner with UN-Habitat and the Global Planners Network. In 2017, the theme for the ISOCARP World Planning Congress was "Smart Communities" with an emphasis on blending technology with social, environmental, and economic planning theory and practice. These programs were revisited earlier this year at the World Urban Forum where ISOCARP organized a session devoted to "International Smart Cities", again in coordination with UN-Habitat and the Global Planners Network. ISOCARP members have also been active in promoting smart city discussions through sessions organized at multiple events including several American Planning Association conferences, Moscow Urban Forums, REAL CORP conferences, Smart and Sustainable Planning for Cities and Regions conferences, and many others[1].

As members of ISOCARP, the global network of urban planning professionals, we need to consider our primary obligation to search for solutions and to propose development which, while embracing this brand-new potential, would maintain established values of sustainable development. Moreover, we need to provide solutions which would aid planners worldwide in their daily practice to successfully use new technology to facing contemporary challenges such as climate change, rapid or shrinking growth, lack of housing, food deficiencies, and migrations among other issues. Therefore, our objective with this White Paper is to provide a disciplinary framework for the further development of smart, sustainable cities.

After this introduction, a description of smart city state-of-the-art follows. It summarizes the strengths, weaknesses, opportunities, and threats of contemporary urban technology development. Further, we present a roadmap of differentiated approaches to the smart, sustainable cities theme as crowd-sourced from both our members and several external, international planning organizations. Summaries of the main inputs accompany the presentation. Stipulations about the future path of smart city development conclude the article.

STATE OF THE ART. SMART CITY AS A FIELD OF THE CONTEMPORARY ECONOMY

OPPORTUNITIES

Smart tools which are necessary to create smart cities are being used in a variety of fields including manufacturing, transportation, agriculture, inventory control and logistics, health-care to name a few. Only recently have smart tools been used to manage urban systems or gather information for planning. A typical urban smart tool application might enhance resources management to improve efficiency, reduce loss, or reuse or recycle water, energy and land. Smart mobility, as another promising planning-related application, covers both autonomous vehicles and various transportation schemes. For example, the use of smart technology can enhance the management of transportation infrastructure and the information from Smart sensors can influence user behavior and, consequently, actual traffic flows and mode choices.

As smart technology and applications become more common they have the potential to improve basic living conditions and address various problems of contemporary urban living. Starting at home, smart apps might improve safety and provide permanent access to healthcare. Smart technology has the potential to reduce crime, improve work and the work trip experience, mitigate unhealthy climate conditions and generally create a more favorable milieu for people across the scales of a neighborhood, a district, a town and even a region.

The economic side of the new technology development remains particularly viable. The development of new applications enhances business productivity and amplifies coordinated methods and synergies. Various problems of contemporary urban living, which smart technology helps to solve, go far beyond commonly recognized insufficient data sets for planning. From traffic jams and inefficient public transportation systems, through unhealthy climate conditions and improper urban environment, perceived lack of safety, inefficient infrastructure and lack of coordination of different urban services; smart tools prove useful in each of the above situations.

DANGERS

The development of new tools requires careful implementation. More and more scientists warn against the disruptive power of technologies. First, progressing privatization and financialization of some services, due to a lack of regulation, may limit their availability. The technology may impede progress if it is implemented naively and without a comprehensive and widely approved vision. While exchange and communication platforms facilitate transactions between people, not all of them are legal. What is more, increases in remote contacts and computer dependence gives way to isolation, furthering societal issues of isolation, loneliness and depression. Increased safety may come with far-reaching surveillance and thus limited freedom, both in physical and digital spaces. Consequently, public space becomes more fragmented with clear divisions into publicly accessible and privately controlled spaces, with limited accessibility and extended control. Even economic growth may not be as sustainable as predicted if systems are characterized by closed architecture, preventing start-ups to develop their ideas. On the other hand, the individual creativity can contribute a lot providing tools which cater to specific needs of individualistic Postmodern society. However, the open and usually bottom-up character of startup applications, while incorporating necessary levels of complexity, may bring the danger of catering to the needs of stockholders and investors at the expense of more deprived groups. The digital divide may thus deepen, which can be further worsen through the replacement of human work by the one of machines.

Further, due to technology driven implementation, development focus may be on certain fields of industry while neglecting other, more urgent activities which may be more complex and more difficult to execute.

HOW SHOULD SMART TECHNOLOGY BE IMPLEMENTED?

The application of properly integrated new technologies, such as daily satellite imagery, drones, graphic visualization and simulation, big data, powerful algorithms and deep learning, transect-based planning and form-based codes, promise plans for new cities in months and instant planning permits. If achievable, such a change in planning could revolutionize the national/provincial-local legal framework relationship, but at the costs of some safeguards [02]. In addition, the development of focused technological planning support using modelling, digital communication, and the introduction of an ICT based platform, can dramatically change the nature of decision making, from the opposition of governance versus citizenry towards a problem focused paradigm[2].

We as a global community of urban planners should realize that transformations to the profession are unstoppable, and as such we must define the right paths of their implementation by implementing the following. First, the challenge of transforming urban settings needs to be powered by people, with an emphasis on bottom-up processes of collaboration and social inclusion – starting from the planning process. Second, novel laws are needed, which incorporate citizen aspirations, creativity and input. Whereas individual initiatives are usually easier to develop and implement, public sector services satisfy broad needs more efficiently. Thus, while public and private partnership is necessary for smart city development, the responsible implementation requires legal frameworks at various levels of governance and adjusted to local conditions.

GOAL AND METHOD

The integration of the principle of sustainability makes the task at hand more challenging. In their definition, the ITU-T Focus Group explains a smart, sustainable city as *'an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects as well as cultural.'* [3] This statement, which incorporates the classical definition of sustainable development given in the Brundtland Report[4] attempts to link two seemingly contradictory fields. Adopting sustainable, resilient and regeneration principles while using and developing innovative technologies to implement them may prove a daunting challenge. This may mean constraining free technological development to satisfy actual, long-term human needs, imposing complex planning principles and sometimes even giving up sophisticated technological solutions for the sake of common sense and established methods.

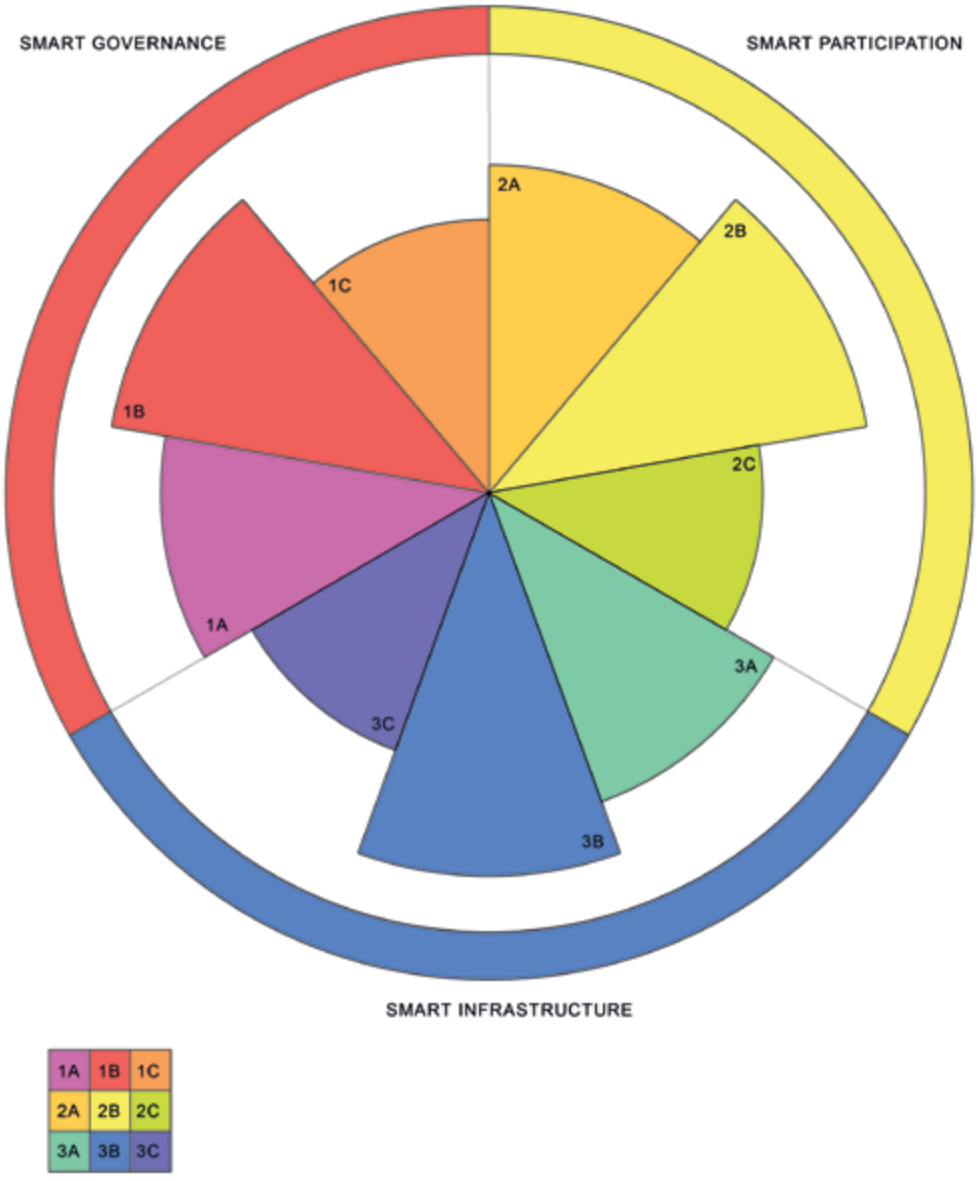

FIGURE 3: Three principal fields of smart sustainable studies: smart governance, smart participation and smart infrastructure and urban services.
Main subfields: 1A. Governance and management practices, 1B. Smart planning and machine learning, 1C. BIG data management, 2A. Crowdsourcing and co-governance, 2B. ICT supported public participation, 2C. Bottom-up smart tools, 3A. Public spaces and augmented reality, 3B. Shared, autonomous mobility, 3C. Energy and resources management

This may as well mean providing solutions which last and reusing resources instead of just producing new tools and delivering new products. This should also consider the long time needed for humans to adopt new ways of satisfying daily requirements and the feedback loop needed to acquire knowledge on the technological impacts on our cultures and health.

The relation of these two principles: technological (and often also, by assumption, economic growth) and the idea of sustainability might prove challenging when balancing public needs and economic considerations. Another set of issues refers to the preservation of the cultural authenticity and vibrancy of the informal sector. This requires enhanced transparency of government actions and open systems, which may undergo collective control through the incorporation of new tools and applications. Integration of planning for sustainability, resilience and regenerations obliges us to adopt universal values, which could then be further shared while developing technological solutions.

In this paper, we review multiple examples of smart, sustainable city implementations and research. To do so, we have defined an initial framework which places each of the examples on the diagram representing main fields of implementation.

The contributions by our respondents pertain to all aspects of urban life and reflect the widespread applications and even broader potential for implementation of technology in urban planning and design, urban management, governance and policy making. The contributions, coming from places all over the world address both general issues and specific practices.

The multiplicity of theoretical contributions and case studies, which include theoretical considerations reflect the complexity of the raising field of science, which deals with the implementation of technology in urban life. In the following section, we briefly reflect on the specific areas of technology applications. Further, the chosen, most representative contributions have been summarized and included in the Appendix.

SMART GOVERNANCE AND PLANNING

GOVERNANCE AND MANAGEMENT PRACTICES

The idea of smart technology challenges the ways how cities are governed and planned [03]. In a recent report conducted on behalf of the European Commission, there is clear commitment amongst European governments to work towards unlashing the full potential of co-creation and collaboration between governmental departments and the public sector, to provide public goods and governmental services. The platform for this new type of collaboration is enabled by vast application of Information and Communication Technology (ICT) tools.

However, to be able to harness the full potential of such tools, integration of infrastructure and technical interoperability is required.

Integration of infrastructures in the city governance represents the process of breaking down information silos in the public administration services and integrating physical, spatial and digital assets (data, applications and services). E-Government and Open Governmental Services (OGS) represent the transition of the traditional public services into open, transparent and collaborative, where governments are responsibly and safely regulating open [public] data access, by making it standardized, inclusive, secure, transparent and easily [digitally] accessible.

The new paradigm shift brings a great need to better understand the relationship between the *'new (digital) forms'* of societal actors, considering the new possibilities due to the availability of the digital interaction footprint in generating deeper insights. However, eliminating the human factor in this *'digital interaction analysis'* does not guarantee unbiased insights. Responsible technology must be supplied to guarantee and protect the democracy of public systems and services. Algorithmic transparency and accountability are deemed as fundamental for accountable and affirmative use of advanced ICT tools. City departments wish to peruse making policies on complete datasets; the process includes establishing fully integrated system of systems for information and resources transparency, and further responsibly opening data towards the private sector.

Goldie illustrates his theoretical considerations giving an example of the Triple Bottom Line Model [02]. It gives no specific guidance to urban planners as to what should be built where or in what form. Thus, an operational sustainability model for city planning can be developed based on automation to a geographical information system which can produce first draft of urban structure plans further finalized by extensive community, peer, political and judicial reviews.

SMART PLANNING IN METROPOLITAN SCALE/ SMART CITY-REGIONS

According to Elliot [04], a successful smart city means using data to inform plan-making with issues ranging from understanding patterns of travel by different social groups to ones ranging from standardizing density levels to those which describe how to protect vulnerable social groups which might be impacted by climate change. The efficient implementation of this sort of solutions at all scales has been made feasible thanks to the widespread utilization of GIS tools. This is reflected, for instance, in the efforts to translate the global issues of growing environmental risk, climate change and the needed radical reduction of greenhouse gas emissions into specific challenges linking smart cities initiatives

and strategic planning. For example, the failure to tackle the issues of affordable houses and long car-based commuting with costs of congestion, wasted productivity and air pollution resulted in relatively low productivity of secondary cities creating regional divides between successful and struggling places and mass high-skilled youth migration. The New Urban Agenda clearly states that these issues demand for a coordinated wide scale approach involving entire city-regions and metropolitan areas which would not be achievable without ICT, both applied for data management and analyses and as management and communication tools.

SMART PLANNING AS A SCENARIO-DRIVEN PROCESS

To Itova [03] planning in its broad sense represents organizing the use of space based on assumptions for possible futures, by producing scenario-driven alternative shapes for the urban environments that foster social and economic prosperity, while not endangering adjacent natural habitat. Therefore, bringing comprehensive, intensive and accurate context information to the planning process is central starting point. Additionally, in this era of hyper-connected people and places, technologies can capture, transmit and process information at the speed of light. Smart planning may well refer to the process of harnessing the full potential of available and emerging sensing, data processing and computing technologies, to enhance the inclusion of complete information spectrum for the benefit of supporting the planning and design process. The production of [urban] data via big data and context-aware ecosystems, from which valuable information is extracted for operationalization in management of public spaces and related services is always a situated process, influenced by its temporal and spatial context.

So far, predictive analytics systems find vast application in the social sciences and services related to national and public security [03]. Collectively known as *sentiment analytics,* the methods of *descriptive, predictive* and *prescriptive* analytics attempt to synthetize, analyze and predict possible outcomes, after combining and processing immense amount of historic and near real-time georeferenced raw data, connecting situational and temporal parameters with behavioral patterns. *Sentiment analytics* models population behaviors captured via social and other media platforms, with a goal to predict future trends and anticipated behaviors.

LAND MANAGEMENT

Connecting land-use data and material flows to economic sectors, enables parallel analysis of resource and land intensities related to economic activities. However, the lack of existing empirical studies addressing the question of the spatial

distribution of material flows and the implication changes in the metabolic profile of regions for regional land use changes, remains a great challenge. Smart technologies related to distributed computing, Ambient Intelligence (AmI) and Deep Learning (DL) have the potential in addressing this specific challenge. The ***Urban Metabolic Networks*** model [05] trains artificial intelligence (AI) on million(s) anonymized data from various consumption trends, collected by residents from diverse demographics at the level of a mega-city, aiming to spot the earliest signs of pre-defined urban flows anomalies and respond with prompt diagnosis.

[BIG] DATA MANAGEMENT [06]

Recent citywide investments in ICT infrastructures have made data broadly available. As a result, there has been increased interest in the methods and techniques for inferring context knowledge from user data for strategic decision-making purposes. The main analytical and computational processes behind knowledge discovery are data mining and context recognition.

Big data and context information are the basis for the next wave of urban planning and management related to urban sustainability, enabled by deep insights; intelligent decision making; machine learning, statistics and related modelling and prediction methods [06].

'Big data' refers to information assets high in variety, volume, velocity, value and volatility, where processing this heterogeneity, increase, complexity, temporality, unpredictability, availability and application in various domains is beyond the capacity of traditional analytical software. Further, big data is always automatically tagged with temporal and spatial labels by their source- mainly sensors. The following systems are widely used when handling big data:

· Tools- classification; clustering and regression algorithms
· Techniques- machine learning
· Technologies- hadoop; hbase and mongodb

Big data analytics and context-aware computing are two integral parts of ICT that share common core enabling technologies: unobtrusive and ubiquitous sensing technologies and networks, advanced data management and processing techniques and platforms, fast and affordable distributed computing and middleware infrastructures and advanced wireless communication technologies, vastly known as IoT.

PUBLIC PARTICIPATION – SHIFT IN APPROACH

ICT networks are an important social medium in contemporary urban life, enabling active and passive participation in the process of spatial consumption, city management and urban planning/design – such as targeting citizens' awareness or sensing and management of the urban environment [07]. The digital form enables better (and instant) detection of changes, efficient utilization of data and transparency in city processes directly enabling resource efficiency. Information networks support communication increase awareness and enhance cooperation between all levels of government and stakeholders. Three democratic values – legitimacy, effectiveness and justice – are generated through smart government as an application, including bottom-up civil contributions all the while maintain governments' responsibility for large-scale urban interventions.

Urban development, governance and public participation based on the preferred 'open model' still must achieve representative level of interaction between civilians and governments by improving accessibility, flexibility and usability of ICT networks and tools thus improving communicative potential and overcoming a gap between intellectualization and action.

CREATIVE TECHNIQUES FOR CREATIVE ENGAGEMENT [08]

Creative public engagement is key in achieving the Sustainable Development Goal 11 part of the New Urban Agenda. There are many existing public engagement techniques including traditional public hearings, community meetings and various planning workshops. Digital, communication and other tools can be used to support public engagement approach or program.

Stephens and Van Epp [08] quote an example of the successful online collaboration in South Ironbound neighborhood of Newark, New Jersey. Historically was one of the most polluted neighborhoods in the United States, it went through the exemplary process of urban rehabilitation. The Ironbound Community Corporation (ICC) initiated an Environmental Justice Movement through community meetings held at various locations with surveys and public engagement activities which aimed to improve quality of air, water and green space. Over 150 residents, small business owners and neighborhood stakeholders were successfully consulted for the resulting Climate Resilience Action Plan, reflecting their needs and benefits.

PUBLIC PARTICIPATION 2.0 [09]

Recently, the traditional hierarchical relationship adopted in the top-down scenario planning process has evolved towards envisioning methods incorporating

bottom-up contributions. Unfortunately, this model has long been challenged by the poor attention to citizen needs coupled with an inadequate opposition to main transformation demands of the most influential stakeholders, the decision makers. Traditional participation process in planning is strongly associated with interest groups, which are a common form of organized citizens, while Transactive Planning assumes continuous and real-time interaction between planners, experts and citizens of all forms.

In terms of planning theory 2.0, planning is a renewed approach to Advocacy Planning where the virtual environment is the collector of interactions. Social scanning via social platforms as a fundamental instrument in collecting ideas, opinions, etc. from citizens can lead from a closed model of decision-making involving governments and representative elected democracy, to an integration of representative democracy and collaborative approaches, enabling decision makers to directly consult citizens before taking a stand.

SOCIAL AS THE NEW SMART [10]

The inclusive, participatory approach has become broadly shared by planning NGOs. The International Federation on Housing and Planning (IFHP) criticize the current smart solutions as they only speak to economic and environmental success criteria, omitting the social aspect. Their approach balances the three pillars of sustainability, using the right tools to capture the social dimension. Failure to capture the social domain will lead to collapse of cities, where citizens will ultimately pay the price. The IFHP "Social Cities" program and tool consist of three steps- collecting and translating data on social indicators in easily understandable diagnosis, co-operation lab for co-creating solutions, and global knowledge-dissemination platform of best practices.

SMART INFRASTRUCTURE

Advocating against the use of technology in urban life would be absurd, what we support instead is technology which endures. Duarte and Firmino[5] point at three essential features for sustainable innovations: they prevail in a given context; they join values of a different character: social, economic, political and scientific; and, they adapt themselves to changing sociotechnical situations. For these reasons we state after [11] that '*Smart means working on how we want to live - not on how we used to live'.*

The unimaginative discussion on physical structures- highways, roads and bridges- should focus on *"intelligence"* opposed to *"smart"*, referring to structures that learn from the environment, adapting to thrive in new conditions and

discount *outmoded* parts. Inhabitants are seeking urban amenities and easy commutes giving them freedom to drive less, while younger generations are choosing new modes of shared semi-private or reliable public transport and walkable neighborhoods.

Urban infrastructure investments must support new ways of living: adapt old systems to new users; use fortifications as urban amenities; repurpose roads and sidewalks; favor compact vehicles; make cities greener by increasing presence of parks, trees and urban agriculture; use lighter and less expensive building systems; encourage zoning supporting mixed-use and densification; and utilize water as a transportation mode.

ROLE OF PUBLIC SPACES/ AUGMENTED REALITY/ DESIGNING INFORMATION-RICH STREETSCAPES [12]

Smart city strategic projects and interventions justify the re-emerging role of cities shifting from car-oriented to human-oriented environments, where urban commons are needed to provide suitable settings for direct interpersonal contacts. Information and communication technologies (ICT) have led to new possibilities of accessing information and opportunities of using the street environment as an interface to transfer various types of information context.

Augmented Reality and urban analytics enable new potential layers and urban semantics, which generate novel types of activities replacing the traditional face-to-face (necessary, optional and social) interaction in the public realm, subsequently bringing higher levels of social isolation. Thus, architects and urban planners need new tools to be integrated into urban environments allowing them to access collective information stemming from the shift from personal to online social interaction.

ALTERNATIVE AND RENEWABLE ENERGIES [13]

Smart cities will be integrated and interdependent with alternative and renewable energies. Today, cities require approximately 75% of the world's energy and produce about 80% of carbon emissions. Smart cities must and will reverse these impacts by becoming both zero-energy and zero-carbon. Eventually advances in energy- and carbon-engineering will enable energy- and carbon-neutral smart cities to become energy producers and carbon removers. Smart city programs will adopt and adapt programs such as the "Living Building Challenge" for urban and metropolitan development scales. Ultimately, cities—which have created most environmental impacts—will also provide the solutions.

For these shifts to occur, alternative and renewable energies must be eco-

nomically competitive with carbon-based fuels; public and private sectors must implement action plans to support and ultimately require alternative and renewable energies; and, public participation must be combined with education and collaborative decision-making.

Natural renewable energy sources include solar, wind, geothermal, hydro, and oceanic. Mechanical renewable energy sources include biomass and hydrogen. Nuclear energy is currently problematic in regard to safety hazards and waste disposal, but emerging technologies (i.e. Thorium fuel) may make this a much more viable alternative energy source in the future. Smart cities will develop specific energy systems based on the availability of these sources.

Within the next two decades there will likely be several game-changers and black swans. Game-changers are events, ideas, or procedures that effect a significant shift in the current manner of doing or thinking about something. An example of an energy game-changer would be extremely efficient and inexpensive solar power and storage that would not only enable zero-energy and zero-carbon development but have far-ranging implications for urban resiliency and energy independence. Black swans are events that come as a surprise and have major effects. An example of an energy black swan would be a computer virus which disrupted city-wide infrastructure. Energy game-changers and black swans will accompany the technological singularity projected for mid-century. The technological singularity (also, simply, the singularity) is the hypothesis that the invention of artificial superintelligence (ASI) will abruptly trigger runaway technological growth, resulting in unfathomable changes to human civilization. (A.H. Eden)

SHARED MOBILITY, SMART TRANSPORTATION & INFRASTRUCTURE EFFICIENCY/ AUTONOMOUS VEHICLE SYSTEMS [14]

Autonomous transportation will change our urban landscapes and daily lives and ways that are currently unimaginable. Most transit systems already have some levels of autonomy such as airliner autopilots and automatic train operation. These systems are becoming increasingly sophisticated, and many do not require any human intervention to operate safely and efficiently.

The complexity of these multi-modal and inter-modal systems will require smart cities to develop intelligent transportation systems (ITS). One highly visible aspect of this technological shift is the development of autonomous or driverless cars. Smart cities around the world are introducing autonomous cars, taxis, and buses in test programs. Projections are for these vehicles to achieve commercial production within the next decade. Autonomous cars will liberate transportation for many persons unable to drive; they may offer an efficient alternative to

car ownership; and they may dramatically reduce the surface area required for streets and parking. They may also increase traffic congestion; create new types of transportation challenges; and exacerbate socio-economic disparities. Smart cities will need to reevaluate their street networks and parking; demographic impacts; and other urban issues in response to potentially radical changes in transportation behavior due to the introduction of autonomous vehicles.

Another autonomous vehicle with enormous potential for smart cities is the unmanned aircraft system or drone. After less than a decade of commercial production, drones are becoming essential technologies for hundreds of commercial applications ranging from precision agriculture to emergency management. Simultaneous with the design of driverless cars, there are several passenger drone prototypes currently in development with some projected for public operation as soon as 2020. Current issues are safety, security, privacy, property rights, and nuisance. As the public becomes more attenuated to the presence of drones, they may ultimately become ubiquitous. Smart cities will need to reimagine their cities to consider airspace and the opportunities and constraints associated with unmanned aerial vehicles.

URBAN METABOLISM, SYSTEM APPROACH/ RESOURCE USAGE OPTIMIZATION

Looking from the perspective of Urban Metabolism, one of the most essential aspects of smart technologies is the optimization of flows of resources. This is specifically valid when considering the environmental impact of human settlements. The systemic analyses of urban flows was started by Wolman, who defined the 'metabolic requirements of a city' as 'all the materials and commodities needed to sustain the city's inhabitants at home, at work and at play'[6]. In the analysis, he addressed a hypothetical city of a million inhabitants in the USA. It described the flows of food, water and fuel into the city and of sewage, air pollutants and solid waste out of it. Whereas typically UM research has addressed flows of energy, water and materials, contemporary perspective has widened and looks for a broader context of sustainability science[7]. Dijst et al. define UM as a 'network of heterogeneous flows in cities'[8] and notice a recent increase in such studies. Recent years observe an increasing interest in GHG emissions and, specifically, analyses of CO2 emissions.

The processes taking place in the urban environment vary in their pace of transformations[9]. Wegener[10] and Dijst[11] enriched the initial set of commonly studied topics by adding long-term transformations of land use and building stock and the evolution of transportation systems and infrastructure. Other processes they have considered those human activities which tend to alter more quickly, such as

household composition, employment, and rapid circulation of people and goods. Dijst et al.[12] also consider the flows of information and money, both in the context of business and personal lives.

Furthermore, considering the scale of human impact on the environment, Steffen et al[13] argue that the analyses should also cover natural processes and the extent to which they are affected by human-driven activities. These transformations stem from social and demographic conditions and the extent to which they affect lifestyles. Lyons et al.[14] name the following features which, influenced by everyday citizens' behaviors, affect the forms of urban settings: transportation, activities and consumption patterns, residential choices and ICT use. Broto et al.[15] acknowledges the role of patterns of production and consumption, and thus the influence of social processes on circulation and stocks of resources and the ecological environment. The processes which take place in cities are interdependent. For instance, urban design influences modal split and transportation modes, which, in turn, affect demand for space, noise levels and air quality, which further impacts the health of citizens, their lifestyles and personal choices. This complexity gets even greater when incorporating issues of urban resilience[16]. For example, transparency about natural hazards may indirectly impact housing prices and, in the aftermath, the distribution of housing. Urban metabolism models may become useful when building land-use models incorporating ecosystem services[17].

A model of material and energy flows, therefore, would create opportunities to better comprehend and optimize the functioning of an urban system[18]. Thanks to the application of GIS tools, quantitative applications of such systematic analyses in urban planning and design field becomes increasingly feasible[19]. Optimization of urban flows, thanks to their enhanced management, gives the opportunity to significantly reduce the consumption, multi-source, recycle and recover all the resources- this way diminishing the overall urbanization impact. As yet however, there are not many normative applications of urban metabolism studies in urban design and planning.

RESOURCE EFFICIENCY [15]

The world's urban population will nearly double by 2050 and urbanization will become one of the twenty-first century’s most fundamental trends. Populations, economic activities, social and cultural interactions, as well as environmental and humanitarian impacts, are increasingly concentrated in cities. This poses massive sustainability challenges regarding housing, infrastructure, services, food security, health, education, decent jobs, safety and natural resources, among others.

The New Urban Agenda presents a paradigm shift based on the science of cit-

ies. It underlines the relations between urbanization and job creation, livelihood opportunities, and improved quality of life, which every urban renewal policy and strategy should include.

Cities concentrate global economic production and consumption, producing some 80% of global GDP. Although cities occupy only 2% of the world's land surface, they consume 75% of natural resources, produce 50% of global waste and account for 60-80% of GHG emissions. The rapid growth of cities has lead to the scarcity of resources. In some cases the situation requires immediate actions as already 780 million people lack access to drinking water and by 2030 global demand for water will supposedly grow 50%[20].

The New Urban Agenda emphasizes this theme promoting resource efficiency and sustainable consumption and production in cities. Whereas the energy demand is expected to increase by 40%, proper urban planning could reduce energy consumption in urban settlements by 50%. There are many factors which influence the usage of energy and resources: the genre of business activities, the configuration and form of structures people inhabit, climatic and geographic conditions, type and way of use of infrastructure. Not least important are human everyday behaviors and the impact of citizens routines and interactions on energy and resource consumption. The critical challenge is changing the flows of resources and energy to optimize their exchange and use in the city.

Vettorato [15] states that the climate change is an overheating phenomenon. Earth's temperature depends on how much sunlight the land, oceans, and atmosphere absorb, and how much heat the planet radiates back to space. The enormous amounts of energy involved in these processes can be re-used [15]. For example, in the US in 2016 alone, 66.4 Quadrillion of BTUs were classified as rejected energy[21]. Assuming a BTU average cost of 20$, the sum of $1,328,000,000,000 was wasted that year in the US only. Cities use energy in an inefficient way, the same level of services may be provided with 50% energy.

Vettorato [15] proposes to optimize the use of energy and resources and this way tackle the scarcity through the intelligent use of space (public and private) and technology, mobilizing, involving and empowering key stakeholders. The proposed strategy is based on the concept of co-benefits 'socio-economic and environmental positive effects related to the execution of a project, exceeding the primary goal'[22]. The overlap of several goals achieved with the same amount of energy or resources makes the reduction and re-use possible.

FIGURE 4: Spatial distribution of all the case studies and individual contributors to the current paper

CASE STUDIES

The case studies below highlight the above ideas with six examples of various scales and context. They start at the level of the whole country as demonstrated by the Rwanda's example of Smart City Rwanda Master Plan supported by UN-Habitat. This initiative, which aims to improve the quality of life using technology, may be further exploited in other African and Asian countries. As further examples show, the metropolitan areas are especially prone to become test fields for smart cities. The case studies address problems of high densities in megacities, looking for transit-oriented infill solutions as in the project described by Now Institute. Two other case studies address Surat and Delhi in India; the first one demonstrating successful application of smart infrastructure development for the benefit of citizens health, the second revisiting challenges faced by Indian capital city due to the increase of local heat island. Improvements of infrastructure and smart governance are the tools implemented to slow down decay and rehabilitate the deterioration town of Port Louis in Mauritius. The last case study addresses the participatory approach using 3D IT communication platform in Schiedam, the Netherlands.

Javier Torner, UN Habitat: Urban Planning and innovation to capture the potential of new technologies and processes (Rwanda)

UN-Habitat supports the Rwandese government in implementing the Smart City Rwanda Master Plan, promoting integration of technology as a critical tool in sustainable urban development to enhance inhabitants' quality of life. The tool is designed to support nation-wide level of smart city developments, guiding Mayors and city managers in further creating local smart city strategies and masterplans.

Subsequently, the 27 ongoing initiatives are organized in three pillars- smart governance and planning; smart efficient services and utilities; and localized innovation for social and economic development. The initiative of using technology as a means to improve quality of life- a citizen-based approach to innovation and technology- has the potential to be scaled in many African and Asian countries including the ongoing discussion in Nigeria and Myanmar.

Valerie Leblond and Simon Flack, Now Institute: Human Scale Density

The Now Institute is an international non-profit organization dedicated to understanding and improving the urban environments, led by the Pritzker Prize winner Thom Mayne and embedded within the IDEAS research platform of UCLA Architecture and Urban Design.

In the limited space for world urban population of accelerated growth, new infrastructure for housing, sustainable mass transit, agriculture and energy must be secured through enabling novel ways for technology and services to keep society breathing to interface with one another in close proximity.

Cities like Mexico City and Beijing are already un-livable regarding transit and proximity to nodes solves already many of the issues surrounding density of old and the coordination of both services and transit. Thus, key to the Now Institute research approach is strategic allocation of density to more than one homogeneous and ever-expanding level of a city, applying this methodology to the city of Los Angeles (CA). One of the pilot projects of re-envisioning of L.A.'s iconic Wilshire Boulevard proposes interpretive transit-oriented, high-density infill strategies, accommodating the city's fragmentation, heterogeneity and idiosyncrasies embedded within multi-layer zones of culture, healthcare and businesses.

Amit Chatterjee, School of Planning and Architecture (SPA), Bhopal: Smart City Mission in Surat, India

Surat is a rapidly growing city housing population size of 4.4 million in 2011 which before 1990s, due to the rapid migration influx shortly after was known for reduced hygiene, facing several management problems and an outbreak of pneumonic plague resulting with large loss of human life.

This urged the municipal government to transform Surat to clean livable city, pioneering in implementing sewage treatment plants (STPs) with biogas energy (methane recovery). The currently running supervisory control and data acquisition (SCADA) system has the entire workflow- equipment, gates, aerators, blowers, pumps etc.- available at single online control place.

Supported by United Nations Development Programme (UNDP) funding, the municipal government worked hand in hand with central and state government and multiple other international agencies, national level technical/scientific institution, private sector partners to prepare comprehensive sewerage network master plan.

The Smart City Mission launched by the Indian Government in 2015 aims to improve public services and citizen interface in 100 cities via pan-city and area projects including integrated traffic and mobility administration center, smart city center for delivery of civic services, common city payment system, citizen interface mobile application etc.

Mahak Agrawal: Climate Resilient Urban Development Strategies for a megacity: A Case of NCT of Delhi

Delhi, India has been one of the mega cities which has been at the top of the emission charts for over two decades and continues to grow beyond its carrying capacity. The city experienced population expansion from approximately four hundred thousand in 1901 to nearly eighteen million in 2016, the growth being accommodated in 685 km² coverage area (or 130 persons/ha) in 1991, to 1200 km² (or 190 person/ha) in 2011, while engulfing its rural counterparts and declining the annual agriculture production by 0.5%.

This physical expansion corresponds with loss of heat sinks at annual rate of 1.4 per cent and increased in built up area by 1.4% resulting with an increase in air and surface temperature by 0.3%. From 1901 the annual average temperature in the city has increased by 1.4°C, out of which 0.93°C spiked in the past three decades alone. Both trends are further interlinked with the loss of

the urban environment and the three together form a vicious cycle, whereby urbanization is leading to loss or destruction of environmental resources and aggravating climate variability.

The research develops a correlation model to study the impact of urbanization and urban planning on the climate variability and environment for a megacity of Delhi, and conclusively develops three alternative models for future development, showing that the city has entered into a stage where there is no coming back but the rate of deterioration can be slowed if resilient strategies are adopted and prioritized at the earliest.

Zaheer Allam: Redefining the smart city: culture, governance and metabolism (case study of Port Louis, Mauritius)

Tools for enhancing productivity and interconnectivity by big data and real-time processing are further expanding the role of economies in the concept of smart cities, while imposing danger of technocratic governance and omitting key environmental issues- loss of biodiversity, urban sprawl and increased vehicular transportation.

Unhealthy environment is further constructed as new towns applying cutting-edge infrastructures only attract upper middle-class professionals, anomaly which can be overcome by showcasing existing cities using smart concept.

Smart Mauritius Initiative in 2015 launched a framework for new Smart Cities leaving Port Louis to slow urban and economic decay, due to lack of available concepts for smartening existing city. The conducted research resulted with theoretical model linking culture, governance and metabolism in a *National Urban Regeneration Scheme* as a resulting framework to sustainably smartening and modelling economic qualification of adoption of the existing city.

Islam Bouzguenda, Universitat de Girona: Perspectives on Citizen Participation for the Digital Age; Urban Development Based Research & Case Study

The new model of the smart city developed with Schiedam city includes citizens' participation as sensing nodes. Three stages of the participation tool were conceptually designed to empower successful citizen participation, which by urbanist and technology expert Antony Townsend, connects people more and brings up new potentials of using data to help understand complex problems better. While traditional ways of civic engagement are no longer appealing to some groups of citizens, widespread technologies in smart cities should empower them to interact with their city and participate in its decision-making processes.

Modulating participation as a leisure activity-- making co-creation enjoyable and interesting, any time available to citizens; improving participation in decision making by empowering the usage of technological and social tools available in the city and mixed reality technologies as a part of future participatory urban planning; and influencing participation with 3D interactive design tools and context visualization-- could help attract more civil engagement.

CONCLUSIONS

The current paper represents a concerted effort of several experts in the field of smart sustainable planning. It provides an attempt to systematize the complexity and richness of this domain. After an introduction containing a review of the state of arts, its challenges and dangers, we look at the three main pillars of the technology application in the planning discipline which are:

- Smart governance and (big) data management,
- Participatory planning and the potential to use the ict as communication to shift the planning focus towards problem solving and bottom-up approach,
- And infrastructure perceived as a backbone for development and opportunity to improve and optimize resources and energy efficiency.

After a review of theoretical approaches, we illustrate them with six innovative case studies coming from the urban design and planning practice.

Neither the catalogue of theoretical approaches nor the list of examples are closed. The classification used here is of an ordering character but in reality each single application joins and uses various technical tools, depending on the case studies' requirements. The current catalogue of methods and case studies just opens a topic, which with time and the development of both research and planning practice will deliver more and more tools. What needs to be underlined however is that to achieve sustainable community development, the technology needs to serve needs of a given society and the pace of development should be adjusted to enable harmonious progress of all the interrelated fields, providing framework for successful cultural, environmental and societal development.

ENDNOTES

1 This article is a compilation of contributions from some of the participants of these events and organizations.

2 Innes, J. E. and Booher, D. E. (2000) 'Public Participation in Planning: New Strategies for the 21st Century', Development. Institute for Urban and Regional Development, University of California (IURD Working Paper Series), (Working Paper 2000-07).

3 United 4 Smart Sustainable Cities program, UNECE and ITU, https://www.itu.int/en/ITU-T/ssc/united/Pages/default.aspx, accessed on 19.05.2018, quoted after Mazrina Khalid, Smart Sustainable Cities session WUF, Kuala Lumpur 2018.

4 Adopted in 1868 by United Nations World Commission on Environment and Development,

5 Duarte, F. and Firmino, R. (2018) Unplugging the City. The Urban Phenomenon and its Sociotechnical Controversies. New York and London: Routledge, Taylor & Francis Group.

6 Wolman, A. (1965) 'The Metabolism of Cities', Scientific American, 213(3), pp. 179–190.

7 Hoornweg, D. and Freire, M. (2013) Building Sustainability in an Urbanising World. A Partnership Report. Edited by D. Hoornweg, M. Freire, J. Baker-Gallegos, and A. Saldivar-Sali. Washington DC: World Bank.

8 Dijst, M., Worrell, E., Böcker, L., Brunner, P., Davoudi, S., Geertman, S., Harmsen, R., Helbich, M., Holtslag, A. A. M., Kwan, M. P., Lenz, B., Lyons, G., Mokhtarian, P. L., Newman, P., Perrels, A., Ribeiro, A. P., Rosales Carreón, J., Thomson, G., Urge-Vorsatz, D. and Zeyringer, M. (2018) 'Exploring urban metabolism—Towards an interdisciplinary perspective', Resources, Conservation and Recycling, 132(October 2017), pp. 190–203.

9 Ibid.

10 Wegener, M. (2004) Overview of land-use transport models. In: Hensher, D.A., Button, K.J. (Eds.), Transport Geography and Spatial Systems. Pergamon/Elsevier Science, Kidlington UK, pp. 127–146.

11 Dijst, M. (2013) Space–time integration in a dynamic urbanizing world: current status and future prospects in geography and GIScience. Ann. Assoc. Am. Geogr. 103, pp.1058–1061.

12 Dijst et al. 2018, opus citatum.

13 Steffen, W., Crutzen, P.J., McNeill, J.R. (2007) The anthropocene: are humans now overwhelming the great forces of nature? AMBIO: J. Hum. Environ. 26, pp. 614–621. The same observation is confirmed by IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.). Geneva, Switzerland: IPCC.

14 Lyons, G., Mokhtarian, P., Dijst, M., Böcker, L. (2018) The dynamics of urban metabolism in the face of digitalization and changing lifestyles: understanding and influencing our cities. Resources, Conservation and Recycling, 132 (May 2018), pp. 246-257.

15 Broto, C.V., Allen, A., Rapoport, E. (2012) Interdisciplinary perspectives on urban metabolism. J. Ind. Ecol. 16, pp.1–11.

16 Dijst et al. 2018, opus citatum.

17 Haase, D., Larondelle, N., Andersson, E., Artmann, M., Borgström, S., Breuste, J., Gomez-Baggethun, E., Gren Å, Hamstead, Z., Hansen, R., Kabisch, N., Kremer, P., Langemeyer, J., Rall, E.L., McPhearson, T., Pauleit, S., Qureshi, S., Schwarz, N., Voigt, A., Wurster, D., Elmqvist, T. (2014) A quantitative review of urban ecosystem service assessments: concepts, models, and implementation. Ambio 43, pp.413–433.

18 Dijst et al. 2018, opus citatum.

19 Blečić, I., Cecchini, A., Falk, M., Marras, S., Pyles, D. R., Spano, D. and Trunfio, G. A. (2014) 'Urban metabolism and climate change: A planning support system', International Journal of Applied Earth Observation and Geoinformation, 26(1), pp. 447–457.

20 http://web.unep.org, accessed 20.05.2018.

21 Data after Lawrence Livermore National Laboratory.

22 Bisello, A., Vettorato, D. et al. (2017). Smart and Sustainable Planning for Cities and Regions. Cham: Springer Internat. Publ.

APPENDIX

Theoretical Contributions

[01] **Introduction: Smart City** (Nicole Wirz Schneider, MAS Raumplanung ETH REG A)

Smart Governance and Planning

[02] **Smart Sustainable Cities** (Stephen Goldie)

[03] **Smart Governance and Smart Planning** (Irena Itova, UniverCities)

[04] **Smart City-Regions** (Trudi Elliott, Royal Town Planning Institute)

[05] **Mining Urban Sustainability/ Land Management** (Irena Itova, UniverCities)

[06] **[big] Data management** (Irena Itova, UniverCities)

Public participation

[07] **ICT and Public Participation/Smart Governance** (Aleksandra Stupar, University of Belgrade)

[08] **Creative techniques for creative engagement** (Ric Stephens, President of ISOCARP and Tim Van Epp)

[09] **Public Participation 2.0** (Beniamino Murgante, University of Basilicata)

[10] **Social is the new Smart** (Morten Nielsen, IFHP)

Smart infrastructure

[11] **Smart means working on how we want to live- not on how we used to live** (Thomas Vonier)

[12] **Designing information-rich streetscapes** (Małgorzata Hanzl, ISOCARP Vice President)

[13] **Alternative and Renewable Energies** (Ric Stephens, President of ISOCARP)

[14] **Shared mobility, smart transportation & infrastructure efficiency/ Autonomous Vehicle Systems** (Ric Stephens, President of ISOCARP)

[15] **Resource efficiency** (Daniele Vettorato, Vice President ISOCARP)