SECURITY IN URBAN CRITICAL INFRASTRUCTURES: CONTRIBUTION OF STANDARDS FOR A HOLISTIC APPROACH OF PROTECTION AND RESILIENCE

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EXTENDED ABSTRACT

With the prediction by the United Nations that 60% of the world's population will live in cities by the year 2030, it is apparent that the immediate global future is one of urbanisation. Central to the environmental and energy security as well as risk assessment in critical Infrastructures must therefore be the increasing domination of the cities. This population growth, needed economic growth, and social pressures for improved infrastructure coupled to the need for human health and ecological protection and environmental as well as energy security make systematic and transparent decision making a complex and often difficult task because of the several interdependencies of critical infrastructures. Evaluating complex technical data and developing risk management options requires implementation of standardization and embedded systems of information and communication technologies. In accordance to literature review, experience has demonstrated that direct transposition of risk assessment and risk management frameworks (e.g. those developed in the United States and European Union) may not work in regions whose social, legal, historical, political and economic situations are not suitable or prepared for acceptance of these methodologies. This paper reviews basic concepts defined in the field of urban security in Critical Infrastructures and extends its perception under the cross-sectoral aspect of standardization and harmonization in the involved technological areas. What are the defining characteristics that would ensure a city can not only survive in a manner acceptable to its current and future inhabitants, but also in a way that will not undermine the standardized and harmonized technologies and policies in national, European and international level. The existence of several EU seventh framework projects, specifically those relating to urban resilience and security could be used to feed into this direction.

Keywords: Security, Critical Infrastructure Protection (CIP), Standardisation, Harmonisation, Resilience, Risk Assessment, Interdependencies, Urbanisation, European Union policies, Construction Regulations, Vulnerability.

1. INTRODUCTION

1.1 National Critical Infrastructure

The European Union defines a critical infrastructure as "an asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions." 1 The USA Patriot Act2 defines a critical infrastructure as "systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters." A number of nations,

such as Australia, Canada, Sweden, Switzerland, the Netherlands and United Kingdom use similar definitions. The governance and resilience of these critical infrastructures and their critical services require prevention, preparation, incident management and fast recovery measures. For that reason governments identify what they regard to be critical Infrastructure sectors, and the related critical products, services and assets. The early Green Paper by the European Commission on critical infrastructures contains an example list of critical sectors, products and services.3 For the critical Information and Communication Technologies (ICT) sector, seven products and services are listed: Information system and network protection, Instrumentation automation and control systems (SCADA etc.), Internet, Provision of fixed telecommunications, Provision of mobile telecommunications, Radio communication and navigation, Satellite communication, and Broadcasting.

The USA recognises eighteen critical infrastructure sectors including Communication sector and the IT sector. The critical Communication sector comprises wireline, wireless, satellite, cable and broadcasting infrastructures; the critical IT sector comprises the provision of IT products and services, incident management capabilities, domain name resolution services, identity management and associated trust support services, Internet-based content, information and communication services, and Internet routing, access and connection services.

1.2 Urban Critical Infrastructures and resilience

Globally, 80% of the largest cities are vulnerable to severe impacts of natural disasters like earthquakes, and 60% are at risk from storm surges and tsunamis, and all face new impacts of climate change. The goals of any sustainable development policies agenda must ensure that even the most modest development gains are protected against losses incurred through natural and human-induced disaster and crisis. Development within planetary boundaries is one of the main priority challenges of sustainable development. Climate change adaptation and the adoption of low carbon and efficient energy strategies and technologies will play a critical role in meeting this challenge. Some of the greatest strides in this area will be made in cities, where energy efficiency measures in urban planning, buildings, and transport, and in the production of goods and services and the design of products, can both mitigate existing environmental concerns and contribute to new economic and job opportunities. All the above topics will be main issues for the agenda of United Nations Habitat III conference in 2016.

Any combined effort and/or dialogue for harmonization and standardization in urban CIP and resilience should bring together member states, national and local governments, urban planners, private sector, and other actors to discuss how cities build resilience in the face of uncertainty to protect lives and livelihoods, ensure continuity of services, and improve equitable living conditions. This effort should also focus on how cities can overcome capacity gaps/constraints to develop and achieve resilience targets and ‘do more with what they have’. The relative policies should empowering “Inclusive, Productive and Resilient cities”. Specifically, all cities should prepare themselves to be “socially inclusive, economically productive, environmentally sustainable, secure, and resilient to climate change and other risks”. Achieving this requires the development of participatory, accountable, and effective city governance “to support rapid and equitable urban transformation”. A holistic approach to urban resilience that considers all functions of an urban system can contribute to making all cities more equitable places to live and work. A European as well as international dialogue will also aim to achieve the following objectives:

• Demonstrate a correlation between urban resilience and economic inclusiveness and development;
• Introduce new, innovative structural and non-structural approaches to building urban resilience that contributes to a more equitable urban environment;
• Make the business case for cross-sectoral investments in urban resilience using examples of how micro-finance, insurance, transport, affordable housing, and renewable/low carbon energy

industries are enabling the urban poor to build resilience to natural and man-made hazards and conditions, and realize new growth opportunities;
• Demonstrate how cities can overcome capacity constraints to effectively develop and implement a resilience action plan.

Resilience is a cross cutting theme that, if approached in a coherent and holistic manner, can address and reduce social, economic, and environmental inequalities in urban areas. In this way, resilience is both a protector of development gains, as well as a conduit for future sustainable development. The resilience standards in urban areas can be achieved across four key areas:
• Socio-economic
• Demographic
• Environmental
• Spatial

It is necessary to include potential resilience themes covered in the above dialogue, like:
• Water and sanitation
• Food security
• Youth empowerment and engagement
• Equitable housing and infrastructure finance
• Transport.

2. SECURITY IN URBAN CRITICAL INFRASTRUCTURES

2.1. **European and International efforts**

For the first time, more than 50% of the world's population lives in urban areas. In 1950, 30% of people were urban dwellers; by 2050 this figure is to rise to 70%. This trend brings with it increased security and safety threats in urban areas. The increased risk of catastrophic events, whether accidental or deliberate, or by way of natural disasters, means there is now more so than ever before, a need to ensure the resilience of our cities. Large scale urban built infrastructure is a critical node within the intertwined networks of urban areas, which include not only physical components, but also integrated hardware and software aspects. To date, a comprehensive and holistic approach to improve the resilience and security of large scale urban developments against attacks and disruptions has not been developed thoroughly. A lot of EUFP7 projects like HARMONISE, VITRUV, RIBS and DESURBS among others are generated for the specific topics.

It is generally accepted that we do need a holistic approach to Urban Security and Resilience. To date there is no comprehensive, holistic approach to improve resilience and security of large scale urban built infrastructure; this is a situation which is not helped by the lack of a clear definition of what amounts to urban resilience. Vulnerabilities to terrorism and natural disasters of our urban areas, together with the mechanisms to address them, continue to be studied, yet no holistic approach has been formulated to develop a systematic approach to the design and planning of large scale urban built infrastructure with resilience in mind. Cities have been identified, by Bugliarelio,1 as being ‘target rich’ environments, within the context of terrorism; however, cities are just as susceptible to natural disasters. In 2010, for the first time since records began, natural catastrophes, such as floods, storms and earthquakes caused more damage (human and economic) than manmade disasters. There is, now more so than ever before, a need for a holistic approach to urban resilience, with an emphasis on having the tools in place which are capable of dealing with all challenges, whether man-made or natural.

The typical responses taken by authorities when dealing with issues relating to resilience traditionally revolve around physical measures, such as modifications or retrofitting of at-risk

buildings, combined with an increase in security personnel. Such measures are typically aimed at tackling issues relating to some form of attack, usually of the more traditional terrorist type, and, as such, are less compatible at dealing with natural disasters and their aftermath. The severity of both terrorism and natural disasters or threatening events over the course of the last decade has prompted a requirement for buildings and related infrastructure to offer not only resistance, but functional capacity (e.g. safe shelter and critical operations) after a destructive incident. In this respect the concept of 'resilience' has become an increasingly utilized metaphor within the policy-making process and in the expanding institutional framework of national security, disaster preparedness and mitigation.

In relation to urban resilience, the objective must be to mitigate the impact and sustain functionality for as far as is practically possible. To achieve this there is a requirement to have the conditions in place so that unforeseen outcomes can nonetheless be accommodated accurately and immediately through collective problem solving with improvisation and innovation. Resilience therefore in this context refers to a system's capacity "to continue its existence, or to remain more or less stable, in the face of surprise, either a deprivation of resources or a physical threat".5 Within the built environment literature, resilience of the 'urban form' comprising buildings and related infrastructures has been traditionally construed as being primarily concerned with protection and recovery from natural hazards. Depicting the evolving and increasingly complex nature of modern day security challenges the terminology of resilience – the ability of the urban system to 'bounce-back' - have therefore assumed a dual guise, encompassing the twin threats and challenges of climate change in parallel with the development of modernist counter-terrorism initiatives.

A representative example in new building concepts protecting against human-induced disaster, especially in cases of aircraft impact, indicates that we have to taking account aspects like subsequent kerosene fire of be considered as realistic threat against critical infrastructure. Typical examples are high-rise buildings in the range of several hundred meters altitude, potentially as part of a large scale urban development, housing several ten thousands of occupants in office and/or residential space. The largest of these buildings worldwide carry symbolic value making them susceptible to attacks. Furthermore, major nuclear facilities have to be considered, especially those designed about 2-3 decades ago without or with low protection requirements against accidental aircraft impact The two recently developed comprehensive and innovative concepts of these building types, based on high performance (HPC) and ultra-high performance concretes (UHPC). The most sophisticated method to calculate the local resistance of a reinforced concrete building component for the loading case aircraft crash is with respect to the DIN 25449 the use of modified, empirical punching strength evidence. The deviation of the corresponding factors is quite complex and includes a certain amount of uncertainties that are not part of this study to analyze or to mention.

Under the Seventh Framework Programme (FP7) Research and Technical Development project on urban security and resilience being carried out across Europe there are opportunities for integration. The development of an integrated approach to urban resilience and the advancement of a holistic approach should encompass a methodological framework. Through the application of a real life case study module within the methodology, a more thorough examination of any proposed interactive semantic intelligence platform is needed. Each of sampled specific case studies would have to be chosen with a focus on large-scale buildings/building complexes/building arrangements such as shopping centres/areas, sports venues or combinations of business centres with underground transportation nodes; etc. Any selected case studies should be representative of the diversity among the built urban form. This will allow a comprehensive assessment and iterative development process in terms of the tools that will be developed while providing a robust test-bed for the integrated information platform to be developed. The state of the art built infrastructure protection products and planning/engineering tools currently practiced/envisaged at these case study areas will be analyzed to identify existing constraints, shortfalls and capability gaps.

Physical, cyber and personnel security generally remain separate in many organisations. An holistic security methodology provide a better understanding of overall organisational security risks by applying converged governance and risk management across all assets. In combination with programme for security risk management expertise, such approach ensures better protection for assets, staff and information. The benefits of the holistic security approach are:
• Understand where gaps exist between security 'layers'
• Bridge the gap between the 'hard' side of security (technical/physical) and the 'soft' (information/policy/ processes/people)
• Identify where security measures are being duplicated and are therefore wasteful
• Ensure investment is in proportion to risk levels
• Make security a strategic differentiator rather than a tax on the business
• Target resources where they deliver maximum benefit for every organisation.

2.2. Environmental security and CIP

Population growth, needed economic growth, and social pressures for improved infrastructure coupled to the need for human health and ecological protection and environmental security make systematic and transparent environmental decision making
a complex and often difficult task. Evaluating complex technical data and developing feasible risk management options requires procedural flexibility that may not be part of existing evaluative structures. Experience has demonstrated that direct transposition of risk assessment and risk management frameworks (e.g. those developed in the United States and European Union) may not work in regions whose social, legal, historical, political and economic situations are not suitable or prepared for acceptance of these methodologies. Flexible decision-making, including the use and development of acceptable or unacceptable risk levels based on the critical nature of an infrastructure type, is one potential approach to assist risk managers in their decision-making. Unfortunately, the newness of the discussions on the interrelatedness of environmental security and critical infrastructure has yet to produce a unified and comprehensive treatment of the fields Environmental security has emerged as an increasingly important concern of governments and their defense establishments because of several trends that have the potential to threaten stability. These potential threat issues include: world population in 2015 will be 7.2 billion, up from 6.1 billion in year 2000; water scarcities and
allocation will pose challenges to certain governments; groundwater depletion; contemporary environmental problems will persist and grow; globalization will be rocky, marked by chronic financial volatility and a widening economic divide; significant degradation of arable land; loss of tropical forests; greenhouse gas emissions will increase substantially; exacerbation of biological species loss; rapid urbanization; increasingly serious urban air and water quality problems; and global climate change induced glacial ice melt backs, sea level rise, and increasing storm frequency

"Environmental Security" is an ill-defined term (McNeil 2000) with many definitions whose two key elements are: repairing damage to the environment for human life support and for the moral value of the environment itself; and, preventing damage to the environment from attacks and other forms of human abuse. Several definitions of environmental security exist and demonstrate that after more than two decades of discussion, the concept of environmental security still has no widely agreed upon formulation (McNeil 2000). The discipline of "environmental security" is neither a pure security issue nor an environmental issue. However, environmental issues are often security concerns because, even without directly causing open conflict, they can result in environmental perturbations or triggers that can destabilize the status quo and result in a loss of regional, national, and local political, social, economic and personal security (Schwartz and Randall 2003). Environmental security concerns can be grouped into three general categories (AC/UNU Millennium Project):
1) security of the environment which is a good in itself;

2) security from environmental change that can create societal instability and conflict; and,
3) security from environmental change (e.g. water scarcity, air pollution, etc.) that would threaten the material well-being of individuals.
Common elements of environmental security definitions include: public safety from environmental dangers caused by natural or human processes due to ignorance, accident, mismanagement, or design; amelioration of natural resource scarcity; maintenance of a healthy environment; amelioration of environmental degradation; and, prevention of social disorder and conflict (promotion of social stability) (Glenn et al. 1998).
Environmental security concerns include chemical/material releases to the environment. This is because, worldwide, an estimated one quarter to one third of disease burden is attributable to environmental factors (European Environment Agency 2003). Chemical or material releases to the environment or environmental alteration result in actual or perceived health risks that can result in societal conflicts between parties in support or opposition to the environmental perturbation.

It is generally accepted that environmental security is a very broad term used to encompass a wide variety of issues. For the purpose of this book, by ensuring environmental security we mean guarding against environmental degradation in order to preserve or protect human, material, and natural resources at scales ranging from global to local. The critical infrastructure concept is directly linked to environmental security. For environmental applications, critical infrastructure may be defined as manmade structures constructed and maintained to assure human health, environmental protection, transportation networks, water supplies, clean air, food supplies and other critical elements necessary to maintain economic and national security. The question not yet fully addressed is how does one accommodate both the importance of critical infrastructure and of environmental security, given the current risk assessment/risk management paradigm? Many papers published in order to address different aspects of this issue. As the fields of risk assessment, risk management, critical infrastructure, and environmental security merge, additional discussions will need to occur to define these interactions and their implications for environmental protection and regulatory activity.

2.3. Energy security and CIP

Security of supply is an important goal of energy policy in many countries around the world. The three pillars of the European Union's energy policy are efficiency, sustainability and security of energy supplies (European Commission (EC) 2008; European Commission (EC) 2006) and a few years before his election as President, Barack Obama said: 'We need a national commitment to energy security, and to emphasize that commitment, we should install a Director of Energy Security to oversee all of our efforts. ''(Senator Barack Obama, February 28, 2006; Governor's Ethanol Coalition Washington, DC). Based on the literature review on energy security topics, we found that the common concept behind all energy security definitions is the absence of, protection from or adaptability to threats that are caused by or have an impact on the energy supply chain. Due to the difficulty of measuring all these threats at the same time, individual authors implicitly or explicitly limit the concept of energy security along one or several of the following dimensions: the sources of risk, the scope of the impact measure, and different severity filter such as the speed, size, sustention, spread, singular it y or sureness of impacts. The choice of conceptual boundaries has a large impact on the results. Depending on the audience and the context of the analysis, further limitations of the concept may apply.

3. CONCLUSIONS

In terms of the security and future long term sustainability of the continuously expanding urban areas of the world, addressing issues of urban resilience must be a priority for all involved in the design and planning of our cities. The culmination of threats posed by global terrorism and natural disasters, together with such impending issues as 'peak oil', results in the need to

proactively tackle matters concerning urban resilience. Having identified a means by which the involved projects/policies can be advanced through the integration and development of existing systems, this paper has sought to highlight the way forward in terms of urban resilience. The primary outcome of an integrated approach, as outlined above, will be to:

Facilitate a systematic approach to develop a security and resilience concept for a combination of complex and dynamic urban systems. This will allow for improved situational awareness across a collection of buildings or building complexes, resulting in the optimization of responses to whatever situation may arise.

Deliver supporting tools for the design/planning stage of large scale urban built infrastructure development; these tools will have been tested and enhanced through the evaluation of the quality case studies. This will result in the introduction of a set of new urban design criterion, which encompasses the values of urban resilience. This will ensure that urban designers embrace the need to consider services, security measures and infrastructure into their design, to ensure a properly integrated environment and a viable finished vision of the design from the outset.

Provide an integrated approach to sharing building infrastructure and security information (building operation systems traditionally work in isolation) including critical flows of materials/energy and sensor technologies etc, while recognizing the important role of security culture and societal acceptance aspects. This will also see the introduction of integrated systems, between complexes of buildings, which are designed to make exiting the wider urban area safer in cases of emergency; this will be possible through the use of systems to adapt to information from sensor technology and to identify the routes which are safe and highlight those which are unsafe.

Furthermore, legislators and regulators for non-ICT critical sectors such as health, transport, environmental and energy should include cyber security aspects as an integral part of their regulatory frameworks in addition to the physical security and safety laws and regulation. This may include security requirements for and standards on the devices with embedded ICT. It also may include standards and regulations for the organisational structure, processes, reporting schemes, and information provision about security and privacy breaches to potentially affected people and to the public.

Several EU Seventh Framework Projects, specifically those relating to urban resilience and security could be used to feed into EU policies, not least HARMONISE, VITRUV, RIBS and DESURBS. This will also result in the enhancement of the pool of European expertise on matters of urban resilience. The improvement of the design of urban areas and systems, increasing their security against, and resilience to, new threats, will be the most important outcome of this study. Cities hold out the promise of concentrated economic dynamism, predictable access to services, and opportunities for democratic citizenship. Urbanization is a transformative process to a large extent, synonymous with modernization, and development. In most cases, as countries urbanize they become more advanced, more developed and more prosperous. The development of integrated, standardised, harmonised actions by bringing together various actors (stakeholders like social services, operators, manufacturers and law enforcement) and leading joint efforts in the design and implementation of global joint initiatives, will contribute towards a better and secure world.

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