CLIMATE RESILIENCE IN URBAN AREAS

Izabella MARIN LAZĂR, Lecturer D. Architect, „1 Decembrie 1918" University of Alba Iulia, Romania, marin.izabella@uab.ro

***Abstract**: The current context, requires the built environment, buildings and public space, to respond to the need to adapt to climatic conditions, all the more so as it represents the space in which we carry out our activity and which is directly responsible for ensuring comfort and health conditions.*

Therefore, in the construction of new buildings, as well as in major renovation programs, climate change will be taken into account by adopting technological and architectural solutions that ensure resilient living conditions and at the same time a reduced environmental impact. The concepts of climate sensitive building / urban planning derive from the need to plan a man-made environment adaptable to these changes by designing buildings capable of responding to the aggressiveness of the natural environment.

The nZEB concept through zonal energy re-configuration projects can be a strategy for resilient urban adaptation. In this context, a multi-criteria approach is needed for the zonal renovation projects so that the energy re-configuration strategy is put in relation with the analysis of the conditions for resilience, by extending the design decisions.

***Keywords:** urban resilience; nZEB-nearly Zero Energy Buildings; Heat Island Mitigation; energy efficiency; renewable energy sources; urban retrofitting; integrated solutions; multi- criteria approach*

1. Introduction

According to the European Environment Agency's Report[1], the observed and forecasted hazards show an increase in the frequency and intensity of extreme, acute hazards, such as heat waves, droughts, floods, heavy rainfall and vegetation fires. Temperature changes and hydrological variability, changing precipitation patterns, sea level rise are the most frequent chronic hazards (slow onset events). Given the high population densities in urban areas, including vulnerable people, there is a need to rethink how cities are planned and built to avoid unsustainable urban growth that can amplify climate hazards.

The phrase „Transforming cities transforming Europe"[2] emphasizes the direction of sustainable development, with urban adaptation essential for overall societal resilience. The protection of residents (including vulnerable people) requires the integration of adaptation actions in all areas, including measures applicable to buildings included in the scope of technological adaptation solutions.

[1] Source: "Urban Adaptation in Europe: how cities and towns respond to climate change"_ EEA Report 12/2020

[2] "Urban adaptation to climate change in Europe 2016: Transforming cities in a changing climate", EEA Report, No 12, 2016, https://www.eea.europa.eu/publications/urban-adaptation-2016, p. 31

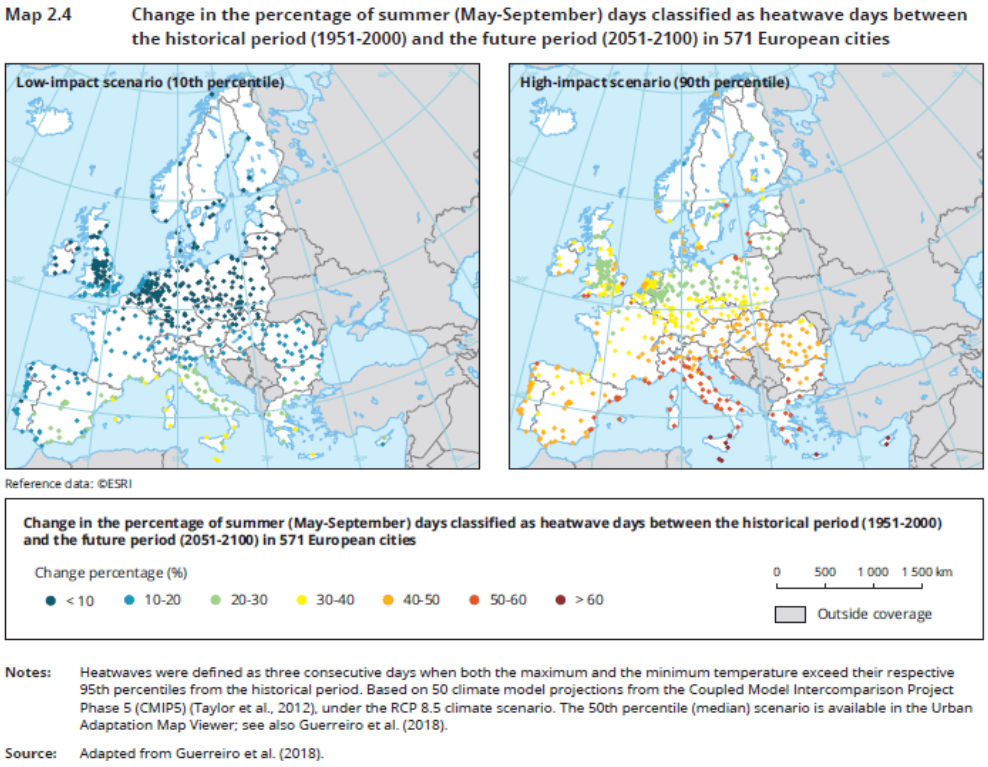

Figure 1: Increase in heat wave weight for the forecast period 2051-2100 compared to historical values 1951-2000 for 571 European cities.

*) Source Urban Adaptation in Europe: how cities and towns respond to climate change _ EEA Report 12/2020

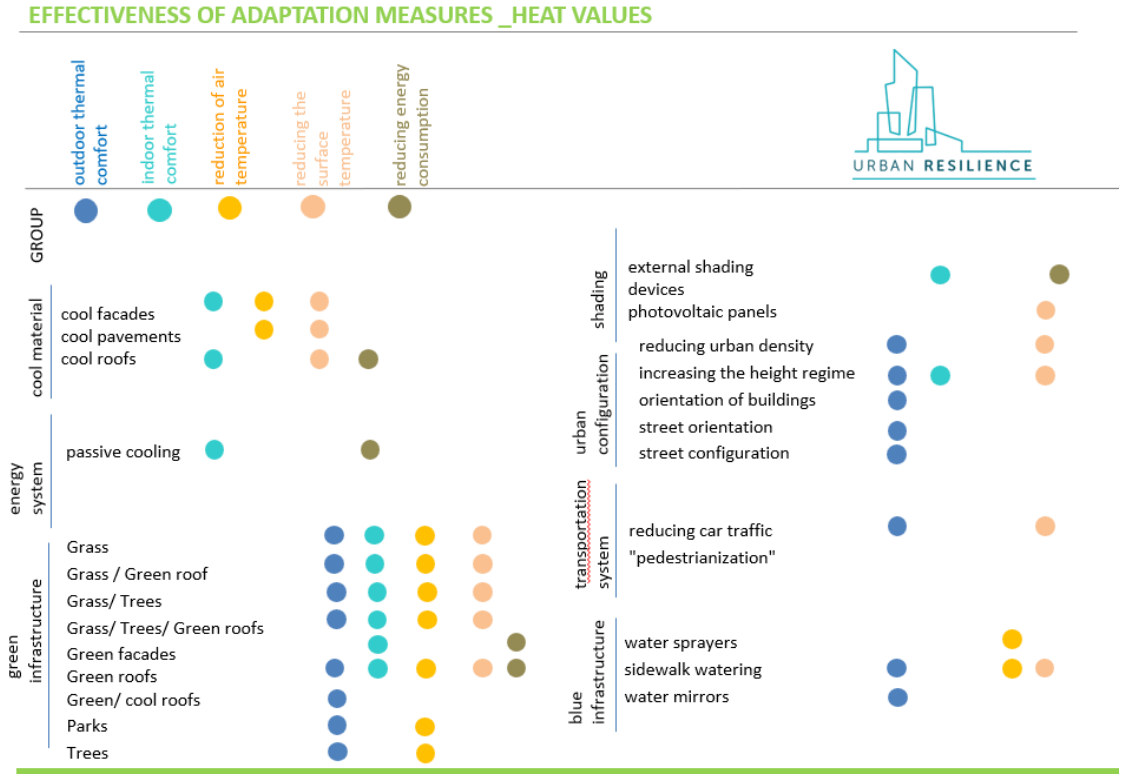

Figure 2: Effectiveness of adaptation measures in the event of heat wave climate risk

*) Source: adaptation Fig. 3.1 – Urban Adaptation in Europe: how cities and towns respond to climate change _ EEA Report 12/2020

The danger of increasing intensity and duration of heat waves affects the urban environment in terms of population health, built environment, energy consumption, etc. The effectiveness of applicable adaptation measures can be quantified by various indicators by monitoring thermal comfort parameters in buildings and temperatures inside urban areas additionally affected by the urban heat island effect.

2. Materials and Methods

"*Resilience is not a single solution, concept or perspective but a multi-criteria approach and a rethinking of the built environment with the aim of finding solutions to the disruptions that occur*."[3]

The term resilience is associated with the maintenance of sustainable living conditions both at the level of housing units and at the community or regional level in extreme situations that can lead to power outages or disruptions to the functioning of vital urban systems. Building resilience is related to ensuring the conditions for passive survival in the event of power or heat supply failure.

This approach implies the use of passive architectural solutions for indoor climate control, building massing, night ventilation, shading elements can contribute to keeping indoor temperatures within bearable limits as shown by dynamic simulations of natural thermal response (NTR) in dwelling units in major renovated collective residential buildings[4]. Based on the NTR simulations it can be concluded that the achievement of passive survival conditions - thermal safety - is conditioned by the realization of energy efficient buildings, which links the notions of resilience and sustainability.

Major renovation projects in urban areas should include, as a complement to the solutions applicable to increasing energy and environmental performance and achieving the nZEB objectives, the extension of the solutions that can be promoted in the concept of renovation for resilience. At the building level, the aim is to increase adaptive capacity, reduce vulnerability to extreme climatic events, and provide auxiliary energy sources.

The result of this multi-criteria approach to renovation programs also entails reducing energy consumption, improving the quality of life and increasing the safety of residents.

major energy renovation →	*integrated multi-criteria solutions* ←	renovation for climate resilience
nZEB solutions	social involvement	safety
SUSTAINABILITY	**COMMUNITY**	**RESILIENCE**[5]

3. Results and Discussion

Medium- and long-term weather forecasts point to an increase in the duration and intensity of heat waves[6], with a significant impact on the climatic risks to which existing

[3] https://www.resilientcity.org/index.cfm?pagepath=Resilience&id=11449

[4] Izabella Marin Lazar – Atlas Verde al României – aplicații în arhitectura clădirilor cu consum de energie aproape de zero (Nearly Zero Energy Building– nZEB), Editura Universitară "Ion Mincu" București, 2021

[5] idem 4

[6] Forecast maps - European Environment Agency - EEA -Climate evolution in Europe
Source: https://www.eea.europa.eu/data-and-maps/figures/european-regions-clustered-according-to

buildings will be subjected, especially as the urban environment is additionally affected by temperature increases caused by anthropogenic factors that amplify the Urban Heat Island effect.

Risk assessment in urban areas with respect to severe climatic stresses in the summer season can be done by assessing how buildings in these urban spaces in their current energy status respond to these stresses. Taking into account the housing density in these urban areas (including vulnerable people), it is proposed to assess the resilience conditions of existing buildings with collective housing function.

The method used involves the simulation of the Natural Thermal Response (NTR) of a representative Locative Unit, specific to the energy typologies of existing residential buildings in the analysed areas. This method is based on hourly time-step dynamic energy simulations described in the paper "Climatic resilience and energy and environmental performance of residential buildings"[7], taking into account the non-functioning of artificial cooling systems (in case of power supply failure) and the lack of passive solutions that mitigate the effect of solar radiation penetration into the living space in terms of thermal comfort.

The graphical results of the use of the energy simulation tool described above for the analysis of the resilience conditions of a representative urban area of the existing building stock with reference to the collective residential dwellings in Bucharest (Izabella Marin Lazar 2021) are presented. It is mentioned that the urban area was also assessed from the point of view of current energy and environmental performance and the identification of proposals for applicable solutions in order to achieve the nZEB objectives.

Figure 3: Resilience assessment plan for buildings within the Test Urban Area - current situation

The conclusions of the resilience analysis have highlighted the vulnerability of buildings within the urban area under test (in their current energy status) in the situation of climatic risk represented by heat waves of high duration and intensity, up to the level of

[7] Dan Constantinescu “Reziliența climatică și performanța energetică și de mediu a clădirilor de locuit”, Ed. Universitară Ion Mincu -București, 2020.

situations of risk to the health of the inhabitants and implicitly the inability to provide conditions for passive survival.

Recognizing that human health corresponds to the quality of the built environment is the direction of sustainable and resilient urban planning, where the design process supports the ability of the building or infrastructure project to manage critical resources (energy, water, information, etc.) more efficiently and in more health-friendly ways.[8]

In the light of the above for the urban area analysed, it is necessary to complement the applicable solutions for increasing energy performance with a range of solutions that enable resilient living conditions. An important aspect is to equip these buildings with photovoltaic panels and an energy storage system (batteries, inverters) in order to provide an additional source of energy in the event of a power failure in the grid.

Through NTR simulations, a series of passive architectural measures, such as the provision of solar control elements such as foldable, heat-insulating and reflective movable shading elements, have been identified as applicable solutions to increase the resilience of the residential units, nocturnal ventilation by means of a perforated false ceiling (the volume flow of air introduced is regulated according to the indoor and outdoor temperatures by means of inverter systems), and the use of high albedo finishes (opaque envelope walls, cool-roof terrace)[9].

Following the application of the described solutions, the reduction of the thermal discomfort is observed with reference to the number of hours in which the indoor temperature exceeds the critical threshold of 28°C. For the configuration of the buildings including the energy reconfiguration package of solutions, practically a projection of the nZEB urban area, including resilience measures, the result is that the ability to maintain indoor thermal comfort is ensured compared to the considered threshold of 28°C.

Within the nZEB urban area, the conditions for passive survival and the avoidance of situations of risk to the health of the inhabitants are highlighted.

4. Conclusions

The findings of the zonal analysis provide a basis for applying multi-criteria assessments of energy, environmental and resilience performance in the development of scenarios for major renovated urban areas.

The results of the study argue for complementarity between the concept of major energy renovation of existing buildings for urban sustainability and the concept of renovation for resilience. Thus the nZEB Green Atlas/energy nZEB decision tools can be used as instruments to reconfigure the existing urban environment towards a resilient environment by realizing that human health corresponds to the quality of the built environment.

5. References

1. *Constantinescu D. –"Tratat de inginerie termică. Termotehnica în construcții", volume 2 "AGIR" Publishing House, Bucharest, 2020*
2. *Constantinescu D., Reziliența climatică și performanța energetică și de mediu a clădirilor de locuit,"Ion Mincu" University Publishing House, Bucharest, 2020*

[8] Bill Millard, Gisela Garrett & others, Extreme heat: Hot cities adapting to a hotter world, symposium report, Ed. American Institute of Architects New York, New York, 2016

[9] Izabella Marin Lazar – Atals Verde al României – aplicații în arhitectura clădirilor cu consum de energie aproape de zero (Nearly Zero Energy Building– nZEB), Editura Universitară "Ion Mincu" București, 2021

3. *Helmuth Erich Landsberg, The urban climate (International geophysics series v. 28), Academic Press, New York, 1981*
4. *Marin Lazăr I.,”Atlas Verde al României aplicații în arhitectura clădirilor cu consum de energie aproape de zero (Nearly Zero Energy Buildings – nZEB), ”Ion Mincu” University Publishing House, Bucharest, 2021*
5. ****Victoria Ochinciuc, (Director de proiect), &echipa de cercetare Consorțiu, Proiect de cercetare: “Reducerea Efectelor Insulei Termice Urbane Pentru Îmbunătăţirea Confortului Urban Şi Echilibrarea Consumului Energetic În Bucureşti”, 2014- 2017, Contract UEFISCDI nr. 102 / 1.07.2014, UAUIM nr.2/2014 https://www.uauim.ro/cercetare/redbhi/rezultate/*
6. *Bill Millard, Gisela Garrett & others, Extreme heat: Hot cities adapting to a hotter world, symposium report, Ed. American Institute of Architects New York, New York, 2016*
7. *Urban adaptation to climate change in Europe 2016: Transforming cities in a changing climate", EEA Report, No 12, 2016, https://www.eea.europa.eu/publications/urban-adaptation-2016*
8. *“Urban Adaptation in Europe: how cities and towns respond to climate change” _ EEA Report 12/2020*
9. ****Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.*
10. ****Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency*
11. ****Legea 101/2020 (M.O., Partea I nr.579/ 01.iulie.2020) și 238/2024 pentru modificarea si completarea Legii 372/2005 privind performanța energetică a clădirilor*
12. *https://www.resilientcity.org/index.cfm?pagepath=Resilience&id=11449*