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Investment Needs and Opportunities of Polish Cities in the Context of Adaptation to Climate Change

Today's cities are growing into one of the primary arenas on which climate change effects are felt most vividly, as well as one place where the potential to offset its deleterious effects is most pronounced. Increased frequency and severity of heat waves, dry spells, torrential rainfall, and other climate extremes indicate that adaptation to climate change is no longer an additional or discretionary policy field but a systemic requirement. Given that the dynamic processes of urbanization and suburbanization are unfolding, and the spatial layout of a good number of cities is characterized by a high degree of surface sealing and a deficit of green space, in Poland, these problems take on particular urgency and importance. Municipal Adaptation Plans (MAPs) are being put into practice, and a focus is being placed on enhancing urban resilience as an institutional response to rising demands voiced by local administrations. Nevertheless, a significant gulf still exists between the extent of stated adaptation needs and the real capital and institutional capacity of municipalities to effectively address these.

Cities are also identified in the world literature as the most susceptible to the effects of climate change in relation to the urban heat island effect and the higher likelihood of pluvial flooding (Croce and Vettorato, 2021). Empirical research additionally supports that climate adaptation at the level of spatial planning is a necessary element of effective implementation in long-term adaptation (Reckien, Flacke, Olazabal & Heidrich, 2015). In this context, Meerow, Newell, and Stults (2016) stress that urban resilience should be considered as it refers to more than just environmental dimensions; it also includes social, institutional, and economic dimensions. Building resilience, they argue, involves a comprehensive and integrated approach that is not limited to isolated or segmented interventions, but must instead encompass systemic transformations in urban governance and infrastructure. Among the measures that have gained significant importance in this framework are urban greening actions, blue-green infrastructure, stormwater retention, and energy efficiency improvements.

The various urban greening initiatives, such as new park increases, the use of green roofs, green walls, and street tree planting, reduce air temperatures, improve air quality, and increase stormwater retention capacity in the urban environment, as it is said. Interventions lead to co-benefits of biodiversity conservation, human health, and urban living as well. Concomitantly, research suggests that the most successful adaptation approaches involve systemic solutions

that integrate green and blue infrastructure components alongside energy and technical infrastructure (De Bruijn, Buurman, Mens, Dahm, and Klijn, 2017). These integrated approaches allow cities to handle multiple climate risks simultaneously, maximizing environmental, social, and economic benefits.

Although there is an increasing number of studies in the conceptual and strategic domains of this research, there are few empirical studies investigating the linkage between declared adaptation demands of municipalities and investments in adaptation measures. This challenge has implications in the Polish context, not least the fact that local government units exhibit wide disparities between areas in population, budget composition, earning capacity, administrative, and human resources potential. Such disparities result in inconsistent capacities in organizing climate adaptation plans and financing them and their application. Hence, the objective of this article is to investigate the gap and to create a typology of adaptation priorities and the spatial distribution of adaptation functions in Polish cities.

The research methodology was supported by a desk research review and a survey of 135 different cities in Poland, with consideration given to strategic documents, Municipal Adaptation Plans, and related academic literature. We used an analytical framework to include some city size categories (small, medium, large) that provided a comparative assessment of implementation capacity based on the size of the local government unit. The field-based empirical research employed structured questionnaires focused on municipalities whose departments handle spatial planning and financial policies, focusing specifically on climate adaptation, municipal investment, and environmental management. The questionnaire encompassed questions about the ecological instruments employed by cities, their capacity and needs for the enforcement of adaptation practices over a five-year horizon, as well as the challenges faced in the operationalization of pro-environmental means. Respondents were asked to determine the scale of adaptation needs and to name a maximum of five actions that realistic approaches to action in the short term are feasible.

Two main hypotheses were tested in this work. H1, the first hypothesis, assumed that larger cities and/or cities with a higher per capita budget have a greater ability to execute adaptation initiatives for adaptation measures. Hypothesis 2 (H2) concerned the structure of adaptation priorities and involved the belief that more urban areas choose, on average, to adopt point-based measures, especially in the area of urban greening, instead of fully developed and comprehensive integrated blue-green and energy-oriented interventions.

The findings of the study show a great gulf between the high level of perceived adaptation requirements and the small range of actions achievable in a short-term time frame that can, on paper, realistically be taken. In the majority of cities, the proposed adaptation needs were high or very high with specific reference to stormwater retention and mitigation of urban overheating, as well as to the development of green space. Meanwhile, the list of actions that could be carried out in five years was quite small and generally limited to projects with limited monetary needs and lower technical and institutional complexity.

Part of hypothesis H1 was confirmed. Larger cities and higher per capita budgets had better implementation potential (the number and complexity of planned action). Those cities had more experts as experts, access to more external funding sources, such as national and European funds, and also greater experience in large-scale infrastructure projects. However, in spite of these, there are substantial constraints caused by administrative red tape, the technical and organizational challenges of investments, and overlapping budgetary priorities, even in this group. This result indicates that it is not sufficient to have financial capacity alone to ensure climate adaptation and that institutional and governance are important determinants.

Hypothesis H2 was fully supported. Point-based greening interventions — tree planting, small green squares, rain gardens, and small-scale retention systems — were clearly more predominant than integrated, capital-intensive strategies, such as retrofitting stormwater systems, or renovation of river valleys or large-scale thermal modernization programs. These preferences might be attributed to the lower unit cost of these interventions, quicker delivery, and higher levels of public acceptability. Visible green interventions appear to be positive in terms of residents' attitudes and can be adopted gradually, rendering them politically and administratively more plausible. However, the body of literature still frequently suggests that isolated and localized interventions are very important and do not replace system-wide and global solutions in the area of climate change adaptation (De Bruijn et al., 2017). If structural interventions do not address the root causes of urban vulnerability, the cities may become increasingly susceptible to increased climate risks.

Among the respondents, the most identified barriers consisted of financial constraints, the lack of trained staff, and institutional issues such as a lack of coherence between strategic papers and planning practice. Respondents also highlighted challenges in interdepartmental coordination and the lack of stable, long-term financing mechanisms for adaptation measures. These observations are in accordance with previous international research, which highlights that the ability to adapt successively requires appropriate multi-level governance structures, institutional coordination, and sectoral policy integration. This matter has excellent importance and strategic character from the perspective of the needs expressed by Polish cities. Local government agencies are becoming more aware that adaptation mechanisms are required but are unable to deliver high-profile efforts at scale. This points to an increased requirement to reinforce financial support tools, to strengthen institutional capacities and to create coherence between climate adaptation, spatial planning, and financial policy. Importantly, mechanisms that allow for the pooling of national, European Union, and private sources of funding as well as the deployment of innovative financial instruments like green bonds, public-private partnerships, and climate funds are being developed. The study thus confirms that there is an extensive gap between the requirements for high levels of adaptation and the actual implementation capacity of Polish cities. Given the growing climate pressures and the mandate to develop and implement Municipal Adaptation Plans, integrated strategies towards urban resilience must supersede fragmented and point-based measures. For such a goal to be realized, it needs more than additional capital; it also requires reform within institutions, more capacity building within public administrations. This topic, discussed in this article, is of core importance for the

future of Polish cities, for their economic competitiveness, for the quality of life of their people in the context of the climatic changes resulting from accelerating climate change. This adaptive deficit, which remains unaddressed today, threatens to lead to further increased vulnerability of urban systems, degrading their sustainability in the long run without coordinated and decisive efforts to remedy it. On the other hand, successful and well-entrenched adaptation policies have the potential to improve social cohesion, economic stability, and resilience of urban communities against contemporary and future climate hazards.

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