Vol. 15, No. 2
2024

Ecological Safety and Balanced Use of Resources

Journal homepage: https://esbur.com.ua/en

Received: 02.07.2024. Revised: 30.10.2024. Accepted: 02.12.2024

UDC [551.583+504.75.06]:911.375

DOI: 10.69628/esbur/2.2024.36

Design thinking to avoid maladaptation in building climate change resilience of urban areas

Marharyta Radomska*

PhD in Technical Sciences, Associate Professor
State University "Kyiv Aviation Institute"
03058, 1 Liubomyr Huzar Ave., Kyiv, Ukraine
https://orcid.org/0000-0002-8096-0313

Mara Zeltina

Doctor of Biological Sciences, Professor
Riga Technical University Liepaja
LV-3401, 14 Liela Str., Liepaja, Latvia
https://orcid.org/0000-0002-1027-043X

Abstract. Adaptation of settlements to the climate change effects is an urgent task for researches and multiple stakeholders interested in efficient functioning of urban systems and safety of residents. The development of adaptation plans is complicated due to lack of certainty about the results of these actions. From the other hand, cases of maladaptation are already numerous, which is why this research was aimed at defining the principles of adaptation planning, which help to avoid the risks of maladaptation. The case of the joint project developed by Master students from Canada, Iceland and Latvia for the rehabilitation of the abandoned industrial facility in the centre of Kyiv, Ukraine, was used to analyse the drivers of maladaptation and suggest the principles of efficient implementation of climate adaptation into city development initiatives. The method of multi-criteria evaluation was used to compare possible post-rehabilitation projects and determine the role of selected factors if raising probability of maladaptation. The weight of factors, affecting the choice of the alternative, was set involving developers, specialists with the experience of designing adaptation plans, non-governmental organisations and researchers. The recommendations for the mitigation of the maladaptation risks in designing adaptation plans were developed and used to reconsider the results of the joint project and abandon the alternative prone to maladaptation. It was shown that climate issues should be considered as a separate category and target instead of including it into the broad category of environmental protection. Evaluation highlighted the importance of design thinking and system structure analysis for the multidisciplinary teams working on the urban development, involving adaptation actions. The results of the research are applicable for preparation of project groups, working on urban development and post-war-reconstruction, to guarantee efficient implementation of climate adaptation needs and prospects in corresponding plans

Keywords: multi-criteria evaluation; urban development; expert assessment; environmental protection; adaptation to climate changes

Introduction

Climate changes create complications for development at all levels of social organisation – from local communities to global regions. The information accumulated to date is vast, yet hard to cope with and needs certain expertise to use it efficiently. At the same time, adaptation has already turned into an applied filed of work, which is of high demand and obligate to fit into tight deadlines. Policymakers are working on frameworks, built on the research and

Suggested Citation: Radomska, M., & Zeltina, M. (2024). Design thinking to avoid maladaptation in building climate change resilience of urban areas. *Ecological Safety and Balanced Use of Resources*, 15(2), 36-46. doi: 10.69628/esbur/2.2024.36.

*Corresponding author

analytical data, while local players are in need for clear plans and suggestions. The previous years of adaptation strategies implementation has yielded both positive and negative results, which might have different roots. At the same time, the analysis of 1,628 papers, conducted by L. Berrang-Ford *et al.* (2021), demonstrated that most of adaptation actions have fragmented character, which could be caused by lack of efficient design. D. Reckien *et al.* (2023) also noted the growing number of maladaptation cases, which raises the need to study them in detail and feed the insights into the development of new adaptation plans. Based on the study of the known cases of maladaptation M.F. Rahman *et al.* (2023) has strongly emphasised the value of understanding and building on local preconditions, when developing adaptation plans. This makes each adaptation plan unique and calls for thinking up some new approaches for each locality. Thus, in the development of such plans a component of design must be articulated and relevant actions and expertise embedded. The multi-criteria evaluation (MCE) has been proved to be efficient for the solution of various environmental tasks and W.-M. Wang & H.-H. Peng (2020) have demonstrated its efficiency for urban sustainable development planning in particular.

Resilience of ecosystems is a key for supporting healthy environment for humans and wildlife. Design and implementation of adaptation plans is therefore a part of building functional system of environmental safety. However, the experience of maladaptation is being accumulated, which calls for developing special set of skills and competences in this field. The training of specialists in the field of adaptation to climate changes is still not well developed and limited number of university programmes is offered in the field. K.H.D. Tang (2022) has offered a novel model of climate change education, based on three modules – knowledge, action competence and community involvement. This approach can help students as citizens, but there is also need in training professionals for these specific tasks. Most commonly, environmentalists of any specialisation are involved in the process of developing such plans, since they normally possess well-established background in climate change science and management of natural resources. However, it is now seen that such specialists often lack design skills and have little to no awareness about failure risks an adaptation falls under. Recognition of the need for adaptation and activity of nongovernmental groups is not enough for successful adaptation, it is more a question of efficient collaboration between parties, as it is shown by J.E. Taylor *et al.* (2023) in the study for Alaska. This means that the organisation of the adaptation planning is also a task to be performed by pre-trained professionals.

Ukrainian researches are also concerned with the need to develop education for climate adaptation. In particular, V. Fedoniuk & M. Fedoniuk (2022) offered to implement selective courses on climate adaptation to all potentially involved specialists. At the same time N. Klevtsova (2021) stated that there is a need to standardise the adaptation plans, but there is a lack of framework for that. Overall, there is a need to develop framework for the development of successful climate adaptation plans with the focus on avoiding maladaptation as a potential outcome. Thus, the aim of the paper was to consider the role of design thinking in successful adaptation to climate changes and the importance of maladaptation consideration. The important insights of the research are principles of mitigating maladaptation risks in the process of designing adaptation solutions.

Materials and Methods

The risk of maladaptation was considered on the example of a joint project developed by Master students from Canada, Iceland and Latvia, formerly living in Ukraine. All of them have successfully completed special course in climate adaptation and natural resources management. The project was developed with the assistance from the Environmental Unit of Egis Ukraina (International Developer Company) and was submitted to the International Competition of Adaptation projects – Team up for Climate – 2024. The project was developed for the central districts of Kyiv – Shevchenko and Solomianka, facing intensive growth of thermal pressure from the urban heat island (UHI), amplified by warming climate, which is common for many cities of temperate climate. The aim of the project was to shift the balance in the ecosystem toward more comfortable and safe living conditions by reducing the UHI. For this purpose, members of the working team chose the project site – mostly abandoned First Kyiv Machine-Building Plant. The list of post-rehabilitation alternative projects was elaborated and their design was drafted. Using the methods of multicriteria analysis the working group defined the best alternative for implementation. Later they took a short course of environmental design and were invited to revise their development accounting recommendations on the maladaptation risks reduction.

The interconnections in the system "residents-climate-living conditions" are extremely complicated and require cross-disciplinary efforts to solve. To facilitate this process, it was important to comprehend the structure and dynamics of such systems, which may be accomplished by conceptual modelling as an alternative to complex mathematical calculations. The given research generally followed the framework of multicriteria analysis, suggested by R. Stevens (2021). The general method in this case consisted of three basic phases. System description (sketch) is the process of defining and characterising a system in terms of its components (preferably different variables) and interactions. System structure analysis involved investigating internal linkages and creating a variable effect matrix, and MCE – forecasting the influence of factors on the circumstances for each scenario. The MCE focused on a single issue, allowing several scenarios to be evaluated. The study's research topics were based on the environmental harm caused by the fuel storage fire. The MCE steps were designed to collect numerical data that describe the characteristics of the options under examination. For this the parameters with the effect on the system interactions defined were formulated. As a result, different scenarios or

alternatives under consideration reflected variations in these parameters. The next step was to determine parameter "weights" – their relative importance for the studied system.

In this research, pair-wise estimates of the relative importance of parameters by experts were used. The relative importance of factors was evaluated by the members of the project group and their supervisors (totally 8 persons) and the experts from the field of project development (2 experts, EGIS Ukraina), representatives of nongovernmental organisations with previous experience of climate adaptation projects designing (2 experts from National Ecological Centre of Ukraine) and researchers from Kyiv Aviation Institute (3 experts). All experts rated the weight of each factor relative to all others individually and mean values were defined mathematically. The factors included: necessary investments in development; expected economic potential of the project area after restoration; social benefits to the local community and city on the whole; environmental pollution reduction (in particular, air quality improvement) and UHI reduction potential; threats to adjoining objects, including residential areas, university campus, subway station and existing commercial facilities; traffic intensity, which is typically high in the centre of the city with its narrow streets not prepared for the car flow of modern times; aesthetic appeal of the developed area. The research was conducted according to American Sociological Association's Code of Ethics (1997).

In methodological words, "utility" refers to the examination of standardised dependencies between the components influencing the situation, the evolution of an event inside a system, and the system's state. This utility value ranges from zero to one. The particular form of the relationship between the utility and each parameter – whether linear, logarithmic, or otherwise – is derived using real data or reasoned assumptions and expert opinions about how each parameter's range impacts the state of the system under study. The values for each "utility" parameter were determined based on the estimated linkages between this parameter's range and its influence on the system "residents-climate-living conditions". This process was facilitated by plotted utility functions, with each scenario shown separately. The total utility for each scenario was calculated using the following equation:

$$Total_{utility} = \sum w_i \times u_i, \quad (1)$$

where w_i – is relative weight of each parameter; u_i – is utility value defined for each scenario. The resulting total utility is used to rank different scenarios from the perspective of their efficiency.

Results

The city of Kyiv, Ukraine, is facing growing heat pressure due to climate changes and reduction of green spaces. Over the last 10 years, Kyiv has been repeatedly ranked among the top 30 capitals with the most polluted air. Compact structure of urban area does not allow for the development of green infrastructure to compensate the loss of natural areas, which provide thermal pressure relief and air pollution mitigation. Therefore, abandoned industrial sites offer a good opportunity for solving these problems, but needs careful considerations of the best alternative development for each specific case. The First Kyiv Machine-Building Plant (formerly Bilshovyk) was established in 1882 and after the revolution of 1917 was re-quipped to produce a variety of machines for heavy industry. In 1980s it shifted to the production of tires for big industrial vehicles. Part of the territory was gradually abandoned, since the specialisation of the enterprise was narrowed, but the remaining production is still functioning. In 2021 the enterprise was sold to the private company, but the given part belongs to the city (Morozov, 2021).

The site is located in the middle of the city and is facing objects of different functions, including residential, commercial and industrial buildings. It is also surrounded by one of the busiest highways of Kyiv and a subway station. Thus, the analysis of the development of such site is complicated, since land uses of different purposes are combined there. These functional components affect the necessary preparation and reclamation for the new land use and, of course, have impact on the possible type of use and cost of project development. At the first approximation the target of the development was formulated as a project most beneficial for the city. This has raised question what is considered to be beneficial, and the working group set up for: environment quality and climate resilience; sustainability; economic efficiency; infrastructure improvement; community well-being. Based on these expected benefits the group defined the factors most important for project alternatives comparison and their relative weighting (Table 1).

Table 1. Relative importance of the decision-making factors of in choosing the best alternative of the post-rehabilitation development

Factor	Weight
Necessary investments in development	19.66
Expected economic potential of the project area after restoration	17
Social benefits to the local community and city on the whole	14.33
Environmental pollution reduction (in particular, air quality improvement) and UHI reduction potential	20
Threats to adjoining objects, including residential areas, university campus, subway station and existing commercial facilities	5.17
Traffic intensity, which is typically high in the centre of the city with its narrow streets not prepared for the car flow of modern times	8.67
Aesthetic appeal of the developed area	1.33

Source: created by the authors

The list of alternative projects was developed accounting the diversity of interests and demands of different interested parties. This, of course, means that each stakeholder has "affinity" to certain type of development (Fig. 1).

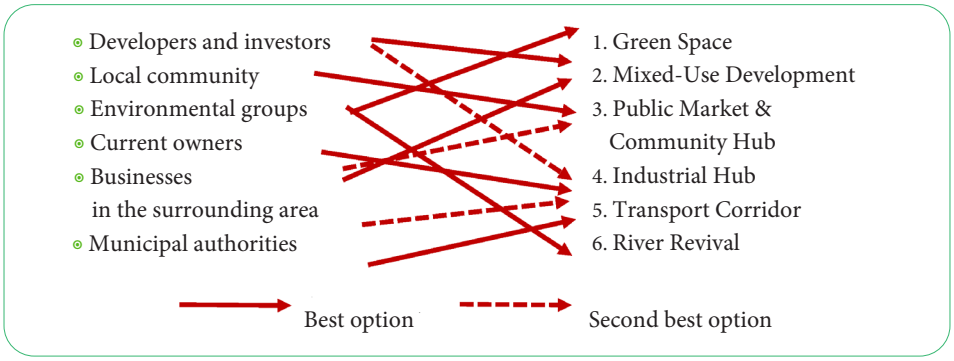

Figure 1. Stakeholders' preferences in the choice of the post-rehabilitation development
Source: created by the authors

This would affect the weighting of the same factors done by each stakeholder; therefore, weighting of factors given here is intended to be a "mean" perspective. The resulted multi-criteria comparison of the defined alternatives showed that the best one in terms of benefits for the city was "Mixed-Use Development" (Fig. 2).

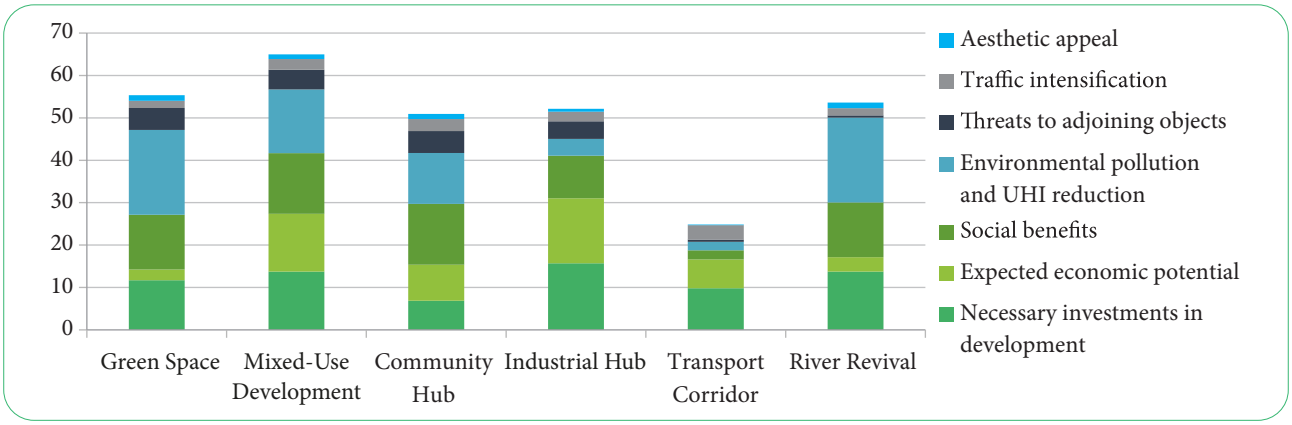

Figure 2. Comparison of the alternative development projects (without maladaptation prevention)
Source: created by the authors

This alternative was rated as an expensive, but the payback potential of this alternative was considered to be the most reliable and highest. Due to central location in the city and the demand for its residential and commercial areas would be high. Nevertheless, the central positioning of the site raised concerns about the quality of environment, in particular, air pollution levels are rather high, and this might reduce the attraction to the complex for families with children. Additionally, a well-planned and thorough remediation is necessary to remove possible health threats from the residual soil pollution at the territory. The second-best options were "Green Space" and "River Revival", which offered the improvement of the state environment and the UHI reduction.

The lowest rating was set for "Transport Corridor". This is the option, which is currently considered by the municipal authorities. However, despite its obvious importance for overloaded highway crossing by the site it would provide minimal benefits from other points, and it would further contribute to traffic flow increase as a more suitable alternative pathway through the city. Therefore, it would eventually lead to the deterioration of environment quality and the UHI amplification. Going back to the initial purpose of this analysis it became obvious that negative externalities like those of the "Transport Corridor" were typical for the best option as well and in terms of climate changes response it was an obvious maladaptation.

Considering the given case of the First Kyiv Machine-Building Plant development and available analysis of maladaptation presented above, a complex of recommendations was suggested in order to reduce the risk of maladaptation. It is necessary to set the hierarchy of the project goals and formulate the primary target as climate change adaptation. This will automatically shift the focus of the design and assessment towards the needs of climate actions, instead of pursuing more general and thus inefficient goals. Putting adaptation on top will shape the list of alternatives and affect the weighting of factors so, that none of

stakeholders will be dominating over others. This, in turn, will facilitate setting compromises between stakeholders, since their primary aim will be out of the direct fields of interests. Separation of the factor of adaptation, or UHI reduction, as in the given case study, from others, even if they have strong connections as environmental pollution reduction, is decisive for efficient adaptation. It was found that low levels of air pollution did not guarantee that heat pressure would disappear of get minimised, instead it could mask the problem by giving false impression of it being managed in a bundle.

An object of study (facility, site, enterprise, area, etc.) should be viewed as a system. It is important to separate its structural elements or functional units and consider consequences of all suggested project alternatives on these structural elements. Without the development of special methodology for this step it is enough to contrast their expected changes to the points, listed as attributes of "beneficial project", formulated as a target of the development. Since not all trends are obvious and easily predicted the "impact-effect" interactions between structural components of the studied object should be assessed in detail at the early stages of the development process. This step does not demand special preparation, but gives valuable insights into the dynamics of the system. The results should use to balance the decision-making process by controlling extremely influential factors, able to push the adaptation plan towards their preferred targets. It is also a good tool for the detection of maladaptation preconditions and potential affected parties. This is seen from the factors and components of the system, which are most affected by others and thus more prone to give unexpected effects. By performing system impacts analysis one creates better ground for designing efficient responses to climate changes. Life cycle assessment should be applied to the alternative chosen as the best one, so that any possible externalities would be taken to light and mitigated if possible or managed via modification of the adaptation plan. Most practitioners stress the need to evaluate adaptation plans in as many temporal perspectives and possible, and thus short, medium and long-term overview of the adaptation plan development must be done using expertise available among the working group and outside. The role of design thinking in prevention of maladaptation was stressed by experts and its role if crucial at both ends of the development process: at the beginning to create an efficient adaptation plan and at the end – to check the correspondence of the plan to the principles of good design. Consideration of maladaptation examples provide a good background to build on, enabling avoidance of the adaptation pathways, which have already proved to be inefficient.

It is also a good start for brainstorming ideas directly opposite or modified as compared to those leading to maladaptation. In many cases it is good to split the area, considered for adaptation into functional facies – derived from geology this term covers any part of a unity, which possesses a certain set of attributes making it distinct from other parts. In the given context functional facies would represent a unit of a system "city – climate effects". The dividing principle may be of any kind and besides the obvious land use units, it is possible to deduct based on stakeholders, environmental media types or components of urban infrastructure. Despite the seemingly complicated this approach is rather efficient, being based on the same framework it yields comparable results. The case study of the First Kyiv Machine-Building Plant was reconsidered accounting given recommendations. The rethinking of the project showed that it was enough to separate environmental pollution from climate issues to get different view of the benefits of suggested alternatives (Fig. 3).

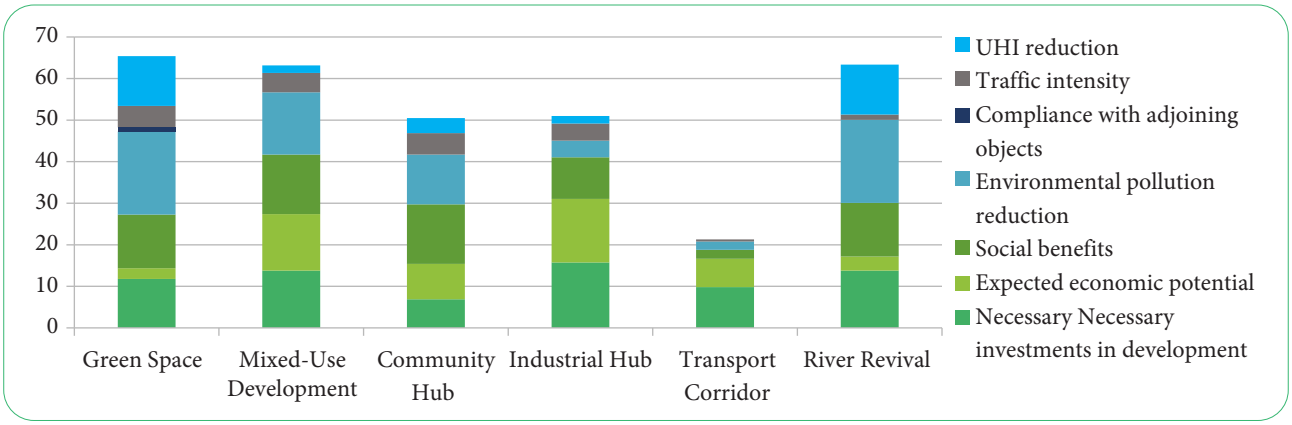

Figure 3. Comparison of the alternative development projects (reconsidered after maladaptation risks mitigation)
Source: created by the authors

As a result, even though "Mixed-Use Development" was preferred due to social and economic reasons, it would be outweighed by "Green Space" development and was equivalent to "River Revival". The difference was small but in a long-term perspective it would grow. This refusal from big developments in city centres is a sound pathway to climate resilience, because centres are the hearts of UHIs. The change is more clearly represented at

the step of impact interaction analysis: impact matrices show factors division into those that cause changes in the system and those which change under the combined pressure of other. It is also the reflection of driving forces of the system status: one can clearly see which factors should be dealt with to bring dynamics to the system and which component is a receptor and will receive pressure of this dynamics (Fig. 4-5).

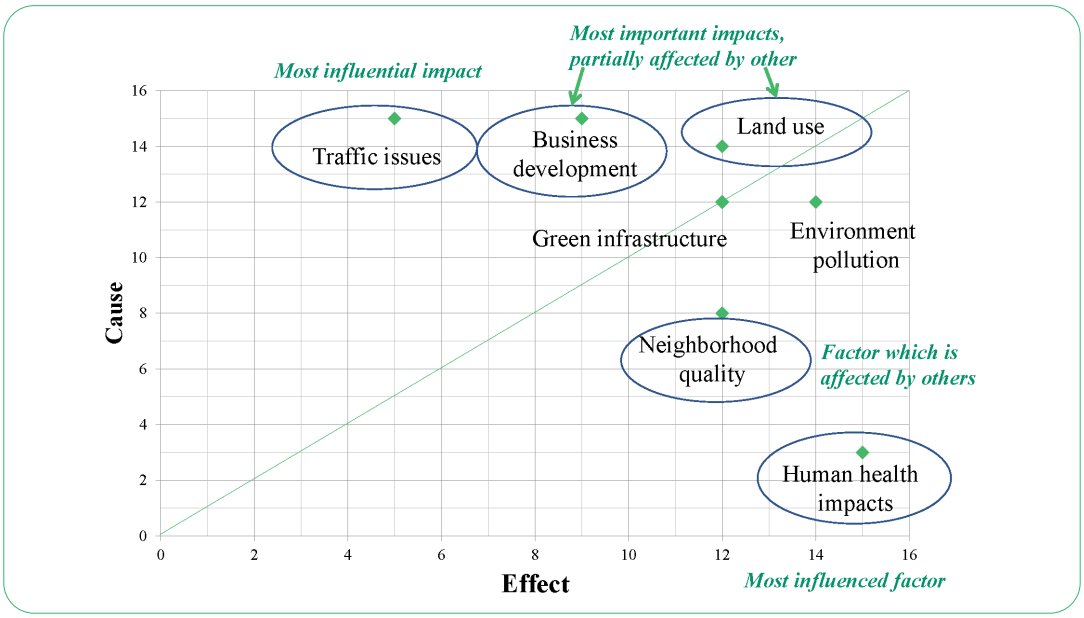

Figure 4. Impact matrix for initial consideration of system drivers

Source: created by the authors

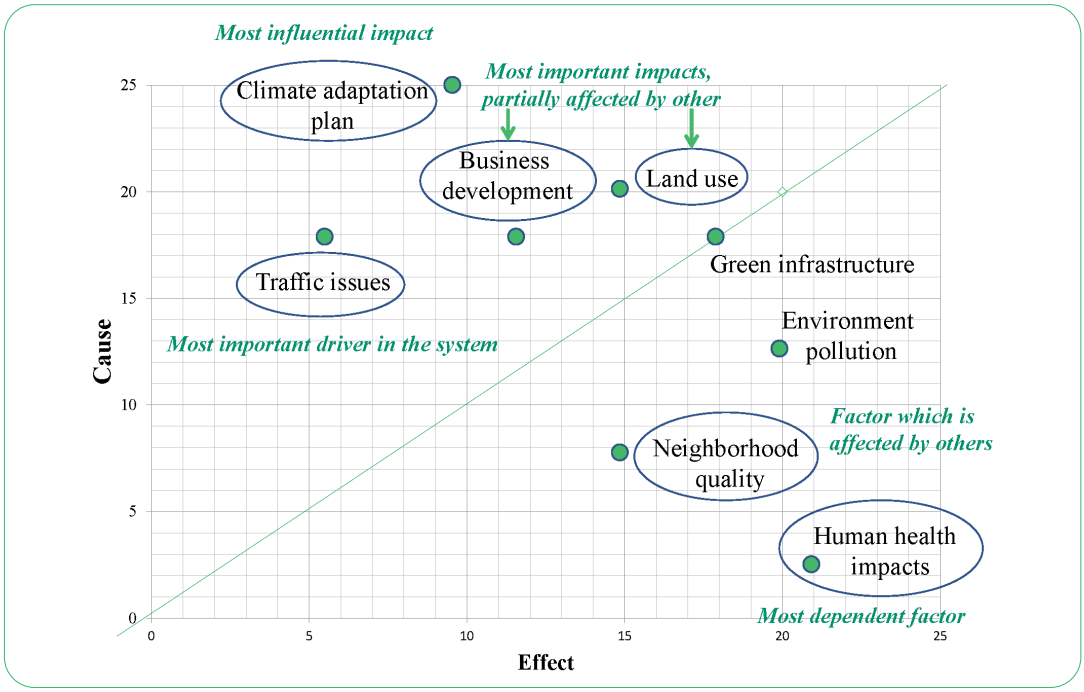

Figure 5. Impact matrix with separated climate factor

Source: created by the authors

The same amendment to the matrix (separation of environmental and climate change issues) slightly changed the relative position and roles of the factors, but climate adaptation plan and its implementation turned to be at the dominant position. Climate adaptation was shaped by the land use and business development, but it was definitely the factor which set frameworks for business and land use as well as all other factors in the system. Another important

insight was traffic issues factor: it appeared to be as one of the major sources of all problems in the area and a constraint for any alternative, limiting room and opportunities for any development or adaptation. It was also one of the reasons for UHI origination, deepened by climate effects. Thus, traffic issues factor is indeed the one which should be dealt with before any adaptation plan gets chance to be efficient. Green infrastructure occupied central position in the impact matrix, which means that any interventions in this component would affect others and was at the same time limited by influential factors. Nature-based solutions are often seen as the best approach in adaptation, being such, but it was shown that they were still able to produce externalities and should be considered in details as well as technical and organisational solutions.

Developing action plans to tackle climate raised problems is a type of work, which in on great demand, but lacks comprehensive background in terms of mitigating risks of failure. It is already known that considering local conditions is a decisive component for the successful adaptation, but it is not enough to know the problems and resources. The analysis of maladaptation cases is important for the systemic understanding of the problem and the designing experience is necessary to engage creativity and innovative approaches into the process. Maladaptation is caused by many reasons, many of which are not understood until the onset of the problem. The effects of maladaptation are spread over various affected groups and might be of different scales; this highlights the need to conduct systematisation and vigorous analysis of the known case, collect additional data about them and work on their classification and causation substantiation. Having learned the roots of such failures, more efficient plans of adaptation will be developed.

There is also a clear lack of adaptation components in the urban development plans and projects of post war reconstruction are in the area of great risk of being inefficient, since they are developed within minimal time periods and often without experienced specialists among the project teams. Development of consistent framework for the analysis of project solutions will be helpful in making them maladaptation-proof and highly efficient. However, adaptation can be well-planned at the moment of plan approval, and then fail because of dynamic nature of climate change effects themselves and new issues, raising on the way of actions implementation. Accepting the impossibility to prepare to all possible challenges, the authors still see the need for design thinking to be important tool in preparing ground for adapting the plan itself to addressing the unexpected problems.

Discussion

Design thinking method has historically been much used in solving complex, changing, disputable issues of the interested parties in an integrated way. M. Zeltina (2021) previously showed that despite well-developed strategy, principles and great potential in achieving sustainable development goals, design thinking is little integrated into sustainability science and planning. L. Shi & S. Moser (2021) indicated that local players were able to develop good adaptation plans without national leadership, but this would possible if members of the action group possessed the design competences. There is a strong belief that the most important thing is to start doing something in response to climate changes, and that it will be a better situation than if nothing is done. But as multiple examples have shown there is a risk of exacerbating climate induced problems and pushing communities into even harder pressure of climate change effects to the extent when there is no way out. Thus, E.L.F. Schipper (2020) argued that maladaptation is just one of possible outcomes of adaptation actions with the likelihood sometimes equivalent to the positive results. Broadly, they stem from institutional, infrastructural and behavioural issues and there is a specific combination of causes for failure in each case. The outcomes could be different and following the patterns, described by A.E. Piggott-McKellar *et al.* (2020) strong evidences for rebound maladaptation were seen in the alternative chosen at the first stage. Moreover, projects of urban development are very vulnerable to shifting maladaptation (Neset *et al.*, 2019), or are able to cause negative externalities (Antoci *et al.*, 2022). The resulted best option seems to be opposite to the essence of the urban development, but degrowth strategy is gradually getting more research support in many systems, as it was shown by A. Zango-Palau *et al.* (2024) for mountain regions.

Enough time has already passed since the beginning of adaptation programmes initiation and implementation, and the analysis of the outcomes can be conducted and not only monitor progress. However, accumulated data on maladaptation has not provided a sound basis for their avoidance and the uncertainty of adaptation plans is still high. This makes research on the maladaptation preconditions important for developing principles of their avoidance. In line with four structural challenges that contribute to maladaptation, defined by A. Bertana *et al.* (2022), the above presented recommendations insist on the need in holistic approach and setting priority on adaptation equal to economic and social considerations. Furthermore, qualitative assessments should be approached as a separate and valuable framework, for which MCE was offered as a good option for partial quantification without losing valuable information.

Among the major problems of national and local adaptation plans S. Juhola & J. Käyhkö (2023) noted the lack of well defined metrics for measuring adaptation failure. This was also highlighted by K. Findlater *et al.* (2023), who formulated the need for a values-based approach to both adaptation and maladaptation in order to grasp all the diversity of factors, affecting the system of climate adaptation. Urban areas represent a specific case of adaptation issues as compared to vast natural zones suffering from changing living conditions. H. Bulkeley (2021) pointed that urban areas undergo the cascade effects of so many complex and intertwined consequences, that it turned into personal problems of urban residents. However, many authors, in particular

A. Hurlimann *et al.* (2021) argued that adaptation is still not fully embedded into in urban policy documents. Moreover, A. Otto *et al.* (2021) revealed the gap between mitigation and adaptation efforts, when some cities dived into mitigation initiatives and neglect adaptation or vice versa, – this should be also considered an element of maladaptation.

Urban areas adaptation has its peculiarities, which might give a help in developing adaptation. Some cities across the globe have a range of similar attributes and problems caused by climate changes as well as possible solution might fit cities located at great distance from each other. Urban budgets are stronger and thus able to support quite expensive projects and not chase profit out of climate adaptation interventions. Nongovernmental and other civil groups are more developed and active in cities, and ready to participate in the process, but this raises the importance of collaboration planning and makes it a separate task of the process. At the same time, all projects will have to fit into compact and often complicated structure of a city. Thus, urban areas are about to dramatically increase demand for adaptation plans and these plans must be very specific to avoid maladaptation.

Some researchers have already developed and presented frameworks for the assessment of adaptations efficiency. Being unexpected in essence, maladaptation could be predicted based on the analysis of prerequisites, which have been defined primarily for agriculture, forestry and water resources management. Just like the given research, L. Wiréhn *et al.* (2018) noted considerable gaps in understanding adaptation regularities, which must be filled in project teams before the initiation of adaptation plan design process. Following B. Boutroue *et al.* (2023), it is important to develop competences of the governance of adaptation projects, since there would always be need for compromises between multiple needs and stakeholders. C. Singh *et al.* (2021) offered 11 guiding principles for adaptation monitoring and evaluation, which could be used to define signs and harbingers of maladaptation, though quite general: lack of equality, low economic feasibility and deficient consideration of local interests. However, it is impractical to concentrate efforts on observations rather than trying to avoid maladaptation drivers at the very beginning – design and development stage. Except a chance to reduce the risks of maladaptation, concentration on improving adaptation design enables separation of inadequate planning from inefficient implementation.

The review of the available conceptual frameworks for maladaptation evaluation by C.-F. Chi *et al.* (2021) concluded that only precautionary framework and assessment framework can be used to prevent maladaptation in the initial planning stage of adaptation. These frameworks contain guidelines and checklists to control the process of design in a way that avoids exacerbating the risks of maladaptation. However, these frameworks cannot detect maladaptation caused by improper implementation of adaptation plans. There is still a range of complications omitted by formal frameworks, since they work with what has been produced at the design stage. But adaptation can be compromised by dynamic nature of changes themselves, varied local conditions, side effects of climate changes and evolution of social and economic situation, independent from environmental processes.

Under such pressure adaptation design process must possess the following characteristics: creative – each case/place/community is specific and there are no solutions fitting everyone; flexible – plans must have "room" for customisation and be able to change in response to new conditions during design and, what is even more important, during implementation; innovative – there are very few analogues and reliable predictions of success is uncertain; intrinsic – must be embedded in all pathways of development of the area and community in question; looking inside – climate changes are not external to communities, they are part of their life and must be viewed in this way and any adaptation should match local cultural and social landscape; prudent – able to meet demands of the future situation; environmentally and socially friendly. These attributes raise the need for the development of design thinking competences in members of multidisciplinary working groups, which are usually created for the development of adaptation plans.

Conclusions

The risks of maladaptation represent a serious problem for building resilience of urban areas, especially in development initiatives. The project of the abandoned industrial site development in the Kyiv was analysed to single out factors, contributing to the choice of alternative, being a potential maladaptation. The post-rehabilitation alternative for the First Kyiv Machine Building Plant chosen using the method of multicriteria evaluation by the student-expert group was "Mixed-Use Development" project. But it had a high likelihood of leading to rebound and shifting maladaptation, as well as negative externalities. The recommendations on the reduction of the maladaptation probability were developed and delivered to the project group. The reconsideration of the project alternatives after design thinking training and accounting recommendations using the same methodology resulted in the rethinking of the best alternative towards the one which would limit the economic development of the area in favour of "Green Space" or "River Revival".

The application of MCE methodology has also demonstrated the importance of separating the target of climate adaptation from all other aims pursued by the development projects. An important insight of the research is the revealing the importance of the impact interaction analysis: impact matrices were able to display the difference in the considerations of various factors, involved in the choice of the best alternative and their real impact-effect ratios. The outcomes of the analysis have highlighted the importance of beginning adaptation projects with a holistic perspective, although each problem needs specific details for actual evaluation. There is still no universal

approach to mitigation of maladaptation risks and these research result can make a contribution to the development of such framework. The next step of the study would be the elaboration of parameters and criteria for evaluation of maladaptation probability and significance. Additionally, there is a need for regular rethinking of concepts, since adaptation is evolving, just like maladaptation. Current trend is to shift from building resilience and keeping the balance in urban ecosystem towards the capacity of continuous transformation of resilience. Therefore, it would be necessary to study the maladaptation as a process instead of an outcome of it.

Acknowledgements

None.

Conflict of Interest

None.

References

[1] American Sociological Association's Code of Ethics. (1997, June). Retrieved from https://www.asanet.org/wp-content/uploads/savvy/images/asa/docs/pdf/CodeofEthics.pdf.

[2] Antoci, A., Borghesi, S., Galeotti, M., & Russu, P. (2022). Maladaptation to environmental degradation and the interplay between negative and positive externalities. *European Economic Review*, 143, article number 104023. doi: 10.1016/j.euroecorev.2021.104023.

[3] Berrang-Ford, L., *et al.* (2021). A systematic global stocktake of evidence on human adaptation to climate change. *Nature Climate Change*, 11, 989-1000. doi: 10.1038/s41558-021-01170-y.

[4] Bertana, A., Clark, B., Benney, T.M., & Quackenbush, C. (2022). Beyond maladaptation: Structural barriers to successful adaptation. *Environmental Sociology*, 8(4), 448-458. doi: 10.1080/23251042.2022.2068224.

[5] Boutroue, B., Bourblanc, M., Mayaux, P.L., Ghiotti, S., & Hrabanski, M. (2022). The politics of defining maladaptation: Enduring contestations over three (mal)adaptive water projects in France, Spain and South Africa. *International Journal of Agricultural Sustainability*, 20(5), 892-910. doi: 10.1080/14735903.2021.2015085.

[6] Bulkeley, H. (2021). Climate changed urban futures: Environmental politics in the anthropocene city. *Environmental Politics*, 30(1-2), 266-284. doi: 10.1080/09644016.2021.1880713.

[7] Chi, C.-F., Lu, S.-Y., Hallgren, W., Ware, D., & Tomlinson, R. (2021). Role of spatial analysis in avoiding climate change maladaptation: A systematic review. *Sustainability*, 13(6), article number 3450. doi: 10.3390/su13063450.

[8] Fedoniuk, V., & Fedoniuk, M. (2022). Adaptation to climate change as a component of the modern educational process in higher education institutions. In *Natural sciences: Projects, research, perspectives: Materials of the 3rd international scientific and practical conference* (pp. 171-173). Myrhorod: Luhansk Taras Shevchenko National University.

[9] Findlater, K., Hagerman, S., Kozak, R., & Gukova, V. (2022). Redefining climate change maladaptation using a values-based approach in forests. *People and Nature*, 4(1), 231-242. doi: 10.1002/pan3.10278.

[10] Hurlimann, A., Moosavi, S., & Browne, G.R. (2021). Urban planning policy must do more to integrate climate change adaptation and mitigation actions. *Land Use Policy*, 101, article number 105188. doi: 10.1016/j.landusepol.2020.105188.

[11] Juhola, S., & Käyhkö, J. (2023). Maladaptation as a concept and a metric in national adaptation policy – should we, would we, could we? *PLoS Climate*, 2(5), article number e0000213. doi: 10.1371/journal.pclm.0000213.

[12] Klevtsova, N. (2021). Standardisation of activities in the conditions of climate change and the possibility of its implementation. In *The 4nd international scientific and practical conference "The influence of climatic changes on the spatial development of the Earth's territories"* (pp. 180-182). Kherson: Kherson State Agrarian and Economic University.

[13] Morozov, O. (2021). *Kyiv's Bolshevik plant sold at auction for UAH 1.42 billion*. Retrieved from https://www.village.com.ua/village/city/city-news/317969-kiyivskiy-zavod-bilshovik-prodali-na-auktsioni-za-1-42-milyardi-griven.

[14] Neset, T.-S., Wiréhn, L., Klein, N., Käyhkö, J., & Juhola, S. (2019). Maladaptation in Nordic agriculture. *Climate Risk Management*, 23, 78-87. doi: 10.1016/j.crm.2018.12.003.

[15] Otto, A., Kern, K., Haupt, W., Eckersley, P., & Thieken, A.H. (2021). Ranking local climate policy: Assessing the mitigation and adaptation activities of 104 German cities. *Climatic Change*, 167(1), article number 5. doi: 10.1007/s10584-021-03142-9.

[16] Piggott-McKellar, A.E., Nunn, P.D., McNamara, K.E., & Sekinini, S.T. (2020). Dam(n) seawalls: A case of climate change maladaptation in Fiji. In W. Leal Filho (Ed.), *Managing climate change adaptation in the Pacific region* (pp. 69-84). Cham: Springer. doi: 10.1007/978-3-030-40552-6_4.

[17] Rahman, M.F., *et al.* (2023). Locally led adaptation: Promise, pitfalls, and possibilities. *Ambio*, 52, 1543-1557. doi: 10.1007/s13280-023-01884-7.

[18] Reckien, D., Magnan, A.K., Singh, C., Lukas-Sithole, M., Orlove, B., Schipper, E.L.F., & Coughlan de Perez, E. (2023). Navigating the continuum between adaptation and maladaptation. *Nature Climate Change*, 13, 907-918. doi: 10.1038/s41558-023-01774-6.

[19] Schipper, E.L.F. (2020). Maladaptation: When adaptation to climate change goes very wrong. *One Earth*, 3(4), 409-414. doi: 10.1016/j.oneear.2020.09.014.

[20] Shi, L., & Moser, S. (2021). Transformative climate adaptation in the United States: Trends and prospects. *Science*, 372(6549), article number eabc8054. doi: 10.1126/science.abc8054.
[21] Singh, C., Iyer, S., New, M.G., Few, R., Kuchimanchi, B., Segnon, A.C., & Morchain, D. (2021). Interrogating 'effectiveness' in climate change adaptation: 11 guiding principles for adaptation research and practice. *Climate and Development*, 14(7), 650-664. doi: 10.1080/17565529.2021.1964937.
[22] Soanes, M., *et al.* (2021). *Principles for locally led adaptation: A call to action*. London: IIED.
[23] Stevens, R.L. (2021). A methodology manual for conceptual modeling to aid multidisciplinary and international project initiation. In *21st international multidisciplinary scientific geoconference* (pp. 79-86). Sofia: SGEM. doi: 10.5593/sgem2021/2.1/s08.28.
[24] Tang, K.H.D. (2022). A model of behavioral climate change education for higher educational institutions. *Environmental Advances*, 9, article number 100305. doi: 10.1016/j.envadv.2022.100305.
[25] Taylor, J.E., Poleacovschi, C., & Perez, M. (2023). Evaluating the climate change adaptation barriers of critical infrastructure in rural Alaska. *Climate and Development*, 15(7), 553-564. doi: 10.1080/17565529.2022.2123698.
[26] Wang, W.-M., & Peng, H.-H. (2020). A fuzzy multi-criteria evaluation framework for urban sustainable development. *Mathematics*, 8(3), article number 330. doi: 10.3390/math8030330.
[27] Wiréhn, L. (2018). Nordic agriculture under climate change: A systematic review of challenges, opportunities and adaptation strategies for crop production. *Land Use Policy*, 77, 63-74. doi: 10.1016/j.landusepol.2018.04.059.
[28] Zango-Palau, A., Rivera-Ferre, M.G., López-i-Gelats, F., & Claramunt-López, B. (2024). Applying a new protocol to avoid maladaptation shows that degrowth is the most suitable strategy of European mountains. *Environmental Science & Policy*, 159, article number 103801. doi: 10.1016/j.envsci.2024.103801.
[29] Zeltina, M. (2021). Design thinking for sustainable development. *Turkish Journal of Computer and Mathematics Education*, 12(6), 1363-1368. doi: 10.17762/turcomat.v12i6.2477.

Дизайн-мислення для уникнення дезадаптації при формуванні стійкості міст до зміни клімату

Маргарита Радомська

Кандидат технічних наук, доцент
Державний університет «Київський авіаційний інститут»
03058, просп. Любомира Гузара, 1, м. Київ, Україна
https://orcid.org/0000-0002-8096-0313

Мара Зельтіна

Доктор біологічних наук, професор
Ризький технічний університет Лієпая
LV-3401, вул. Ліела, 14, м. Лієпая, Латвія
https://orcid.org/0000-0002-1027-043X

Анотація. Адаптація населених пунктів до наслідків зміни клімату є актуальним завданням для науковців та численних стейкхолдерів, зацікавлених в ефективному функціонуванні міських систем та безпеці мешканців. Розробка планів адаптації ускладнюється через відсутність визначеності щодо результатів цих дій. З іншого боку, вже наявні дані про численні випадки дезадаптації, тому дане дослідження було спрямоване на визначення принципів адаптаційного планування, які допомагають уникнути ризиків дезадаптації. На прикладі спільного проекту з реабілітації занедбаного промислового об'єкту в центрі Києва, Україна, розробленого магістрантами з Канади, Ісландії та Латвії, проаналізовано чинники дезадаптації та запропоновано принципи ефективної імплементації кліматичної адаптації в ініціативи з розвитку міста. Метод багатокритеріальної оцінки використано для порівняння можливих пост-реабілітаційних проєктів та визначення ролі окремих факторів у підвищенні ймовірності дезадаптації. Вагомість факторів, що впливають на вибір альтернативи, встановлювалася зі залученням проектувальників, фахівців, які мають досвід розробки планів адаптації, громадських організацій та науковців. Розроблено рекомендації щодо зменшення ризиків дезадаптації при розробці планів адаптації, які були використані для перегляду результатів спільного проекту та відмови від альтернативи, схильної до дезадаптації. Показано, що кліматичні питання слід розглядати як окрему категорію і ціль, замість того, щоб включати їх у широку категорію охорони навколишнього середовища. Оцінка підкреслила важливість дизайн-мислення та аналізу системних зв'язків об'єктів проєктування для мультидисциплінарних команд, які працюють над плануванням розвитку міста з урахуванням заходів з адаптації. Результати дослідження можуть бути застосовані для підготовки проєктних груп, які працюють над розвитком міст та післявоєнною відбудовою, щоб гарантувати ефективну реалізацію потреб та перспектив адаптації до зміни клімату у відповідних планах

Ключові слова: багатокритеріальне оцінювання; міський розвиток; експертна оцінка; охорона навколишнього середовища; адаптація до змін клімату