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PART-3

ENSURING RESILIENCE OF SPATIAL DEVELOPMENT IN THE CURRENT CLIMATE REALITY

SPATIAL DESIGN ACTIVITY IN THE CURRENT CONTEXT OF HIGH CLIMATE UNCERTAINTIES AND RISKS

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Abstract

The article explores the characteristics of the ongoing transformation of spatial design activities in the current context of high climate uncertainties and risks. A comprehensive methodology of Sustainable Ecosystem Design (SED) is proposed as a special type of thinking activity, based on a systemic approach to decision-making and emphasizing the adaptation of individuals and communities to high climate risks and uncertainties. This planning and design thinking is capable of better reflecting the diversity of broadly understood geographical conditions, expanding the range of socially and culturally acceptable solutions for sustainable development in an unstable and risk-prone environment.

Keywords: spatial planning and design, sustainable ecosystem design, climate uncertainties and risks, sustainable development, anthropo-natural systems

I. Introduction

Climate change is a critical risk multiplier that triggers or exacerbates spatial development crises. The impacts of climate change pose threats to food security, health, biodiversity, infrastructure, economy, and finance [1]. The multiplicative effect of climate risks is evident in the crisis faced by governance, planning, and spatial development institutions, which were established under previous environmental and climatic conditions. In other words, within the new environmental and climatic reality, these institutions can no longer be managed according to the conventional metrics developed under classical planning paradigms. This is evidenced by the increasing damage to the well-being of the majority of the planet's population.

In the current context of high climate uncertainties and risks, the existing spatial model of decision-making regarding economic activities is rapidly losing its effectiveness. This decline is a result of the ever-increasing budgetary expenditures required to mitigate damages from natural disasters, with significant compensation costs being deferred to future generations. It is unreasonable to continue designing agricultural policies, constructing roads and erecting buildings in the same manner as before, continually spending resources on reconstruction or rehabilitation due to the adverse effects of climate change that jeopardize public finances and social well-being.

Climate risks are not new; humanity has always responded to epidemics, floods and droughts. History shows that significant climate change has driven some countries to the brink of disaster, while others have successfully adapted to new, challenging realities [2]. The modern risk-reflection of society on the current situation is expressed in growing concern not always accompanied by reasonable actions. The reality is illustrated by the sharp increase in negative news globally, especially after 2020[1] . In such moments, people are overwhelmed by doubts that can either paralyze their ability to act or drive them to unreasonable radical decisions[2] .

People's risk-reflection on climate change lags behind the escalating climate threats, resulting in preventive measures often being delayed. Effective protective actions are typically taken during natural disasters usually perceived by the population as unexpected "black swans"[3] . The situation is exacerbated by the short planning horizon and paternalistic traditions prevalent among a large part of the population, where people, despite being aware of climate threats, are generally reluctant to engage in broadly understood risk insurance through proactive protective measures. The danger of climate vulnerability is frequently underestimated despite N. Stern demonstrating more than ten years ago that the cost of inaction on climate change far exceeds the cost of taking measures [3]. Scientists have calculated that scientifically adapting infrastructure to climate change is highly cost-effective, with a global net present value exceeding 2.5 trillion USD[4] [4]. Considering this phenomenon, G. White [6] noted that people make decisions based on practical choice established by culture and institutions, rather than theoretical choice established by the physical environment (in this case - climate scientists (auth.). In such context, the risks of "gray swans" and particularly dangerous "pink flamingos" increase[5] .

In the context of increasing climate risks and uncertainties, the search, development and implementation of new mechanisms of decision-making regarding spatial development, integrating climate adaptation measures and reducing climate impacts characterized by synergy and long-term sustainable effects, has become more relevant. In the most climate-vulnerable regions and locations, there is an urgent need to rethink urban planning regulations, technological standards and long-established zoning practices. This article examines one such systemic and comprehensive mechanism.

II. Methodology

Spatial design activities under conditions of high climate uncertainties and risks of the "full" world of the Anthropocene are still developing methodologically, as well as the understanding of this new reality of the 21st century [7]. In any case, the real world remains far from the noosphere - the sphere of spirit according to Teilhard de Chardin [8] or the sphere of reason according to V. I. Vernadsky [9]. The most dangerous aspect of the "full" world is its high-risk nature, characterized by the production, distribution and "consumption" of risks [10-14].

It is the risk-reflection regarding the vulnerability of the new world that creates the need for a shift in the fundamental approaches to spatial design activity [15], with an increased emphasis on maintaining the viability of anthropo-natural systems (ANS)[6] , in which humans are not considered beings "accidentally separated" from and opposed to nature. On the contrary, humans play a dominant role, unfortunately simplifying and sometimes destroying ecosystems, as well as creating new, previously impossible ones, including dangerous interactions with living nature.

As institutional systems of the "full" world emerge, it is methodologically important to prevent the appearance of negative strange attractors - future scenarios without humans. This concern underlies the commitments of many countries to gradually transition to carbon neutrality in an effort to slow down climate change. However, the high degree of uncertainty inherent in

[1] The analysis of over 14 million sources, providing publications over the past 125 years in three major languages, showed a sharp increase in anxiety and concern in many parts of the world [2].
[2] The situation is further complicated by the increased danger of climate-related misinformation in the age of global internet access, hindering effective measures for climate adaptation and mitigation.
[3] As N. Taleb wrote in his bestseller, a "black swan" is a catastrophic event that cannot be predicted.
[4] This was later confirmed by numerous studies, although the estimates of the scenarios considered vary: out of approximately 3000 different scenarios, 2904 have cost-benefit ratios less than one [5].
[5] Unlike "black swans", "gray swans" are, although unlikely, still predictable catastrophic events. The most dangerous variant of "gray swans" is "pink flamingos." This term refers to a class of predictable disasters whose risks are ignored due to the cognitive biases of decision-makers, influenced by institutional interest groups.
[6] The anthropo-natural system is a constantly evolving living organism, whose laws of survival and development have formed over billions of years of evolution and periodically undergoes a phase transition before entering a new stage of dynamic stability.

climate knowledge complicates this process. M. Weitzman is particularly categorical in his "dismal theorem," asserting that the uncertainties associated with future climate change are so significant that there is a non-negligible probability of catastrophe. According to M. Weizmann, the danger lies in the tails of the probability distribution of climate risks, where there may be an unexpectedly thick end or "fat-tailed distribution," meaning the tails never entirely diminish [16].

Spatial planning activities under conditions of high climate uncertainties and risks within the "full" world of the Anthropocene are still developing methodologically, as is the understanding of this new 21st-century reality [7]. The real world remains far from the noosphere—the sphere of the spirit, as described by Teilhard de Chardin [8], or the sphere of reason, as conceptualized by V. I. Vernadsky [9]. The most perilous aspect of the "full" world is its high-risk nature, characterized by the production, dissemination, and "consumption" of risks [10-14].

It is the risk-reflexivity regarding the vulnerability of the new world that necessitates a shift in fundamental approaches to spatial planning activities [15], with an increased emphasis on maintaining the viability of anthropogenic-natural systems (ANS), wherein humans are not considered beings "accidentally" separated from and opposed to nature. On the contrary, humans play a dominant role, unfortunately simplifying and sometimes destroying ecosystems, as well as creating new, previously impossible ones, including dangerous interactions with living nature.

As institutional systems of the "full" world emerge, it is methodologically important to prevent the appearance of negative strange attractors—future scenarios without humans. This concern underlies the commitments made by many countries to gradually transition to carbon neutrality in an effort to slow down climate change. However, the high degree of uncertainty inherent in climate knowledge complicates this process. M. Weitzman is particularly categorical in his "dismal theorem," asserting that the uncertainties associated with future climate change are so significant that there is a non-negligible probability of catastrophe. According to Weitzman, the danger lies in the tails of the probability distribution of climate risks, where there may be an unexpectedly thick end or "fat-tailed distribution," meaning the tails never entirely diminish [16].

Given a scenario where the probability of a global climate catastrophe is minimal yet existent, and its consequences tend toward infinity (self-destruction of a significant portion of the planet's population), it is essential to align with UNESCO's position[7]: For humanity to prioritize climate change risks, we need to change mindset [17]. It is most important to increase the value of the responsibility in the behavioral model of economic activity as a foundation for changing the priorities and structure of economic activity (Tab. 1).

Table 1: *Traditional vs resilience approaches to spatial planning and design*

Approaches to spatial planning and design	
Traditional approach	*A resilience approach*
Considers the object or process individually	Considers the entire anthropogenic-natural system (ANS) in which the object or process will be used
Focused on technical issues	Synergistically addresses both technical and non-technical issues
Solves immediate problems	Aims to solve problems permanently or for the longest possible term
Takes into account the local context	Considers local, national and global contexts
Assumes others will address political, ethical, and social issues	Recognizes the necessity of engaging with a wide range of experts in sociology, ecology, etc.
Ignores the importance of achieving carbon neutrality	Focuses on ensuring carbon neutrality

[7] https://ru.unesco.org/themes/obrazovanie-v-interesah-ustoychivogo-razvitiya-0.

The task of reducing climate development risks and enhancing the resilience of anthropo-natural systems (ANS) is addressed by the author's development of the Sustainable Ecosystem Design (SED) tool [18-20]. The subject of SED is practical activity systems that can be identified, described and turned into objects of goal-oriented spatial development transformations in an unstable external environment to improve the resilience of ANS. In other words, it represents a particular approach to reality, focusing on exploring the possibilities, methods, and means of "restructuring" a fragment of reality to align it with "some idea", an ideal with carbon neutrality, preserved biodiversity and high-quality human life. In the current conditions of high climatic uncertainties and risks, spatial planning and design activities are justifiably based on the principles, structures and processes of Risk Management standards (such as GOST R ISO 31000-2019 in the Russian Federation [21] and others), which are oriented to adapting to the increased probabilities and severities of climate change impacts.

SED is implemented through the design of climate-resilient systems and spatial infrastructures that integrate human society with its natural environment for the benefit of both. The essence of SED lies in an ethically oriented, goal-appropriate, systems approach to designing the development of ANS. The primary focus is on coordinated actions in adaptation[8] and mitigation[9] within public administration, economic sectors and infrastructure in response to changing climatic conditions. Driven by their goals, humans consume, conserve, and create ecosystem services.

In SED, priority is given to climate-related, natural-biological, and socio-cultural constraints and regulations, which create a regulatory framework, or "bubble" into which it is necessary to fit increasingly complex economic activities. As a result, the importance of ecosystem regeneration[10] increases as well as of nature-oriented solutions, the potential for cyclical economic development based on balanced and other approaches. The system of constraints and regulations inherent in SED (in some ways extending urban planning norms) reduces the likelihood of hypothetical negative development trajectories for ANS.

III. Results

The research conducted by the author in the Russian Federation, the Kyrgyz Republic and the Republic of Uzbekistan on climate-related issues, with a focus on achieving a synergistic effect of climate adaptation and mitigation measures, has confirmed the effectiveness of institutional approaches to to Sustainable Ecosystem Design (SED) as a special type of spatial planning and design. Under conditions of high climate uncertainties and risks, SED is considered as a goal-oriented activity aimed at implementing sustainable development approaches for territories and settlements. In terms of form, represents forward-looking long-term planning, while in terms of the content of planning decisions, it pertains (with rare exceptions) to strategic planning and is seen as a goal-oriented activity to implement sustainable development approaches for territories and settlements under high risks and uncertainties.

Theoretical model. SED involves a systemic vision, pragmatic solutions, and methods that help coordinate disparate efforts in green architecture, sustainable agriculture, eco-engineering, and more. It is characterized by an indisputable ethic of Life, recognizing the inherent value of all living things. SED can be described using a four-pillar dynamic sustainability model (Figure 1),

[8] Climate change adaptation means planning and taking measures in response to expected climate change impacts. This includes making changes to how we live and what we do before the impacts occur (proactive action), and being prepared to respond to increasingly likely and frequent extreme events (reactive actions).
[9] Mitigation is a set of measures taken to reduce and mitigate the negative impacts of climate change. Its main goal is to reduce greenhouse gas emissions and the causes of global warming.
[10] Regeneration - restoration, renewal, or compensation of something during the course of activity.

where the three dimensions - social, economic, environmental - are joined by an institutional[11] one with six interconnections.

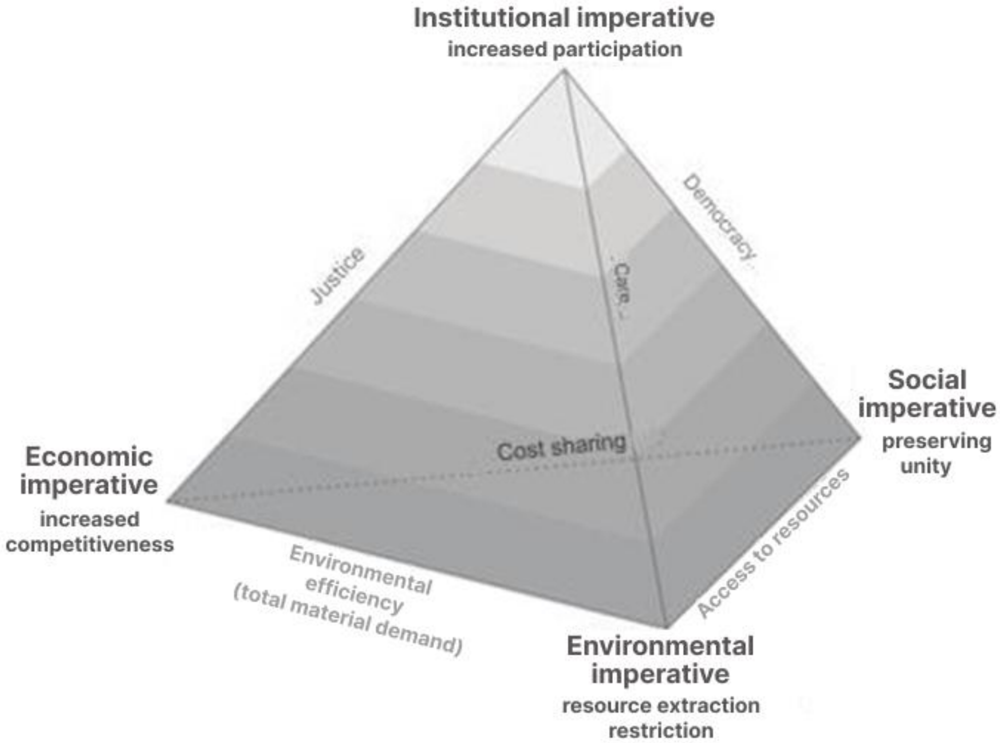

Figure 1: *Four-pillar model of SED under conditions of high uncertainties and risks*
Source: developed by the author based on [22].

The institutional component of sustainability introduces the concept of understanding of value-driven motives and moral incentives for activities aimed at achieving climate neutrality, from local communities to humanity as a whole. The four-pillar dynamic model of sustainability places value on three aspects of development - care, justice, and democracy - derived from the primacy of responsibility for future generations. This value-driven socio-cultural impact, in turn, influences the social, economic, and environmental imperatives (Figure 2). Under high climate uncertainties and risks, this makes spatial development more humane, inclusive, and sensitive to environmental variability[12] .

SED should be viewed as a value-driven, action-oriented, institutional response to ecosystem degradation, increasing climate threats and biodiversity loss. It is a goal-oriented spatial design interdisciplinary approach that seeks to take into account the environmental, social, and cultural features of specific areas when addressing spatial development tasks. It is characterized by the implementation of sustainable development goals; systematic application of regulatory institutions (tools) for ecosystem services; geographical specification of basic methodologies for spatial planning, consideration of the cyclical nature of resource flows; and pursuit of carbon neutrality. In organizational terms, SED relies on the creation of multidisciplinary teams of local specialists and external experts.

SED requires reliable measurements of the contribution of planning and design decisions to people's well-being on a particular territories and the impact of human activities on the environment. There is a growing demand [25] for interdisciplinary synthesis of knowledge based

[11] D. North most successfully defined institutions as "rules of the game" in society, or human-created restrictive frameworks that organize relationships between people. Such institutions (formal and informal) emerged as a behavioral response of people with only partial rationality to threats (real or imaginary) to their security [23].
[12] Of course, the institutional imperative in its Kantian perspective is unattainable, as people are only partially rational and do not possess all information.

on qualitative monitoring observations as the foundation for creating an effective information system for to support spatial design activities in the current context of high climate uncertainties and risks - from primary ecosystem state measurements and analysis of ecosystem service flows (including spatial) to future scenario modeling through knowledge analysis and systematization, aimed at increasing sustainability capital.

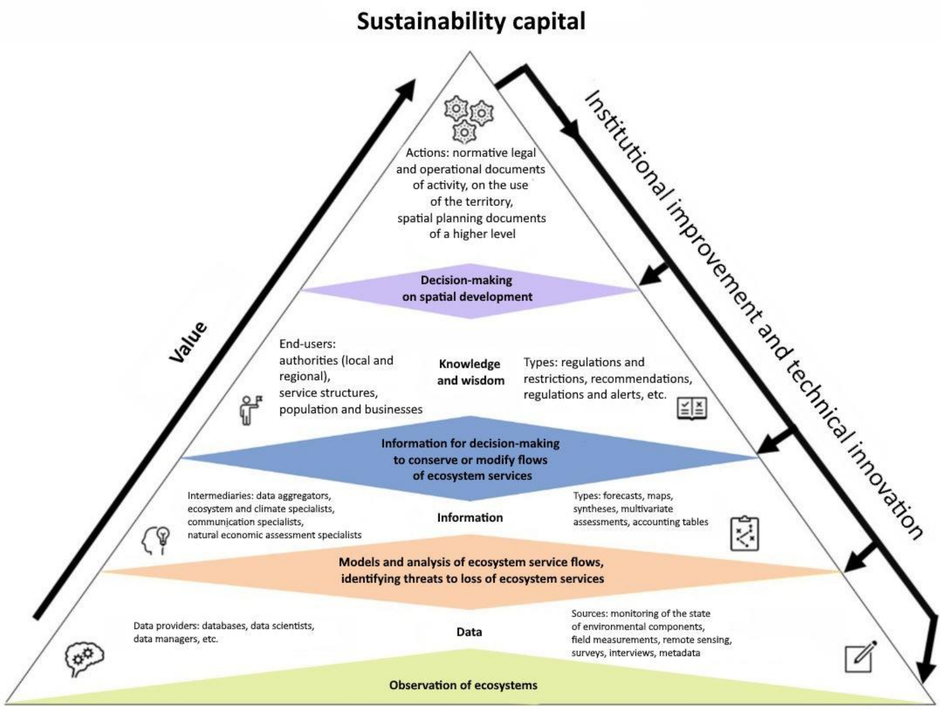

Figure 2: *From ecosystem state observations and ecosystem service flows to sustainability capital*
Source: compiled by the author based on [24].

This chain of creating an effective information system to support spatial design activities in the current context of high climate uncertainties and risks is depicted as a large triangle in Fig. 2. It shows that, starting from its lower part and moving upwards, primary monitoring data are given a higher state status, for example, through statistical and departmental indicators. Subsequently, through generalization within the framework of the System of Environmental-Economic Accounting (SEEA EA) [26, 27], models, and analytics, these systems of indicators are aggregated into complex indicators for assessing the territory development, primarily by the size and structure of the territory's sustainability capital and its dynamics.

The systemic basis for obtaining and transforming knowledge-intensive formalized and dispersed information into knowledge envisaged by the UED allows to ensure the necessary quality of development and analysis of development plans and projects, as well as their assessment for compliance with the goals and approaches of sustainable development, to ensure the search for reasonable trade-offs between different land use options.

Our practical experience in the regions of Russia and Central Asia has shown that natural-scientific and legal knowledge alone is not sufficient for strategic spatial development decisions concerning the future. It is fundamentally important that sustainable development requires wisdom, which expands people's ability to make decisions under high uncertainties and with care for the future.

IV. Discussion

The search for new approaches to the reform of spatial and design for the development of countries, regions, and places is the subject of extensive and rapidly growing literature. An analysis of this literature reveals a broad recognition of the close synergistic relationship between climate change and ecosystem health. regarding the methodological complexity of assessing the impact of extreme risks on socio-economic development. Successful climate adaptation and achieving climate neutrality are not ends in themselves but are crucial criteria for spatial and design activities in an unstable external environment, necessary to ensure the long-term survival of both people and nature.

SED implies goal-oriented integration of practical actions for climate adaptation and reducing negative impacts on the climate from the perspective of minimizing the risks of losing development sustainability. SED is focused on the preservation, restoration, and creation of new viable ecosystems that are important for both humans and biota. It is always territorially specific and unique, combining climate-neutral and sustainable functioning of human and natural spatial systems with engineering and social infrastructures.

The information developed within the framework of SED should enable the application of broadly understood insurance mechanisms, ranging from engineering protective measures to social and economic ones. Insurance for economic risks in the climate sphere is in its infancy due to significant "fat tails" associated with uncertainties. For example, the construction of temperature-independent energy systems or population migration may encounter difficulties in conditions of multi-level and interconnected uncertainties [2]. Addressing this gap has become the focus of the global Network for Greening the Financial System[13].

The principles we set out for a unified system of indicators for evaluating decision-making within the SED and for assessing the efficiency of such decisions allow us to determine the effectiveness of projects and development plans by combining RBM (results-based management) and CBA (cost-benefit analysis) approaches, as well as RIAM (rapid impact assessment matrix). This makes it possible to assess measures within existing informational constraints in terms of their effectiveness, economic efficiency for the innovation beneficiaries, socio-economic efficiency for local communities, and sustainable development of territories in the long term. In this context, while developing SED, we unexpectedly encountered a lack of scientific knowledge about anthropo-natural systems (ANS). The reason for this situation is deeper than it seems at first sight, as it is fundamentally related to the orientation of scientists and experts in biology and ecology towards studying predominantly intact ecosystems. Meanwhile, such knowledge, albeit useful, proved insufficient for the designing solutions of the problems of ensuring the sustainability of ANS, which include industrial, civil and infrastructure facilities.

Despite its obvious demand, SED is still spreading slowly. This is because it imposes increased requirements on the quality of territory study, which requires specialists trained to work in conditions of high climate uncertainties and risks. When using SED tools, the abilities of managers, planners, and designers to think systemically and engage in interdisciplinary interaction come to the forefront; as well as focus on reducing risks of losing viability and ranking these risks; ability to identify and prioritize critical "red points" of effort, ability to work with large data sets and artificial intelligence systems. Widespread use of SED is also hindered by the currently short planning horizon of many resource managers, who perceive the importance of only immediate social and economic tasks and the political conjuncture. They perceive the real tasks of strategic planning as declarative, and scientific activity as disconnected from real life.

Our experience has shown that SED approaches are currently most positively received by people in areas significantly affected by climate change, such as the Aral Sea region or southern Kyrgyzstan, which have suffered from natural disasters or anthropogenic and natural catastrophes.

[13] NGFS - Central banks and supervisors - Network for Greening the Financial System. Scenario Portal. https://www.ngfs.net/ngfs-scenarios-portal/

V. Conclusions

Spatial design activities in the current context of high climate uncertainties and risks require a system-forming SED methodology, which sets the vector for goal-oriented systemic transformations of spatial development in an unstable external environment to enhance the viability of disturbed ANS through a system of planned and project measures for spatial development within interconnected, geographically specific constraints and regulations of economic activity.

SED allows reducing losses and damages through comprehensive development of territory and synthesis of climate adaptation and mitigation measures. It increases the efficiency of public and private investments from the perspective of sustainable development of territories, facilitates sustainable use of natural capital, and enables the education of the population on the sustainable use of development assets and their capabilities in the face of climate challenges.

In the context of the climate agenda, SED is expressed in giving climate-neutral development a human face, perceiving climate threats from a general security perspective, strengthening positive synergies between climate adaptation and mitigation measures, and creating institutional conditions to increase the interest of key economic sectors and a wide range of stakeholders in achieving climate neutrality. And the leading position is taken by the ability of managers, planners and designers to think systemically and engage in interdisciplinary interaction.

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