

Urbanization of Biosphere: From Mega- to Ecopolises

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Abstract. Sustainable development requires principle changes in goals, indicators and values urban areas to well-known principles from the fundamental work “Limits to Growth” [20]. Multidisciplinary and cross-sectorial teams of experts, planners and authorities need to elaborate jointly national and inter-regional strategies to the ecological mode of urbanization to turn dynamics of megapolises growth to ecopolises. New type of urban and ecopolis strategies as the core of urban strategy tested on the example of Korolev science city in Moscow Region by ecosystem restoration, evaluation of risks and calculation of resources required for implementation ecological master plan. This task force elaborated and designed with strong participation with the city council of Korolev by a joint Russian and Italian team of students and professors [15].

Keywords: Urbanization · Megapolis · Carrying capacity · Sustainable development · Ecopolis · Coherent development · Post-industrial · Urban risk

1 Industrial Approach to a Growth

Although researchers attempted to find solutions to the problems facing humanity during the last decades of the twentieth century, handling these problems continues to be an issue as the conclusions they drew questioned in the twenty-first century [1, 14, 20]. As no new common ground (paradigm) has emerged, Aurelio Peccei - the founder of the Club of Rome and Institute of System Researches - has said that one needs compelling arguments to “forecast a potential catastrophe in the coming decades” and that “there is a necessity in the Great change of the direction of human activities” [19]. Predictions were not accepted. Modern science cannot forecast evolutionary changes in biosphere, which will ensure safety of human population [2, 20].

We need to open social, scientific and professional meaning of “sustainable cities.” The concept of “Ecopolis” as urbanization strategy and experiment started in 1980’s in USSR - developing human settlements that are coherent with regional ecosystems carrying capacity. Science starts with the determination of goals and terms. Science attempts to monitor and model dynamics, while philosophers and other thinkers try to understand trends to define limits of urbanization. After the Da Vinci Urban Project, several utopian projects have mostly been successful and generalized plans been developed. Finally, Garden Cities open new area for humans - eco-return to reasonable natural milieu. Industrialization since the 19th century has led to population super density urban sprawl, swallowing forests and agricultural areas in the countryside. This

has brought impacts on biosphere that not been predicted. A new profession, “eco-urbanist”, has emerged through research and project practice design. During the past decades in Russia, we in fact eliminated long-term planning and strategy in human settlement policy.

2 Post-industrial Shifting from Growth to Development

The direction of urbanization in general has not been clear. Today we need to revisit the long-term values and support state strategy in urbanization design. Models should followed by the development of low risk scenarios in regional ecosystems capacity and local ethno-cultural context. In this way, important projects appeared: bioregionalism, eco-cities and ecolopolises as self-supporting settlements. In Russia several large-scale projects were fulfilled starting from the beginning of XX centuries in the vicinity of Moscow (beginning of XX c. on railway St. Prozorovskay) and in 1970–1990 in Science City’s Poushino, later in Korolev (previous Kaliningrad Moscow region).

Ecopolis approach tested in Old Kosino and Vologda. Megacities as another kind of human settlement are suggesting certain social metabolism where matter and energy flows. Human ecology issue is not on a short list of modern progress. Due to given scenarios of population growth [17], new limits of centralized management can be expected - systems will develop to super complex level with risks of unpredicted disasters - “normal accidents” [20]. Strategy of global urbanization is slowly moving toward a new integrated policy that is influenced by climate change, shifting to alternative energy, sea level rising, the decline of per capita plough land on the planet limited fresh drinking water supply for global citizen, urban stress, etc. [9]. Those different risks required the integration a system with the lowest integrative risks by means of new mode of urbanization - ecopolis. Our determination is – Ecopolis is a multifunctional unit in planning and it even partly produces vital resources from within, e.g., drinking water, food (fish, game products, cattle, wheat vegetables, and fruits), natural berries, mushrooms, and additional planting local plant species. City ecological service fulfilled through environmental and settlement monitoring, ecosystems restoration, ecological network connection among regional and Ecopolis ecosystems. Ecopolis as a project have started at the very beginning of 1980’s in Science City Poushino in the Soviet Union era. Poushino Science-City was in some way the “town of future” as there was no industrial impact, only recreational. That impact was carefully studied in all seasons and it showed that recreational needs (e.g., walking, gathering flowers, fishing, hunting, mushrooms picking) actually use territory more than 600 times bigger than its own city territory.

Training and education of local deputies can improve official’s vision of planning and possibly expand it to “geological time scale.” Only after participation in long term modeling experiments and projects participants (volunteers, deputies, and local scientists) were motivated and ready to think and discuss future changes of landscape, city and human habits, and to model “common vision of desired future.” Values of sustainable development has to start in human mind first [11, 14, 16, 22].

Local city natural reserves planned and workforce was dedicated officially to take care of them, including volunteers mostly with high education background.

The Ecopolis experience established a link between academic philosophy and everyday human practice. It finally realized the first steps of coherent development of regional ecosystems and urban milieu. This is the new meaning of modern cities: biodiversity and ecosystems restoration become the center of urban system dynamics modeling [15, 18, 21] on the way of sustainable satisfaction of human needs.

3 Multidisciplinary Approach to Avoid Misunderstanding

The term “Ecopolis” invented simultaneously with “Coherent Development of the Nature and the Society” [2] concept elaborated in the 1980s. Important to give description of the term “Ecopolis” – is a human settlement and its immediate surroundings metabolically coherent with natural regional ecosystems and offer fruitful social and cultural milieu. This theoretical ideal directs efforts of scientists, planners, citizen, politicians, health and ecological services to organize field polygons as application of the theory. “Fragments of the Ecopolis concept are recognizable in many cultural landscapes and cities as green areas, urban forests, streams and channels. Ecopolis is a human settlement of the future, whose ecological parameters are controlled and whose inhabitants culturally prepared for constant changes, both in the mode of life style and in nature” [2]. Research and experiment on mutual adaptation of man and nature started in Poushino (Moscow region) in 1980 and run for several decades, with extensive participation of local scientists, citizens and the administration of the Science City Project. Observing eco-cities in different countries practice, difficult to recognize scientific approach except for taking care of elements of city metabolism such as water and air quality, and urban infrastructure planning to save energy. Large-scale research results since 1980s was widely discussed [3, 11, 12]. As far as we know, the “Ecopolis concept” has not implemented in practice internationally, taking into account presentations at international conferences and two World Exhibitions (1985, 1987). Significant that independently, ecological research and open space design of human settlements on planets has been done in the by I. Gitelson in Krasnoyarsk laboratory in Russia. Worldwide known the unique experiment “Biosphere II” in Arizona supported by Eco-Technics Institute in London and is in operation until today. The eco-villages are small communes and popular in many countries and are managed without science background, just by using organic farming and follow agriculture techniques [8].

In Russia, science traditions often based on philosophy and biosphere theory invented by Vladimir I. Vernadsky. His theory was one of the cornerstones to urban areas review and improvement. The term “ecopolis” [2] covers the historical experience of urban design policies and instill in the practice the modern understanding of humankind vital dependence on the biosphere conditions and technical irreplaceable ecosystems service.

Later the catch-all title “sustainability” has become popular lexicon of environmental projects. As it was analyzed in the School of Architecture at Alghero (Sardinia - Italy), projects often referred to as descents of scale, particular in the architectural dimension and construction, or in qualitative and quantitative methods [3]. Discussion around terms and meanings we value as normal processes in the sense given be

Herman Daly to “Strong” sustainability opposite to the “non-substitutability of natural capital by “artificial” capital (human, social and economic). The sum of natural and anthropogenic capital in other words be kept at a constant value, or each component can be kept constant. It is reasonable, if we think that the two types of capital are interchangeable with each other, need to be proved” [4–6]. The latter is could be accepted if we think that the natural and manufactured capital is complementary, what is not obvious.

Therefore, those capitals should be operate coherently because the productivity of one depends on the other [2, 12].

Land use and development are emergent properties of a complex system – they are not leverage points in themselves. The first step in research and education efforts done jointly with local institutions, reasonably elaborating observation of domestic design and construction traditions. Important to figure out their “environmental reasons” including their bioclimatic function role and mediating energy flows).

The goal is to identify modes of development and regeneration of dwelling that fit these approaches. This exploratory work also accompanied by research and educational activities in close connection with energy supply by renewable sources. Important to recovery traditions of local construction with low environmental impact, including practice of “eco-friendly and durable building materials with significantly longer lifecycle” [7].

4 SD Principles in Local Planning

Only very recently environmental risks start to be discussed and taken into account referring to ecosystems carrying capacity and their general conditions. Large-scale experiments as well as practically tested guide for planning needed with continuous long term monitoring are crucial to value theory “Coherent Development of the nature and the Society” [2]. At the same time, basic principles of Sustainable Development (SD) need implementation:

1. Climate change as factor influencing mitigating potential impacts in future by modeling urban planning and smart houses using;
2. Addressing more projects to aquatic, marine systems, and underwater settlements;
3. Taking into consideration industrial load, field ecology data, biodiversity and general environmental issues;
4. Using information technology, system dynamics to design simulation models highly urbanized territories metabolism, and management scenario.

Each principle represent a part of simultaneous actions in the system eco-urban planning finally focused on a certain objects (Table 1).

From these principles, several core objectives and professional fields of activity follow:

Monitor, protect and restore highly urbanized systems. That suggest rehabilitation of the local reserves, parks, water bodies improving environmental structure of the territory, carrying capacity, and efforts to maintain them. Finally improving connectivity and avoiding fragmentation.

Table 1. Management and coherent action principles for ecological Korolev sustainable development

Six principles of coherent SD	Eco-logical actions on all levels planning
Protect, restore and enhance existing ecosystems and network of green areas, water bodies	Ecological infrastructure maintain at all levels. Policy of coherent of landscape mitigation and life style Fragmentation and improve ecological network Mitigation fragmentation of different landscape levels
Closing the matter and energy cycles: environmental resources management	In climate change dynamic prevent flooding Improve carrying capacity recreational places. Suggest planning new one Suggest management to complete waste and water cycles
Natural resources management	Maintain load and monitoring the reserves as the system network Establish green service Provide visit centers, materials for education & recreation Organize the collaboration and activity of professional corps and volunteers on levels of activity
Boundary of urban- countryside planning and design	Support and fulfil transforming edge zones of urban ecosystems to countryside ecosystems as joint Econet practicing as an milieu connecting urban-countryside and regional ecosystems Restore, local and regional land fields, abandoned, residual lands for new functions Support practice of urban agriculture
Sustainable housing	Save and use local renewable resources with smart buildings Reuse and return to social use abandoned buildings balance density of citizen population and social needs
Risk management	Invent integrated risk management of land-use: hydrological, geological, territory planning, industrial, postindustrial activity, civil activity Invent monitoring of natural and urban milieu risks dynamics, established public source of on-line information, including health risks, quality of air and water and other vital resources. Invent maps of urban risks interrelations from geological to health and criminal and integrated risk, imparting natural disaster

Risk management deals with either the adaptation to storm water and flooding, or the industrial risk nano-particle air pollution, as space technologies are located in Korolev.

Fulfilling the EKorolev project as social practice used different strategy and tactics mainly based on human resources.

Implemented by the City Green Service, the most important was to improve elements and certain places that are public, open and coherent with the goal and values of

the project. In addition, highways improved and reduced the traffic load from national park. Even good projects are not easy to implement in city. As we know municipal government often practice independent tactics and more important tasks that needed to complete urgently. Finally, measures addressed to sustainable project development loose importance.

The Master Plan was assembled together with other sketches, graphics, photo-simulations, and suggestions sheets, in which every single idea is represented.

PowerPoint presentation also provided for the public – that make it easier to understand and discuss project with images, slides and animations.

5 Conclusion

The final report was presented as hierarchy of concept, strategy and project plan to colleagues, from universities, experts and finally to administration and mayor of Science City Korolev. Latter the Russian-Italian team of the EKorolev project was designing Master Plan of Geological Park on Sardinia, materials published bilingual in Moscow [3, 12]. Project is an example of principles that request simultaneous actions, controversially to “step by step” practice that bring postponed conflicts and controversial effects [1, 15]. The meaning of the EKorolev project is multicultural, multidisciplinary as City is evaluate as the most complex system created by humans. Such complex systems need model design to choose the best scenario with the lowest risk. “Build inclusive, safe and sustainable cities and human settlements” [8, 10, 13], cities need to take care of local ecosystems as it was highlighted in the United Nations General Assembly in 2015. The need in long-term Urbanization Strategy of Russia for new and old settlements, importance “ecopolis” approach discussed on meetings Public Chamber of the Russia in 2014–2017 years.

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References

1. Beck, U.: Risk Society: Toward a New Modernity. Sage, London (1992)
2. Brudny, A., Kavtaradze, D.: Ecopolis. Principles and Problems. ONTI, Pouschino (1981). (in Russian). Brudny, A., Kavtaradze, D.: The coherent development of the nature and the society. The International Exposition. Vneshtorgisdat, Tsukuba, Moscow, Japan (1985). Brudny, A.A., Kavtaradze, D.N.: “Ecopolis”: prognosis turned into project. Social Science, no. 2 (1984)
3. Casu, A.: Approaches to sustainable planning. In: Kavtaradze, D.N., Casu, A. (eds.) EKorolev. Projects of Regional Sustainable Development. The Report on Russian-Italian and Italian-Russian Student Workshops in 2007–2008, Educational monograph, UN Decade, Education for Sustainable Development, Acropol, Moscow (2011)

4. Daly, H.: *Beyond Growth. The Economics of Sustainable Development*. Beacon Press, Boston (1996)
5. Daly, H.E.: Toward some operational principles of sustainable development. *Ecol. Econ.* **2**, 1–6 (1990)
6. Daly, H.E.: Operationalizing sustainable development by investing. In: *Natural Capital, ISEE Conference*, Stockholm (1992)
7. Deelstra, T.: Public participation in improving urban life and environment. In: *Cities and Ecology, MaB Program, Suzdal, USSR, Collected Reports*, vol. 2, pp. 153–167 (1988)
8. Gerzberg, L.: *Ecosettlements in Russia*. In: *International Conference. School of Public Administration, Moscow State University, Public Administration, Russian Federation in Modern World*. Oral presentation (2015, in print). Ignatieva, M.E.: *Ecopolis-search for sustainable cities in Russia*. In: *The Sustainable City II: Urban Regeneration and Sustainability*, pp. 53–61. WIT Press (2002)
9. Indicators: European Environment Indicators (2016). <http://www.eea.europa.eu/data-and-maps/indicators/#parent-fieldname-title>
10. ISS (2014). <http://www.un.org/sustainabledevelopment/cities/>
11. Kavtaradze, D.: *Ecopolis and new urban functions*. In: *Conference on Proceedings, IALE Congress, China* (2011)
12. Kavtaradze, D., Casu, A.: “EKorolev”- Dimensions in Urban and Countryside Planning Sustainable Development/NISPACE HSE, November 2015
13. Kavtaradze, D.N.: Public and professional education in urban ecology, perception and evaluation of urban environment quality. In: Bonnes, M. (ed.) *Proceedings of the International Symposium on a Pluridisciplinary Approach in the European Context Rome, Project 11. MAB, Italia* (1991)
14. Kavtaradze, D.N., Boukvareva, E.N., Sidorenko, V.N.: Using of system dynamics and geographical information systems for ecological nets planning. In: *Proceedings of System Dynamic Society Conference, Norway, July 2000*, p. 213 (2001)
15. Kavtaradze, D.: *Urbanizatsij of the Biosphere/Problemi okrushauschei sredi i prirodnyh resursov. Obsornaj informatsij*, no. 7. VINITI, Moscow (2005)
16. Kavtaradze, D., Boukvareva, E., Sidorenko, V.: ‘Econet-ABC’: Imitatsionnaya upravlencheskaya igra po sozdaniyu seti osobo ohranyaemyh prirodnyh territoriy regiona [‘Econet-ABC’: Simulation game for Creation of Regional Natural Area of Preferential Protection]. *Izd-vo Che-Ro, Moscow* (2005)
17. Meadows, D.H., Meadows, D.L., Randers, J., Behrens III, W.W.: *The Limits to Growth*. Universe Books, NYC (1972)
18. Numata, M.: Water-oriented approach to urban ecosystems. In: *Cities and Ecology, MaB Program, Suzdal, USSR, Collected Reports*, vol. 2, pp. 39–46 (1988)
19. Pececi, A.: *The Chasm Ahead*. T MacMillan Company Collier-MacMillan ltd., London (1969)
20. Perrow, C.: *Normal Accidents: Living With High Risk Technologies*, Revised edn. Princeton University Press, Princeton (2009)
21. Sukopp, H., Henke, H.: Nature in towns: a dimension necessary for urban planning today. In: *Cities and Ecology, MaB Program, Suzdal, USSR, Collected Reports*, vol. 2, pp. 30–36 (1988)
22. Turner, G.: *Is Global Collapse Imminent? Research papers Series N 4. Melburn Sustainable Society Institute. University of Melburne, August 2014*

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