Resilience as a Sustainable Design Process in the World Climate Change

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Abstract. The World’s changing climate, directs all the efforts of humanity in the adaptive nature of reducing the impact of their activities. The author focuses in the text on the idea of 'resilience' in the reorientation of design practices towards to build a bank of matter. The use of information from already occurred events, should lead to adapt in to climatic conditions, as it happens in nature. The first part, show the principles and context of building design process which is not always in the sustainable development idea. It shows the activity of architecture and construction, as negative impact on the environment which we can also experience and categorized as an effect of changing climate. The second part, attempts to determine aspects, which should characterize the early and last design stage, which defines the ecological life cycle of an architectural object – building as a creator of Cities. The conclusion, talks about the paper refers directly to the architectural-environmental dimensions, orienting the design process of buildings in respect of widely comprehended climatic changes. Author’s research results highlight the fact in the idea of the matter bank – the equivalent of city matter. Moreover, ideas are formulated as the 'resilience' which draws from the information, from already existing events and through processing by adjusting them and using again. The work aims to draw attention to the ever-growing methods of researching the building, such as: Life Cycle Analysis and Building Information Modelling, as the future of sustainable, conscious architecture design in a changing climate.

1. Introduction
Resilience in free translation means: flexibility, elasticity, resistance and what's most important: ability to adaptation and regenerate based on previous events. The term 'resilience', comes from psychology but now functions commonly. The concept of resilience refers to social observation in the development of children and adolescents who grew up in adverse conditions. It is possible to observe similar behaviours or relations in the nature. With reference to architecture, all correct and incorrect design / implementation solutions should assume the exchange of information. This should facilitate the anticipation / making of correct design decisions. Based on previous achievements, errors, etc. through absorption, subsequent adaptation and long-term use, should lead to positive architectural relationships and a smaller impact on the biosphere.
2. Negative environmental impact
Thinking about the influence of the building sector or wider about human activity is possible to observe the result that changes the climate. In industrialized countries, about 75% or more people live in cities, and half of all humanity will move there to the end of the century. According to publication from 1972, "A Blueprint for Survival" determined the increase in population on earth, which by 2040 will reach the dimension of 15.5 billion and thus the will to change, solutions is in the spectrum of the dystopian character of the transformation of the natural environment on Earth. The requirements of changes in everyday life were estimated in the perspective of electricity consumption and real costs borne by the prism of non-renewable material sources in the sphere of the ecosphere's tolerance. [1] Human expansion in the meaning of its activity is also included in the book "Limits to Growth" from 1972. [2] The publication identifies the problem of growth, its boundaries and the possibility of balance in the context of the growing global five basic elements: population, food production, industrialization, pollution and consumption of non-renewable natural resources. Those life needs of human activity correspond to a consume of 25% of wood and 40% of extracted raw stone, gravel and sand each year. Construction absorbs 16% of global freshwater and 40% of energy. As a result of burning fossil fuels, 70% of sulphur oxides are produced in the production of electricity used to supply homes and offices. Moreover, the emission from activities gives about 50% of carbon dioxide, mainly in the industrialized countries, which is the result of the functioning of buildings, thus leaving a negative ecological footprint, [3]. Next, buildings for efficient functioning need a certain amount of energy, and are responsible for 40% of energy consumption and 36% of CO₂ emissions only in the EU. Currently, about 35% of the buildings in the EU has more than 50 years, [4].

Moreover, human activity reaches a negative impact on the environment which is closing in the concept of anthropopression - exerting a negative impact on the environment (land grabbing, felling of forests, water consumption, pollutions etc.). All these elements lead to the determination of planetary boundaries aimed at preventing the potentially adverse irreversible effect of human activity. [5] This indicates the need for a correct approach to the design process: materials, buildings, cities etc. In the meaning of the stage of initial concepts is possible to estimate the right decisions in the built environment shaping. Therefore, all design processes should implement resilience-building measures and adaptive practices - leading to regenerative design principles. [6] To meet these principles, the design process must close the building in a simple specification like DNA.

3. Matter in the design process – DNA
According to author [7] the idea of DNA is a record of material shapes, mechanisms, processes and cycles of life, which creates a variety of formations while maintaining their personalization. The spectrum of variants in the design process leads to the architectural design and then to implementation. The process of designing architecture, which takes into account the algorithm of material record, which is a combination of substances and energy in the object’s lifecycle, becomes flexible, and therefore can be improved. In this way, it approaches the theoretically unattainable perfection, as well as "Perfectus propter Imperfection” which means "the world is perfect for its imperfection". The DNA of a selected model, taken at the stage of design decisions is contained in the aftermath, which reveals the life cycles of the object.

The assessment of what a form looks like (its characteristics and materials) is hindered by the bodily presence of the decision, which was closed in the matter. In this sense, an object/building becomes a subject, whose architecture was closed and defined in the design process. Hence, comparison of the properties and form of matter with the DNA, which is actually a biological record, gives rise to a variety of formations. (Fig. 1)
4. Life cycles of the architecture

Life cycles are needed to determine the algorithms of suitability of products / objects and the impact that they have on the environment in the chain of existence. To determine the effect of materials used for the formation of an architectural object on the environment, their life cycle should be traced, from the extraction and processing of raw materials through the production process > distribution and transport > construction of the facility > use of the building (cited above) to the demolition and re-use - recycling - demolition waste or landfill in case of all analysed materials. The method of this assessment, Life Cycle Assessment (LCA), allows to estimate any kind of material impact on the environment and its resources. Examination with the LCA method is carried out in four steps defined by the International Organisation for Standardization matters - ISO (International Standard Organization) in PN-EN ISO 14040 and ISO 14041. Authors [8] research shows that by combining two aspects of the Life Cycle Analysis - LCA and digital analytical software tools including Building Information Modelling - BIM in the early stage of the design process indicates an achievement of a high-level ecological goal. [9]

What is most important is that the destruction of objects raises the question of what happens to waste after demolition (after a life) of objects. Tingley [10] specifies that a lack of base (bank) information, data and project which takes into account the second life of materials makes it impossible to determine their full life cycle, which is also important for the meaning of embodied energy. Research on the value of the embedded energy in the existing building stock was conducted in Sweden, Germany and Denmark. These studies by asset construction inventory had to determine the potential reuse of materials used in the structures of the tested objects. Various types of indicators were used in the inventory: the use of the material (kg / m² / year) % recycling, embedded energy and production of carbon dioxide.

Design process takes into account the element of re-used matter as complimentary design for (and from) deconstruction [11] and adaptive reuse [12]. Design for deconstruction, which is designing for demolition, already is in the process of creating the concept envisages the stages and life cycles of the building, part of the demolition, thus determining the rank of materials for reuse. Adaptive reuse - envisages reuse of existing buildings and old structures, are for new purposes and helps to raise productivity, which has a significant impact on the sustainable development of the environment which was specified by the Department of the Environment and Heritage [13]. From an economic point of view, re-use of products / materials / objects is cheaper and faster than the production or construction of new ones, provided that they are included in the life cycle of a building. The lack of coupled databases (resilience) provokes caution when designing or even lead to abandoning the idea of using
recovered matter. It is essential to determine the availability of this matter on the local market and get an idea of the possibilities of its adaptation for specific purposes, approximated in the research of Akhtarkavan et al. [14]. Citing exhibits of EXPO, it is worth mentioning the British Pavilion (arch. Nicholas Grimshaw, 1992), Switzerland Pavilion (arch. Peter Zumthor, 2000.) and the life cycle of the Pavilion of Christ (GMP Architects, the building was demolished and reassembled elsewhere). These projects were based on the principles of design for deconstruction. They contained a built-in script from the concept to the demolition, thus reducing the amount of construction waste. (Figure 2.a)

The realization of adaptive reuse can be seen in Tate Modern (2000), Elbphilharmonie Hamburg (2014) by Herzog & de Meuron, which converted the existing old structure (the main hall of Bankside Power Station - Tate Modern and the old port cocoa warehouse - Elbphilharmonie) into noble functions public buildings. The trend of adaptive reuse and the possibilities of regeneration and revitalization of degraded areas (recycling area) can be observed in many adapted and revitalized buildings all over the world, eg. Turzyński Quarter - Szczecin, StudioA4; Docklands, London; MASS MoCA, USA, etc. (Figure 2.b)

A full picture of the end of the life cycle of waste materials, i.e. garbage (tyres, bottles, cans, paper, etc.) and local materials (ground, wood, etc.) for re-use, is reflected in individual realizations: Earthship Houses - Michael Reynolds; SECU - Sustainable Emerging City Unit (material strawpanels) EiABC; Japanese Pavilion (material: paper), EXPO 2000 Hanover - Shigeru Ban; Corrugated Cardboard Pod (material: corrugated cardboard), 2nd year project Newbern Al., USA 2001 - Gabriel Comstock, Amy Jo Holtz, Andrew Olds; PHZ2 (material: discarded cardboard), Welterbe Zollverein Essen, Germany 2008-2010 - Dratz & Dratz Architekten, Strohhaus (material: straw waste), Eschenz, Switzerland 2005 - Felix Jerusalem. The projects are characterized by the use of various types of processed garbage as defined in part by Hebel et. al. [15]. (Figure 2.c)

The above examples show possibility to re-use existing matter resources, prolonging life cycles without the need for their elimination in a landfill, and the introduction of environmentally friendly solutions to a lesser extent affecting the environment in a life cycle of exploitation. They also show that architects see many opportunities for ecological use of various structural elements, materials, waste (adaptive reuse, recycling, upcycling, etc.), as well as designing, taking into account the dismantling (design for deconstruction) in the construction of architectural objects. It is therefore necessary to be aware of the record and exchange the above mentioned information and experiences.

It is noteworthy that currently various types of databases are being developed more and more often, for example a map of all buildings in the Netherlands (Bert Spaan, Waag Society) or Map of all trees
in New York (tree-map.nycgovparks.org). It is also possible to compare the largest cities with each other by Urban Observers (Richard Saul Wurman, RadicalMedia, Esri) or find the best localization of photovoltaic panels at roof using Project Sunroof Works (Google). By using the floodmap.net platform we can check when our area/plot will be flooded, e.g., showing floodplains at a certain time. It is also possible to find solutions, that can be implemented in projects and should be found and analyzed on sites, such as 2030 palette (Architecture 2030) or at Tectónica (A.T.C. Ediciones). Alejandro Aravena shares information by the company ELEMENTAL (Aravena, Arteaga, Cerda, Oddó, Torres) in the spirit of open source. ELEMENTAL has made available four house designs (ABC of incremental housing) in DWG and PDF formats on its website. This points the way to the exploration and use of DNA specifications as a publicly available bank of matter for every building, urban or simple thing, with all solutions, resulting from the design process.

5. The idea of the bank of matter

As citizens of the planet Earth people become shareholders of an environmental "bank". We pay into and pay out the "urban" deposit. The assets of matter, that is the resources of a reliably estimated value obtained as a result of past an event, that triggers future benefits the individual that is the environment. Dimension of asset of matter is defined as a building containing materials tucked into it. The computational character of the amount of matter contained in an object is so far uncharacterized globally and taken by the author as an expression intentionally hypothetical.

The bank of matter consists essentially of urban components. Metabolism and consumption of the city specify the loss of natural resources. Classification of losses by the possibility of conversion or liquidation of economic resources is often resolved in the landfill and rarely used again. The spectrum of information flow about how to use a resource, does not engage fully conscious consumers. The lack of information bank accounts (buildings) and deposits (materials / matter) causes desynchronization of the design process with an attempt to use assets (materials contained in buildings). A proposal that solves this problem is direct access to the information which specifies the amount of the proceeds and time (usefulness) of the material, which is (contained) in the building. The built-in material is equivalent, which is dedicated and used again (death – in life cycle) of the product-subject-object-building-city.

In the dimension of defining the material it is possible to enter a number of examples. We will focus only on buildings that are the overriding effects of the structure of the city. Usable objects and waste will remain subordinate elements. The deposit which town gives is huge in the spectrum of activities and formal diversity. The record information about the objects should be characterized through the exchange of data of their functioning and the stages of life of building components. Each newly built building, which could be part of the urban structure would be catalogued as the future equivalent of re-used matter. Scheduling data in a clear way is the future comprising the record of bank matter. A method of recording bank data should take place on two levels – superior and inferior. Master data:

- The areas covered by the design, which are also and above all, the elements of the spatial meaning of recycling space, having its time dimension and material dimension which were created by buildings, objects, waste, etc.;
- Designing for / demolition: to determine rates and characterize the amount of elements in architectural objects possible to be recovered and the prospective use of materials, structures, etc.;
- Designing for / from the reuse: indication of the proportion of existing usable structures, and thus creating a catalogue of existing facilities;
- Design the life cycle of buildings: specify the time and stages of operation of the elements in a building.
The subordinate data - elements: communication infrastructure; garbage economic; elements of urban details suitable for re-use, etc.

Characterization and cataloguing of the above data can also be found in the formal functioning of the natural environment, which is a determinant for a thought experiment in discourse on the philosophical structure of the urban future operation (Fig. 3). However, the environment does not need artificial record bank matter, as it operates on the principle of nameless rights which are an indispensable, innate part of it. The solution is a neural flow of information about buildings (contained in materials in buildings) in the global structure of all cities, which will systematize the material catalogue with the possibilities of using the life cycle of their individual components (building components). Monitoring of data and the rights contained in the material / material deposit, will direct decisions about the future of the city resource management in a coordinated way to sustainable development on the axis of man - nature. The transcription which builds the city from particles of matter / materials combines principle of complementarity of individual elements in accordance with the matrix code of information, and it will enhance the process of design decisions and results in the actual-time (DNA) contained in each building-facility architecture. Correlation of actions in the design process (DNA) leads not only to determine the carbon and energy embedded, but also as a material embedded as actually reused in the future. The city as a treasury of the affected materials in its structure will bring the processes of decisions in the design process to effectively form solutions on completely different tracks thinking about resilience, ecological footprint, regenerative design, 3R + 1R, etc. The idea of the city which casts light on such a problem determines the balance of ways to synchronize existence of materials in the cycle and stages of life of the building.

6. Conclusions
If the ‘resilience’ is an ability to adaptation and regeneration based on previous events, it should assume as a basis the exchange of information available for all designers in every steps of a design process. It means that bank should be open source. The specification of each building should be elaborated and can give all pieces of information about the matter (as like DNA) of the building, urban or simple thing in all life cycle and after usable - inter alia in terms of embodied energy, embodied carbon, embodied materials (for reuse, recycle, etc.).

The elements that form an integral part of a building in the dimension of the city, determine its life cycle. The city consists of equity of materials in buildings, roads, bridges etc. (assets). Comparison of the town to the bank of matter, according to the author is appropriate because of the correlation between the values of money - material and capital - material. The computational aspect determined by CAD programs (BIM) enables the calculation of an integral part of the embedded energy of the material, as well as design, taking into account any modifications in the life cycle [16]. On this basis, the architect shapes the object and determines the full life cycle of its elements, and what should happen with them after exploitation of with the correct design process (DNA), led by architect / designer by 3 + 1R rules. The knowledge of matter contained in the objects and elements of the city, allows conscious design, through the use of specific information in the design process and re-record them in a public database network (resilience). Unfortunately, the lack of such information field in the technocratic social environment makes it impossible to carry out the design process in a structured manner. The enigmatic nature of information imaging results in an ambivalent approach to the project in fully implemented idea of sustainable development (life cycle of matter / material). The exchange of information takes place after some time, and the sharing of information (e.g. a full life cycle and materials) about objects very often does not exist. In practice there are existing schematic pictograms characterizing the components of an object (that show its cycle of life), but without scientific research and permanent record they are merely conceptual record ideas.

However, let us assume that there is a general information exchange network. Everyone has access to it and it is possible to estimate the amount of material collected in facilities, thus allowing to estimate the liquidity of matter in the environment (city). This would be undoubtedly a huge
inducement towards determining the life cycle of the city, causing long-term design in the architectural / spatial planning (regenerative design). The assumption of the above text is a reflection on the creation of the database / information bank of matter in the context of aberration ecological footprint (matter ecological footprint) left by the architecture, through the used technical and technological solutions and materials (embedded energy, life cycles, matter) leading to a hierarchy of significant consequences of the decisions taken depreciating environmental / ecological factors. A designer or operating system (BIM) (storing information in the public network / database / bank of the building - the amount of materials, the amount of embedded energy, with the possibility of recovering the components, costs, time, stages of life past, present, future data about object) - will allow the design process to be accessed by the same designers and future designers to be accessed a new facility and the recycling of components for the manufacture of another element, etc. Expectations towards the buildings in the context of the city will be related not so much with disposal in landfill, but on the contrary with the ability to recover their components and design of spatial / creative perception of the city as a bank of matter / materials in the form of liquid algorithms forming present and future capital of the built environment with the pluperfect materials.

The author believes in the success of the proposed solution, which is the focal point in the present and future scientific discourse on the central (master) a public bank (base / network) information (as resilience) managed deposit (subordinate) in the resource bank of matter (the city) with capital (assets / materials) contained in buildings during the design process (DNA). (Fig. 3)

Figure 3. The City as a bank of matter. Scheme of the main elements
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