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Procedia Engineering 21 (2011) 976 – 984

Procedia Engineering

www.elsevier.com/locate/procedia

2011 International Conference on Green Buildings and Sustainable Cities

The unsustainable city. Urban entropy and social capital: the needing of a new urban planning

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Abstract

The attention to sustainable urban development, participated urban planning, the consideration of territory as non renewable resource, sustainable mobility and so on has been characterizing also the investigation in the field of urban and regional sciences. Moving from these assumptions the paper seeks to codify a new process of sustainable town planing which is able to indicate the real actions to operate on the city. This paper intends to describe this new process called: Ecotownplanning starting from the systemic approach to the city. The paper is divided into three parts. The first part aims to build the background by placing the contribution inside the debate on global change, in particular as regards the issue of entropy. Tthe second part points out that one of the strategic factors to trigger the change may be to rebuild the social capital within cities. Finally, concrete actions are proposed for urban planning (Ecotownplanning) that can help recover the operational condition of sustainable urban development.

Selection and/or peer-review under responsibility of APAAS

Keywords: Global change*; Sustainable urban development; Systemic approach; Social capital; Ecotownplanning*

1. Gaia: entropy without armony

Considering the earth as a living organism capable of self-regulation, through the constant search for balance among its several components, represents the basic intuition of the "GAIA hypothesis" worked out by James Lovelock in the '60s. According to Lovelock's view, based on the systemic logic and cybernetics, the living planet is able to reach balance by absorbing the entropic effects produced by the behaviour of some biological components (biocenosis), in some cases by neutralizing/eliminating those

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doi:10.1016/j.proeng.2011.11.2102

components. Every organism modifies its biotype (from bacteria to human beings) but the effects of this modification are then balanced by the cycles of the planet, Lovelock [1].

In the course of the history of our planet all the events capable of producing epoch-making changes have been almost metabolized and included into the big cycle: order/chaos allowing to reach new balances. Consequently the vital cycles of living bodies are functional to our planet survival; for example, we should consider that the coral reefs are made up of the carcasses of sea organisms or that the biosphere is fed also by the methane produced by bacteria and decomposition of biological masses.

Gaia has always been living thanks to a dynamic harmony entailing birth and death. At present, a new condition seems to appear, which is characterized by an increasingly difficult achievement of balance; there are earth components whose capability of change produces effects that the planet is not able to compensate. The phenomenon appears and grows, following an exponential rule, particularly in the last decades. Many other components of the planet organism seem to suffer and be incapable of participating in that dynamic search for harmony that for some billion years has characterized life on the earth. Unfortunately, the cause of the unbalance should be unequivocally attributed only to one earth species: man. The theory of Anthropocene analytically describes the process of change produced by human activities, Crutzen [2]. The climate changes, felt also at local level, are a socially appreciable sign of the undergoing global dyscrasia.

Gaia goes on by cycles: the chlorophyll photosynthesis, the cycle of oxygen, the geo-chemical cycle, the ocean streams; according to the alternation: cold/hot, order/chaos, and so on. The cycle of oxygen allowing life on earth shows worrying modifications. The increase of greenhouse gases, the main cause of temperature increase on the planet, is producing important unbalances in many relationship cycles of earth system. The ocean stream (the Gulf stream), but the Mediterranean ones too, which determine the global climate balance, are changing (in temperature, salinity and flow) and seas are no longer capable of absorbing the carbon dioxyde for the survival cycle, because of the surface water heating (which hinder the mixing with deep water. The concept of the cycle as representation of the structural harmony of the planet occurs in many important studies of the school of ecology in particular and finds some of the most interesting contributions to the subject in the writings of Eugene P. Odum and "The Closing Circle" by Barry Commoner.

The human entropy, described by Rifkin [5] is increasing and is pushing from the inside the global earth cycle by making a disconnection inside the harmonic motion which causes a change towards a spiral process.

Human beings, thanks to scientific and technological progress, are now capable of extending their biological life on the planet, almost altering their cycle and making their ecological mark deeper and deeper. Some experts interpret the development of not curable diseases and lethal virus (such as Cancer, AIDS and Ebola for instance) as the Gaia's utmost attempt at reducing the anthropic pressure that she is incapable of balancing again. Considering earth as a supermarket planet from which drawing resources and energies to feed anthropic biological cycles, with high anthropogenic effect, has characterized human ethic of the last five centuries, a relatively short period for earth history, but tragically lethal for the planet. The quantity of entropy seems to be no more metabolized by Gaia or anyway does not allow to reach a balance in a fast way as in the past.

The energy dependence only on non-renewable fossil fuels, which produce human impacts and effects now no longer governable, is leading human settlements to structures characterized by high entropy, which is manifested in the alarming pollution of air and soil but also of water, electromagnetic (OEM) and acoustic. The bad, or for someone, the good news is that oil seems low, with annual world extraction of approximately 3.928 billion tons of crude oil, and sooner or later it will end. This phenomenon, in addition to trigger significant economic upheavals, business follies and social conflicts (for gaining the last barrels), will lead to a sudden structural crisis of human settlements which, thanks to fossil fuels,

survive by fuelling their functional system and allowing the experimentation of all urban activities: residence, mobility, manufacturing, marketing, etc. .

Italy unfortunately has won the dubious distinction of the world's largest operator with a 47.4% of national energy needs covered by fossil fuel placing itself above even the U.S. (37.1%). Every day in our country about 1.7 million barrels of around 270 million liters are burnt and in case of sudden depletion of energy source we can rely on accumulated stocks that allow the operation of the country just for two months. There are two geometric figures that are able to effectively describe the terms of the worldwide energy crisis and that can be used to work out a theory of the energy inversion. The first is the Gaussian curve that describes a distribution of values according to a bell-shaped pattern used by many researchers to model physical and human phenomena known as Hubbert's curve

«Growth, growth, growth — that's all we've known. […] World automobile production is doubling every 10 years; human population growth is like nothing that has happened in all of geologic history. The world will only tolerate so many doublings of anything — whether it's power plants or grasshopper». Thus in 1975 the Texan mathematician and geophysicist Marion King Hubbert, for years active in the research labs of Shell Oil, stigmatized the problems of growth, mobility and the depletion of our major energy source: oil. Hubbert developed a model to estimate the potential of a mining field for so-called conventional oil. The curve, similar to a normal distribution, describes a "bell-shaped" trend of the estimated amount of recoverable oil, and is divided into four different phases:

- Phase 1 - Rapid expansion: the fossil resource is available in huge quantities and limited energy is necessary for its extraction, production increases exponentially;
- Phase 2 - depletion of the loose resources: the deposits are exhausted where the mining is carried out with limited resources and it is necessary to take more substantial resources to continue the production, which suffers, however, a first significant slowdown .
- Phase 3 - peak and decline of the curve: the progressive exhaustion of the resource requires the use of increased investment coming to a peak of economic unsustainability from which the curve starts a declining profile.
- Phase 4 - final decline: the production continues with its inertia, but without the benefit of new investments that lead subsequently to a final halt in production.

The problem now lies in understanding where we are placed in relation to the production curve. On this definition there are different points of view that, however, show a common element: almost all world regions have reached and exceeded the peak; the only region in the world that has not reached the peak yet is the Middle East. Many scholars are doing their utmost to build algorithms to estimate how much oil we can still pull out in order to calculate how long our world system will survive.

In any case it is generally accepted that the highest point of the parable has now passed and we are now descending on the profile of the bell. In a rational consideration of the energy problem, a serious policy of research development for renewable energy sources should start, instead we are committed to define the exact point of the descending profile or, worse still, look for new sources that can allow the extraction of some more oil barrels. What seems to be wholly missing is the consideration of the more or less close exhaustion of the only energy resource on which the world economy is based: oil.

We continue to consume according to an obtuse perspective of the contingent. As exposed by many parts we are consuming the resources of the planet: environment, fossils, etc. .. as if they were limitless. Each day human beings consume the fossil resource (coal and oil) accumulated by the planet in 100,000 years. Our huge growth comes up against the limits of the thinness of the biosphere [6]. When the energy resources will run out we will be crushed by the weight of our anthropic production. Accordingly it could be interesting to mention the behavior of the snail described by Ivan Illich, "The snail builds the delicate architecture of its shell by adding ncreasingly wider turns one after another, then it stops abruptly and begins to create decreasing convolutions. A single wider turn would give the shell a size sixteen times

greater. Instead of contributing to the welfare of the animal it would places an excessive weight. At that point, any increase in its productivity would be only for remeding the difficulties arising from the shell dimension exceeding the limits set by its purpose. When the limit point of the turns development is exceeded, the problems of excessive growth multiply in geometric progression, while the biological capacity of the snail can follow only an arithmetic progression at best [7].

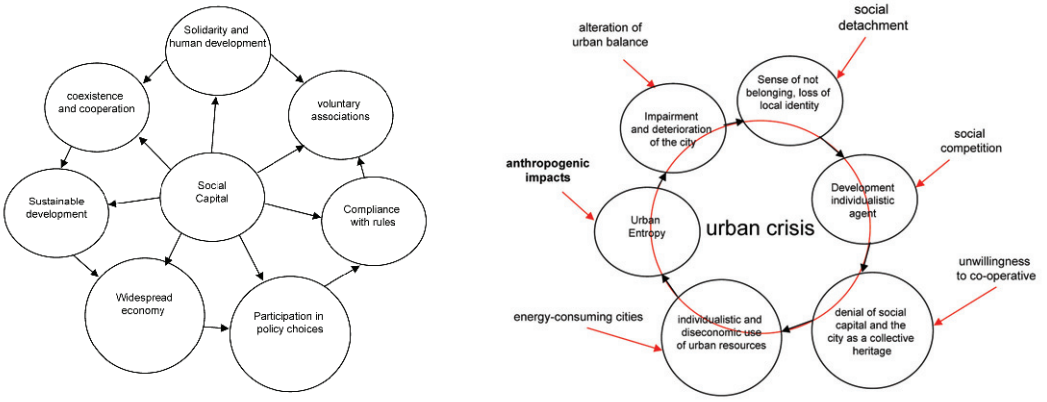

Fig. 1. Conceptual schemes of the components of the social capital and the of the entropic damage chain in the urban system

The entropic phenomena are therefore related to human activity concentrated in particular in urban contexts. The fact that cities are the strategic places where triggering the "reverse energy" is widely shared by scholars from many disciplines: urban planners, geographers, urban sociologists, transport planners, etc. .. The term energy inversion is intended to indicate the process of total change in covering all urban subsystems as identified in the systemic interpretation of the city. The process of change must cover the entire urban system by acting on the component systems (the physical system, the functional system, the socio-anthropic system, etc.). The first system on which acting is the socio-anthropic system by triggering a radical change in the behavior of citizens, city-users and operators in the governance of territorial transformations. It is necessary to overcome the tendency to individualism and promote processes that can catalyze, revitalize and enhance the social capital of cities. Of course, in order to enable a gradual process, it is necessary to act on the processes of population training by transferring, in the contents of knowledge, the values of energy conservation, recycling and reuse, but also participation, tolerance and sharing. It is clear that this action requires a very long time to lead to results that can produce energy-efficient returns. In this sense policies and systems of rules are to be implemented in order to adopt certain behaviors within the city and to pursue the recovery of social capital that represents a key condition for triggering the energy inversion.

2. Social capital and urban crisis

Most of the world energy crisis, which sees the urban and metropolitan systems of the planet as the most energy-consumer systems with the highest entropy, can be traced back to a dangerous social phenomenon of social individualism of population that inhibits the ability to catalyze new sustainable ethical behaviours in the socio-anthropic component. In urban systems, particularly in the socio Fig. 1. Social capital as a generator of positive factors for the urban system

anthropogenic component, the common bond between individuals that Lydia Hanifan reported as "social capital" seems to be missing [8].

Social capital represents the whole of personal relationships, the sense of belonging to organizations or

places, the solidarity among individuals, the good will, the personal commitment, participation, etc.,. essential to the operation of complex organizations such as the city (Fig. 1). In the city the citizen, sharing the social capital, shows a strong sense of belonging to place and site care by making that spontaneous control of public space which Jane Jacobs called "eyes on the road" [9]. The lack or loss of social capital leads to the urban "individualism" theorized in the agent-based model by Robert Putnam [10]. The aim of this work consists in suggesting a systemic approach to social capital theory in order to describe urban crisis. The presence of a significant social capital within the city is one of the factors leading to urban negentropy. It should be noted the strong link between social capital and human capital that in the modern economic interpretations has a meaning similar to the basic one. The crisis of social capital is divided into a series of phenomena that impact on the urban system, in other words the entropic interaction of components opposite of those structuring the capital city causes the crisis.

It is to this "condition" that many large metropolitan concentrations seem to be dangerously directed aslo in those places where the collectivization of urban life has always been a key element in the life of the city. In southern Italy this entropic “trend” is stressed by the conditions of structural decay characterizing the cities. It is a systemic crisis that seems to affect, with a ripple effect, the different sub-areas. The systemic logic then becomes the main tool for interpreting the city.

As highlighted in interesting studies of the early '90s: "the concept of system is an indispensable tool for the analysis of urban phenomenon since it has become clear that it was necessary to move from a purely physical or admministrative definition of the city to a functional and almost "closed" one, where it is possible to understand the agglomeration processes caused by the increased mobility of operators and interdependence of locations [11]. The general crisis is due to the production of entropy in one of the subsystems, which is transmitted, with a riple effect, to all the others and to the entire city.

For an endogenous malfunctioning in its parts or in its structure, a subsystem can be characterized as an "entropic generator " and triggers a chain of damage that can lead to the collapse of the entire urban system (Fig. 1). Therefore it is possible to connect the urban crisis with the entropy produced, in particular within the socio-anthropic subsystem. Together with the action on the socio-anthropic system new procedures are to be developed for planning sustainable cities that, in a cyclic process, find their foundations in the social capital.

3. The Ecotown planning a possible answer for a real sustainable city

The systemic approach, mentioned before, applied to the city moves from General Systems Theory, [12] and is one of the main references for *Ecotownplanning*. It is possible to find also a strong reference to the new vision of the city “as a complex, self-adapting system, or even a living ecosystem”, [13]. Here we aim at suggesting a systemic approach to the climate change problem in urban contexts, which entails the analysis of the different subsystems and the study of its components and relationships as regards global warming.

The present imbalance refers to a systemic problem and it is necessary to systematically work in order to recover the balance. The interventions should come from this approach in order to structure a sustainable urban planning. Consequently we could state that *Ecotownplanning* takes its approach from the systemic theory of the city and aims at recovering an endosystemic balance by stopping the production of entropy inside the different subsystems (physical, functional, socio-anthropic, and so on) and the production of negentropy, thanks to the acknowledgement of energy-related interactions between

the different subsystems, [14]. For instance, the availability of an efficient waste cycle allows the production of energy useful to the functional system and avoids the amassing of rubbish (which could cause a sanitary problem to the socio-anthropic system).

Among many system properties, we can detect one particularly interesting for our study: each system is included in a bigger system (meta-system) and, in turn, its parts are sub-systems. It is possible to affirm that among the different sub-systems forming the urban system we can detect three of them: a functional system, a physical system and a socio-anthropic system (Fig. 2).

This conceptual distinction does not find any confirmation in physical reality, where systems are indivisible, but abstraction is permitted due to the adoption of the systemic logic for building up the interpretative framework. The functional system consists of all urban activities (functions) and relationships (communications).

The physical system consists of all urban spaces (houses, streets, and squares) inside which activities occur and channels where communications (physical, energy, telecommunications, etc.) flow.

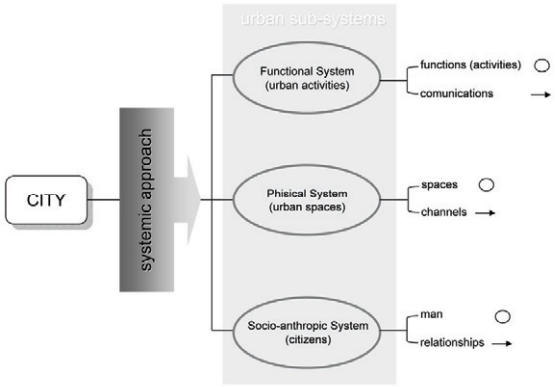

Fig. 2. The urban system and the three sub-systems detected in the systemic approach

The socio-anthropic system is composed of the urban community: the citizens (urban actors, stakeholders, decision makers and so on) and relationships among them.

The three sub-systems include the urban system and are linked by connections with each element of the functional system. [15]. Ecotownplanning is naturally rooted in: Gaia hypotheses, complexity theory – which represents the contemporary embodiment of general system theory [16] - urban ecology, in the theory of entropy and "antropocene", in bio-architecture, in the definition of sustainable city, in the assumption (being apparently revolutionary but expressed already in the 1970s and 1980's) that the city should be considered as a natural ecosystem [17] and as such should be rebalanced with earth ecosystems. Ecotownplanning, moving from a systemic approach, shows the real actions needed to be implemented in order to manage urban transformation, targeted to reduce anthropic entropy. The whole process, considering again the classic phases of urban transformation governance (knowledge, decision and action), could be articulated in the following phases:

Knowledge phase

- Systemic interpretation of the city;
- Reading, calculating and assessing urban entropy;

- Multilevel interpretation of the urban condition;
- Listening of the experiences and proposals of urban stakeholders, actors and citizens;

Decision phase

- Definition of reachable targets;
- Sharing the targets with the urban actors;
- Setting up policies for sustainable governance of urban transformations;
- Transformation of policies into urban plan actions;
- Communication and diffusion of urban plan choices;

Action phase

- Definition of regulations to implement urban plan actions;
- Applying management and support initiatives to implement urban plan actions;

As regards the first phase, some studies should be worked out in order to show the conditions of the city's different parts. By using Geographic Information System (GIS) it is possible to work out an information model of territory, structured according to levels that can be populated through geo-referenced data on city. The urban information model enables urban planners to obtain and show the different pieces of information about anthropic/entropy phenomena. So it will be possible to work out several knowledge bases (digital maps) regarding the presence and entity of the processes.

We can roughly expect the following information documents:

- Map of urbanized surfaces according to building material and typology;
- Map of the land use, showing the "intensity of use";
- Map of the intensity of vehicle flows on network;
- Energy Map (energy consumption of the activities in the territory);
- Map of urban heat islands;
- Map of urban micro-climate;
- Map of air quality;
- Map of green features;
- Map of urban solid waste production;
- Map of soil permeabilità;
- Map of urban sunlight reflection;

Starting from the collected information, its analysis and shared systematization of the targets, differentiating the "ethics" according to the different urban subsystems, the following actions can be anticipated:

Functional System

- Planning multifunctional urban zones;
- Reducing excessive intensity of use, also by adopting new technologies (ICT);
- Restoring the qualities of urban contexts by pointing out and recovering the original morphologies and use of urban colours;
- Safeguarding the remaining green spaces and planning new urban green space, including shaded areas;
- Paying particular attention to developing and dealing with urban vacant sites;
- Recovering vacant sites, by designing parks and gardens or by locating there new structures for energy production from alternative sources (solar plants, wind parks and so on);
- Supporting the processes of urban identity and sense of belonging;
- Safeguarding the memory of the place;

- Tending to the recovery the semantic values of the city;
- Arranging forms of sustainable urban mobility (discouraging private vehicle transfers and fostering public transport and mobility cycle);
- Implementing sustainable mobility through car sharing, car pooling, and so on;
- Organising interchange car parks outside the urban agglomeration and not locating multi-storey car parking in the centre or near it;
- Promoting the recycling and integrated management of waste;
- Using alternative sources for the energy needs of city (photovoltaic, solar, thermic, solar thermodynamic, wind, biomass, and so on);

Physical System

- In the new planning system, urban orientation should be considered according to the heliothermic axis and the predominant winds;
- Safeguarding the ecological network and green areas;
- Providing for protected and wooded pedestrian routes (green corridors);
- Providing for an interconnected network of urban green areas articulated into spaces and corridors;
- Providing for a urban cycle network;
- Promoting bio-architecture;
- Providing for rain water collection, recycle and phyto-purification;
- Aiming at high thermal insulation inside buildings;
- Supporting micro-generation and diffused generation of electric energy;
- Preferring the use of local materials;
- Using “green” roofs for buildings;
- Preferring the use of natural and/or recycled materials;
- Providing for the use of new wall paints capable to capture CO_2 and CO;
- Use of fountains and water vaporisers in order to calm down urban temperatures and heat islands;
- Use of gasification plants for urban solid waste treatment;
- Planning the carbon sequestration plant near carbon or industrial plants that cannot be replaced;
- Use of light materials and chromatisms to increase the sunlight reflection;
- Increasing public green areas (for air filtering from dust, abatement of temperature and CO2);

Law and Management Interventions

- Working out appropriate building regulations and implementing technical laws for mitigation of and adaptation to climate change;
- Providing for a system of municipal certification of building energy efficiency;
- Spreading the social culture of recycling and supporting separated waste collection;
- Fostering the birth of the *Energy Service Companies* (ESCO);
- Discouraging mobility congestion in the urban centre (using road pricing, congestion charges, and so on);

4. Conclusions

The urgent need for new procedures, actions and, maybe, methodologies to face up to urban climatic change is felt by every urban operator. In Italy many institutions and organizations are implementing networks and producing interesting studies. All over the world experts share ideas and tests in order to intervene in the city. It is necessary to radically change models of behavior and the use of resources and, probably, to redefine the model of economic development too.

A new town planning is required, which would reorganize its protocols through a systemic approach to the city, based on sustainability, organizing through participation and developing through actions of urban mitigation and adaptation. The first implementable action of mitigation concerns the models of individual behavior in relation to saving, recycle and reuse. Each person should be aware that there is a need for a new social ethic, starting from little, daily changes of behavior. It should be a duty of experts and operators to lead these changes, a crucial topic of new town planning practices. Sustainability should become a value diffused through the practices of participated town planning. It is essential to foster new bottom-up initiatives that can rightly enter the Ecotownplanning process.

Maybe it is not useful to search for sustainability in the present town planning laws. Instead of discussing and analyzing the possible connotations of sustainability and interaction in existent Italian town planning tools, whose matrix refers to 60 years ago when environmental and ecological theories were considered irritating assumptions of visionaries against urban development, it would be better to conceive a sort of town planning renaissance in our Country. Eco town planning should represent an offer of method, procedures and laws which propose new sustainable development of cities capable of driving urban transformation. This does not mean to choose the zero option, stopping any activity and change, but to join development with the policies of sustainability, compatibility, solidarity and inclusive modernisation. The principles of Gaia should be restored. The experts, regional scientists, town planners and operators managing urban and territorial transformations should operate in a new perspective. We should hurry to recover a global balance (even if non perfect) and assure a satisfying urban quality to future generations whose survival will depend on our present choices.

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