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GLOBAL SYSTEM DYNAMICS AND FUTURE**

We cannot solve our problems with the same thinking we used when we created them.
Albert Einstein

Abstract: The future of mankind is dependent how we undestand the world in all its complexity. The emergent behaviour of the world cannot be completely determined from the behaviour of its individual components at all the levels: individuals, communities, states and alliances. The world is full many man-made local and global networks which altogether greatly influence our everyday life. COVID-19 pandemic has crushed many networks and we have to analyse the reasons and envisage the ways out of the mess. Before this crisis, the future world activities were described by the UN SDG's, the possible risks analyzed by the WEF Risk Reports(World Economic Forum) and the future developments described by several scenarios starting from the CoR Report in 1972 on The limits of growth. From the COVID-19 crisis on the natural wish is to reinstate the previous state of all the networks and activities but this is really a short-run idea. The attitude business-as-usual is a dead end. One should think about the long-run activities which need new paradigms not only proposed but also accepted and implemented. In this essay some of the ideas about the future related to global systems dynamics are analyzed.

Key words: complexity, society, crisis, networks

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1. INTRODUCTION

In this paper first the main principles of global social systems are analysed, stressing the importance of values as limiting and guiding properties of social systems. Then the next question arises: why the systems may collapse? The theory of complex systems is able to describe singularities, catastrophes, domino effects, cascades, etc., but the crucial question is how to estimate the risks. The analysis by WEF has indicated several geopolitical and geo-economic uncertainties around the Globe but in its last Report [1] the infectious diseases were shown only as the last in the list of 10 on possible impacts. The 2020 crisis has opened the Pandora's box demonstrating how fragile the man-made networks are. The economic networks have been built up using the paradigms carved in stone tablets — growth is needed in all stages, profits are important, financial systems are balanced, etc. Unfortunately, even a role of thumb known as the Seneca effect, was forgotten: the growth is slow, but ruin is fast. This is actually wisdom from an ancient Roman philosopher [2]. How to manage in the future, is a real challenge for the mankind? It means changes from technology-driven society to socially oriented technology using wide opportunities of digital revolution. The encouraging side is that the knowledge about social systems, where values are taken into account, has been already elaborated although in the political life not followed. But, a consequence from the Seneca effect tells us that we have to adjust to changes using the best knowledge available. To build up a value system acceptable over all the world is a concern for all of us like it was once stressed by John Donne.

First, the present situation is briefly analyzed with a focus on existing knowledge about the behaviour of social systems (Section 2). Then in Section 3, the attention is turned to the proposed activities from academia based on present challenges. Whether is it enough for restoring the normal life of the World, is another question? It seems, however, that the crisis should be used for essential changes in the global systems which needs changing the paradigms governing the development of the World. Such ideas are envisaged in Section 4. Finally, some conclusions are formulated in Section 5.

2. THE PRESENT SITUATION

2.1 Society as a complex system

Mankind has created a strongly networked World where in addition to networked Nature the society and human actions are networked. The behaviour of ice in Antarctis, the influence of rain forests in Amazonas area on climate, the dependence of life on El Niño and La Niña in coastal areas of South America or on Golf Stream in Florida and North Europe is out of human control. But human activities influence the melting of ice, acid rains, deforestation of rain forests, etc and in this way human feedback has an influence on Nature. The man-made networks have even stronger influence on society. These networks concern economy, energy, transport, information flows, migration, etc. The economic networks have created a lot of pressure in the society and although already the French revolution called for "liberty, equality and fraternity", the situation in the World is far from it. Mankind faces many challengies: energy generation and distribution, poverty, natural and man-made disasters, water crisis, pollution, etc, just to mention some of them.

Such a networked World can be described by using the concepts of complex systems (see, for example, Mainzer [3]; Erdi [4]; Byrne [5]; Barabasi [6], etc) A short introduction to complex systems is given by Weiler and Engelbrecht [7]. Complex systems are characterized by many constituents (elements, parts, etc) which all are linked and the links are characterized by interactions. These interactions determine the behaviour of the system as a whole. As a result, new qualities may emerge in complex systems which cannot be deduced directly from the properties of constituents.

Human behaviours are strongly influenced by values. Inglehart and Welzel have constructed a cultural map of the world [8], where survival values and self-expression values are depicted against traditional values and secular-rational values. This map shows clearly the groupings of English speaking countries and Latin America, catholic Europe, protestant Europe and Confucian countries, ex-communist countries and Africa.

Actually society is a complex social system. It can be modelled by networks and clusters, communities and alliances and is spatially and temporarily differentiated. Society is able to function not only because its structures but the behaviour of its members (constituents is physical sense) and links (interactions in physical sense) between them play the most important role. Turning to complexity of physical systems, the

interactions between the constituents are described by physical laws and can be measured with certain accuracy. In complex social systems the situation is much more complicated because the links are based on accepted rules (laws), traditions, language, and governance, on economic and environmental conditions and certainly on values. This leads to an interesting question how to combine our knowledge on complexity with "soft" qualities like values. It has been suggested (Engelbrecht [9]) that if physical systems are governed by thermodynamics then social systems are governed by values. In this sense, values determine the connectivity of society. Clearly the cultural norms influence individual behaviour and in this way also the actions and decsisions of individuals.

2.2 Crises in society

Before looking ahead, one should be aware of several fundamental notions derived and used in the analysis of complex social systems: singularities, catastrophes, cascades.

The concept of singularity was introduced by J. von Neumann already in 1950. His definition of the singularity was that the singularity is the moment beyond which "technological progress will become incomprehensively rapid and complicated." Kurzweil [10] defined the Technological Singularity as: "... a future period during which the pace of technological change will be so rapid, its impact so deep, that human life will be irreversibly transformed.

In mathematics, the singularity means discontinuous change. Such problems are dealt by the so-called catastrophe theory derived by the French mathematician René Thom [11] and British mathematician Eric Christopher Zeeman [12]. A 'catastrophe' means that in a nonlinear system the equilibria can appear or disappear due to small changes in some leading parameter. Geometrically such catastrophes are classified, according to Thom, as fold, cusp, swallowtail, butterfly, etc depending on the shape of the potential function called control surface which describes the process. In physics, catastrophe theory can be used for describing the phase transitions and gravitational lensing (detecting of black holes). In physiology, the human behavioural patterns including nervous disorders can be described by using the concept of a control surface. The catastrophe theory has been used for describing the behaviour of stock markets: jumping from bull market (index rising) to bear market (index falling) which causes a crash. The geometry of control surfaces, however, shows

that beside jumps there exist also smooth paths from one equilibrium to another. Such processes need careful changes in control parameters or in other words, deep understanding of the processes. For example, it has been shown that the large-scale social processes, like war-peace, can also be described using the catastrophe theory. In this case when public opinion is divided between "hawks" and "doves", the negotiation may move the process of the war threat to peaceful solutions. The similar description could be used in the analysis of riots. It seems that the catastrophe theory can be used as a metaphor explaining how jumps (discontinuities) can be avoided by changing the control parameters in a different way.

Next, one should understand the consequtive effects in man-made or natural systems. The domino effect is a chain reaction — one event sets off a chain of similar effects like the toppling of dominos. This metaphor has been used widely, even for describing the political events like Dwight D. Eisenhower in 1954 described the spread of the influence of communism. Another important effect is related to propagating failures. Pescaroli and Alexander [13] have defined "cascading effects ... in disasters, in which the impact of a physical event or the development of an initial technological or human failure generates a sequence of events in human subsystems that result in physical, social or economic disruption. Thus, an initial impact can trigger other phenomena that lead to consequences with significant magnitudes. Cascading effects are complex and multidimensional and evolve constantly over time".

In order to avoid the failures of systems, one should understand the reasons why such effects will take place. Helbing [14] has argued that disasters should not be seen as 'bad luck' but "Systemic failures and extreme events are consequences of the highly interconnected systems and networked risks humans have created." According to his analysis, the drivers of systemic instabilities are: "increasing system sizes; reduced redundancies due to attempts to save resources; denser networks (increasing interdependencies between critical parts of the network); a high pace of innovation (producing uncertainties)". It means that actually the globalization and increasing network densities may push systems towards systemic instabilities or in other words "hyper-connected world leads to hyper-risks" [14]. One should note that the phenomena described above are typical to complex systems which possess emergent properties. Often, these properties are counter-intuitive and surprising.

It seems that in this context, the functioning of society and the role of values must be better understood than the common knowledge. One

should start from the understanding and trust in order to avoid the conflict of cultures. Umberto Eco [15] has indicated the possible scenarios when two cultures meet. He distinguishes the following possibilities: conquest (European civilization subjugated Amerindian cultures); cultural pillage (Greeks transformed Egypt into a Hellenistic kingdom but admiring Egyptian wisdom); exchange (reciprocal influence like contacts between Europe and China). All of them have certainly a variety of modifications. The question whether such meetings produce stress, especially in a short run, is another question. Putnam [16] has analysed the diversity in the community and based on the experience in the USA, shown that ethnic diversity tends in a short run to reduce social solidarity and social capital. The conflict of cultures may be a real threat to the connectivity of a tolerant society. Collier [17] stresses that due to national barriers there might be an optimal degree of diversity in the contemporary society.

3. THE RESEARCH FOR FUTURE AND RISKS

The forward-looks what should be researched and what kind of knowledge is needed for step-by-step development of the society are constantly derived by the scientific community. Most steps are planned to meet the challenges the World faces related to sustainabilty. In very general terms, the global sustainability needs also the changes in society. This was clear already three decades ago when several needed transitions in society were listed by Waldrop [18]: (i) a demographic transition to a roughly stable world population; (ii) a technological transition to a minimal environmental impact; (iii) an economic transition — to live off nature's 'income' rather than depleting its 'capital'; (iv) a social transition to a broader sharing of that 'income'; (v) an institutional transition to facilitate a global attack on global problems; (vi) an informational transition to allow large numbers of people to understand the challenges the society faces. These ideas form actually a backbone for future developments and changes in society discussed in many studies.

Concerning the main challenges of research, the UN's17 SDGs with their targets and indicators [19] are widely recognised as strategic goals for research and educational institutions. These goals are interdisciplinary and strongly interwined as is characteristic to a complex system. Still some important fields of prospective study need to be stressed like noted by ISC [20]; IAP [21, 22]; EC SAM Report [23]:

— Earth system megatrends (ecosystems, urbanisation, land degradation, water pollution, migration, etc);
— secure, clean (low carbon) and effective energy;
— emerging health-care technologies;
— digitalisation and big data analysis;
— security (including cybersecurity) and defence;
— climate-compatible and sustainable agricultural management for food security;
— value changes, environmental consciousness and cultural dimensions of climate change;
— smart, green and integrated transport;
— humanities for interpreting all the changes and their ethical dimensions;
— basic sciences (particle physics, genetics, space studies etc.) which form the foundation for future (yet unknown) applications and/or technologies.

The general roles of academies are recently described by Engelbrecht, Djurovic and Reuter [24].

Although stressed before, the 2020 COVID-19 crisis has clearly brought the attention to the need to develop the risk competence. The knowledge about risks developed by scientists exists but whether the decision-makers listen to calls to change the political attitudes is another matter. Mostly, the attitude to the crises has been taken as the phenomenon of the black swan (Taleb [25]) — an improbable event which will not take place.

The analysis of global risks is carried out by the WEF. The 15th WEF Global Risk Report is made public in 2020 [26]. Like in earlier reports, the top 10 risks by likelihood and impact over the next 10 years are listed. Comparing these lists for last five years (2016–2020) then by likelihood the extreme weather problems are mentioned four times as the first in the list, and by the impact the weapons of mass destruction are mentione three times as the first. The infection diseases are four times listed among the last of the list. It is quite natural that the attention is paid to biodiversity, cyberattacks, natural disasters, food crisis, state-on-state conflicts, etc. It is surprising that the infectious diseases have not been estimated as a real threat, although the WEF 2020 Report indicates that the health systems are weak and cannot meet the challenges of the well-being. One could ask whether a sentence in the Report (p 9) “When health systems fail to mitigate vulnerabilities and adapt to

changing contexts, they increase the likelihood of economic crises, political instability, social rupture and state-on-state conflict" has been taken seriously by policy-makers. There is an important character of the WEF Risk Reports. Namely, the Global Risks Interconnections Map is produced which depicts the interconnections between the impacts of events. The impact of infectious diseases is, for example, related to global governance problems and possible social instability. However, not all links re indicated. It is for example surprising that the infectious diseases are not related to the possible collapse of the infrastructures and unemployment, as we witness in 2020.

In the risk analysis the socio-economic data mining has gained more and more importance (Helbing and Balietti [27]). However, one cannot forget the ethical and legal issues related to data mining and threats to privacy.

4. LONG-RUN PERSPECTIVES

It is not only COVID-19 crisis in 2020. This crisis has actually opened the Pandora's box of global financial, economic and societal crises. One cannot say that the scientists have not thought about that. The predictions about the future of the World (Meadows et al.[28]; Randers [29], etc) warned the mankind that the resources for constant growth are limited. In many studies (Helbing [30]; Jacobs et al. [31]; von Weizsäcker and Wijkman [32], etc.) the need for changing the presently existing paradigms is stressed.

The main obstacle for changes in economy is in following assumptions (Helbing and Kirman [33]) which have a paradigmatic value: (i) an economy is an equilibrium system; (ii) selfish behaviour of individuals yields a result that is beneficial for society; (iii) individuals and companies decide rationally; (iv) the behaviour of all the agents together can be treated as that of an average; (v) financial markets are efficient, all the relevant information concerning an asset is reflected in the price of that asset; (vi) the financial markets function better if their liquidity is greater; (vii) the more connected is the networks of individuals and institutions, the more it reduces the risks and the more stable is the system. The analysis of economy as a complex system leads to the conclusions that these assumptions are erroneous (Helbing [30]) and cannot work in the long run (see Section 3 on ideas of needed transitions). That is why fundamentally new kind of economics is needed for "networked minds" as

Helbing [30] states. This leads to the need that global networks must be redesigned by using the knowledge from complex systems and digital revolution. The leading principle in all these actions is the transfer from technology-driven society to socially oriented technology. In order to manage socially-driven technology, Helbing [30] proposed to create a Planetary Nervous System (PNS) as Citizens Web which is an open, public, intelligent software layer for creating public good.

Looking ahead does not mean that one should not deal with challenges for society and research (see Section 3 above). The present crisis 2020 gives however an excellent possibility not to return to business-as-usual but to change a lot. As described above, one should understand that the profit making economy directed to the continuous growth is not sustainable in the long run (Weiszäcker and Wijkman [32]). The actions to encourage social innovation and improve general well-being should be the avenues for moving ahead. According to the complex systems theory the top-down governance is not effective for large networks and in many cases the bottom-up initiatives should be supported.

WAAS has issued a Statement [34] on Planetary Momentum. The following is stressed: "The community and its leaders should find the ways to change the situation from disunity to global solidarity again based on complementary top-down and bottom-up initiatives. Academia should analyze the risks and formulate paths to innovation and cooperation together with personal responsibility. Attention should be paid to decision theory, rational choice and values in framing solutions taking into account the complex relations, interactions and reciprocal immediate and long-term influences involved. It also means that transdisciplinary thinking is needed. All sectors should seize the opportunities to alter established practices which have failed and have no future. Lessons concerning the weaknesses of social systems must be studied in depth and analyzed to understand why and how conventional thinking has led to global crises, the vulnerabilities generated by globalisation and networking, and the ideas needed to foster effective social innovation. It calls for changes from technology-driven society to human and human-oriented technology utilizing opportunities generated by the digital revolution as illustrated by web-based distance learning which is already permeating our education system and work places."

The leading academics have listed many challenges and unanswered questions for extending the boundaries of knowledge (Helbing[30]; Djurovic [35]; Christophorou [36]; Šlaus [37]).

5. FINAL REMARKS

One is clear — we must change the way we manage our techno-socio-economic systems, as strongly stated by Helbing [30]. Whether we shall be able to change the existing paradigms or follow the business-as-usual or choose a step-by-step evolutionary way, is a crucial question. Voros [38] has stated that future outcomes can be influenced by our choices in the present. In order to take decisions is not an easy job and needs deep understandings about the complexity of society. The present 2020 crisis gives a possibility to refresh the networks of the global society avoiding mistakes made in the past. Whether the changes follow pragmatic ideas of evolution or the revolutionary steps based on changes of paradigms will be taken depends not only on policy-makers but on all the society. One should always remember what John Donne said in 1624:

"No man is an island entire of itself; every man is a piece of the continent, a part of the main; if a clod be washed away by the sea, Europe is the less, as well as if a promontory were, as well as any manner of thy friends or of thine own were; any man's death diminishes me, because I am involved in mankind. And therefore never send to know for whom the bell tolls; it tolls for thee."

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