ЦРНОГОРСКА АКАДЕМИЈА НАУКА И УМЈЕТНОСТИ
ГЛАСНИК ОДЈЕЉЕЊА ПРИРОДНИХ НАУКА, 26, 2023.

ЧЕРНОГОРСКАЯ АКАДЕМИЯ НАУК И ИСКУССТВ
ГЛАСНИК ОТДЕЛЕНИЯ ЕСТЕСТВЕННЫХ НАУК, 26, 2023

THE MONTENEGRIN ACADEMY OF SCIENCES AND ARTS
PROCEEDINGS OF THE SECTION OF NATURAL SCIENCES, 26, 2023

UDK 502/504(100)

Momir Djurović[*]
Jüri Engelbrecht[**]

IS THE FUTURE KNOWN?

Abstract

The present state of the World and possible developments are analyzed. The complexity of the processes in society and technology requires a change from the current global practices.

Keywords: Future development, Earth resources, Environmental challenges

INTRODUCTION

Starting 2.5 million years ago, the Earth underwent a series of glacial and interglacial periods. Since about 11,500 years back we have been living in the Holocene epoch [1]. In the past 500 years the biosphere has been changing significantly. In that period the human population has increased 15 times, from around 500 million to around 8 billion today, with a growth tendency towards over 9 billion by 2050. At the same time the populations of mammals, fish, birds, reptiles and amphibians have experienced an average loss of 68% [2]. Furthermore, the first twenty years of this century have been a time of astonishing advances in communications and information technologies, including the social media, the internet, digitalization, smart phones, and much more. In addition, due to various scientific and technical advances the humans are expected to extend their average lifetime to longer than has ever been known in the past. At the same time, mostly due to human activities, the plant and animal species are allowed less space to live, resulting in loss of many of them. The sea level rise, floods and rise of temperature are becoming more common. The past 50 years have

[*] Momir Djurović, Montenegrin Academy of Sciences and Arts
[**] Jüri Engelbrecht, Estonian Academy of Sciences

been characterized by intensive urbanization, resulting in humanity consuming more of the Earth's resources than it can naturally make up.

These changes will bring about many societal and environmental challenges. Certainly, not all of them have been caused by humans, but humans have worsened some such as the climate change [3]. The great dangers facing the human population in the coming centuries might arise largely due to incorrect use of technological or scientific advances [4].

STATE OF CONTEMPORARY EARTH — PHENOMENA, EFFECTS, AND NUMBERS

The Earth is changing due to natural cycles such as changes of the angle of its tilt and its orbit in relation to the Sun, and due to the change of its life forms. The human species are disrupting ecosystems by building cities, cutting down forests and eliminating wildlife habitats, and by influencing the movement of invasive species around the Planet. Furthermore, by burning fossil fuels increasingly more greenhouse gases are generated, which contributes to global warming resulting in the Earth's temperature being higher than it would be otherwise.

The most obvious effects of the above which can be observed today and which the contemporary world is experiencing come in the form of: Overpopulation and Health Issues, Climate Change, Water Shortage and Soil Degradation, Loss of Biodiversity, Overhunting and Resource Depletion, Excess Waste, Loss of Polar Ice, Acid Rains, Depletion of Ozone Layer, Wars and Terrorism, Unemployment and Severe Income Disparity, Poverty and Refugee crises, Urbanization, Child Labor, the Nitrogen Cycle, Genetic Engineering, Drug abuse, and others.

Essentially, humans have created an ecological Ponzi scheme [6]. Consumption, as a percentage of Earth's capacity to regenerate itself, has grown from 73% in 1960 to more than 170% today. Increased emissions of greenhouse gases have caused temperatures to rise. As a result, the global warming has exceeded 1°C and will exceed 1.5 °C between 2030 and 2052. In particular, this is warming of the Arctic more than twice as fast as anywhere else on the Planet. Sea levels are rising in an average of 3.2 mm per year, and their rise is predicted to reach 0.2m to 2m by 2100. Even if the Paris Agreement [7] is fully ratified, the process of global warming may produce an increase of between 2.6°C and 3.1°C by 2100. At present the global temperature rise is the main cause of air pollution that impacts amongst other things even the spread of COVID-19 and other diseases. One of the biggest environmental problems is the gradual melting of the Greenland ice sheet which has lost a record amount of ice in 2019 [8]. The rising sea level has already, gradually,

started to affect some of world's cities.The ocean acidification and warming effects can be seen amongst other things in coral bleaching and subsequent coral reef loss. Thus, the rise of the sea temperature is resulting in water and food insecurity [9].

The global policy has not been sufficient to fully address these existential threats. In fact, in many countries the anti-environment [10] agendas are on the rise.

Beyond many consequences these effects resulted in:

- Humans have altered almost two-thirds of Earth's land surface. It means that 85% of the global wetland area have been lost in the last 300 years;
- Animal species and insects are disappearing rapidly. It has been estimated that over the past 500 year about 1.300 species were extinct. The number of large predatory fish is 30% lower than only a century ago;
- Many plant species globally areunder the threat of extinction;
- More than 65% of our oceans are endangered to some extent;
- Not every aspect of biology is fully understood yet.

This list can be extended since many more processes are influencing the life on our Planet. The most current include the influence of the use of social media on the ways we communicate. This has been complicated and often out of control resulting in rise of nationalist sentiments worldwide which could challenge the global stability and influence the geopolitical balance.

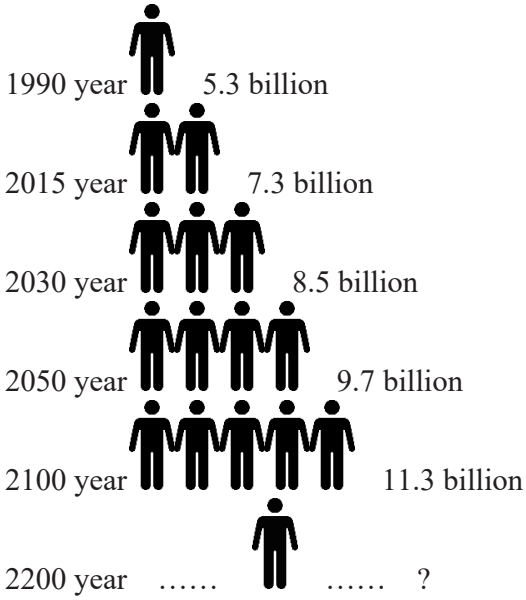

Fig. 1 World population (UN Dept. of Economics 2015) from 1990 to 2100.

Some examples listed below demonstrate the consequences of contemporary global and local policies.

The new technologies and devices mostly require rare earth metals putting pressure on the Earth's natural resources. In China, where 90% of the world's rare earth metals are found, it is estimated that the mines will be depleted in the next two decades.

It has been shown that the global food system [11] is the cause of one third of all human-generated greenhouse gas emissions: 30% of them come from crop production, livestock, and fisheries. In addition, 60% of the world's agricultural area is used for cattle breeding, while making only 24% of global meat consumption. Agriculture also consumes a vast amount of freshwater being the leading cause of deforestation. These processes are badly affected by the top-soil erosion.

Water pollution strongly influences our ecosystems, including human health It can cause contamination of drinking water contributing to waterborne illnesses. Toxic elements dissolved in water can make their way to humans through different forms of food. Water pollution also may impact the growth of plants or other food crops.

Environmental threats which include climate change, flooding, tropical cyclones, heat waves, epidemics, urban sprawl, toxic superfund sites, oceanic dead zones, loss of biodiversity, overpopulation and many more, are changing the Earth [12]. Adapting to environmental threats requires undertaking long-term changes in the ways we use the environment and interact with it what is indirect response to reducing human vulnerability. It is, often, done little to reduce the sources of the threats. A variety of control procedures can help mitigate the damage caused by these environmental threats, while they will also help mitigate the damage caused by natural disasters. These problems have to be solved if the World is to remain a friendly habitat for humans and other species.

Around 1.3 billion tons of food is wasted or lost every year [13]. Moreover, 40% of food waste happens at the post-harvest and processing levels, while 40% of food waste occurs at the retail and consumer levels. The wasted food is responsible for 4.4 GT of greenhouse gas emissions annually.

Air pollution has been the cause of death of 4.2 to 7 million people worldwide (WHO) annually. It mostly comes from industrial sources, motor vehicles emissions, burning biomass and due to dust storms.

Among the biggest environmental problems are deforestation and plastic waste. Forests the size of 20 football fields are cut down globally at every minute [14]. If the existing rate of deforestation isn't stopped our forests might be destroyed in less than 100 years [15]. The plastic waste has grown from 2.3 million tons in 1950 to 448 million tons by 2015. Every year, about 8 million tons of

plastic waste escape into the oceans from coastal nations and 91% of it is not recycled. Production of all plastic is expected to double by 2050.

Humans have entered the field of genetic modification of DNA with the purpose of curing many diseases what has already introduced many challenging debates among scientists [16]. DNA debate topics include: genetic screening of embryos, unwanted human embryonic stem cells used for scientific research, the cloning of humans should be explored further, use of genetically modified organisms in addressing the agricultural needs, patents for human gene editing and results of genetic testing done on individuals should be available, gene therapy should be cost effective, significant compensation for those whose cells and tissues become profitable medically, and organizing a national DNA database.

Currently, the number of international migrants worldwide [17], i.e. people residing in a country other than their country of birth, is about 3.6% of the world's population. The number of international migrants has increased over the past four-and-a-half decades: it reached 281 million in 2020 compared to 221 million in 2010. In 2020, refugees accounted for 12% of all international migrants. Nearly half of all international migrants worldwide were women or girls. COVID-19, the pandemic, has resulted not only in widespread loss of lifes, but in the closing of national borders thus slowing the growth in international migration while holding back economic development in some of the poorest parts of the world. At the same time it is amplifying wealth inequalities across the globe. Europe and United States of America have been the main countries of destination for international migrants since 1970.

Development of technology is strongly effecting human life. External memory aids are used every day. For example, most of human population, and particularly in the developed world, have already used their smartphones as an 'externalized' memory. The externalization of memory calls into question humankind's transience. A large part of these aids come from technology (digital voice recorders, computers, programmable watches, PDAs (personal digital assistants), cell phones, smartphones, Facebook,…). It has not been demonstrated any connection between technology usage and impaired memory.

Not to ignore that one of the biggest contemporary problems is poor governance. Bad governance is characterized with lack of transparency and accountability, inability of a public institution to manage public affairs and public resources, corruption, abuse of human rights, crime, no freedom of expression, etc. in public organizations. Failure of a government to meet the needs of society are being increasingly regarded as one of the root causes of poor governance. Thus, the bad governance, as a result of multiple market failures, is often the cause of the climate crisis [18].

THE FUTURE CHALLENGES — A VIEW AHEAD

The Earth in 500 years may be something different than it is today [19]. In coming centuries an increasingly globalized humanity is going to be hit, the most hardly, with climate change, energy depletion and dwindling resources, overpopulation, and technological uncertainties. In the 22nd century, the eco-technic societies will dominate the globe, and humans will be colonizing the space, while accelerating diverging paths for humans and "transhumans".

It has been shown [20] that technological change is exponential. So we might expect to have in the 21st century changes equivalent to 20,000 years of progress at today's rate. Technological changes are going to be so rapid and profound that we might expect that, only in a few decades, machine intelligence might surpass that of humans. This will result in merging of "biological and non biological intelligence, immortal software-based humans, and ultra-high levels of intelligence..." [20].

In the case that the humans can change their current damaging behavior, the Planet may keep on with humankind, its forests, oceans, fields and cities for many more centuries. But, what will happen if the humans continue overusing everything surrounding them, even practicing a "dark ethical turn" such as producing babies with a different characteristics than they have today?

The global warming [21] is going to be the most serious risk to the Planet, although it is hard to predict what is going to happen exactly. It might happen that in the next few centuries, the sea level rise will be 5 m or more followed by intense heat waves, increased incidences of infectious and respiratory diseases, changes in ecosystems as well as loss of biodiversity.

The urban areas will be designed such to contain everything needed to support human survival. Large scale archologies [22] will be an alternative to traditional cities. The future cities will increase in size with technology increasingly used in their development and running. Governing these cities will become more complex. They will be equipped by many technologies, e.g. to cool buildings more efficiently, sensors which will help the older people to communicate with community in all issues, with vehicles which will be less pollutant and many more. They might be built underwater and underground. On top, many of them might be organized as artificial islands being self-sufficient with food and water desalination done locally able to cruise around the World. The offshore settlements, supplied by power produced from a combination of OTEC plants, offshore wind farms, tidal and wave plants, solar arrays, some even utilizing fusion will act as filters for trash and chemicals from the ocean. They, being entirely carbon neutral, will serve as CO2 capture.

The life in such cities will not be determined by national boundaries. These ocean settlements will be some of the earliest "post-growth economy" [23]. Homes of the future will be 3D-printed [24] using materials like carbon nanotubes with swarms of drones. Superhigh skyscrapers, combining vertical farming with residential and commercial space with all necessary resources such as energy and water, will be common. Each of these self-contained structures will operate with little or no impact on the environment.

The advances in the science of genomics [25] could lead to radical new possibilities. Fully tailoring or enhancing organisms (including humans) by precisely manipulating genes will be possible. By the end of the 21st century human intelligence will be largely amplified by AI. Mind uploading enters to mainstream society. Some simulation of a human mind might became available even at the beginning of the 22nd century. More advances will occur in the latter decades of the 22nd century. It might happen that human's biological brains can be literally discarded in favor of artificial ones. The advances in genetic engineering might enable humans to adapt to the gravity of the Moon and Mars being space colonies of humans. This will give humans greater power over biology such to help meet needs for food, fuel, and medicine. Gene editing techniques can improve the nutritional value of crops while minimizing losses by creating plants with resilient characteristics, like disease resistance. There will be a need to maximize efficiency of agriculture processes. For example, the annual meat demand could be achieved by "cultured" meat [26]. The new food production processes will include gene-editing techniques like CRISPR-Cas9 [27] which will involve editing an organism's own genes by practicing "switch off" or replacement of undesired genes, rather than introducing genes from other organisms what might require modification of a safety assessments.

The future of energy is determined by the need for a green energy to allow us to avoid climate catastrophe. It can be summed up in: clean, sustainable and renewable energy, which includes decentralization, decarburization, and digitalization megatrends [28]. There is even an increase in requests to design entire communities that have their own localized renewable energy and storage systems. There would not be a single source of energy. The energy of the future will be generated by: wind, solar, geothermal, hydro-, and nuclear power. The question is how soon these sources can reach dominance. If we want to avoid the global warming, this rise of alternative power production should happen soon. The sunlight is by a long shot the most present power source on the planet Earth. The sunlight energy that falls on the Earth in an hour is sufficient to power all human needs for a year. Wind power will be nearly as important in coming years. The fusion power plants aim to fuse the hydrogen isotopes deuterium and tritium and release large amounts of energy in this process [29]. The nuclear power

industry has been working on safer technology solutions since the Fukushima accident. Concepts include nuclear reactors dozens or even hundreds of times smaller than they are today, being more distributed. In the decades ahead, geothermal energy is expected to boom as scientists succeed commercially to tap into the energy deep beneath the Earth's crust. Space-based energy technologies, the things like using hydrogen from the Moon to power fuel cells on Earth, or orbiting solar panels that absorb day and night direct sunlight and beam the energy to stations on the Earth via radio- or microwaves, are still science fiction for now.

Energy systems of the future will be different from what they are today. Hydrogen which makes up 75% of all matter in the known universe, can become the medium of choice for transporting energy across the globe. The idea of converting sunlight, water and carbon dioxide into usable chemical energy that can be stored for extended periods of time has long been a most difficult target for scientists.

Thus, the future of energy will be mostly concerned by solar fuels, space technologies, geothermal power, offshore wind, nuclear fusion, nextgen nuclear power, and carbon capture and sequestration.

Computer power and information technology will grow exponentially through the 21st and 22nd centuries [30]. AI and computer simulations will help in more accurate earthquake forecasting. Using geophysics, the faults in Earth's crust will be mapped. To reduce sudden, large scale shocks lubrication wells will be available.

The interaction of humans and machines will be very common, to the effect that we even "won't be able to keep up unless we enhance our own intelligence by merging with the intelligent machines we are creating" [31]. This will result in AI occupying almost every level of life such as government, business, the military, manufacturing, service sectors and, even, "private" life. The knowledge and skills could be possible to download and store directly within the brain. These interaction will transform the World significantly. Use of drugs to boost brainpower will become even more common.

In the 22nd century many medical functions will be automated and provided at home level. Home capsules capable of multispectral scanning will be available as tools for disease or body damage observation. "Medicine on distance" will be common.

There will be a rise of new propulsion technology what will result in a "nomadic and rootless" culture [32]. A private "sub-orbital spaceflight" will wipe out the borders between nations. Humans moving from the Earth might become multiplanetary species. The space travel willbecome low cost being relatively routine what might introduce many new challenges, the most important being its

security. Transforming of Mars will be underway, while large settlements might be constructed on Moon.

By the early 22nd century the room-temperature superconductors [33] will be in common use in many applications that might transform much of the world's infrastructure and road networks. The result will be among others: lossless energy transfer, better containment of fusion energy, improved imaging for medical scans, and a variety of new magnetic cushion hovering or flying vehicles. A new revolution in materials is taking shape [34]. Technology of the scale of six orders of magnitude smaller than nanotechnology (10^{-15} meter), the finest known structures of matter, will be in use. This means working with quarks and strings to manipulate the properties of atoms, what might include smart materials (self-healing or self-cleaning materials), memory metals (revert to their original shapes), piezoelectric ceramics and crystals (transferring pressure into energy), and nanomaterials. Nanoscale objects and machines can be created including direct manipulation of molecule-sized nanoparticles. Nanomaterials could have applications across medicine, electronics, composites, energy what will raise questions of many regulatory issues.

Even in 40ies of this century, the 3D printing could become a common approach for manufacturing highly complex, low-volume, highly customizable parts [35]. The 3D printing will result in "the next industrial revolution". It will be used to create different food products, too.

Many more changes are going to happen in the coming time such as: our solar system will be affected by a million degree gas cloud [36], the smallest change in the pH scale can have a significant impact on the acidity of the oceans, the plastic crisis will grow to 29 million metric tons per year even by 2040, force fields[37] will be in military use, autonomous vehicles will reduce deaths from motor vehicle crashes as well as CO2 emissions, improved energy storage systems will play an important role in providing enough energy on demand, and some more.

HOW TO FACE CHALLENGES?

In the above text the attention was paid to biophysical limits of the Earth and possible technological ideas for the future. However, one should not forget the ethic social limits [38]. In the beginning of the 21st century, many think-tanks indicated that the most important challenge for the mankind to survive is the question how the mankind will face the challenges described above. That means the importance of social systems in developing new technologies and understandings of the biophysical limits, which should make the society sustainable. There are several key problems:

- better knowledge about societies as complex systems where networking and links (connections between the individuals, groups, states, etc.) dictate the outcome must be achieved [39];
- changing the old paradigms which hinter the progress [39];
- using all the possibilities to develop interdisciplinary research for modelling and forecasting the future;
- one cannot solve the challenges described above without paying attention to values [40].

Scientists have, already, warned society about the shortcomings of policy in managing economy and environmental issues. This was clear, even, three decades ago when several needed transitions in society were listed [41]: a demographic transition to a roughly stable world population; a technological transition to a minimal environmental impact; an economic transition — to live off nature's 'income' rather than depleting its 'capital'; a social transition to a broader sharing of that 'income'; an institutional transition to facilitate a global attack on global problems; an informational transition to allow large numbers of people to understand the challenges the society faces. Furthermore, some have warned [42] of the obstacles in the present economy that hinder the progress pointing that: an economy is an equilibrium system; selfish behavior of individuals yields to a result that is beneficial for society; individuals and companies decide rationally; the behavior of all the agents together can be treated as that of an average; financial markets are efficient, all the relevant information concerning an asset is reflected in the price of that asset; the financial markets function better if their liquidity is greater; the more connected in the networks of individuals and institutions, the more it reduces the risks and the more stable is the system. These warnings are erroneous and cannot work in the long run. That is why, fundamentally, a new kind of economics is needed meaning that global networks must be redesigned by using the knowledge from complex systems and digital revolution. The leading principle in all these actions would be the transfer from technology-driven society to socially oriented technology.

In brief, the future developments should include human-centered economy, the new paradigm for global human development, interdisciplinary social science, global higher education, etc. It is clear that in all discussions about the future cannot have only the material values, but also soft values need to be taken into account. However, the future is not predetermined, it is not predictable, while its outcomes can be influenced by our choices in the present. [43]. 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 and environment.

CONCLUSIONS

The effects of life on the planet Earth are hard to predict [44]. Disrupting one part of an ecosystem might and will influence many others. To annihilate the unpredictable future, it is evident many changes are needed, namely:

- Forgetting the policy of the perpetual economic growth;
- Accounting the true cost if restoration of the environment (carbon pricing);
- Eliminating fossil fuels;
- Regulating markets (controlling monopolization and limiting corporate influence);
- Reining in corporate lobbying of political representatives;
- Educating and empower women;
- Nationalism being out of policy.

The World of the 22nd century will be different from the World of today. Technological change, global warming, policy making and rising inequality will increase the complexity of many issues. To survive future challenges and demands, the humans need to get better in understanding the emerging issues by addressing them with adequate policies and interventions while acting quickly to maximize success. Currently, the human induced climate change is the biggest challenge facing the Earth. A warming Planet can result in result in heat waves, storms and droughts that can change the land having all of Earth's living forms at risk. Certainly, many human activities would affect many species. The Earth will, as it happened in the past, revive and restore itself. But, at the end, it is the Sun which will run out of hydrogen, the fuel that sustains it, that will ultimately destroy the Earth turning the Solar System to darkness forever.

The most compelling 21st-century technologies, robotics, genetic engineering, and nanotechnology will have a different effects and threats than the technologies that have come before, such culture and democracy find themselves in crisis.

Beyond many natural processes and features technology is going to affect our lives in the future the most. Technology has the power to make the world prosperous, while at the same time it can result in many uncertainties. No doubt, the technology should be the power of civilization and culture while serving democracy by opening up an opportunity to redesign the World. It is true that many technologies, when used by individuals, can act beyond democracy and progress, too. Science and democracy tend to undermine each other. The relation of technology and democracy is becoming complicated, effecting the most rationalization of individual freedom, what might be so complicated that decisions should be reached by help of machines. Thus, due to technologies the elite will have greater control over the masses.

Science and democracy tend to undermine each other. They involve a wide range of activities, like science advice, science policy, sociotechnical controversies, lay-expert relations, constitution of democratic citizens, climate change, genetic engineering, or even make nanotechnology very everyday's issues.

The human population is going to reach 10 billion by 2050. The capacity of the Earth is still not known exactly. Is it 12 or 20 billion humans is less important than the knowledge that the Earth has its capacities and limits. Are humans capable to find "another" home in such short time?

The problems of the future will be far more extraordinary than experts currently believe. Some situations can turn out even worse than the scientists can predicted them now.

Are we approaching a status in which the humans gained a "near" immortality by becoming one with the robotic technology?

The future depends on our choices in the present.

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