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ENVIRONMENTAL ENGINEERING VERSUS CLIMATE CHANGE AND PROTECTION OF THE ENVIRONMENT

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Abstract

The observed climate changes pose a serious threat not only to humans and the environment, but also to the further development of life on our planet. Stronger and more frequent climatic anomalies connected with unprecedented hurricanes, and droughts as well as catastrophic floods, on the other hand, are a real threat both to humans and the environment. Unfortunately, during Covid-19 pandemic the situation is getting worse, since all countries are facing serious biological and economic crisis and climate issues become less important. However, environmental engineering is a science counteracting these negative phenomena. First, it provides the technologies that reduce the GHG (greenhouse gas emissions), especially in the traditional energy sector. Secondly, it enables the development of RES (renewable energy sources). Thirdly, it helps to shape the landscape in environmentally friendly way and it provides the technologies that reduce the negative consequences of environmental disasters. Thus, environmental engineering gives hope that the climate crisis will be overcome.

***Keywords**: Environmental engineering; Climate crisis; Carbon dioxide; Renewable sources of energy; Protection of the environment; Covid-19*

Introduction

Technology is "the study and knowledge of the practical, especially industrial, use of scientific discoveries" [1] and "the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society and the environment" [2]. It modifies surrounding environment.

Technology is changing. The 19th century gave as many inventions as all earlier generations together. During the 20th century the technology has become so powerful, that even the destruction of the whole biosphere is possible [3]. But also on the level of technology and science basic strategies for protection of the environment are being now implemented.

The exploitation of the nature leads to many negative environmental impacts of different scale: from local pollution like smog, to global threats, like climate change.

Environmental destruction has led to the emergence of environmental sciences, covering different fields from philosophy to technology. Among technical sciences we must distinguish green chemistry, green engineering, sustainable chemistry [4-6] and – above all – environmental engineering.

Environmental engineering belongs to the technical studies and is connected with using of engineering methods:

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- "For preserving, rationally shaping and using the external natural environment, e.g. water resources, waste management, air protection, soil protection.

- For preserving and shaping the internal environment of buildings and structures, devices and installations" [3].

Environmental engineering is creating technologies that help to sustain the homeostasis of the environment, help in coping with natural disasters (like hurricanes or floods) and are reducing the negative consequences of industry, especially in the context of pollution of the environment: both external and internal.

Internal environment is especially important, since people spend most of their time indoors and the quality of air in buildings may be much worse that outdoors. We may even talk about the sick-building syndrome (so-called SBS). It relates to the buildings, where the inhabitants experience health and comfort problems, which seem to be connected with staying in these buildings, but it is difficult to identify specific cause or illness [7, 8].

The greatest global environmental problem is, however, the climate change. Environmental engineering plays a very important role here.

Climate Change

The climate change is connected with the greenhouse effect, which relates to the growing emissions of the GHGs (so-called greenhouse gases) to the atmosphere [9]. Solar radiation passes through GHGs and heats up the Earth. Most of this heat will be, as a back-radiation, reflected by the GHGs to the Earth. The mechanism is quite similar to the situation in the greenhouses, usually made out of glass panels [3].

The greenhouse effect was and is a natural phenomena. It keeps the temperature on the surface of Earth around 15°C. If there were no GHGs in the atmosphere, the temperature on our planet would be around -18°C [10]. Such conditions are unhabitable to life as we know.

The greenhouse gases list includes [11, 12]:

- CO_2 (50% of the warming potential of all GHGs),
- CH_4 (18%),
- CFCs (14%),
- O_3 (12%),
- NO_x (6%).

Water vapor is also a GHG, but it is not emitted by humans, its concentration in the atmosphere changes along with the changes in the global temperature [11].

Among the greenhouse gases, it is important to underline chlorofluorocarbons (CFCs) – the only gases in this group which were invented by humans (so there are no natural emissions). What is more, besides the threat to our climate, they are also responsible for the ozone hole.

The biggest warming potential, as much as half of the greenhouse effect, is connected with CO_2 emissions. In 2017 global emissions of this gas were at the level of 37,077,404Mt and almost doubled from the year 1990 [11]. Countries with the highest emissions are China (10,877.218Mt, 29% of the world emissions), the USA (5,107.393Mt, 14%) and the European Union (3,548.345Mt, 10%). Fortunately, the emissions from the USA and the EU are falling down. In China they are still growing, which is connected with growing industrial production.

It is also worth mentioning that: in 2013 a GHG was discovered, called perfluorotributylamine (PFTBA). The warming potential of this gas is estimated to be as much as 7100 times higher than in case of carbon dioxide [12]. This gas was created by humans and is in use in the electronic equipment. So far no counteraction was taken to limit PFTBA emissions.

It is possible that many other dangerous gases were invented, however this has not yet been detected.

Too big anthropogenic emissions of greenhouse gases magnify the warming effect and by this are making this phenomena dangerous. Climate anomalies are more frequent and more violent. Polar caps are melting – it creates floods dangerous to many coastal areas and islands. It is worth mentioning Kiribati – a country with 100 000 inhabitants living on the Pacific islands [13]. The rising level of the ocean was the reason why two islands disappeared under the water in 1999. All the others will share their fate before the end of this century. Even now, where the islands still exist, the salty sea water penetrates the islands again and again, polluting freshwater, destroying agricultural crops and damaging buildings. The people of Kiribati are producing only 0.6% of the GHGs emissions, but must deal with consequences of global emissions. One of the ideas of how to fight the problem was building a huge floating platform on the sea, but the cost around 2 billion $ was much higher than this country could afford. Finally, they bought land on Fiji to grow safe crops and to have a place for evacuation when the situation will deteriorate. Additionally, each year 75 Kiribatians receive the permission to emigrate to New Zealand [13]. Much larger human migrations in different parts of the world, caused by the global warming, may be the reality in the near future.

The challenge is also connected with establishing the real contribution of anthropogenic emissions in the overall GHGs emissions [14]. In fact, the problem is not just about the percentage share of the emissions from the natural and anthropogenic sources. It is true that significant amounts of CO_2 infiltrate into the atmosphere from the natural sources, but they occur in the result of the geological and biological processes, taking also into account the changes in the solar activity. Such processes stabilized along with the biosphere formation and were responsible for a quite stable concentration of CO_2 until the mid-20th century. So, a balance has been created between what nature can emit and what it can absorb. By adding significant new emissions of CO_2, man destroys this balance, since these additional emissions accumulate in the atmosphere. This amounts to about 35 billion tons of CO_2 emitted every year from anthropogenic sources (data for the year 2016) [15].

In order to deal with these problems, it is important to take a wider approach. In case of anthropogenic emissions of greenhouse gases, we should think not only about direct, but also indirect consequences. As an example, it may be presumed that carbon dioxide content in the atmosphere will be twice as large as today – see Table 1.

Table 1. The consequences of doubling the CO_2 concentration in the atmosphere [16].

	Cause	Temperature changes
Doubling of the CO_2 content in the atmosphere		+1.20°C
Indirect consequences of the doubling of the CO_2 content in the atmosphere	Change in the water vapor content	+1.85°C
	Change in the distribution of water vapor	+0.90°C
	Change in the vertical troposphere temperature profile	-1.10°C
	Albedo change in the Earth's surface	+0.38°C
	Cloud height change	+0.51°C
	Change in the cloudiness level	+0.43°C
Total:		+4.16°C

The direct consequence is rise in temperature by an average of 1.20°C; however, the indirect consequences add another 3°C more, which makes all together +4.16°C. As Intergovernmental Panel on Climate Change suggests, an increase of just 2°C of global temperature may destroy the natural climate stabilizing mechanisms. This means global climate catastrophe [17, 18].

There are also many other important factors that influence the climate. The most important one is deforestation, especially in the context of rainforests. During the whole 20th century, 50% of such forests were destroyed [19], about 12 million hectares are cleared every year [20]. In Amazonia, 80% of grubbed-up forests are used for cattle farming, and 20% is mainly used for soybean farming. It is connected with the phenomenon that 1/5 of the present world population eats 12 times more meat than 50 years ago [21]. This food must be produced somewhere. Unfortunately, the Amazonian rainforest suffers from this. One of the most important functions of forests is stabilization of the climate. Cutting down of such huge parts of forests may be as deadly for the climate as GHGs emissions.

Of course governments and international institutions, like United Nations, are aware of the problems. During Earth Summits many documents and conventions were signed. These agreements aim at reduction of GHGs emissions and reduction of the tree felling. Also new technologies are being promoted, which help to protect the environment. What may environmental engineers do to fight the climate crisis?

Possible Reductions of Greenhouse Gases Emissions in Industry

The scientific revolution, which begun in the 16th century, enabled a rapid expansion of the human knowledge [22]. It was followed in the 18th century by the Industrial Revolution. Indeed, it was connected with industry and emergence of factories which introduced mass production systems. Diverse human activities were subordinated to it, all leading to the development of the technological world as we now know it [23]. Before the industrial revolution, societies had no technology for causing widespread environmental degradation. After this revolution, it was possible.

Among the first solutions, the so-called philosophy of dilution should be mentioned. By building higher chimneys, we were making the problem of pollution less harmful, since pollution travel over long distances and with this distance their concentration decreases. However, this philosophy transferred the local problems to a regional or even global level.

Then, we begun using end-of-pipe treatment technologies, connected with different filter devices. These technologies are cost-efficient on a short-run basis, but they may become quite expensive in the long run.

Now, there are much more possibilities, which may be introduced by the environmental engineers [24].

With the technological progress, it is possible to produce the same quality products, but using much less material or energy than in the past. As an example, we may mention the world's famous Eiffel Tower in Paris, which was built in 1889. Using the modern technologies (like metal alloys), now we would need only 1/7 of the steel that were used in 1889.

Technology also helps us to fight with plastic, which may have a negative influence on our health. The microplastic particles have been found in the ice, water and even air. Scientists suggests that every human being "consumes" 50 000 such particles every year [25]. However, the solutions do exist. In Indonesia, a company Avani Eco has created the bag which is not plastic, but is 100% of plant origin. They are using cassava, the vegetable very popular in Asia, Latin America and also in Africa. The cassava bags are looking plastic, but they are not. The bags are compostable and by this degradable. They also just dissolve in water, so are safe for the animals, even in case of eating the material [26].

Such approaches translate into novel strategies for the production processes and consumption of raw materials. We may distinguish for ways of changing the flow of materials [24]:

- Reducing the materials flow: dematerialization, spreading technologies that are using less energy and materials.

- Slowing down the materials flow, which results in better quality of products and longer useful life. For instance, in terms of corrosion, modern cars last much longer because of better protection of the surface.

- Closing the materials flow – recycling, use of the material again (recycling).

- Substitute the materials flow – trans-materialization, substituting rare resources with common ones, harmful substances with no harmful, or at least less harmful, and fossil fuels with renewable sources of energy.

This is the basis for the very important EU's waste hierarchy from best to worst [27]:

- Reduce, or waste reduction, reducing the product flow,

- Reuse, make products more repairable and with longer lifespan, or give to the next user,

- Recycle, this most often refers to the materials in the products; composting, for organic waste, the resulting compost may be used in farming,

- Fermentation to biogas, this is also an option for organic waste, and biogas used for energy generation,

- Incineration, organic waste may be burned and the heat applied, e.g. in district heating; incineration, without recovery of the heat produced,

- Landfilling, the worst option that we should learn to avoid.

These postulates are at the core of the cleaner production idea [28, 29]. There are free levels of such production [30, 31]:

- Production processes – e.g. using less of raw resources and energy, removal of toxic compounds, lowering the level of pollution, introduction of environmentally oriented innovations, introduction of BAT: Best Available Technologies [32].

- Products – e.g. Life Cycle Assessment of the product, so looking for possible reduction in environmental impacts during use of the product.

- Services – choosing between services that have the lowest possible environmental impact. So cleaner production is not connected only with the industrial sector, its application is much wider.

The cleaner production leads to improvement in efficiency, also in quality, reduction of hazardous factors and cost savings. As we can see, cleaner production is better for the environment, and less costly than all the previous solutions [3].

The next step is called C2C, or cradle to cradle approach. It begins with the presumption that the ideal production scheme should not only be non-polluting, but the products should also be good enough to use in a new cycle of production. In this case, the resource flow does not lead from cradle to grave (landfill) but rather becomes a new cradle, thus 'cradle to cradle'. While the cleaner production methods aim to improve the process to be "less bad", the C2C approach is aims to "be good" to the environment [33]. Hundreds of companies have been already certified as C2C companies.

Even more may be achieved; however, not in every industry. The approach is called Zero emission technologies. They refer to an engine, process, or other energy source, which do not pollute the environment and is not affecting climate. Usually it is an electric motor, driven by compact energy source like hydrogen fuel cells or batteries [34].

Such technologies are excellent for the climate change mitigation and create a lot of space for environmental engineers. However, there is one sector of economy, which needs a closer look due to the pollution it creates. This is the energy sector, and the greatest pollution there is connected with coal burning, which leads us to the next section.

Possible Reductions of the Greenhouse Gases Emissions in the Energy Sector: Coal

According to UNDP (2017), 87% of the entire human population has access to electricity. The new phenomena happened in 2011, when – for the first time in history – the electricity production in the countries that do not belong to OECD, i.e. developing countries, was higher than OECD, and the trend has continued in the following years [15].

The demand for electricity is growing all over the world, since we just cannot live without energy. The challenge is not only how to produce enough electricity, but also how to deal with environmental consequences of such production, especially in the context of fossil fuels.

The energy may be produced from:

- fossil fuels,
- renewable sources of energy,
- nuclear power (which is not going to be discussed here, because it is not the industry covered by environmental engineering).

The present global situation is presented on figure 1.

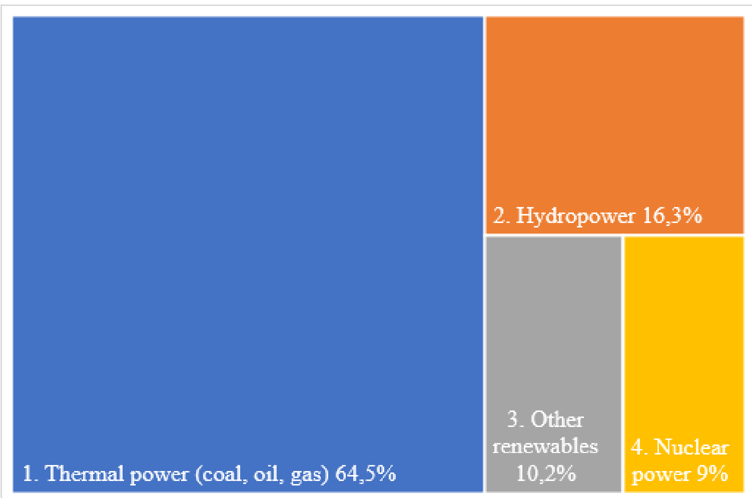

Fig. 1. World Gross Electricity Production by Source [15]

The first place is taken by fossil fuels (coal itself has a share of 38.3%), the second for renewable hydropower, the third for renewables other that hydropower (all renewables together have a share of 26.5%.), and the last place is for nuclear power. Thus, fossil fuels still matter.

Using such energy is responsible for pollution of the environment. What's more, they are running low – see table 2.

Table 2. Depletion of non-renewable energy sources [35]

Resource	World usage per second	Estimated date of exhaustion [year]
Coal	203 [metric tons]	2140
Oil	986 [barrels]	2047
Natural Gas	92653 [cubic meters]	2068
Uranium	0.00004 [metric tons U-235]	2144

Coal is perceived as 'dirty' resource, because of huge emissions of CO_2. The energy sector delivers 60% of the anthropogenic CO_2 emissions [3]. Many countries are withdrawing from supporting coal energy, but maybe we are giving up using coal too easily?

There are many new coal-related technologies, which are perceived – for the first time in the history – as environmentally friendly. Among such Clean Coal Technologies (CCT) we will discuss three. They are i.a.:

- Carbon Capture and Storage (CCS),
- Catalytic Reactors,
- Blue Coal.

Carbon Capture and Storage (CCS) is an American technology. There is a very low emission of CO_2 to the atmosphere, since most of it is captured and stored deep in Earth's geological formations (like exhausted gas reservoirs, or as mineral carbonates), under very high pressure. The reduction level is even up to 90% in comparison to standard coal power station. There are 17 such plants in different parts of the world, which can capture around 31.5 Mt of CO_2 annually. In the USA alone the storage capacity of CCS plants is so high, that – if the level of energy produced from coal in this country is going to be stable and on the present level – they will be able to capture carbon dioxide at least for the next 900 years [36]. There are, however, some concerns about safety of such installations, and possible accidents and leakages.

The second promising technology is the Catalytic Reactor, constructed in the American Rice University. It uses CO_2 as its feedstock and produces clean solutions of liquid fuels. In the latest research, the reactor produced highly purified formic acid, excellent energy carrier. As the inventor Haotian Wang said, "It's a fuel-cell fuel that can generate electricity and emit carbon dioxide – which you can grab and recycle again. It's also fundamental in the chemical engineering industry as a feedstock for other chemicals, and a storage material for hydrogen that can hold nearly 1,000 times the energy of the same volume of hydrogen gas, which is difficult to compress" [37].

Finally, the Blue Coal, which was invented in Poland [38]. In this case the coal is partially degassed at 4500°C. It still has a very good calorific parameter. What's more, comparing to traditional coal, it contains much less impurities and burns almost smokeless.

So, it seems, that there is some future for the coal, especially if we take into account that proved coal reserves will be available for more that the next 100 years. Notwithstanding we must also look for other energy carriers, and especially on renewables, since our energy mix supposed to be more balanced.

Possible Reductions of Greenhouse Gases Emissions in Energy Sector: Renewable Sources of Energy

Renewable sources of energy are heavily supported in many regions [39, 40]. In the European Union a very far-reaching strategy was introduced. It's first version, known as 3 x 20 to the year 2020, was implemented in 2009. There were three main goals to be reached [41]:

- increase of energy efficiency by 20%,
- reduction of emissions of the greenhouse gases by 20%,
- the level of energy produced in the Community from renewable sources of energy should also reach 20%.

The present horizon, which will end in 2030, includes new goals [42]:

- increase of energy efficiency to 32,5% or more,
- reduction of emissions of the greenhouse gases by 40% (compared to the emissions level from the year 1990),
- the level of energy produced in the Community from renewable sources of energy should reach 27%.

The United Nations also supports renewables. In 2015 new 17 Sustainable Development Goals were implemented. One of them is Goal no. 7: Affordable and Clean Energy, devoted to promotion of all renewable sources of energy in every part of the Earth. It is interconnected with goals No. 9: Industry, Innovation and Infrastructure, and No. 8: Decent work and Economic Growth. Renewable Energy Market develops dynamically, which means that more and more people are getting their job there. In 2017 about 10.3 million people were working as scientists, entrepreneurs or workers developing renewable technologies [43].

The basic list of renewables includes [44]:

- hydropower,
- wind power,
- bioenergy (biomass, biogas, biofuels),
- solar energy,
- and geothermal energy.

Hydropower is the most popular, with 69% share in the renewable market [45].

What about pollution from renewables? Are they really pollution-free sources of energy?

Well, it depends on the source of energy. There are some emissions of nitrogen oxides and sulphur dioxide connected with burning of biomass or biogas and carbon dioxide and hydrogen sulphide emissions in case of geothermal power, but they are very low [46-48]. Acquiring other renewables is connected with almost no pollution. However there is one weak point. Manufacturing of devices and installations, like wind turbines or photovoltaic panels, needs raw materials like metals and is not neutral to the environment [49].

Let us analyze the basic problems connected with the renewable energy sources.

In the case of the most popular one, i.e. hydropower, there are some environmental impacts that are controversial [50]. First of all, it changes the local environment, landscape and climate. This is a serious hindrance in case of dams built near nature protected areas, like national parks. Dams are also obstacles for the fish migrations.

In the case of water reservoirs there is also a necessity for relocation of people and their settlements. It is worth to mention the biggest hydropower plant on the World, which is producing electricity for 100 million people. It is Three Gorges Dam on Yangtze River in China, where 1.4 million local people were transferred to other locations [51]. Finally, sometimes it is difficult to keep the water purity in storage reservoirs, especially in case of installations on rivers with high level of pollution. That's why the right choice of a dam location is the biggest challenge.

The second most important renewable source of energy is wind power. The biggest wind power plant on the World is in China. It is Jiuquan Wind Power Base (Gansu Wind Farm), with a capacity of 5,16 GW now, and 20 GW in the future [52].

The biggest problem in case of the work of wind turbines is connected with the high variability of wind strength – between day and night and throughout the whole year [50]. This creates a problem with variations in the efficiency of the wind turbines. The solution is to create better technologies for the energy storage, in times when the winds are heavier. One of the possibilities is the generation of hydrogen. This is an excellent energy carrier, which may be used during weak wind conditions, when production of electricity from wind is impossible.

There is also important environmental obstacle in case of wind power. Production of electricity in the wind turbine is not polluting the environment, but the production of such installations is not environmentally neutral. In case of rare metals that are needed (like neodymium), we must also be aware of pollution which is connected with mining of such materials [50, 53].

The third place corresponds to the bioenergy. It is energy obtained from biological processes and sources, mainly from biomass and biofuels.

The biogas is connected with fermentation which is taking place in municipal landfills, in sewage treatment plants, as well as in biogas plants [54]. Two basic components of biogas are methane and CO_2. Burning CH_4 – an important greenhouse gas – means, that smaller amount of this gas will end up in the atmosphere, which is a positive effect.

The World's biggest biogas plant is in Korsko in Denmark. It can process 1 million tonnes of agricultural products and food waste annually, and produces 45.4MW of electricity [55].

In case of biomass it is worth noticing that the growing popularity of agricultural crops connected only with biofuels, at the expense of other crops, was the reason for huge upgrowth, 2.5-fold, of the food prices index in the EU by the end of 2010 [56]. What's more, in case of developing countries popularity of biofuels turned out to be the another reason for more intense logging of tropical forests and replacing them with energy plants for biofuels. Shift from natural ecosystems to energy plants for biofuels means also additional emissions of carbon dioxide, 400 times bigger than using created biofuels will save every year [57]. Another problem is connected with transport of biomass over long distances, not only in the context of one country or region, but also between the continents. This means much lower energy efficiency.

So, is there a future for the biomass? The obstacles do exist, but they are recognized, and possible to defeat. The good thing is that biomass is almost everywhere. As for now we are using only about 2/5 of biomass resources that are available [58], so this energy source has a big potential.

As for now the biggest biomass power station is Drax in North Yorkshire in the United Kingdom. Its capacity is 2 595MW [59].

The fourth place corresponds to the solar power. There is no doubt that solar energy is vital for the whole biosphere, even if all living creatures directly use only a small portion of it – 0.02% [60]. 50% of available solar energy heats up the Earth, 30% lightens the planet and 20% is responsible for the material flows: water, carbon, coal and sulphur cycles [50, 60].

Currently the biggest solar plant is Bhadla Solar Park in India with capacity of 2245 MW. It was built in 2020 [59]. Also European Union is preparing to build an impressive solar station on the Sahara Desert. It supposed to supply 20% of the Community's energy needs [61, 62].

In Europe insulation generally is moderate, with high variations. There are plans of SBSP (space-based solar power plants), which could produce stable amounts of energy outside the Earth's atmosphere, but the problem is how to transmit this electricity to the surface of the planet [63].

Production of electricity from the solar systems is not polluting the environment, but again the production of such installations (and dismantling) is not environmentally neutral and is responsible for pollution of the environment.

Finally, the geothermal energy: the country number one in this case is Island, where 99% of electricity is produced from geothermal facilities.

Geothermal installations use the heat absorbed in underground waters and water vapor, as well as in hot rocks [64]. The source of this heat is magma. What is important, with this source of energy it is possible to produce not only heat, but also electricity. The main factors are available temperature of geothermal water and capacity of the given resource. In case of the first factor, production of electricity is possible when the water temperature reaches 150-200°C. Unfortunately, in many regions the temperature is much lower, so only heat production is possible. Still, it is worth to use it.

He biggest geothermal power plant is The Geysers in the USA with the capacity of 1520 MW [65].

The role that renewable energy play in energy mix will grow in the future. American National and Atmospheric Administration in 2014 presented the results of their research suggesting that there are enough means and technology to produce 70% of energy from renewables (mainly wind and sun) in the USA alone to the year 2030 and that it will be profitable [66]. This creates plenty of room for environmental engineers and their work.

Environmental Engineering, the Outside Natural Environment and Cities

As it was already said, environmental engineering helps to shape both the internal and external environment. Both give us a lot of opportunities to fight with the global warming and pollution of the environment. What is important, not only pure technology matters.

In the case of external environment another very interesting topic is a natural phenomenon – sequestration of CO_2 by terrestrial ecosystems. According to our own evaluation for Poland, we found out that forests and agricultural cultivation together can absorb 87.5 million tons of CO_2 (so 58% of the whole country's emission). What's more, there are possibilities for increase of sequestration (by promoting actions like afforestation) even by further 20% [67].

By properly shaping the external environment, environmental engineers may significantly help with solving the problem of excessive global warming. However, we must be careful. Even in case of ancient civilizations, people thought that they knew how to modify and control the environment, but a lot of mistakes were made. The Sumerian civilization might serve as an example [68]. This was the earliest advanced and literate civilization in the history. It flourished around 3000 B.C. in Lower Mesopotamia, between famous rivers: Euphrates and Tigris. The land had very good conditions for development of agriculture, which were enhanced by widespread irrigation system – which may be perceived as the first environmental engineering installation on the Earth. Unfortunately, such additional water washed the salts out of deeper parts of the soil to the surface. The results were increased soil salinity and further degradation of the whole local environment [68]. It led to fall of the agriculture and collapse of the whole Sumerian civilization.

The main present problem with the outside environment is, that it already has been shaped.

First of all, by nature, since we have a set of very different environments on the Earth: from the abundance of life in the case of tropical rainforests to extremely difficult conditions on the deserts.

Secondly, by man: in Europe, almost the whole continent was covered by forest till the Middle Ages. Expansion of men resulted in most of this forest being cut [19]. Transformation of the natural environments into the artificial ones has usually a negative impact on the climate. As it can be observed now, in times of climate changes, natural disasters are more and more common, intensive and devastating [69]. Fortunately, environmental engineering can create the technologies that may protect us, at least to some extent, from such natural disasters. There is even a discipline close to environmental engineering, called safety engineering, in which the focus is on preventing accidents in the case of engineering ventures, which means that risk assessment must be always included [70].

There are many cases, from which we should draw conclusions.

For example, an important reason for the devastating scale of flood in Poland in 1997 was building homes on the floodplain terraces in the valley of the Odra river. For many decades of the 20th century, these areas were not flooded, so people thought that they were safe. However, floodplain terraces are never safe [71].

Even greater problem is with deforestation, not only in the already mentioned context of climate change. Forests are also able to hold back water, even after heavy rainfall. When the forest is cut, the barrier, which held all the water, goes with it and we have floods. One of the worst such disasters happened in the valley of Yangtze in China. Huge deforestation in this area was the reason of a gigantic flood in 1988, when 3700 people were killed, and as much as 60 million acres of fields were destroyed. The cost of this flood was 30 billion US $. The right conclusions have been drawn. Further logging of trees in this area was prohibited. What’s more, a program of massive reforestation worth 12 billion US $ was introduced [72]. The total cost of the flood and reforestation was US $ 42 billion, so much more than the previous profit from deforestation [72].

However, there are also positive examples, even in the case of almost totally artificial environments, like in the cities [73]. Many improvements are possible, especially in houses and public buildings, connected with introducing ideas like ecological or even passive houses. Such buildings require ultra-low energy both for space heating and cooling [74].

There are five basic principles of passive house design [75]:

- no thermal bridging,
- superior windows,
- mechanical ventilation with heat recovery,.
- quality insulation,
- airtight construction.

Such design may also be connected with green roofs, or even green walls, which extend the urban green areas, which are so important from the perspective of proper climate shaping.

It is also worth mentioning revolutionary technology from China called Broad Sustainable Building. The construction plan is to build from steel units. It is possible to assemble 95% of the building in its factory before any real building takes place at the construction site. The fabrication process takes around six months. In 2015, BSB completed J-57 hightower in Changscha, a 57-level mixed-use was built in just 19 days (!!!). An important advantage of the technology is, that such buildings are also very easy to dismantle, and there is almost no waste left [76].

However, no matter how advanced technology we will use and how much we are going to take care about the green environment in the cities, our capabilities are always going to be limited by the existing infrastructure on the one hand and climate on the other. And there are other factors that we must take into account, among them the Covid-19 pandemic.

Covid-19 Pandemic and the Climate Change

Covid-19 is the biggest biological threat of the present time. It may seem that during pandemic technical sciences, like environmental engineering, are less important. However, being in a quarantine is much more bearable with access to electricity or water, which are engineering issues [77].

As for July 5, 2021 the World's total number of coronavirus cases was 183 825 470 and 3 197 552 910 deaths were noticed in 192 countries [78]. On the other hand, 3 197 552 910 people were already vaccinated [78].

From the perspective of environmental protection, it is worth to notice, that during first lock-down in Spring 2020 the quality of air significantly improved, especially in big cities. In Los Angeles in April 2020 the air was very clean. In normal conditions it is impossible, due to big car traffic [79]. Also in Europe we could observe 25% decrease in the level of air pollution at that time [80]. Unfortunately, the effect was temporary, situation worsened again after returning to normal life.

All environmental hazards, that were known before the pandemic, are still around us. Fighting the virus, we should not weaken our actions for protection of the environment. Unfortunately, it is going to be more difficult than ever, because coronavirus caused not only biological threat, but also huge economic crises, which is bigger than the one that happened between 2007 and 2009. Many economic sectors may disappear or will be touched by very deep recession (like service sector, tourism and transport). The consequences will be high unemployment and probably high inflation. In case of the strongest World's economy in the USA the unemployment for the year 2020 was estimated at 32.1%, so higher than during the Great Depression (which was the biggest economic crises so far for this country) [81]. Finally the situation was the worst in May 2020, when unemployment level was 13%. Because of the very good US economic performance in the third quarter of 2020, in December 2020 it was much less – 6,7%. But the coronavirus pandemic is far from being over, deterioration of the economic situation is still possible.

The pandemic already changed global supply chains. In the world before the Covid-19 the rule for the supply chains was: the cheapest way. So, some products, or parts of the products, were sometimes manufactured in distant locations. Usually in poor countries, where the price for work is very low. Poor countries were hit hard by the virus, so many supply chains were broken. As a consequence many global corporations suffered. So, it looks like that in a new world supply chains will be no more the cheapest way but rather the most stable way. This will hit poor countries because many companies may withdraw from them. As for now there is a shortage of many global products (for example in home electronics), because many supply chains were broken [82].

If more countries will be forced to follow the second lock-down path, the total economic crisis is a reality. It would mean not only deterioration of the quality of life of the whole human population, but also inter alia possible resignation from the fight against the climate change. Even during the first months of Covid-19 pandemic the politics seemed to be much less interested in actions against the global warming, than earlier. In the meanwhile, global warming is still progressing. The World Bank warns, that the costs of extreme weather phenomena related to climate anomalies (hurricanes, droughts, floods) in the era of negative climate change are already so high, that they may destroy all the achievements taken to date for protection of the environment and sustainable development [83]. We must be aware, that the biosphere is out of balance, and global climate anomalies and climate change warming may kill more people than Covid-19. Environmental engineers are still needed, since clean environment is very important to our health, and they still provide us with technologies that are helping with better protection of the environment and the climate.

Conclusion

This article is an outline of the chances connected with environmental engineering in the context of global warming and protection of the environment. It shows that environmental engineering is a powerful tool, which in many ways can help in protection of the environment and in fighting the climate crisis: from the energy sector (both based on fossil and renewable energy) through industry ending with shaping the internal environment of buildings. It is justified to say, that environmental engineering gives us hope that the climate crisis will be overcome.

We must remember however, that for the right development of the whole human race even the best technology is not enough. In this context it is worth to mention the central idea of global strategies, introduced by the United Nations and the European Union, which is called sustainable development. It is a positive vision of the future, a try to solve global problems, like climate change and degradation of the environment, but also poverty or inequality. It is an interdisciplinary approach connecting both scientist from different countries, and different specialties (of course also environmental engineers) with different societies and ordinary people. Only together we can make our future better.

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