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affiliated with the President of the Polish Academy of Sciences

on

climate change and water resources management in Poland

Anthropogenic (human-induced) climate change

1) The observational evidence indicates that **the warming of Earth's climate system** and the effects that accompany this process are now **beyond any doubt**. The IPCC's special report [1] on global warming of 1.5°C states: "Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C


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between 2030 and 2052 if it continues to increase at the current rate." Once this limit is exceeded, it will be most likely impossible to stave off the catastrophic effects of global warming for the biosphere and humanity. In order not to exceed the limit of 1.5°C or exceed it only slightly, we must lower global net anthropogenic CO_2 emissions by about 45% from 2010 levels by 2030 and reach net zero around 2050. Likewise, non-CO_2 emissions must undergo deep reductions. Curbing global warming to 1.5°C will require swift and far-reaching transformations in such fields as energy, the use of land, cities, and infrastructure (including transport and buildings) as well as industrial systems. Such transformations must be unprecedented in scale and involve substantial emissions reductions across all sectors, a broad range of mitigation measures (with a view to reducing emissions), and considerably increased investments in the relevant fields.

2) The impacts of climate change on sectors and systems are very serious, affecting in particular water resources management. Global projections show that **climate change may increase the risk of water deficit and worsen water security, in addition to magnifying the risk of droughts and floods** in many regions of the world, including Poland. This will affect the supply of water to meet the needs of humans, industry, agriculture, and electricity generation from conventional sources.

The impacts of climate change on Poland's water balance

3) The fundamental factors influencing the water balance are temperature and precipitation, which change with the changing climate.
4) Observations and projections **clearly point to a rise in temperature in Poland** in the future. This translates into a higher likelihood of summer heat waves, which may be accompanied by droughts.

5) Climate change causes alterations in precipitation patterns. Projections usually point to similar directions of these alterations, some of which have already been observed in Poland:
   – We have already observed changes in the temporal distribution of precipitation, especially **a rise in the ratio of total precipitation during the cold half-year to total precipitation in the warm half-year.**
   – Temperature rise causes changes in the phases of precipitation. **During the winter, we can expect less snow and more rain**. Snow provides the basis for the replenishment of groundwater, which discharges into water ecosystems (rivers, reservoirs, and lakes) and water-dependent ecosystems (moist or wet areas, swamps, and peatlands). Consequently, the absence of snow may cause or exacerbate water deficits.
   – If there is any rise in precipitation during the warm half-year, it will be small. Therefore, **there will be a larger water deficit in the growing season**, leading to the drying out of soil moisture, especially as higher temperatures translate into increased evaporation.
   – The number of precipitation days will decrease, the intervals between precipitation events will be longer, and the intensity of such events will increase. Consequently, **longer precipitation-free periods** (or periods with precipitation substantially below the normal level) **may be interrupted by heavy downpours.**

The impacts of climate change on water resources management in Poland

6) Climate change may magnify all three water problems in Poland: water deficit, destructive water overabundance, and water pollution.
7) We must reckon with more frequent droughts (meteorological, agricultural, and hydrological droughts) as well as destructive effects of water overabundance. **During a single year, both drought and flooding may occur. What was once deemed "abnormal" is becoming the new normal, and the future extremes may be even more intense than those we know from the past**, negatively affecting the inhabitants of Poland and the country's economy.
   – The climatic water balance is regularly negative. Consequently, evaporation exceeds precipitation in the summer, which is when nature and agriculture need water most. **Such deficits are compensated from soil water resources.** In average conditions, a negative water balance during the summer posed no problem, because long rainy periods in the autumn and snowmelt in the spring replenished the resources of soil water and groundwater. Unfortunately, this situation is changing. Examples include the winter of 2019/2020 in Poland, when snow accumulated only in the mountains. Similar situations will be more and more frequent.
   – **Droughts in Poland are occurring increasingly frequently.** Examples include the spring of 2020. It may turn out that the dry years of 2018 and 2019, when the amount of precipitation in vast regions of Poland was much lower than the multiannual average, is being followed by another dry year, the third successive one. The precipitation in May 2020 failed to compensate for the water deficits.
   – **Torrential rains will be more frequent.** They will be particularly dangerous if they occur after prolonged drought. When overdried and parched soil crusts do not absorb water, a heavy downpour may result in severe flooding. Examples include August 2015, when the amount of rainfall during one heavy rainfall event was equal to the amount of precipitation normally recorded in a month.
   – Changing climate may lead to **the worsening of water quality**. Heavy rains will intensify surface runoff, leading to **the increased transportation of pollutants from catchment areas**, especially in areas characterized by vegetation degradation. Inflow of pollutants combined with rising temperatures will affect the quality of water in transformed rivers with simplified biological structures and lower self-purification capacities. Reservoirs may experience **more intensive blooms of cyanobacteria**, which occur in nutrient-rich, shallow, and warm waters. Such blooms will be likewise favored by longer water retention periods in rain-free periods. The Sulejowski Reservoir and the Siemianówka Reservoir should serve as warnings.

In the era of climate change and the ongoing degradation of the natural environment, we should change our perception of water and water resources management in a fundamental way.

8) The first pre-war issue of the periodical *Gospodarka Wodna* (1/1937) featured a paper by E. Romański entitled "*Gospodarka wodna w Polsce*" [Water Resources Management in Poland], which defined the goal of water resources management in the following way: "to drain water falling on the Earth's surface into the sea, while keeping the harmful effect of such water to a minimum and while maximizing its usefulness as an environment, as matter, and as mass" [2]. This belief in the overriding importance of

the economic use of water and flood prevention combined with efforts to minimize the harmful impacts on the environment, which prevailed until the end of the previous century, has proved insufficient in the face of present-day challenges. The objective thus formulated has been long deemed highly anachronistic and inappropriate, especially in the face of ongoing climate change.

9) The new ideas that took root in the EU with the adoption of the Water Framework Directive (WFD), which points to **the overriding importance of good-quality water ecosystems and ecosystems that depend on water combined with efforts to minimize the negative impacts on the economy**, represents a better response to the challenges facing us. The implementation of such guidelines should be coupled with efforts to prepare administrative bodies for adaptive management, taking into account uncertainty as to the scope and scale of the impacts of climate change and the effectiveness of potential water policy instruments.

10) **Water retention** in the broad sense, which means storing excess water and then reusing it in the drought periods, is **the remedy** to the high temporal variability of precipitation and river flows.

– All of Poland's reservoirs together accommodate a mere 6.5% of the annual volume of river runoff. The current draft of the "Plan to Counteract the Effects of Drought" (*Plan Przeciwdziałania Skutkom Suszy*, PPSS) [3] is expected to increase retention in reservoirs to 15% in 2027.

- It is not very realistic for this task to be implemented in Poland in such a short timespan through large-scale retention. It is very difficult to achieve retention at the level of 15% of river runoff for location-related reasons, due to Poland's lowland-dominated landscape and high costs. Although water retention in mountain valleys in the context of flood protection is relatively effective, the creation of lowland reservoirs not only poses the problem of inundating relatively large areas so as to build such reservoirs but also generates numerous problems related to the maintenance and use of such facilities.
- Contrary to popular belief, **large-scale lowland reservoirs likewise fail to resolve drought-related problems, especially in the context of agriculture**. The small slopes found over a vast majority of Poland's landscape make it practically impossible to distribute water using gravity flow systems. Pressurized pipelines supplying water to specific crops are currently hard to imagine.
- The negative water balance and the poor quality of water are further aggravated by the degradation of the environment and the improper use of the landscape along with water and water-dependent ecosystems. **Natural rivers and river valleys, wooded areas, wet meadows, and wetlands effectively retain water and are important tools helping to mitigate the effects of agricultural and hydrological drought and reduce the risk of flooding**. In addition, wetlands and forests sequester (i.e. capture and store) carbon, thus helping to lower CO_2 concentrations in the atmosphere.

11) **Natural, small-scale retention** (for example in river channels, wetlands, and floodplains) **and landscape retention should be seen as crucial for the mitigation of the effects of flood and drought**. Without question, such retention must be enhanced [4].

- In recent decades, the hydrological system has undergone considerable transformations, which are conducive to water runoff, as opposed to retention. The simplification of the system of rivers, the excessively developed network of water drainage systems in agricultural areas, and flood protection achieved through the construction of dams and the straightening of river channels all reduce water retention capacities in light of the already observed and expected torrential rains.
- Rivers and river valleys whose ecological status is "good" (in keeping with the WFD) are places where the retention of good-quality water is relatively easy. **Key measures should include the absolute protection of watercourses in natural and semi-natural condition**. Technological interventions are not recommended in such watercourses.
- Action must be taken that aims at the renaturation or rehabilitation of watercourses whose morphology has been altered – **the restoration of the natural course of such water bodies and their connectivity to river valleys**. Such measures improve retention capacities, the restoration of groundwater resources, biodiversity and the ecohydrological system's climate change adaptation capacities. Also, they are consistent with the most recent EU Biodiversity Strategy for 2030 [5], published several weeks ago as part of the new European Green Deal [6]. A noteworthy step in this direction involves drafting the National Surface Water Renaturation Program in Poland [7].
- An alternative to the renaturation of watercourses whose morphology has been strongly altered (straightened, dam-controlled, characterized by poor connectivity with groundwater) involves **developing small, flow-through reservoirs**. Good water quality is crucial for the further reuse of water retained in this way.

12) Faced with the threat posed by climate change, we must take one step beyond what the FWD and the Floods Directive require us to do, namely **enhance the landscape's hydrological buffer capacity and**

landscape retention. For rural landscapes, water must be held near where it falls or must effectively percolate into groundwater.

- This process extends far beyond the purview of the water authorities, because it involves taking numerous initiatives in rural areas, such as:
  - effectively promoting measures aimed at increasing soil humus levels (which have fallen gradually in recent decades),
  - preserving meadows and pastures in river valleys,
  - extensifying drainage systems in selected areas,
  - changing the structure of forests and tree stands in the areas of groundwater recharge, in river valleys, and so on.

Poland's "Plan to Counteract the Effects of Drought," which is currently being developed, is a good step in this direction [3].

- Such measures **stand no chance of succeeding without systemic financial support for farmers and forest management units.**
- **Ensuring the quality of the environment** – which means the protection of habitats and ecosystems whose status is good together with the broadest possible revitalization of other habitats and ecosystems – **provides the basis for action and represents the first step that must be taken**. Artificial retention and groundwater replenishment methods are measures of last resort.

13) Poland's agriculture is currently dependent on rain. This situation will most certainly not change. Supplemental irrigation of crops will be increasingly important. In the coming decades, in light of the changing climate, **agriculture, which currently accounts for the smallest share of water use, will turn into the main user of water**.
   - We should bear in mind that unlike municipal management and industry, agriculture returns most of the water that comes from irrigation not into watercourses or soil but into the atmosphere (in the form of vapor). This water returns to Earth as rain, but often far from where it evaporated, perhaps even in another country.
   - In the future, water for agricultural use will come from small-scale retention (ponds and waterholes in agricultural farms) and – unfortunately to a large extent – from groundwater resources.
   - Excessive or uncontrolled exploitation of groundwater may have significant negative impacts on the environment (such as **the drying out of small watercourses and groundwater-fed peatlands and the disappearance of riparian woodlands and alder carrs)** and negative socio-economic consequences (for example **an increasingly desiccated landscape and lower productivity of small farms with irrigation-based production**). Exploitation of groundwater requires monitoring and protection measures, which should set new standards for the management of water resources in Poland.
   - **Water used for irrigation must be used sparingly**, for example through micro-sprinklers, drip irrigation, and root irrigation.

14) In urban areas or areas characterized by a large share of impervious surfaces (buildings, squares, streets, and parking lots), intensive rainfall increases the losses caused by **flash floods in cities**, whereas droughts and rising temperatures intensify **the urban heat island effect**. Given high real estate prices and the pressure on land development, increasing the buffer capacity of cities may pose an even greater challenge than in rural areas.
   - **Water and green spaces in urban areas effectively mitigate the negative effects of climate change** by lowering temperatures, increasing air humidity, and retaining excess water where it falls. Climate change adaptation therefore requires immediate action integrating green spaces and urban water management into spatial planning.
   - **Urban planning should prioritize the creation of many scattered points of local stormwater retention** with the use of blue-green infrastructure (natural, semi-natural, and artificial areas and facilities that combine areas of greenery and water), which must be an important component of the urban fabric [8].

15) **Water resources management must be integrated**. This notion, introduced at the end of the previous century by the Global Water Partnership [9], is turning into one of the concepts underlying the modern outlook on the management of water resources.
   - Integrated water resources management requires **a combined approach to the resources of surface waters and groundwater, water quality, and the recycling of water, as well as the quality of the environment and boosting its resilience to stress caused by extreme events.** Water management based on this approach results in reduced water deficits and improved water quality.

- **Responsibility for water must go beyond** the institutions that traditionally manage water resources. **The key partners are planners, farmers, foresters, energy production experts, and civil society institutions.**
- It is crucial to **educate the public**, so that people perceive water and natural aquatic ecosystems as something valuable, in terms of more than just raw materials.

16) The integrated approach may be further intensified through **the combination of flood and drought risk management in a single planning document and then in an implementation document**, which should be linked together through search for increased water retention possibilities [10].
   - There is a particular conflict of requirements related to flood prevention and those related to drought prevention. In the former case, we need **"dry" retention**, or green areas that store excess water runoff (for example polders). In the latter case, we need **"wet" retention**, or the storage of water resources in locations conducive to such efforts, with the water so stored later being used in shortage periods. Planned actions should aim to minimize this conflict.
   - It is necessary to recognize **the importance of the natural environment and biodiversity as an important element of efforts to improve water quality and retention and adapt to climate change** [11].
17) Poland's water resources are not great. In terms of both precipitation and river flows *per capita*, **Poland ranks among the countries with the smallest water resources in Europe. However, what is and should remain our asset is not the water that flows out of the country but the water that is retained in the landscape and replenishes the resources of surface water and groundwater. Landscape retention should be considered an important component of Poland's water resources.**
18) Water-related threats during spectacular floods (such as those in July 1997 and May-June 2010), drought or events that cause the dramatic worsening of water quality (for example the failure of the collectors channeling sewage to the Czajka wastewater treatment plant in Warsaw in 2019) lead to many temporary measures being taken. However, what is clearly more important is **the readiness to take consistent, long-term, integrated, and knowledge-based actions that primarily serve the purpose of climate change adaption (flood and drought risk reduction) and to reduce the negative impacts on climate (CO_2 emissions reduction)**. Other goals, such as inland navigation, should be subordinate to those actions.

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