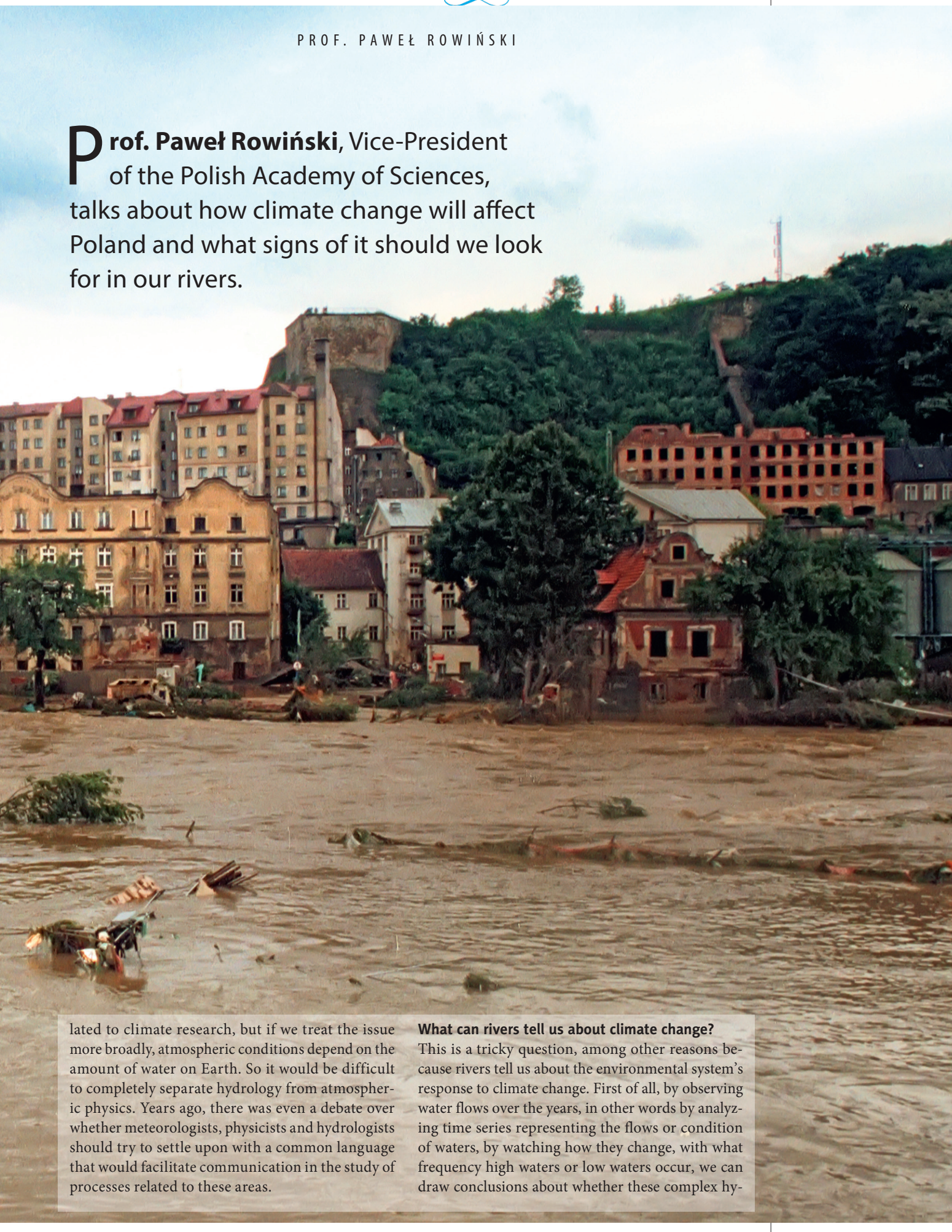
Too Much Feedback

ACADEMIA: **What exactly is environmental hydrodynamics, the field in which you specialize, and what is its relation to the climate?**

PAWEŁ ROWIŃSKI: The word hydrodynamics has two parts: "dynamics" indicates movement, and "hydro," of course, means water. So hydrodynamics deals with everything that is related to the movement of water. I mainly study rivers, which are extremely complex. For example, turbulence, something we know from airplane travel, for instance, can be observed in rivers and better understood. Such turbulence in rivers is one of the least understood problems in science, even though it influences many processes occurring in the aquatic and natural environment. Among other things, it affects the status of habitats in river ecosystems, the development of benthic flora, the transport of pollutants and sediment, and also flood waves. This is not directly re-

PROF. PAWEŁ ROWIŃSKI

Prof. Paweł Rowiński, Vice-President of the Polish Academy of Sciences, talks about how climate change will affect Poland and what signs of it should we look for in our rivers.



lated to climate research, but if we treat the issue more broadly, atmospheric conditions depend on the amount of water on Earth. So it would be difficult to completely separate hydrology from atmospheric physics. Years ago, there was even a debate over whether meteorologists, physicists and hydrologists should try to settle upon with a common language that would facilitate communication in the study of processes related to these areas.

What can rivers tell us about climate change?

This is a tricky question, among other reasons because rivers tell us about the environmental system's response to climate change. First of all, by observing water flows over the years, in other words by analyzing time series representing the flows or condition of waters, by watching how they change, with what frequency high waters or low waters occur, we can draw conclusions about whether these complex hy-

Previous page: flooding experienced by the Polish town of Kłodzko in 1997

drological systems react to climate change. Rivers are in large part responsible for catastrophic phenomena, i.e. floods and droughts, which have a huge impact on our lives. No one needs to be persuaded that a flood or drought can have dramatic effects, and it seems that in the future we will witness many more extreme phenomena like these. This is the main direct impact of climate change in Poland, which will not be as drastic as in tropical countries, which will experience extreme high temperatures. The climate in Poland will slowly shift towards a two-season year: a cool, rainy season and a dry, hot season. There will definitely be long periods when there will not be enough water. Droughts usually last longer than floods. If there is no snow, there will be no snowmelt flowing into rivers. Indeed, springtime snow-melt floods are occurring less and less often. This, in turn, has many economic consequences, such as in river transport and agriculture. On the other hand, we are observing more and more dangerous summertime precipitation-related floods.

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Is historical data on rivers helpful in making predictions?

Definitely. This is the broad subject of study known as statistical hydrology. It teaches us how rivers react at times of low water, and when high water comes. Such historical situations recur, and so they can be predicted with a certain likelihood. Added to this is complex analysis of how all these processes vary over time. Back in the 1990s, I was part of a group led by Prof. Zdzisław Kaczmarek, which took part in the US Team Country Study. That was more or less at the time when the Intergovernmental Panel on Climate Change (IPCC) received the Nobel Peace Prize and he coordinated the Polish involvement in those projects. We then created models that answered the question of how river systems will react to various climate change scenarios. Such scenarios are devised based on a model of the global atmospheric circulation, and as time goes on these models account for more and more processes, they are becoming more and more precise. Back then these scenarios were posited on the basis of tools that were far from perfect, without answering questions regarding water relations under changing conditions, and such models were devised in Poland as well. Today, these models are more accurate, because computers are becoming more efficient ad we better understand all the processes, and so we can achieve better quality results. Compared to those of today, the methods we used back in the 1990s were far from ideal. This is probably why there was then a strongly audible voice of skeptics, who did not believe that climate change was actually taking place.

I should once again stress that the phrase "climate change" is a kind of a useful oversimplification. In fact, we are talking about different climate scenarios. Vast, complex models are built depicting what will happen to the climate, and then, by positing various likely scenarios, we try to determine what will happen with many other systems, for example with water resources. But the answer is not black-and-white. Depending on which climate scenario actually comes to pass, we can determine what will most likely happen to the rivers. I say "most likely," because even the IPCC report points to different scenarios. We are certain about the ongoing trends, but quantitative processes may proceed in various ways.

Is unpredictability the biggest problem?

It is an inherent part of natural science, including climate science. Speaking in mathematical terms, most of the phenomena we are talking about here are described by nonlinear equations. Often we do not know precisely what will happen because we are dealing with so-called unstable systems. Different elements of a system mutually influence one another, and there are many feedback loops within the system. We can only try to visualize what might happen based on observation, how the Earth's system will, colloquially speaking, go crazy. There is a danger that once a certain threshold is crossed, for instance in terms of temperature, the situation may go out of control. But we do not exactly know where that threshold lies. Will it be 1.5°C or perhaps 2°C? And then what? Certainly, in our geographicsl latitudes, the frequency of floods or droughts will surely increase, but all of this will have further consequences, and we don't know exactly what kind, because it depends on the extent to which individual elements of the system influence each other.

Ticks are a good example. They were once only a summer pest, but with warmer weather lasting longer, ticks now appear from March to November. This has led to increased cases of tick-related meningitis and borreliosis in Poland and throughout Europe. What will happen if the temperature rises by 1°C? We don't know, it's difficult to predict. Perhaps the tick

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season will be all year round, but how will that affect human and animal health? It's difficult to estimate.

And that's just the biological aspect. What about the social one, such as migrations?

We can certainly expect human migrations, as people will want to escape from destructive weather phenomena. And the recent migration crisis has shown that we don't even know what to do with a small inflow of people to our area.

Many people think that a degree or two is insignificant.

Yes, they think the weather will simply be warmer, but more pleasant, that we may have a Mediterranean climate here in Poland. But even the tick example shows that changes will not be pleasant. We are not used to insects from different climates that cause malaria, for instance, and if it gets warmer, they may appear in Poland.

Because Poland is among the more wealthuy societies, there is a chance that we will manage to adapt to such changes. But it will be difficult to come to terms with the fact that if the sea water level increases by several meters, at some point we may find the sea reaching as far inland as the Polish town of Płock. We still don't fully realize what possible geographic changes may occur.

Taking all this into account, it would be cheaper and easier for people to make changes to their lifestyles rather than worry about an inevitable catastrophe.

Habits are hard to break, but actually if everyone in the world suddenly stopped eating meat, it would significantly reduce the emission of harmful gases into the atmosphere.

Unfortunately, the opposite is happening. Soon developing countries may be eating a lot more meat, as this is what happens when societies become richer. It is a problem of mentality, education, and contradictory signs aimed at young people. If politicians say that climate change is so-called "leftist talk" and there is nothing to worry about, some people will choose to believe it. But although the COP24 regulations are not yet binding enough to change the world, we are standing on the threshold of very serious decisions.

This is where trust in scientific research pointing to climate change comes in. It turns out that even among the scholars themselves, there are many people who doubt this research or try to interpret the finding differently. Geologists, for example, look differently at the Earth system than hydrologists. Did you also notice that there are more or fewer skeptics in particular scientific disciplines?

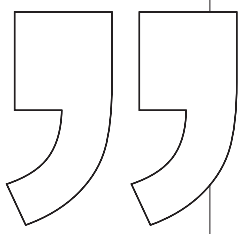
The number of skeptics is definitely on the decline, because it is hard to refute facts. But you are right, various things happen in Poland. You mention geology; there was for instance a resolution passed in 2009 by the PAS Committee on Geological Sciences, which perhaps did not exactly call climate change into question, but it showed great skepticism with respect to the anthropogenic causes of climate change. At the same time there was a resolution passed by the PAS Committee on Geophysics, which in fact supported the IPCC's position, not mincing words in presenting a rather pessimistic scenario. The position of this latter committee was in fact updated last year. The point at issue was the previously observed increases in CO_2 concentrations in the atmosphere, based on ice-core data, but we know after tall that they never attained today's levels. To this we need to add the incredibly rapid growth in CO_2 levels. In defense of the geological community here, we should stress that geologists are engaged in intensive debate about whether the current geological era should be called the Anthropocene, in recognition of the human impact on the Earth.

At the water festival sponsored by the Polish Academy of Sciences back in October 2018, someone said that water could become a luxury at some point. What can we do to prevent this from happening?

Water is the most precious commodity we have and it cannot be replaced. At the same time, we are not

used to viewing it in economic terms. These days, with water meters installed in our homes and having to pay water bills, we do know that it has its value. Of course this value varies depending on the region of the Earth. There are places, many at that, with no access to clean drinking water at all, and this affects significantly more than one billion people. But here in Poland, we also do not have too much of it, either. In terms of annual precipitation, Poland ranks in one of the last places in Europe.

Also, it is not just water quantity that matters, but quality as well. We still don't have enough quality water. On the world scale, more than 5 million people die each year because of poor water quality. We should also remember that with decreased supply, the quality of water dwill drop further. This can lead to many disasters, including armed conflicts. Water can't be replaced. We can look for solutions to replace coal, but nothing will replace water.



We constantly hear that there are nearly inexhaustible amounts of groundwater in Poland, but we don't realize that this water is also polluted. This is partially due to the revolting habit of building septic tanks that are leaky, so that they have to be emptied less often.

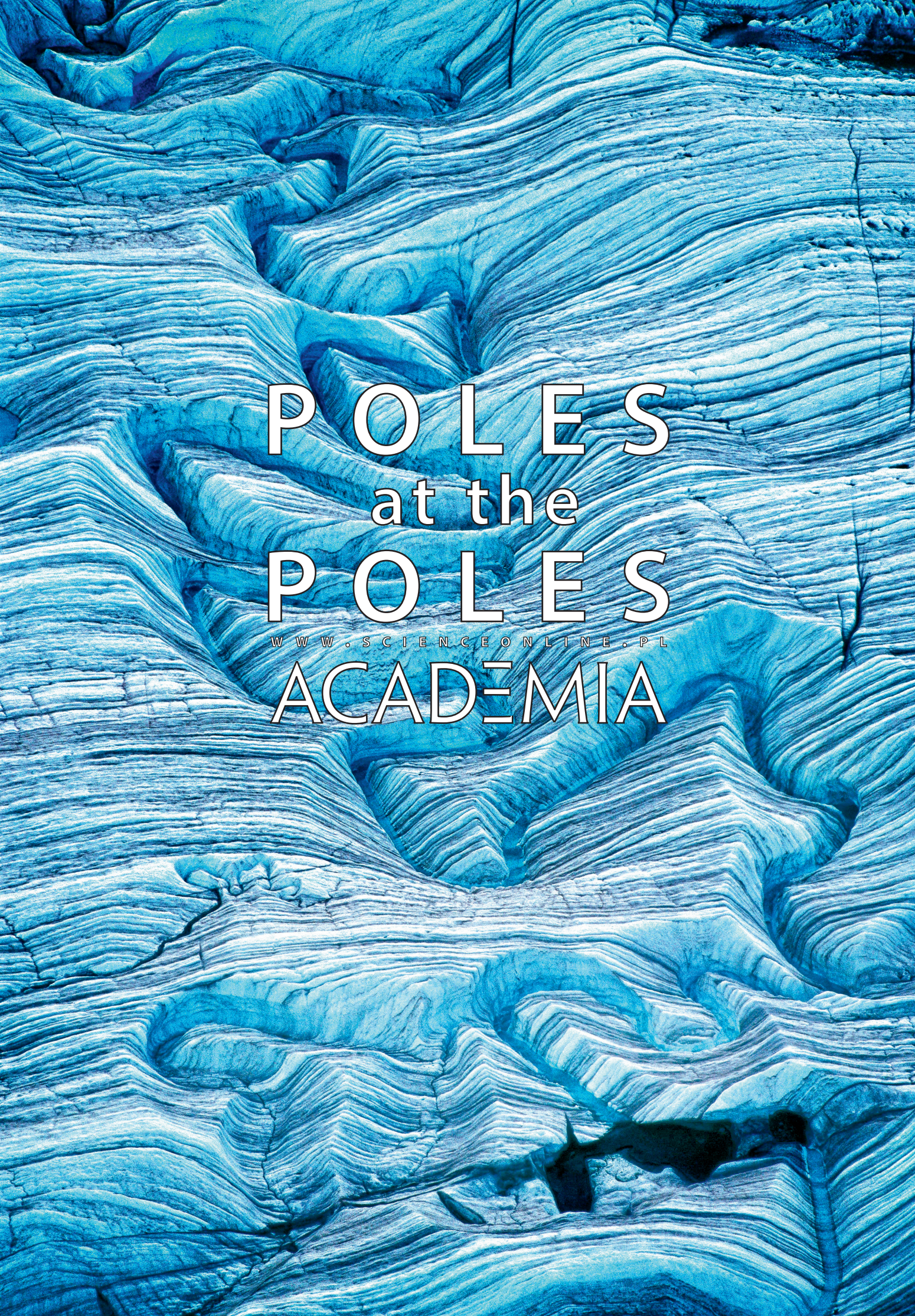
Which countries have plenty of clean water?
In Europe, Scandinavia is an excellent example. Its people understand the importance of water. They are best at adapting to climate change, just look at their hydropower systems, although technically some of the praise should go to Mother Nature as the mountains help derive energy from the gravitational force of water. But a lot depends on effective, balanced policy.

Is there an antidote to the upcoming water crisis? Is it possible to desalinate, purify and treat water on a large scale to make it drinkable?
It is, but it's still quite expensive. Plus there is a cultural aspect to consider. In many countries there is a tendency to treat rivers as sewage dumps, disposing of everything possible in them. In Poland, too, we have not fully managed to cope with this problem. The draining of waste from private farms is very common. We constantly hear that there are nearly inexhaustible amounts of groundwater, but we don't realize that this water is also polluted. This is partially due to the revolting habit of building septic tanks that are leaky, so that they have to be emptied less often. People don't realize that by doing so they are poisoning themselves as they are also drinking this contaminated water. For years now, there has been discussion about the problems with water quality in the Vistula River, or also in the Baltic Sea. Although we have to admit that these days things are improving, as more and more sewage treatment plants are appearing. But we're far from a satisfactory state of affairs. As I see things, education remains the most important factor here.

One of the main missions of the Polish Academy of Sciences is to use scientific research in practice. How does it look from your perspective? What's working and what could be improved?
Many scientists often study fundamental processes. And it is a good thing, because without solid research, good science is out of the question. But a huge number of studies are in applied research, and it would be a good thing if the findings obtained were garnered greater attention. A good example is coal power in Poland. Research clearly shows that we should not be using coal, but the topic is treated politically. After all, the closing of coal mines can in fact stimulate development, technologies, science, and the national economy. Much research carried out within the Polish Academy of Sciences head in this direction, to just mention the ultra-modern PAS Research Center for Energy Conversion and Renewable Energy Sources (KEZO) in the Warsaw suburb of Jabłonna. Discovering new technological solutions is an important driving-force of innovation. Science shows that all areas of life really comprise one great big system, and that only this holistic way of seeing things will allow us to take proper action. Problem solving only in emergencies will never bring long-term results.

So what we need is an interdisciplinary dialogue involving politicians?
Unfortunately, in Poland we have never had good cooperation between scientists and politicians. The voice of science gets ignored. Maybe because it deals with long-term issues, while politicians are mostly concerned about winning the next elections. But of course the answer to your question is: yes.

Interview by **Justyna Orłowska**
Photography by **Jakub Ostałowski**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