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ACADEMIA

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FROM THE EDITORS

A Ray of Hope

Space… The Final Frontier – that's how every episode of "Star Trek" begins. Back in the 1960s, when the show was developed, it may indeed have seemed that soon the only challenge left for humankind would be space exploration. And yet today it turns out we are preoccupied with far more mundane matters, especially security-related issues: ever-increasing entropy is on the horizon, in the form of conflicts, crises, and an impending climate catastrophe.

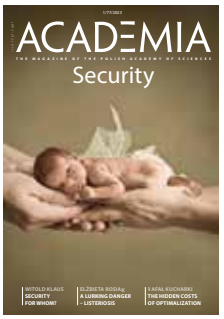
The Polish Academy of Sciences, too, in its own modest scale, is at a turning point in its history. On the one hand, a radical reduction in funding, an attempt to marginalize or even replace it as an institution, and restrictions on academic freedom are all making themselves felt. On the other, a self-reform agenda being proposed by the Academy itself, the ongoing digitization and expanding outreach of its publications (including *Academia* magazine, of course) and a new operating strategy do offer a certain ray of hope for the future.

In this issue of *Academia*, however, instead of focusing on ourselves, we delve into some deeper reflection on the numerous facets of the important theme of safety and security – especially the loss thereof. Devastation of the environment and biodiversity, geopolitical upheavals in Poland's backyard, more physical threats posed by earthquakes, food poisoning, ticks and snakes, as well as new uses of nuclear energy, symbiotic relationships with fungi, depopulation and migration, disappearing cultures, and public perceptions of security – these are just some of the topics into which, we might say, we "boldly go."

Prof. **Dariusz Jemielniak**
Vice-President of the Polish Academy of Sciences

Michal Zaborowski, "Pygmalion," oil painting, 2018

A Polish painter, born in Gdańsk in 1960. Graduate of the Faculty of Painting at the Warsaw Academy of Fine Arts, where he earned his diploma from the studio of Prof. Ludwik Maciąg in 1985. He is the author of the monumental polychrome "Heavenly Jerusalem" in the church of the Pallottine Fathers in Warsaw, and a giant stained-glass window in the church of the Pallottine Fathers in Ozarów. His works – which have been exhibited in European and American galleries – focus on mood and ambiance, isolating people and things out of time.



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Security for Whom?

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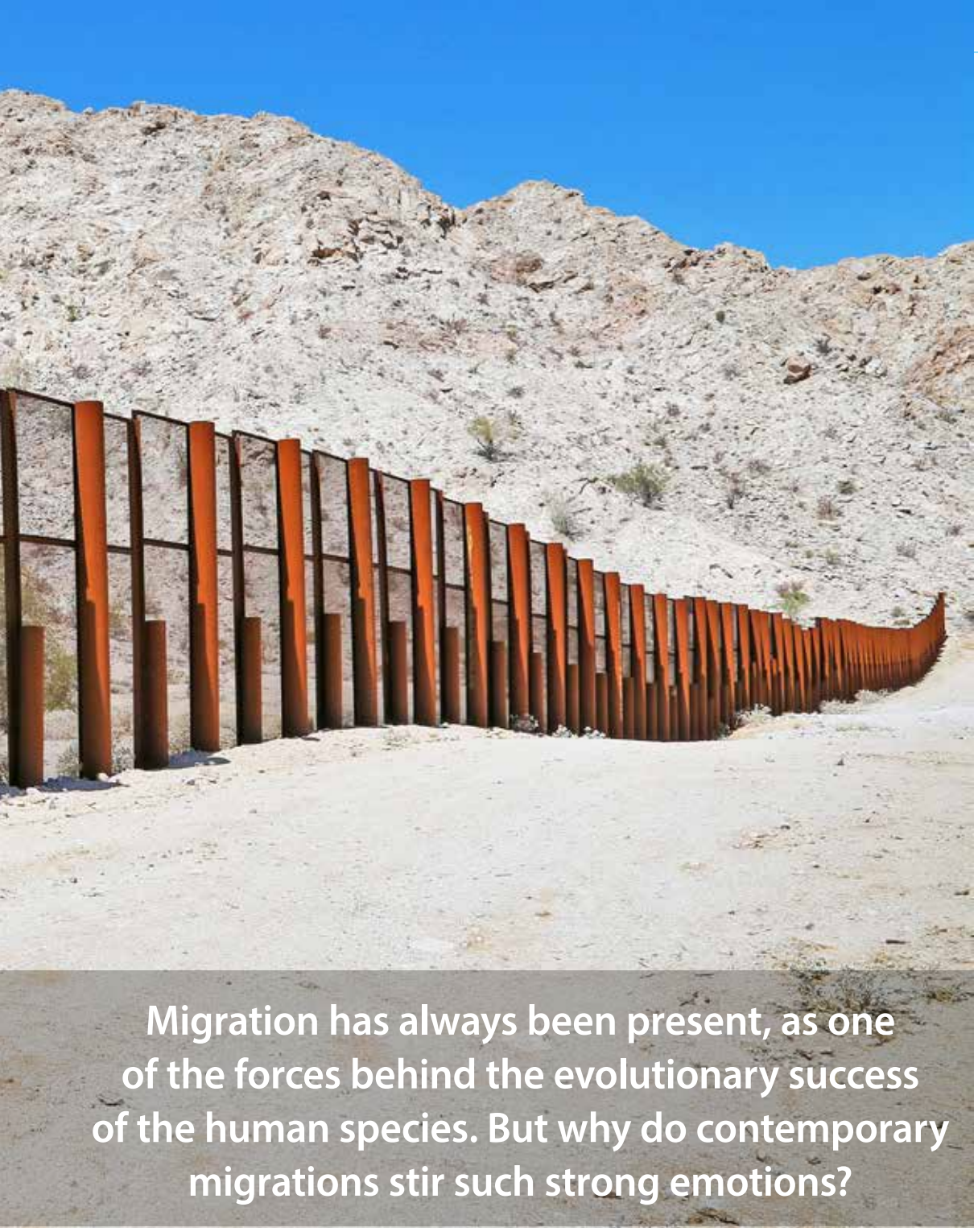
The words "migration" and "security" very often go hand-in-hand in political statements and media reports. Migrants are portrayed as posing a threat to the safety and security of modern societies – not only in Poland, but also in many countries of the Global North. As early as 2007, the world-renowned Polish social theorist Zygmunt Bauman noted that refugees are the modern-day embodiment of the wicked witches or goblins known from urban legends. Moreover, the term "refugee" is now applied both to people fleeing their homes to seek international protection and to various groups of unwanted migrants.

To migrate is simply to move from one country or region to another. When we think of migration, however, most of us are instantly struck with images of people climbing fences or crossing the sea on overcrowded boats. We do not imagine people travelling by airplane: ourselves or our friends traveling freely around the globe, going on vacation or seeking employment, winning scholarships to study in a different country, attending conferences, or moving abroad for love. This illustrates how divided the world is: between



Migration has always been present, as one of the forces behind the evolutionary success of the human species. But why do contemporary migrations stir such strong emotions?

RYAN M. BOLTON/SHUTTERSTOCK.COM

Large steel fence protecting the border between Mexico and the United States at the Tinajas Altas Mountains in Arizona (Sonoran Desert)

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some who do have the right to migrate – mainly white and rich inhabitants of the Global North, and others whose right to do so is taken away (or at least called into question) – persons of color, poorer people, inhabitants of the Global South.

People

When we think about the security threat posed by migration, we again think about ourselves, and about those who might be dangerous to us. In most cases, however, this threat is imaginary or abstract. Examples include the fear that we may lose our way of life. In the European Union, we even have a commissioner once officially described as being tasked with "protecting" our European way of life. And yes, this official's responsibilities include migration. When ordinary people are asked about their concerns related to migration, they are likely to mention the threat of higher crime, of terrorism, and – especially in Poland – a danger to the Catholic religion.

Such fears are easy to instill. This is done very adroitly by politicians – chiefly those from populist and right-wing parties, but such rhetoric is increasingly being pushed irrespective of party lines. Indeed, protecting national borders from "others" is now at the forefront of public debate. Migration is exploited as a talking point, to get voters to come out to the polls. Fearmongering about various groups of "others" (people portrayed as not belonging) has become an

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Migrants from Colombia at the US-Mexican border

increasingly prevalent message in political discourse. A stark example can be found in the Polish political scene over the past 20 years (with scare tactics ranging from the prospect of higher crime, to refugees, to fear of "gender ideology" and the LGBT+ community), but other countries have also taken a similar route. The threat posed by people on the move is typically found in narratives about borders (being protected from "attacks" and "invasions"), crime and terrorism.

These fears are often exaggerated, not backed up by evidence. Instead, they are fueled using lies or misrepresentations that have little to do with reality. Such misinformation campaigns are aimed at stoking up negative emotions, primarily fear.

But what does not get mentioned in these narratives? The safety of the migrants themselves. When this topic does very rarely turn up in the media, it takes the form of shocking images. One such example was the image of the body of a two-year-old Kurdish boy from Syria, Aylan Kurdi, found on a Greek beach in 2015 – he had drowned in a failed attempt to flee to Europe. Similar incidents also took place along the Polish border with Belarus, with migrants hiding out in the woods, suffering injuries and even dying, as reported by the activist group *Grupa Granica*. Emphasis is rarely placed on the reasons why people decide to flee their homes, on the desperation that drives them to leave places where people suffer harm, or on the journey itself and the related dangers. The latter are largely created by us, the societies of the Global North, through the hands of our elected politicians.

However, narratives that juxtapose "our" safety and security vs. "theirs" – in a nutshell, "us" vs."them" – are unnecessary. We can and should bring these two viewpoints together in the spirit of solidarity and shared responsibility for others, and remember that the safety of some people very often affects the safety of others.

Borders

The process of "protecting" borders takes place on several levels. On the legal level, it involves making it more difficult for citizens of many countries to legally visit the countries of the Global North. It is nearly impossible for them to obtain a visa. But without a visa, they are unable to travel by ship or plane. Unless they have valid travel documents, no one is allowed on board.

On the physical level, it involves erecting fences and walls. Such barriers are increasingly widespread: the Transnational Institute reports that between 1989 and 2018 walls were built along 58 borders, and the reason for building two-thirds of them was the prevention of migration, terrorism, and contraband of goods and human smuggling and trafficking. However, these physical walls, built at the cost of millions of euros, are not an effective barrier. Many people are so desperate that they find ways to overcome these walls. But this comes at the price of numerous injuries: bone fractures from jumping off the walls and cuts caused by barbed or, increasingly, razor wire. Over the past two years, we have observed such incidents on the Polish-Belarusian border.

On the electronic level, it involves installing electronic equipment along both land and sea borders. Sales of such equipment and border protection management services are a gigantic industry worth nearly $50 billion a year according to the Transnational Institute's estimates.

These tools are backed up by the actions of the border guard agencies, such as their growing use of violence against migrants. Here, we should ask what forms of violence we can accept as a society. Is shooting migrants one of them? If so, what does such a stance say about us and our values, which we are so proud of?

This elaborate system benefits individuals and organizations that facilitate illegal border crossings. These include both international criminal organizations and individuals. Without their "help," migrants are often unable to get from their countries of origin to the countries of the Global North. The International Organization for Migration (IOM) estimates that trafficking people from Latin American and the Caribbean into the United States alone brings in an average of $7 billion a year. However, smugglers earn such money only because legal migration channels are closed to these people. Consequently, the societies of the Global North are at least morally responsible

not only for the earnings of criminal organizations, but also for the deaths of migrants. Border security measures prompt migrants to attempt to cross borders in increasingly dangerous places – across deserts, seas, and raging rivers. According to the IOM's estimates, since 2014, 56,000 people have died trying to cross borders, and two-thirds of those deaths took place *en route* to Europe and the United States.

Crime

Let us now turn to the relationship between migration and crime. It is quite simply a myth that migrants commit more crimes than local inhabitants. Most studies demonstrate conclusively the opposite – that those who migrate in search of a better life commit far fewer crimes. They are primarily focused on earning money and supporting their families in their countries of origin or settling down in their new countries. Or, to put it another way, they simply do not have the time to commit crimes. Besides, getting caught and convicted of a crime entails serious consequences, which often include deportation. Therefore, engaging in crime means risking the failure of their whole migration project.

Of course, this does not mean that no migrant will ever commit a crime. Such situations do occur among migrants, as they do in every community. However, migrants as a group certainly do not pose a major threat. Many people link certain types of crimes with specific nationalities. Such accounts are most often untrue or largely exaggerated, and they are based on prejudice and stereotypes as opposed to facts.

Rising crime rates are typically seen among the children of migrants born and raised in a new country – a situation that results from the integration fiasco. These children want to be treated in the same way as their peers, but that is not the reality. Their prospects of success are hindered by the prevalence of xenophobic attitudes and the relatively poor financial situation of their parents. They have the same aspirations as their friends, but they cannot fulfill them in a legal way. But does this make them inherently more "criminal"? It does not, if we compare them with other individuals of the same socioeconomic status, but with no migration experience in the family. If truth be told, the responsibility for such behavior on the part of young people with migration backgrounds falls on the host society, which has excluded them and condemned them to a life of poverty, on the scarcity of jobs or the prevalence of low-wage positions, and on the lack of quality education.

The same holds true for the widely discussed French neighborhoods inhabited by people of African descent. Crime rates there are no higher than in other neighborhoods that have similar socioeconomic characteristics and are inhabited by white, ethnically French people. So why are the police afraid of these places? Because police officers too often misuse force or even resort to violence there, which makes them hated by residents of such neighborhoods. Both sides fear each other, which fuels mutual aggression and the use of violence for trivial reasons. Similar phenomena occur in American ghettos inhabited by black communities.

That said, the fact remains that individuals with migrant backgrounds are overrepresented in many European prisons. Why is this the case, if they don't actually commit more crimes? This results primarily from how the criminal justice system operates. Such individuals are more likely to be arrested by the police and remanded in custody (they stand out because of their skin color or because they live in bad neighborhoods) and to be sentenced to more severe punishments, including more frequent imprisonment, and less likely to be granted parole or released on bail. New types of crimes, ones that no one else commits, are also created to apply to them. Examples include illegal border crossing.

> It is quite simply a myth that migrants commit more crimes than local inhabitants.

Terrorism

Lastly, let's consider the topic of terrorism. As law professor Ilya Somin argues, the alleged link drawn between terrorism and migration results from political manipulation. No data confirm the allegation that an influx of migrants increases the number of terrorist incidents perpetrated by such individuals. This goes both for European countries and for the United States. Instead, we see a very different trend: a growing number of terrorist attacks against migrants, committed by alt-right groups.

A certain relationship between migration and terrorism can be observed – but it is back in the countries that people flee to seek refuge in safer countries, including the EU. Indeed, according to the Global Terrorism Index 2023 study, terrorist attacks occur most frequently in such countries as Afghanistan, Somalia, Syria, Iraq, and Nigeria: many nationals of these countries show up at the Polish-Belarusian border and ask for protection in other EU countries. ■

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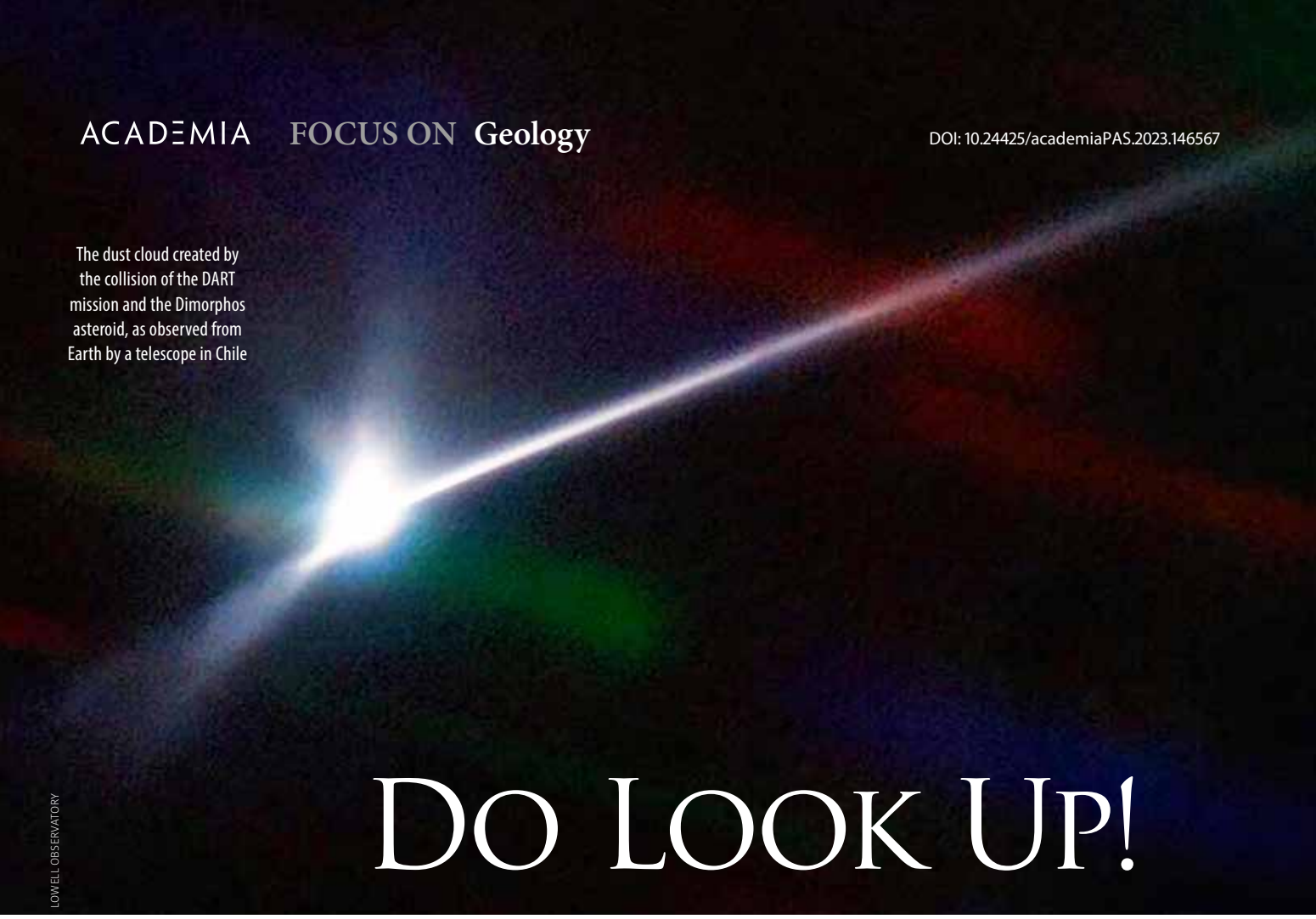

The dust cloud created by the collision of the DART mission and the Dimorphos asteroid, as observed from Earth by a telescope in Chile

LOWELL OBSERVATORY

Do Look Up!

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Every day, about 100 metric tons of extraterrestrial matter falls onto the Earth, most of it comprised of imperceptible particles.

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Tiny pieces of extraterrestrial matter, the size of grains of sand, enter the atmosphere all the time. As they heat up they leave behind a glowing trail, which we observe as "shooting stars." Such events are completely safe, and some people even consider witnessing them to be a lucky omen. But when much larger pieces of matter, asteroid-sized, strike the Earth, they may have truly catastrophic consequences.

Danger from space

Around 66 million years ago, the Earth was hit by one such asteroid, about 11 km in diameter, and the impact drastically affected the lives of all organisms on the planet. The event occurred in what is today Mexico, and the asteroid left behind a 180-kilometer crater named Chicxulub. Everything within a radius of 1,000 kilometers or more was engulfed by a fireball, anything within a few thousand kilometers was destroyed by a devastating shockwave, and territories as far away as today's Canada and even West Africa were hit by hurricane winds so strong that they sent giant trees flying like toothpicks.

For most of the organisms living still further away, the impact of the asteroid had little immediate effect. But even their world changed beyond recognition just a few hours or days later. A dense veil of dust blasted into the atmosphere by the impact enveloped the sky, turning day into dark evening. As a result, the temperature fell rapidly, perhaps even by more than 10 degrees Celsius. After that, plants stopped growing, which in turn caused herbivorous organisms to starve. Carnivorous animals and scavengers initially enjoyed an unexpected feast, but they were soon also left with nothing to eat. The largest particles of the

Don Davis's artistic concept of an asteroid impact with the Earth 3.5 billion years ago. The work was done by Bern Oberbeck and Dr. Kevin Azhnle of NASA's Ames Research Center. Source: NASA https://images.nasa.gov/details/ARC-1991-AC91-0193

material ejected into the air settled relatively quickly – up to a few hours later. But the smallest particles of dust stayed suspended in the atmosphere for at least several months, perhaps even years. The impact was so immense that these particles left behind a geological layer that can be observed all over the Earth. Composed of a mixture of asteroid and terrestrial rocks, its thickness varies from over 50 meters in Mexico to just a few centimeters in regions on the other side of the globe.

Long-term aftermath

The collision caused the Earth to experience rapid climate variations that continued for thousands of years, perhaps tens of thousands. Due to the specific location of the collision, the effects of the impact were disproportionately large given the size of the asteroid itself. The Chicxulub impact happened to strike a shallow, warm sea that had long been abundantly inhabited by organisms whose skeletons had formed carbonate rocks – composed mainly of calcium carbonate ($CaCO_3$), albeit with a sizable addition of sulfur dioxide (SO_2). When the asteroid slammed into the Earth, those rocks heated up, instantly releasing a huge amount of carbon dioxide, raising the temperature of the atmosphere. However, a significant amount of sulfur oxide was simultaneously ejected into the air, and this compound, especially if it reaches the stratosphere, causes the atmosphere to cool. Consequently, the subsequent tens of thousands of years were characterized by erratic shifts between warm and cold, as well as dry and wet periods. These chaotic changes in climate conditions were so rapid that organisms that had been perfectly adapted to life in the stable, warm climate of the Cretaceous (such as *Tyrannosaurus rex*) had no chance to adjust. The organisms that did survive were ones that were versatile and capable of easily adapting to change.

The Chicxulub catastrophe 66 million years ago is nevertheless the only case of a global extinction event that was caused by the impact of an extraterrestrial object. Stretching 180 kilometers across, the Chicxulub crater ranks as the world's third-largest impact crater – after the Vredefort structure in South Africa (about 300 km across) and the Sudbury structure in Canada (originally 200 kilometers). We do not really know what effects these two gigantic impacts had on our planet, but they both occurred roughly 2 billion years ago, back when the Earth was still inhabited only by relatively simple, single-celled organisms resembling today's bacteria, which did not go extinct that that time.

Small asteroids

Smaller, but still relatively large collisions, with asteroids more than a few kilometers in diameter, are also

very rare. On average, they happen every few million years, or perhaps every few tens of millions of years – the larger they are, the longer we have to wait for the next impact of similar size. The human race has typically witnessed collisions with smaller asteroids, ranging from a few meters up to tens of meters in diameter, which in turn may result in the formation of craters from tens of meters up to a few kilometers wide. These smallest events are relatively frequent, occurring once every few decades to every few hundreds of years. For example, over the past 120 years, we have seen five such notable collisions, and only some of them resulted in the formation of a crater.

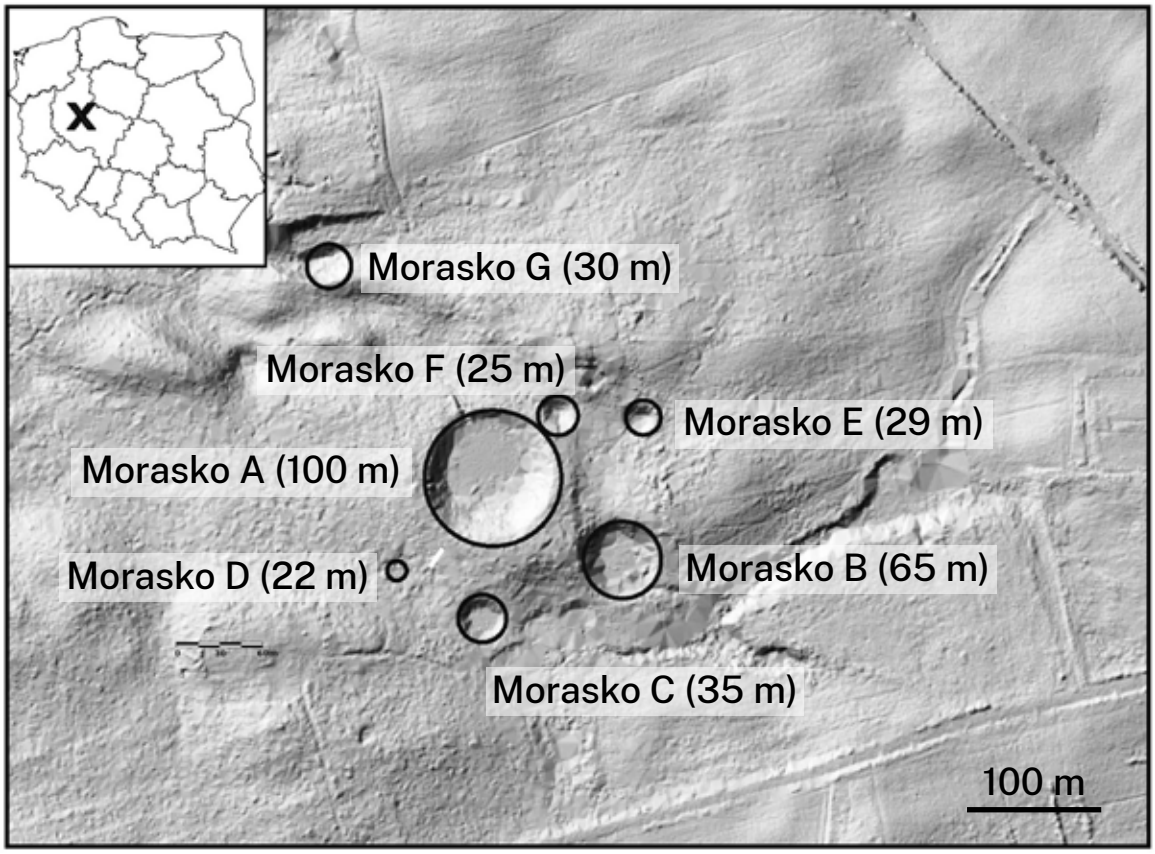
The most recent important event of this kind happened in 2013, when a rocky asteroid exploded in the atmosphere over the city of Chelyabinsk in central Russia, causing a shockwave leaving more than 1,500 people injured. Previously, in 2007, an asteroid around half a meter in diameter slammed into a field in Peru near the village of Carancas, creating the youngest and smallest impact crater on Earth. In 1947, an "iron rain" descended upon the Sikhote-Alin Mountains, about 300 kilometers north of Vladivostok, creating a group of impact craters and giving quite a scare to the Soviet troops stationed there (this came, after all, not long after the use of the atomic bombs in nearby Japan). But it was back in 1908 that what may have been the largest extraterrestrial body in recent history exploded over Siberia near the Tunguska River. It was probably slightly over 50 meters in diameter, but despite the huge swath of destruction it left behind, there was no crater – it is suspected to have been similar to a comet, composed mainly of dirty ice. Its explosion while still in the atmosphere caused large trees located even 30 kilometers from the impact site to snap like matchsticks.

Most such events, impressive as they most certainly were at the time they occurred, do not leave lasting traces in the geological record. If we had not seen the explosion over Chelyabinsk with our own eyes, after several weeks or months, we would have been unable to distinguish the effects of such a sizable explosion from those of an ordinary storm. The traces of the explosion over Tunguska remained visible for about 20–30 years, but they were later covered over by the regrowing forest. The Carancas crater also disappeared almost without a trace within a few years – the small hole in the ground came to be filled in by sediments carried by a nearby river. The only recent impact whose traces will still remain visible for at least several hundred years is that caused by the Sikhote-Alin incident.

Traces left by collisions

If we can't identify the traces of such local microcataclysms, then how can we study them? Fortunately, some of them do leave scars on the Earth's surface, which remain recognizable for thousands of years. On Earth, we currently are aware of a dozen-odd such crater impact sites, ranging from 15 meters up to a few hundred meters in diameter. One such site is situated in Morasko, on the outskirts of the Polish city of Poznań. It is actually a group of seven craters, all of them formed at the same time, when a roughly 20-meter iron asteroid broke apart while passing through the atmosphere. When the largest such fragments struck the Earth at a speed of several kilometers per second (several times faster than a bullet fired from even the very best sniper rifle), they literally exploded. Consequently, a fragment that was itself about a meter in diameter formed the main crater, nearly 100 me-

Photo of the author at Estonia's largest crater, named Kaali



A digital terrain model showing the Morasko group of craters (based on data from geoportal.gov.pl)

ters across and tens of meters deep. Several similar, but smaller structures were formed nearby, and the entire area was showered with iron meteorite fragments. Over the past several thousand years, similar events have occurred in various locations on the Earth. Examples include the Kaali crater in Estonia and the Campo del Cielo craters in Argentina.

It has recently turned out that even impacts from such tiny asteroids can have truly catastrophic consequences, albeit on a very local scale. Scientists have dug through material ejected from four different impact craters located on two continents. They took samples in three different countries: Estonia (the craters Kaali Main and Kaali 2/8), Poland (the Morasko crater), and Canada (the Whitecourt crater). Those craters were formed thousands of years apart, but they had one thing in common – all of them contained charred fragments of organisms that had died during the cosmic catastrophe.

Planetary defense

The diameter of an impact crater is usually 10–20+ times larger than the diameter of the asteroid that formed it. For example, an asteroid with a diameter of about 100 meters that moves at a speed of about 20 kilometers per second will form a crater 1.5–3 kilometers in diameter. The exact size and range of the destruction zone depends on the angle of impact, the type of the asteroid, and the type of material it collides with, and many other factors. But if a similar celestial body decided to target Warsaw's Old Town Square, for instance, the ejected fragments of our capital city would reach Berlin, Prague, or even Budapest. Such a collision would trigger an earthquake that could damage buildings in Vilnius and hurricanes that would shatter windows in Gdańsk, and any people who happened to be outdoors within a radius of about 30 kilometers from the impact site, or up to the Warsaw suburb town of Nowy Dwór Mazowiecki, would suffer first-degree burns. Most of Warsaw would be covered by a several-meter layer of ejected material, leaving behind a hole in the ground that would be around 3 kilometers wide and 650 meters deep.

Fortunately, as long as we know early enough that such a danger is approaching, we can do our best to mitigate it. This year, we witnessed the space mission named DART (Double Asteroid Redirection Test), which included the first real test of the planetary defense system. A tiny spacecraft that weighed just 600 kilograms collided with a small 160-meter asteroid and successfully altered its orbit. And so, as long as we draw the right conclusions from the movie *Don't Look Up*, we still do have a chance to prevent a true disaster. ■

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Equilibrium Upset

21 February 2023, US President Joe Biden at the Royal Castle Gardens in Warsaw, Poland, delivering a speech on the anniversary of the Russian invasion of Ukraine, as part of a visit to Poland

Paradoxically, Europe is now more secure than it was before the war in Ukraine, although challenges still abound.

Roman Kuźniar

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If we can judge Europe as being more secure today than it was prior to February 2022, it is because we did not then realize the extent of the threat of Russian aggression against Ukraine and its possible implications, and because we underestimated the Russian president's determination to carry out his plan to "pull together the Russian lands" and return Ukraine to the motherland (which Putin considers to be Russia) using military force akin to what Germany did to Poland in 1939. An overt threat is less dangerous than a covert one, because we can prepare for it. Moreover, we in Europe also overestimated Russia's military capabilities, in the sense of the Russian Army's capacity to fight a modern war. Russia's military potential was regarded as powerful, and its armed forces as the second- or third-ranking military in the world, which could easily crush any country in its neighborhood except China and the bloc of NATO countries. Yet in the course of this war, the Russian Army has proven itself to be sluggish, poorly commanded, underequipped due to corruption, and logistically inefficient. Ukraine is dramatically beleaguering this "invincible" army, causing it great losses in personnel and equipment (albeit at great cost to itself). Thanks to Ukraine, the offensive potential of Russia's armed forces has been greatly reduced.

Standards of security vary for different areas of Europe. Some countries enjoy a high level of security (due to their location, defense potential, alliances); this mainly applies to northwestern Europe. But there are also other countries, mainly in southern and eastern Europe, that are considered less secure. The main dividing line, however, runs between NATO and EU countries on the one hand, and non-members of these

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communities on the other. The latter, irrespective of their own weaknesses, are exposed to intimidation and destabilizing provocations on Russia's part, even if the latter is not in a position to directly threaten them militarily. The importance of belonging to the North Atlantic Treaty Alliance for the security of European countries is evidenced by the prompt reaction of Finland and Sweden to Russia's aggression against Ukraine. Both countries – proud of their traditions of neutrality, stretching back many decades – immediately declared their desire to join NATO; Finland has already managed to become a member of the Alliance (in April 2023).

The improvement of the security situation in Europe is not just an ironic outcome of Putin's catastrophic mistake to launch the aggression against Ukraine, with all the negative consequences of that decision for Russia's potential and position. We should also mention the Russian regime's evolution towards totalitarianism, which will hamper the country's economic performance and developmental prospects, and consequently its ability to pose a threat to its surroundings. All these factors lie outside Europe's control.

But there is also the flip side of the coin. Under the influence of the Russian aggression, there has certainly been a security awakening within Europe. The events of February 24 (and thenceforth) sounded a loud alarm bell for European countries. In response, they have taken multidirectional measures to bolster their own, and above all European security.

The North Atlantic Alliance

Sweden's and Finland's decision to join NATO is of symbolic weight, evidencing the pact's great importance for Europe's security. It has reacted decisively to Russia's aggression by strengthening its eastern flank (primarily by stepping up the US military presence there) and requiring Member States to boost their defense spending. Back when the Soviet Union was collapsing, a member of the Soviet politburo once warned the Americans that they would have the worst

thing happen to them: their enemy would disappear. The implication was: "Now it will be difficult for you to maintain the cohesiveness of the West." Putin has given the West, especially Europe, a common enemy again. Europe, as part of the Alliance, had to react to this. This, of course, is favorable for the security of the entire continent.

The credit for strengthening Europe's security in the wake of Russia's aggression against Ukraine is not only due to NATO, but also to the Europeans themselves. The most spectacular manifestation of this change in attitude towards security has been the famous *Zeitenwende* (epochal turn) in German policy announced by Chancellor Scholz three days after the Russian invasion. Although in the Chancellor's speech before the Bundestag the term *Zeitenwende* was used to describe Russia's aggression itself, the term was soon used to refer to the attendant shift in German policy. At least three elements deserve to be recalled here. The most important was the announcement of an additional 100 billion euros to strengthen the German Armed Forces and to reach the Allied defense spending threshold (2% of GDP) within a few years. The pivot in Germany's foreign policy has included a radical turn in Berlin's relations with Moscow. Russia has been recognized as a threat, which has translated into energy policy: the objective of complete independence from the Russian hydrocarbon supplies. This is indeed a sea change, given the previous special relationship between Germany and Russia, which had deep historical roots (stretching back to Peter the Great). Germany is now poised to become a pillar of European security within 5–10 years.

Energy security

When talking about the security of a country, or even a continent, it is important to clarify the concept in at least material and geographical terms. In the view of the Copenhagen School, which has been popular for several decades, security has no boundaries in the material sense. As for the criterion of geographic scope, one can argue whether or not the recent high-profile case of Taiwan falls within the concept of "our" security. Until recently, EU and NATO countries were eager to participate in out-of-area operations, away from their borders, because they believed their security required it. Today, that has changed.

Energy security comprises an important part of security by any definition. Although it is not directly related to a country's independence or territorial integrity, without energy no country can survive or develop. Europeans, especially those in the EU, attach great importance to energy security, all the more so because the Old Continent's energy resources have been heavily depleted. In Europe, efforts to ensure energy security have for some time now gone hand-in-hand with concern for climate and environmental protection. The two challenges cannot always be optimally combined, and sometimes they are at odds. It is largely thanks to the EU's programs, which are negotiated and ultimately accepted by the Member States, that Europe as a whole is not faring badly in terms of energy security.

It was only through close cooperation within the EU, notwithstanding the national efforts, that it was possible after February 24 to quickly wean Europe off the supply of energy commodities from Russia – which previously had shown a tendency to treat such supplies as an instrument of its policy, and sometimes as a means of pressure and blackmail. The previous dependence of a large share of the EU countries on Russia was excessive and quite simply unwise. The country's war against Ukraine helped diversify Europe's supply of energy resources. In parallel, the EU has accelerated the increase of the share of renewable

Kharkiv, Ukraine, 31 January 2022. An armored personnel carrier column, on the move as Ukraine prepares to defend itself against a Russian invasion

SENELINE/SHUTTERSTOCK.COM

ALEXANDROS MICHAILIDIS/SHUTTERSTOCK.COM (2)

Photo 1
Finnish President Sauli Niinistö and NATO Secretary General Jens Stoltenberg at a press conference during a meeting of NATO foreign ministers in Brussels, Belgium, 4 April 2023

Photo 2
European Commission President Ursula von der Leyen (right) and US Secretary of State Antony Blinken making a statement to the media before a meeting at EU headquarters in Brussels, 4 March 2022

energy sources in the so-called energy mix (the proportion of different energy sources that contribute to each country's energy security). There is a priority on energy from wind, solar, and hydrogen, while nuclear power is also returning to favor in many countries. This is combined with the transition to a low-carbon economy and transportation. The whole effort is referred to as the "Green Deal," after the name of the major European Commission program launched in 2019, and reinforced by the European Reconstruction Fund adopted by the EU in the wake of the COVID-19 pandemic. All this is almost as important for the security of Europe, especially its people, as is increasing the military capabilities of the countries on the continent in the face of Russia's aggression against Ukraine.

Other risks

One threat the EU has been facing for some time is uncontrolled migration, which surged about 10 years ago due to conflicts in the Middle East and Africa. Some European countries unfortunately had a hand in triggering or fomenting these conflicts (e.g. in Iraq, Libya, Syria). The ease of entering Europe, coupled with the willingness on the part of some EU countries at the time to accept this increased wave of immigration, has made the EU area the target of constant migratory pressure. Trafficking people into Europe has become a lucrative business for organized crime in the neighboring countries to the south, and also – as in the case of Lukashenko's regime in Belarus – a kind of weapon to be leveled against the community. In European countries, this triggers negative reactions, in the context of cultural security and social cohesion. Combining the requirement of humanitarianism with the requirement of border control is in this case not easy. This problem of the continent's security remains unresolved despite the increased efforts of individual countries and the EU as a whole to stem uncontrolled migration. Thanks to the close cooperation of relevant services within the EU, the threat of Islamic terrorism, which only 10–15 years ago was taking a bloody toll in Europe and contributing to an atmosphere of fear (including in connection with migrants), has been brought under control. For the first two decades of the 21st century, terrorism, not just Islamic terrorism, was regarded as a major threat to Europe's security.

The Old Continent does not yet feel the threat posed by the transition from a liberal international order to multipolar power politics. China's rising potential and geopolitical aspirations play a great role in this process. China's influence is growing in Central Asia, the Persian Gulf, and Africa. A shift toward a more conflict-oriented Chinese policy could be precipitated by the Taiwan issue. Although the Europeans are trying to prevent a cold war between the West and China, one could nevertheless materialize regardless of their will. EU security policy cannot ignore this problem.

★ ★ ★

Europe's security problem remains its dependence and inadequacy when it comes to traditional, military security. Here it must rely on the US and NATO, of which it is a part. The development of a common EU security and defense policy, let alone EU strategic sovereignty, is proceeding with difficulty. In non-military spheres, however, Europe's security is in much better shape. In this respect, the situation of the EU countries and the Union as a whole is better than any other part of the world. The EU deserves great credit for this, as an innovative security community. This is worth appreciating, and the Union itself is worth strengthening. ■

Further reading:

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Securing Tomorrow's Energy With Biogas

Associate Professor Paweł Kowalczyk of the PAS Institute of Animal Physiology and Nutrition explains how research on animal feed can – perhaps surprisingly – improve our health and help bolster Poland's energy security.

You conduct research at the intersection of food safety and energy security – two areas that are not immediately perceived as interconnected in any way.

PAWEŁ KOWALCZYK: Our Institute's core research is related to veterinary medicine and agriculture. In medicine, we analyze tissues of farm animals and implement the findings of this research in the context of various systems in the human body. Research on the circulatory system and organs of the pig, including the heart, provide an excellent model for studies of ischemic events in humans. With this goal in mind, we organize workshops addressed to medical and veterinary students. We want future doctors to work on animal heart tissue, for example in cardiology and veterinary medicine, and to learn the anatomy of heart valves.

In addition, we conduct research related to agriculture, more specifically the analysis of nutrients in the diet of animals that receive animal feed. We check which ingredients can cause inflammation in

Innovative Agricultural Biogas Plant utilizing a revolutionary "biotechnological accelerator"

PROF. JACEK DACH, UP

the tissues of the digestive tract in animals. Ingredients used in the food consumed by pigs and present in their feces may have a considerable impact on energy security.

In what way?

Pig farming results in the production of a large amount of manure and slurry, and their piles can be seen lying on fields. It is a huge waste not to put this organic material to use. Moreover, manure slurry – which a liquid, fermented mixture of livestock feces and water (from washing stands and watering animals) – easily soaks into the ground, and if it is handled incorrectly it can pose a threat to the environment.

We should bear in mind that the European Union must reduce the emissions of greenhouse gases, such as methane and nitrous oxide, by a net 55% by 2030 because the border tax on CO_2 emissions will come into effect in the following years. To avoid this tax, we should look for alternative energy sources. At our Institute, we are therefore developing and optimizing research work related to animal nutrition.

The large surpluses of manure and slurry generated from pig farming could be a valuable source of potentially useful biomethane. Biogas plants with a capacity of 0.5-1.5 MW could be built alongside agricultural facilities. State-owned companies are interested in building such facilities because they could use such substrates in biogas plants.

To produce manure and slurry more efficiently, livestock animals must be fed efficiently, or with feed high in protein and macro- and micronutrients. Our role as scientists is to study, optimize, and select feed and nutrients that can fully meet the needs of animals, while simultaneously allowing them to produce manure efficiently with no detriment to their health. The best feed mixtures are based chiefly on high-protein plants from the legume family, such as the medick, the soybean, the broad bean, and the horse bean.

Do these mixtures also affect the quality of the meats produced from these animals?

Yes. By using food mixtures rich in micro- and macronutrients, we want to produce beef or pork with special, health-promoting properties. We hope that by producing such meat we can contribute to reducing the incidence of modern lifestyle diseases, such as atherosclerosis and heart disease, and such neurodegenerative disorders as Parkinson's disease and Alzheimer's disease. Unfortunately, typical Polish cold cuts and sausages do not yet have such properties. Of course, some small factories produce high-quality cold meats and cheeses using home methods. Such products contain much smaller amounts of harmful fats. We also want people to eat healthier meat and sausages and thus take better care of their health. We are collaborating with many scientific and medical centers in Poland in this field, as a result of which complementary and interrelated systems of health and food safety and energy security can be created.

Are the climate costs of animal husbandry offset by the production of biomethane from animal feces?

Animals are natural incubators of biomethane, which is released into the atmosphere on a daily basis. Chemically, biomethane and methane are the same substance. The only difference lies in their origin and in the level of greenhouse gas emissions associated with their combustion. Unlike methane, which is the main component of extracted natural gas, biomethane is formed through the fermentation of biological waste (feces, wastewater, distillery waste, and waste from fruit and vegetable production). Burning biomethane, either pure or contained in biogas, is likewise linked to the emission of carbon dioxide, but this is carbon dioxide that has been drawn out of the atmosphere relatively recently by crops. In simple terms, burning biomethane results in net-zero emissions of CO_2. In other words, we release into the atmosphere what was extracted from it, so the overall level of greenhouse gases in the atmosphere does not grow.

> By producing good-quality meat, we can contribute to reducing the incidence of diseases such as atherosclerosis, heart disease, Parkinson's, and Alzheimer's.

Burning natural gas, on the other hand, involves reintroducing CO_2 that has been trapped underground for millions of years. More greenhouse gases in the atmosphere lead to higher mean temperatures and climate change. As scientists, we want to bind this methane and put it to good use. Biogas extracted in this way can be stored in special tanks and sold on exchanges for heat and energy production. Traditional agricultural biogas plants produce biogas with methane content at the level of around 55%. After purification in special modules, it is used to produce biomethane with methane content of about 98%, which is around the level found in natural gas. Poland's biomethane production capacity is estimated at up to 8 billion cubic meters, but practitioners believe that this figure will be up to 4 billion cubic meters, taking into account the limitations related to the availability of substrates and to the gas network. Biogas plants truly are the

PAWEŁ KOWLACZYK

future for our country. According to estimates by leading state-owned companies, to produce 2 billion cubic meters in Poland, which is how much is needed to create the most optimal energy mix, we would need around 10,000 biogas plants of about 0.5 MW. This solution will work best for smaller cities of up to several thousand inhabitants. The future belongs to modern energy sources, and biomethane plants are among the stable and environmentally friendly ones.

What does this look like in practice?

If farmers want to have biogas plans, local-government leaders can notify the National Support Center for Agriculture (KOWR), for example, and fill in applications for financial support under the program "Energy for Rural Areas." Poland has nearly 150 small biogas plants with a capacity of 0.125 MW. They are used to power houses or barns. Building a small biogas plant costs about 250,000 zlotys, and the net cost of a large plant, or one with a capacity of 0.5 to 1.5–2 MW, is around 16 million zlotys. If you want to invest in a larger plant, you can build a suitable installation and connect it to the existing power or gas installation. The best locations are areas of former State Agricultural Farms, small housing estates, nurseries, preschools, and small towns. In the future, biogas installations may be built in larger cities too.

In Germany, there are now already 9,500 biogas plants. In Poland, we're still grappling with certain psychological barriers. For example, people think that biogas plants emit unpleasant smells. But this is not actually true. Besides, anyone who sets up a biogas plant and compares their energy bills before and after will realize that we really should take advantage of this innovation. The establishment of new plants may soon be accelerated by the Biogas Plant Act. This bill stipulates that biogas plant projects can be initiated, for example, by natural and legal persons that run agricultural farms, wine producers, and energy cooperatives. Biogas plants will have to use the substrate generated on such farms. This holds great potential – we already produce more than 1 million cubic meters of manure slurry per day, which could be used for this purpose.

What could be the share of biogas in Poland's energy mix?

It is estimated that this share could reach 45% by 2030, even more in the following years. It's worth mentioning that one biogas plant generates about 3 million zlotys in profit every year. Initially, you have to invest more capital, more specifically around 16 million zlotys, but you can apply for targeted research grants or subsidies from government agencies. Biological and other organic waste can also be used in biogas plants, but we should remember about the need for methane bacteria. Moreover, biogas plants can also be used for cooling. In other words, we can use them to keep warm in the winter and keep cool in the summer.

Have such solutions been used worldwide?

Yes, but they lost impetus after the initial phase. Those were mostly small projects. A biogas plant produces fuel in a steady and predictable manner, thus powering gas-fired cogeneration plants. By using innovative technologies, companies could gain energy security and independence and simultaneously reduce their net greenhouse gas emissions. In Germany, the first biomethane plants were established in 2006. By May 2021, it had already 232 such plants. Other countries that support biomethane production include Denmark, where the authorities expect it to meet 75% of the country's gas demand as early as 2030 and 100% in 2034. These examples demonstrate a very promising outlook for the development of biogas plants in Poland.

Interview by **Justyna Orłowska, PhD**

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Losing the Ground Beneath Your Feet

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Any insufficiently understood dynamic geological process can be potentially dangerous.

Drone view of the active part of a landslide in Kasinka Mała, in the municipality of Mszana Dolna

KRZYSZTOF KARWACKI, 2019

Adam Karol Chaszczewicz

Polish Geological Institute
– National Research Institute (PGI-NRI) in Warsaw

ADAM CHASZCZEWICZ, 2023

Cracks forming in the walls of a residential building built on landslide colluvium – Dąbrówka Starzeńska, Dynów municipality

The theme of a natural disaster destroying homes, villages, or even whole cities has captured people's imaginations since the dawn of civilization. Ancient texts are replete with the stories of such events. The Epic of Gilgamesh tells the age-old tale of a devastating flood. The story of the annihilation of Sodom and Gomorrah in the Bible may be linked to the seismic activity of the Dead Sea rift. Letters written by Roman officials and intellectuals provide us with accounts of the eruption of Mount Vesuvius and the destruction of Pompeii. Later medieval and modern texts also bear testimony to natural disasters. One example is the mention of a rockfall on 24 August 1598 near Bardo Śląskie, which, briefly blocking the channel of the Nysa Kłodzka River, almost led to the flooding of the entire town. These days, we are not helpless in the face of such violent natural phenomena. They are the subject of intensive research, helping us to try to anticipate them and prevent their disastrous aftermath.

Underestimated Dangers

The term "geological hazards" (or "geohazards" for short) refers to various dynamic processes whose impact on the Earth's surface poses, or could potentially pose, a danger to people's lives or wellbeing, to infrastructure or property, or to the natural environment. Apart from earthquakes, floods, landslides, and volcanic eruptions, the category "geohazards" also includes hurricanes, tsunamis, meteorite impacts, weather anomalies, and even major shifts of the Earth's magnetic poles. The term is therefore not a synonym for natural disasters, but rather draws attention to how any insufficiently understood dynamic process affecting the Earth could prove dangerous to people and might cause damage on a hard-to-anticipate scale.

Poland enjoys a seismically relatively stable location, situated far from the edges of tectonic plates and volcanically active zones. It is also quite distant from warm tropical waters. As a result, an incorrect conviction long prevailed that the country did not have to be very worried about geohazards. Although newly occurring landslides had been noted regularly in the Carpathian Mountains since the eighteenth century, for quite a long time it was still not realized how significant a problem they actually represented. In the twentieth century, as wetter periods occurred every few years, or every decade or two, intense precipitation increased the occurrence of downslope movements of large amounts of rock and soil ("mass movements"). Major incidents of this sort are referred to as "landslide disasters". After each such disaster, the public takes a greater interest in the issue, but only briefly so. This situation continued essentially through most of the twentieth century. Although several regional studies were carried out in Poland in the decades after WWII, and in the late 1960s the first nationwide survey was undertaken, the available data remained insufficient to fully evaluate the scale of the danger. It is now estimated that, by the beginning of the twenty-first century, nearly 10,000 individual landslides had been identified in Poland's segment of the Carpathian Mountains alone, plus 2000–3000 more in other parts of the country.

A major turning point in the history of landslide research in Poland came in 1997–2001. Heavy precipitation and rapid thawing, flooding, and waterlogging occurred repeatedly over that period, leading in certain places to subsequent landslide disasters. Influenced by these tragic events, the Landslide Counteracting System (LCS, also known by its Polish acronym SOPO) was launched in 2006. It was originally intended that nationwide mapping work would lead to some 20,000–30,000 landslides being inventoried. However, the results exceeded expectations. Currently, after the SOPO project's more than 16 years of operation (as of May 2023), more than 70,000 landslides are registered in the project's database. However, the mapping work has still not been completed, so the number continues to grow. The true value of the Landslide Counteracting System became clear in 2010. When another landslide disaster struck, specialists were able to provide ongoing support to local authorities in countering the impact.

Reactivated after long years

Landslides are geological formations that occur in the near-surface zone of the Earth's crust as a result of gravitational displacement of rock material, shifting

along the surface of a rupture, slip, or flow. A landslide is a type of mass movement. It occurs due to the discharging of stresses present in unstable slopes or hillsides. The effect is to break the continuity of the rock masses, forming a shear plane, along which gravitational sliding of material occurs. This surface generally takes the form of a shallowly situated fault, with a mostly cylindrical, sometimes rectilinear shape. The displaced rock formations, referred to as colluvium, usually form characteristic landforms such as scarps, toes, ridges, grabens, and depressions.

The factors leading to the activation of mass movements are numerous. In most cases, slopes and hillsides become unstable after periods of intense rainfall, snowmelt, or flooding. Water reduces the angle of internal friction within the rock medium and acts as a lubricant for discontinuities existing in the ground. The geological structure of the area is also an important factor. The arrangement of rock layers, their compactness and permeability parameters have a considerable influence on the stability of slopes. The role of the land relief and the undercutting of slopes by watercourses should not be overlooked either. Importantly, human activity can also be a factor triggering the activation of mass movements – overburdening a slope by constructing buildings on it, undercutting a slope by digging trenches, or following improper cultivation and land reclamation practices can all be conducive to them.

Landslide-damaged fragment of road between Wetlina and Brzegi Górne

KRZYSZTOF KARWACKI, 2022

The sliding of rock masses usually leads to the formation of characteristic relief elements. Their presence is so indicative that they are one of the criteria used in geological mapping work to determine the presence of a landslide at a given site. However, the typical colluvium surface relief becomes obscured over time. Partial or full leveling of the landslide surface, however, does not mean that the discontinuity within the ground ceases to exist. Once established, the discontinuous form may be inactive for hundreds or thousands of years until, under favorable conditions, the stability of the slope again becomes breached. The same is true of landslides that have been deliberately covered over as a result of various earthworks. The only fully effective practice for eliminating a landslide is to remove the colluvium all the way below the slip surface. However, this is only possible for small forms. If this cannot be done, landslide stabilization measures need to be taken. This is a complicated operation, usually involving major financial outlays. Therefore, the most common and simplest practice is to exclude areas affected by mass movements from use.

Unfortunately, due to relatively low public awareness of the threat of landslides, the ad hoc refilling and leveling out of their characteristic relief features is a common practice in Poland. In such cases, the memories associated with mass movements in that location quickly become forgotten or deemed no longer relevant. A decade or two later, the area in question may even come to be considered stable and attractive as a location for investment. Such a process of forgetting is referred to as "landslide amnesia" and, unfortunately, can lead to tragedy if a leveled landslide becomes active.

The SOPO project

Most of the landslides identified so far in Poland are located in the Carpathian Mountains, running across the southeast of the country. Particular ranges such as the Beskids, Bieszczady, and Carpathian Foothills are most threatened by mass movements, mainly due to their characteristic geological structure. They are dominated by successive layers of sandstone and shale, comprising a system particularly susceptible to landslides. It is estimated that mass movements in the area affect the living conditions of several hundred thousand residents of communities in the Carpathians. Sometimes farms, hamlets, or almost entire villages and settlements turn out to be situated on landslide areas. Sections of local roads, public utility networks, and telecommunications infrastructure are regularly

PIOTR NESCIERUK, 2010 (4)

Devastation caused by a landslide in Kłodne, Limanowa municipality

destroyed there. Landslides also occur in large numbers in the intensively expanding urban agglomerations of Rzeszów and Kraków, and in the foundations of national roads, expressways, and highways. Geological formations located on the slopes of artificial reservoirs also pose a great threat: a sudden slide can give rise to a huge wave on the lake, forcing water to overflow the crown of the dam. One reservoir known to be at such risk is Lake Międzybrodzkie in Silesia. Landslide formations have also been a major problem in the design of natural gas pipelines linking Poland and Slovakia.

However, numerous landslides can also be found in Poland outside the Carpathian Mountains, although they are much more dispersed and the danger they pose is generally local. For instance, they can be found in the Sudetes, as well as in other mountainous and highland areas of southern Poland. They are observed within the loess covers of the Lublin region and in karst areas. They also occur in post-glacial formations in northern Poland – including in the slopes of lake troughs and moraine hills. They are commonly identified in the slopes of river valleys and their headwaters. Particularly distinct forms are found in the Vistula River valley on the banks of the Włocławek Reservoir. The coastal strip along the north of the country is also not free of them, as they occur in large numbers in cliff-like areas.

Extensive research on landslides and areas threatened by mass movements in Poland (which is among the tasks of the Polish Geological Survey) is pursued by by the Geohazards Center of the Polish Geological Institute – National Research Institute (PGI-NRI). The maps of landslides and terrains prone to mass movements developed under the Landslide Counteracting System (SOPO) project are now being used by many public and private entities. The results and progress of the ongoing landslide inventory can be viewed via a web application (available only in Polish) available under the link given at the end of this article. The project also monitors selected formations using drones, laser scanners, satellite technology, borehole surveys, and GPS measurements. The SOPO project is divided into stages. During the current third stage, ending in 2024, plans call for mapping work in the Carpathian region to be completed. In the next stage, we will then intensify our efforts in the rest of the country, already started in previous years. ■

Further reading:

Landslide FAQ by the US Geological Service: https://www.usgs.gov/faqs/what-landslide-and-what-causes-one

The research journal *Landslides* https://www.springer.com/journal/10346/

The SOPO project application: https://www.pgi.gov.pl/osuwiska/123/aplikacja.html

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Keeping Artificial Intelligence Under Rein

Rapidly developing artificial intelligence technologies are expected to help us in various sectors of life, but their applications also entail certain risks.

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Artificial intelligence (AI) is transforming our world in revolutionary ways. The possibilities it open up appear limitless: from autonomous drones to personalized medical treatments. But growing reliance on AI also raises the need to address the emerging safety concerns.

In January 2017, the Shadow RQ-7Bv2, an unmanned aerial vehicle (UAV) used by the US Army for reconnaissance, took off from its launch pad at a training range in southern Arizona in a typical military exercise. Drones of this type, which are typically used for simple terrain observation and guidance of artillery fire, have a range of up to 77 miles, or roughly 120 kilometers, from the ground control station. That particular drone, however, was different: it was fitted with enhanced capabilities to act independently (with autonomy). Once it left the launch pad, the control station lost all communication with the device, which soon began a surprising journey. Immediately after the launch, it changed its course towards the Rocky Mountains and disappeared.

The operators were convinced that the drone would crash against the mountain slopes: it had a limited range and was not designed to operate at high altitudes. But the aircraft somehow managed to rise to an altitude of 4,000 meters and fly across the entire mountain range. It crashed 600 kilometers away from the launch pad, most likely because it had run out of fuel. It remains unclear why the drone performed the whole flight or how it accomplished it. It is suspected that air currents may have played a key role in that they not only extended the drone's range, but also helped it attain the necessary altitude. The direction it chose to take was yet another mystery. Since the reconnaissance unit had been earlier stationed at a base in this part of the country, the device's memory may have retained the coordinates of its former base, and poor Shady – as the press dubbed the drone – was simply "trying to go back home."

Unpredictability

The incident offers a compelling illustration of several key problems arising out of the development of AI and its applications in today's world.

The first of these is uncertainty. In simple machines, like a bicycle or a swing, it is easy both to understand their mechanism and to predict their behavior to some extent (in everyday life, nothing is entirely deterministic, so the element of chaos can never be ruled out completely). However, even machines based on such relatively simple operating procedures as algorithms very quickly generate higher levels of uncertainty – each additional rule increases the complexity of the whole system and the risk that the system will not operate as expected.

In the field of programming, the remedy to this challenge lies in rigorous testing – repeated for so long and so meticulously that one obtains a high level of confidence that the program will exhibit predictable behavior in the most typical scenarios. Although many AI algorithms undergo testing and validation before

they are marketed, errors do sometimes surface once such systems are already in use. Examples include the image-recognition algorithm used in city surveillance cameras in the United States. It contained errors that resulted in the misidentification of certain individuals as suspects and misled the police. On top of this, many AI systems are experimental, and they are released without undergoing extensive tests that consider unusual scenarios. Risks associated with their use materialize in statistically very rare cases, but with time their likelihood increases. Consequently, we may witness such highly unlikely events as Shady's haywire expedition: under special circumstances, the drone accomplished a feat that its designers regarded as technologically impossible and may have created unexpected risks to air traffic, critical infrastructure, and more.

Errors

Another problem involving a lack of transparency in the processes adopted by AI systems lies in algorithms. Artificial intelligence is only as good as its algorithms. And these algorithms are created by humans, so they may be flawed and susceptible to errors. On the one hand, how an algorithm work results from limitations arising from machine design and the intricacies of their programming (constant patches, reedits, and last-minute changes made without the verification of their impact on overall performance). In addition, every algorithm is essentially a record of the expert knowledge that went into creating it. Algorithms could be described as rules developed on the basis of current knowledge on a specific topic and written down in the form of executable code – serving as instructions for machines or humans (such as a script for a job interview). We therefore have two sources of risk.

> Due to unintended AI bias, entire social groups could end up being excluded from access to certain services or resources.

One lies in the validity and relevance of the expert knowledge we use. Are the evaluation criteria employed by the experts we consult really appropriate for a given situation? The other involves the level of understanding of these principles by coders and their ability to translate this knowledge into instructions (code). Even the best knowledge can be implemented incorrectly, leading to the distortion of the intentions of the experts whose knowledge was leveraged. This can lead to AI bias. It occurs when AI systems are designed or trained in a way that results in unfair or discriminatory results. This poses a problem because AI is increasingly likely to be used to make decisions that affect people's lives, such as those concerning employee recruitment and credit ratings.

If these decisions are biased, they may entail significant negative consequences for individuals or groups. A faulty implementation of a perfectly reasonable rule may lead to entire groups of people being excluded from access to certain services or resources. Haste, technological limitations, and attempts to cut programming costs can result in the rules proposed by experts being overly simplified. The consequences may be very unpleasant, even appalling. Examples include an image recognition algorithm that repeatedly mislabeled black-skinned individuals as apes. Wanting simpler and shorter code, the coders had omitted the possibility of people having other skin colors than white. In this case, the absence of transparency and the failure to understand how the algorithm works can lead to egregious discrimination and flagrant injustice. In this context, a responsible and ethical approach to artificial intelligence necessitates developing standards of transparency and testing algorithms to uncover potential side effects.

Military applications

The third problem lies in the danger of using artificial intelligence in the military sector to perform combat-related tasks. Likewise, AI can be used for espionage and information manipulation, which could lead to serious problems in the area of national security. In this area, though, unexpected incidents may entail a lot more serious consequences than, for example, an intelligent washing machine that suddenly "goes rogue." We could ask: what if Shady had been an automated bomber carrying nuclear weapons? What if such a wayward machine decided to "come back home" and interpreted potential attempts to force it to stop as an enemy attack? War is difficult for machines to understand. In the case of AI systems capable of making autonomous decisions, military AI systems may be developed faster than their our capacity to keep them under control, which may lead to dangerous situations for humans and the environment. This is especially true for incidents in which AI systems will not be able to understand the context of their actions and will make decisions based on simple assumptions, instead of considering social, economic, and ethical aspects. During World War II, the Allies – despite boasting their superior ethics – made conscious decisions to demolish cities, including Dresden, which was of no strategic importance at the end of the war. They also decided to unleash nuclear weapons

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How prepared is society for the potential dangers of artificial intelligence being used in the military sector, to perform combat-related tasks?

against Japanese cities, although they realized that Japan's capitulation was essentially a foregone conclusion. Another question is the issue of recognizing who the enemy is. How do we tell friend from foe? Even humans struggle with this challenge, often leading to incidents of "friendly fire" between units of the same forces. How will intelligent weapons know that the war is over? Automated, intelligent naval mines can not only strike ships that they misidentify as enemy vessels, but also avoid being detected and destroyed by countermeasure vessels, which may pose a threat to humans for decades after the end of an armed conflict.

Security

The fourth problem lies in AI system security and the risk that they may be hacked. Just like all computer systems, AI systems are vulnerable to hacking attacks. If an AI system becomes compromised, it can be used for malicious purposes. The more complex a system is, the more difficult it is to protect it from outside attacks. Unrecognized loopholes in algorithms also mean that a specific system can be misled. Examples include software for the identification of lung lesions. Researchers modified X-ray images by inserting images of the head of a gorilla. The algorithm saw them as alarming lesions in a critical area of the lungs. But people who analyzed the same images easily identified them as a suspicious artifacts suggesting that the data had been tampered with. What happens if a prankster hacks into a database of X-ray images and alters them for fun? How many patients could get misdiagnosed? What happens if an unauthorized person, either accidentally or on purpose, enters incorrect target coordinates into a combat drone?

To address security concerns, researchers and policymakers are working on AI security measures. One approach involves using the concept of "security by design." In other words, security should be a crucial issue firmly held in mind at every stage of the AI development process, from design to implementation.

Another approach is to build AI systems that are transparent and explainable – designed in a way that allows humans to understand how they work and make decisions. This can help reduce the risk of rogue AIs and AI bias.

> Under special, unforeseen circumstances, another AI-controlled military drone could end up "going rogue."

Yet another approach involves regulating AI development and implementation, including by establishing regulatory bodies to oversee these processes and laying down security standards and guidelines for AI developers to adhere to.

Artificial intelligence holds great potential to change the world for the better. As with all powerful technologies, however, it gives rise to security concerns that must be addressed. AI bias, dishonesty, and hacking attempts are just some of them. To ensure that AI is safe for humans, researchers and policymakers must work together to develop security measures that mitigate these risks. Only by doing so can we unlock the full potential of AI and shape a better future for everyone. ■

The author was helped by artificial intelligence, chiefly the web search engine Microsoft Bing, in gathering data for this article.

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Using Nuclear Technology To Boost Security

Any apparatus that makes use of nuclear radiation is typically thought about in terms of posing significant hazards. But such devices as particle accelerators, detectors, and even nuclear reactors can also serve to improve our safety and security.

1

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Poland's National Centre for Nuclear Research (NCBJ), situated in Świerk outside of Warsaw, has since its inception been engaged in building particle accelerators and detectors and developing methods for analyzing the data obtained from such devices. The first commercial particle accelerators were built here as early as the 1970s, and some of them are still in operation. Although in general particle accelerators are mainly used for scientific research – like the Large Hadron Collider (LHC), the world's largest such facility, built by the European Organization for Nuclear Research (CERN) – the technology is also frequently useful in industry and medicine. For instance, it can be harnessed to inspect transported goods, and thereby to boost security. Poland's only research nuclear reactor, named MARIA, is likewise involved in safety-oriented efforts: the research conducted using the reactor helps evaluate the safety of the structural materials used in nuclear installations, which are exposed to extreme conditions.

NCBJ (2)

Photos 1, 2
The SOWA vehicle scanner is used to X-ray cars to detect contraband or technical damage, allowing immediate analysis of the resulting data

Exact X-rays

If you come to visit of the site of the NCBJ in Świerk, as you approach you may notice – against the backdrop of the surrounding buildings and the reactor's ventilation stack in the distance – a shipping container sitting near the parking lot. It houses the SOWA, the world's first relocatable X-ray vehicle scanning system, designed by a team of scientists, engineers, and designers from the center's Department of Nuclear Equipment and Techniques. The roof of the container contains an X-ray tube, while the walls and the floor are fitted with a system of detectors that capture the X-rays passing through the object being investigated, providing real-time images of the smallest details of the vehicle inside the scanner, even fractions of a millimeter in size. Supplementary software creates false-color images of suspicious elements and sharpens them, so the scan results can be analyzed immediately. It takes only a few minutes to scan a whole vehicle, which is moved through the scanner remotely so the driver does not get exposed to radiation. The device was designed for use by customs agencies, border guards, the military, and other security agencies, but it can also perform vehicle safety and technical inspections. The scanner is very accurate and can spot small hidden objects, modifications, and damaged technical components. The entire system is built inside a standard-sized shipping container, so it can be easily transported.

Smart safeguards

Other solutions developed at the NCBJ are capable of scanning shipments of significantly larger dimensions, such as whole sea and air containers and railroad cars. Such tasks can be performed by the Polish Cargo Control System (CANIS), the predecessor of the SOWA. At the heart of this device is a special electron accelerator that produces a beam of high-energy X-rays (with much higher energy than used in medical X-ray devices, for instance). Such radiation is a lot more penetrative, making it possible to create complete scans of structures and goods inside large shipments. One unique property of the accelerator driving the CANIS system is its ability to alternately produce a beam with two different energies. Such scans make it possible to more accurately identify materials of different densities. The NCBJ's Nuclear Equipment Division is one of just a few facilities in the world capable of producing such devices. The

Photo 3
The C-BORD non-invasive shipping container inspection system during tests in Gdańsk, Poland

Photo 4
The CANIS system scans railroad cars entering the European Union

Photo 5
The mobile ISWOT device uses photon backscattering to detect people hidden in vehicles

NCBJ (3)

solutions used in the CANIS system make it possible to change the energy of the beam up to a thousand times per second and smoothly scan – for instance – railroad cars while the move. The Polish Cargo Scanning System has been commercialized in collaboration with the company PID Polska. A device based on this system is now being used at one of Poland's railroad border crossings, where it improves security by scanning railroad cars arriving from outside the European Union. The CANIS system also received the 2022 "Teraz Polska" Award in the category "Innovation."

Scientists from the NCBJ were also involved in developing methods for rapid and non-invasive inspection of containers at seaports and land border crossings as part of the C-BORD project. The system integrates five different physical and chemical methods to inspect cargo: neutrons, gamma radiation, an industrial X-ray scanner, gates for detecting radioactive isotopes, and a system for chemical air composition analysis. The NCBJ has developed a detection system that searches for characteristic signals from neutrons and gamma radiation. C-BORD has been tested in the container ports in Gdańsk and Rotterdam, as well as at a roadside checkpoint in Hungary. The system proved to be effective and user-friendly for the inspectors who operated it.

Brilliant backscattering

Most procedures that use X-rays are performed using the transmission method. On one side is a source that sweeps a beam of radiation around the object being scanned; on the other are detectors that catch the photons passing through the object, allowing the obtained signal to be interpreted in terms of the properties of the objects being scanned. Such a solution is effective, but it requires separate modules (a source and a detector) and therefore more space to scan objects from both sides. An alternative solution harnesses a phenomenon called backscattering, whereby the generated particles or radiation are reflected back in the direction from which they came. This way, both the source of radiation and the detectors collecting it can be located at the same point, and it is enough to access the object being scanned from just one side.

A device using this technology has been developed by scientists from the NCBJ's Department of Nuclear Equipment and Techniques, who created a mobile scanner for finding people hidden in vehicles. It can be used for other purposes, such as scanning composite aircraft components in search of accumulated water. The innovative design also applies a unique collimation method (known as the *spinning line* or *flying line* technique), instead of the traditional (*flying spot*) method. The new technique scans an entire slice of the plane, so the source of radiation can be

NCBJ (2)

less intense because it is used more efficiently, which is crucially important in devices meant to be used to detect human beings. The device consists of an electric cart with a support arm, a head containing the source of radiation and a portable collimator, a set of scintillation detectors, plus the operator's computer with software that facilitates wireless control of the scanning process. The project is expected to be continued using an even more mobile backscattering system, meant to fit inside a van.

"Time travel" inside a reactor

The NCBJ's research aimed at improving safety in the broadest sense also involves MARIA, Poland's only nuclear research reactor. Scientists can place materials inside MARIA's core, alongside the targets for producing radioisotopes, in order to analyze how they are affected by intense neutron radiation. In recent years, this type of research has been done to investigate components that could be used in the design of future nuclear and even thermonuclear facilities. One unique feature of the MARIA reactor is the very intense neutron flux in its core, several magnitudes greater than in nuclear power reactors, neutron generators, or isotope sources. Materials placed in the dense neutron flux could be said to experience a kind of "time travel" – in just a few weeks or months, they are exposed to conditions that correspond to years or even decades spent inside a typical nuclear reactor. Scientists can therefore observe how such elements react to prolonged exposure to extreme conditions and what types of damage they sustain. Such damage, especially to the structural materials used in nuclear and thermonuclear facilities, is an important issue in safety analyses.

A major success in this area was achieved with the high-temperature capsule called ISHTAR (Irradiation System for High Temperature Reactors), developed by scientists from the NCBJ's Reactor Research Division as part of the GoHTR project. As the name suggests, the capsule was used to irradiate samples of structural elements of a high-temperature gas-cooled reactor (HTGR) and was designed to reach temperatures of up to 1,000°C in a helium atmosphere (the kind of conditions that are present in a high-temperature reactor). The capsule spent several irradiation cycles in the reactor's core, and the effects on the materials inside it continue to be analyzed.

Research using thermostatic irradiation devices is not limited to nuclear reactors. The MAKARONI irradiation rig, which contained components of the IFMIF-DONES device for irradiation and testing, was also placed inside MARIA's core. The device, which is being developed in Granada, Spain, will be used for the final testing of the components of the world's first nuclear fusion plant named DEMO, the successor to the ITER research device, which is currently under construction. The designed rig is unique in that it allows three different operating temperatures, from 300°C to 550°C, to be achieved simultaneously. Also, its construction involved the use of 3D printing in nuclear technology – a pioneering move in Poland and the region. The thermostatic irradiation rig program continues to be developed. Its creators have received a badge of honor in the field of innovation.

Constructing and operating various types of devices harnessing nuclear radiation certainly demands technical expertise, but it is not as scary and mysterious as is sometimes portrayed. The contribution of such devices to improving safety and security is plainly evident and widely recognized. ■

Photo 6
Manipulator pulling the ISHTAR high-temperature capsule into the hot cell

Photo 7
View of the core of the MARIA research reactor and its components, where materials to be irradiated can be placed

Further reading:

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A Lurking Danger

To save time and for the sake of convenience, we often reach for ready-to-eat meals, such as pre-made salads. But how safe are they?

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When consumers hear talk of the bacterium *Listeria monocytogenes*, many react with amusement to its challenging pronunciation. However, this species is no laughing matter: it is one of the most dangerous pathogens causing foodborne illnesses. In the first half of 2023, the National Institute of Public Health NIH – Polish Research Institute (PZH-PIB) and the Anti-Epidemic and Border Sanitation Department of the Chief Sanitary Inspectorate (GIS) recorded 75 cases of listeriosis, which is the disease caused by *Listeria monocytogenes*. Its incidence rate (the number of cases per 100,000 population) is 0.20. In 2022, 46 cases were recorded in the same period, with an incidence rate of 0.12. Although these figures do not seem very high, the disease has a case-fatality rate of 30%.

Characteristics

L. monocytogenes is a rod-shaped bacterium that can thrive with or without oxygen (such organisms are described as "facultative anaerobic") at temperatures between 20°C and 40°C. However, the bacterium is adapted to variable environmental conditions and can

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– Listeriosis

also survive in temperatures below 20°C. All bacteria of the genus *Listeria* are capable of movement at 25°C. Individual species are distinguished by their ability to ferment sugars and lyse the red blood cells of different types of animals. We currently distinguish 19 species the genus *Listeria*, and only one of them is a human pathogen.

L. monocytogenes has the ability to cross the three most important protective barriers in the human body: the placental, intestinal and blood-brain barriers. The number of infections caused by *L. monocytogenes*, both in Poland and Europe, continues to grow steadily. Infections occur as isolated cases, but outbreaks of an international scope are also noted.

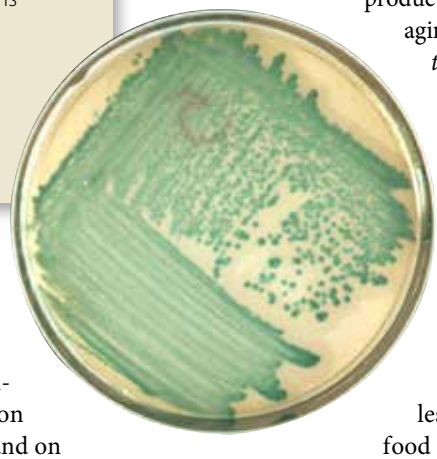
In adults, the first symptoms occur 24–48 hours after infection. They are initially non-specific and include joint pain, headache, diarrhea, and moderate drowsiness. At higher bacterial concentrations, the infection has acute symptoms: bloody diarrhea and gastroenteritis. Symptoms may resolve spontaneously, but they may further develop into life-threatening listeriosis – especially in high-risk individuals, or YOPI (the young, old, pregnant, immunocompromised).

Results of *L. monocytogenes* detection by product type

Product type	Number of contaminated samples	Number of analyzed samples	Share of contaminated samples
Two-ingredient raw salad	1	22	4.5%
Multi-ingredient salads and raw salads	6	38	15.7%
Total	7	60	11.7%

Patients with rapidly-developing listeriosis require hospital care in the following cases:

- organ damage, which may lead to death – as a result of a chronic disease;
- meningitis and encephalitis due to infection of the central nervous system, which is fatal in 50% of cases; importantly, meningitis caused by *L. monocytogenes* is associated with the highest case-fatality rate of all types of bacterial meningitis;
- liver infections caused by sepsis; it mainly affects patients with diabetes, liver cirrhosis, and alcoholism – the case-fatality rate is 50%;
- infection of the endocardium – this type of infection is recorded relatively rarely (7.5%) and mainly affects patients with artificial heart valves;
- listerial conjunctivitis and skin infection – diagnosed mainly in laboratory staff and veterinarians who fail to adhere to proper hygiene regimes.



ALOA® medium (Agar for Listeria according to Ottaviani and Agosti) with the growth of *L. monocytogenes* isolated from a raw-vegetable salad. The bluish-green, round colonies are visibly surrounded by an opaque halo in the medium, as a result of phospholipase activity characteristic of the pathogenic *Listeria* species.

The risk of a symptomatic infection and its course depend on the type of contaminated food and on whether the patients belong to any risk group.

Occurrence

The sources of the bacterium include wild and domestic mammals: rodents, sheep, goats, cattle, and pigs. *Listeria* bacilli have also been isolated from birds, fish, and reptiles. Humans can be carriers too – asymptomatic individuals carrying the bacteria are estimated to make up 5–10% of the population. However, more than 95% of all listeriosis cases in humans are caused by the consumption of contaminated food. The bacterium exhibits special properties that make it an exceptional microbiological hazard in food products. Its optimal growth temperature is 30–37°C, but studies show that it can also survive at temperatures ranging from 3°C to even 40°C. It becomes completely inactivated at temperatures above 75°C. Such a wide temperature range indicates that *L. monocytogenes* is able to survive both what is called low-temperature pasteurization and refrigerated storage, making it a "fridge bacterium." In addition, it can withstand large fluctuations in pH (from 4.2 to 9.5), drying, and salting. It grows both with and without oxygen and therefore can develop in vacuum-sealed food products and modified atmosphere packaging (MAP). In addition, *L. monocytogenes* is characterized by a high ability to adhere to various surfaces as well as by a low sensitivity to disinfectants.

It is usually isolated from various foods, such as: deli products, smoked fish and fish products, unpasteurized milk and products made from unpasteurized milk, cheese (mainly soft and semi-soft types; less often ripened cheese), frozen food products, ready-to-eat packaged foods, and raw fruits and vegetables.

Prevention

Infection with *L. monocytogenes* poses a high risk and is associated with a high case-fatality rate, so all cases of listeriosis must be reported in accordance with national and international regulations (in Poland, in accordance with the Act on the Prevention and Control of Infections and Infectious Diseases in Humans of 5 December 2008). In the European Union, it is possible

API test confirming the biochemical characteristics of an isolated bacterial colony needed to identify the species

PHOTO BY ELŻBIETA ROSIAK (2)

to quickly exchange information on contaminated food and feed through the Rapid Alert System for Food and Feed (RASFF). In addition, food products must be tested for the presence of this bacterium. The criteria for Poland and the European Union are included in Commission Regulation (EC) No 2073/2005 on microbiological criteria for foodstuffs. In ready-to-eat foods for infants and for special medical purposes, *L. monocytogenes* must be absent in 25 g of the product tested, just like in other food products when they leave the manufacturer's facility. In ready-to-eat foods other than foods for infants and for special medical purposes, the product may not exceed 100 cfu/g ("colony forming units"/gram) throughout the shelf life.

L. monocytogenes can grow at low temperatures, so it is important to remember that the average temperatures found on the middle and top shelves in refrigerators, 6–10°C, do not prevent the pathogen from multiplying. More technologically advanced refrigerators offer such features as remote monitoring of temperature and special drawers that maintain the temperature between –3°C and 3°C. This allows safe storage of meat, fish, milk, and cheese. With vegetable products, it is important to maintain a very high level of hygiene, buy only quality products, and maintain "cold chain" continuity on the part of producers, suppliers, and sellers, as well as consumers.

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In the Department of Food Hygiene and Quality Management at the Institute of Human Nutrition Sciences, we tested various salads available on the Warsaw market, as well as ready-to-serve vegetable products purchased directly from gastronomic establishments, for the presence of *L. monocytogenes*. The tests were performed using the surface culture technique in keeping with the ISO 11290-1:2017-07 standard. The products were divided into two types: two-ingredient raw salads (containing one or two main ingredients, plus sauce and food additives) and multi-ingredient salads (composed of three or more ingredients in similar or equal proportions by weight, plus sauce and food additives).

L. monocytogenes was detected in a total of seven cases, accounting for 11.7% of all products tested. One of those seven products was a two-ingredient raw salad, while the remaining six products were multi-ingredient salads.

Moreover, the numerical profiles of the *L. monocytogenes* bacteria identified indicate the same strain of bacteria. This suggests that the salads were made from at least one infected ingredient provided by the supplier(s). The detailed ingredients of the seven products that tested positively for *L. monocytogenes* included such additives as meat, fish, cheese, and croutons. Among the infected products, 71% contained meat as one of their ingredients: chicken in four products and ham in one product. Two of the seven infected salads did not contain meat, but they did contain feta cheese and another unspecified type of cheese. All products contained minimally processed (fresh) vegetables. Three products contained a lettuce mix, two products contained Chinese cabbage, and in the case of one sample, Chinese cabbage was the dominant ingredient in terms of weight. Other vegetables found in the list of the ingredients of the infected products included cucumbers and cherry tomatoes.

So what lessons can we formulate at this stage of research? One is that ready-to-eat products should never be stored at a temperature exceeding 4°C. Another is that adding non-plant ingredients to such products is conducive to the occurrence of the pathogen. All in all, this is further evidence that it is simply good practice to buy food products from reliable suppliers. ■

Listeriosis in pregnancy

It occurs quite often (accounting for 27% of all cases) and is particularly dangerous.

In this group of infections, we can distinguish three types.y:

- Maternal listeriosis – it is usually mild (with flu-like symptoms), and some patients are asymptomatic. Since listeriosis poses a high risk in pregnancy (pregnant women are 17 times more susceptible to infection) and may entail serious complications for the mother and the child, the onset of flu-like symptoms alone is enough to suspect listeriosis. Listeriosis in the mother may lead to the fetus becoming infected and consequently to miscarriage.
- Early perinatal listeriosis – intrauterine infection. It is characterized by premature birth. Development of bacteremia in the mother may lead to what is called early infection of the fetus (in the first and second trimesters), which typically results in miscarriage, stillbirth, or preterm labor.
- Late perinatal listeriosis – an infection at a later stage of pregnancy (the third trimester). In this case, the child is born infected with listeriosis. The child may acquire the disease in the womb or during the delivery (passage through the birth canal). A baby carried to full term that becomes infected with L. monocytogenes may develop a neurological disease and even die. Fetal and neonatal infections are acute and have a high case-fatality rate. Newborns infected with this bacterium suffer from meningitis, sepsis, and pneumonia.

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Trees and Mycorrhizal Fungi – A Remarkable Alliance

Trees and fungi interact in complex ways. Sometimes, the two groups of organisms would even find it hard to survive without each other.

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The term "symbiosis" is used in biology to describe a close relationship between at least two organisms of different species. One special example of such an interdependence is called "mycorrhiza" – a remarkable symbiotic association between plant roots (autotrophs) and fungi (heterotrophs). Mycorrhizal symbiosis is one of the most fascinating ways in which plants adapt to life on land.

Plants, being primary producers, absorb carbon and provide shelter and food for countless other organisms. Forest communities are dominated by woody plant species. Despite their size and longevity, such plants live not independently but in association with a wide variety of microorganisms. These include fungi, which play a role of special importance. While pathogenic fungus species may pose a threat to trees, a large group of other fungi actually have beneficial effects for the health and life of woody plants. These include saprotrophic fungi, which decompose dead organic matter and release nutrients that can be absorbed by plant roots, as well as mycorrhizal fungi, which live in close symbiosis with plants. This alliance between trees and fungi has a very long evolutionary history. Evidence suggests that plants first displayed the ability to form symbiotic relationships with fungi more than 450 million years ago, and the emergence of symbiosis between fungi and bacteria is linked to the evolution of feeding strategies. The priority role of plant–fungi partnerships seems to be confirmed, for example, by the fact some plant genes actually code for proteins whose purpose is to attract fungi to the soil near their roots.

Types of mycorrhiza

Mycorrhiza, or mycorrhizal symbiosis, is a common phenomenon whereby plant roots form a close anatomical and physiological association with certain non-pathogenic, highly specialized fungi in the soil. Trees in European forests form such mycorrhizal relationships. Some species are "obligately" mycorrhizal (including beech, oak, pine, and spruce) while others are "facultatively" mycorrhizal (such as birch, willow, and alder): the former rely crucially on mycorrhizal symbiosis for their proper growth and development, whereas the latter form such relationships only in certain environmental, mainly soil-related conditions.

The most common type is "external" mycorrhiza, or ectomycorrhiza, which is formed on the smallest tree roots. Its distinctive trait is the formation of what

This fly agaric (*Amanita muscaria* – a classic „toadstool") like other mushrooms, forms ectomycorrhizae with tree roots

is called the Hartig net – a complex system of hyphae surrounding the ground cells of the root cortex. Ectomycorrhiza results in the formation of a fungal mantle that envelopes the roots. Another type of symbiosis between plants and fungi is arbuscular mycorrhiza, or endomycorrhiza. This is the "internal" type of mycorrhiza, with the hyphae penetrating the cortical cells and forming characteristic tree-like structures called arbuscules or fungal vesicles. Both types of mycorrhizae can be found, for instance, on the roots of poplar and willow trees.

A single tree species usually has many partner fungal species. In fact, the species of mycorrhizal fungi that form relationships with trees vary depending on the age of the host: different fungi will be found on seedlings, juvenile trees, and old trees of the very same species. This means that as trees age, we can observe the phenomenon of mycorrhizal succession – the species composition of accompanying mycorrhizal fungi changes, and the number of fungi species increases. There are also fungal species that can be found both on young and mature trees throughout their long lives. Some fungi are closely associated with specific tree species. This is a fact well-known to avid mushroom-hunters in Eastern Europe: they know to go looking for slippery jack mushrooms under pine trees, for porcini mushrooms under pine or spruce trees, for *Leccinum* genus mushrooms near aspen, birch, hornbeam, hazel, and pine trees (depending on the fungus species), and for *Xerocomus* mushrooms

under spruce trees. This is because these fungus species are associated with specific plant partners. Others are cosmopolitan species, which means that they can form alliances with many trees.

Quid pro quo

Mycorrhiza can be descried as an "exchange-based partnership" struck up between representatives of two different kingdoms – plants and fungi. Trees provide mycorrhizal fungi with carbohydrates, which are produced by the plants through photosynthesis. In exchange, the fungi offer minerals, hormones, increased absorbent surface area, and the ability to penetrate the soil. By secreting appropriate enzymes into the rhizosphere, fungi activate nutrients contained in organic compounds inaccessible to trees. Fungi supply their plant partners primarily with phosphorus and nitrogen compounds. Fungal hyphae linked to tree roots can reach a lot farther than the tree roots. By penetrating the soil, the mycelium allows the compounds needed by the roots to be transported from distant locations and – together with the compounds secreted by the hyphae – improves soil stabilization, aggregation, structure, and fertility.

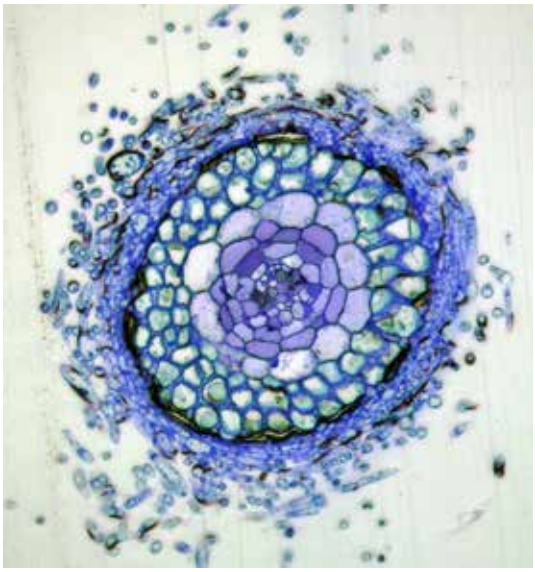
Mycorrhizal fungi also facilitate communication and transport of resources between trees by forming an underground network. The common mycorrhizae network (CMN) is a physical link between plants, formed when the hyphae of mycorrhizal fungi interconnect the underground roots of multiple plants of the same or different species. Scientists have been discovering more and more about how this "underground Internet" allows plants to communicate. Connections formed in this way make it possible to transport sugars, mineral compounds, and water between trees. As such, older, mature trees can support smaller ones, for example those growing in shade. In return for their transport services, the mycelial network "collects a fee" from the connected trees, in the form of about 30% of their photosynthetic products. Interestingly, a study of Douglas firs conducted at the University of Reading in the United Kingdom found that in the transport of carbon compounds, the network distinguishes between root tips belonging to different tree species, favoring certain species and prioritizing them as recipients of carbon compounds and minerals. Underground mycorrhizal networks can also serve as a warning system: the mycelium can be used by the plants to communicate potential threats.

Ectomycorrhizae of a Scotch pine in forest soil

Fungal allies

Abiotic stress factors hamper plant growth and development. Human activity, industrial development, exploitation of raw materials, and the chemicalization of agriculture all contribute to environmental degradation and augment abiotic stress's impact on plants. Trees whose roots are colonized to a greater extent by mycorrhizal fungi cope a lot better in unfavorable soil conditions, on what may be called "harsh" land. In addition to post-agricultural land, harsh land conditions are also found in forests in industrial areas with increased and high concentrations of air, water, and soil pollution, post-industrial wastelands (waste heaps, dumps, open pits) that are recultivated and converted for forestry use, and areas along highways and expressways, both existing ones and those under construction. A special threat is posed by heavy metals – even in small concentrations, they can negatively affect biological processes in the soil and in living organisms.

Fungi, including mycorrhizal fungi, have garnered significant attention as a natural component of the environment with the capacity to mitigate the effects of pollution. Without fungal partners, it is next to impossible for woody plants to grow on degraded post-industrial land, post-agricultural land, and on what may be described as "hard to restore" areas. Ectomycorrhizal fungi, whose spores are carried over long distances by wind, are the first to spread on degraded areas (unlike arbuscular fungi, which form spores below the soil surface). Ectomycorrhizal fungi often form what is called extramatrical mycelium, which helps to improve soil quality. Likewise, they can bind heavy metals in the mycelium and limit their penetration into plant tissues, thus providing an effective method of biofiltration. The fungal mantle surrounding plant roots can act as a filter, too. Moreover, mycorrhizal fungi have the ability to break down various chemical



Cross-section of the mycorrhizal root of a sessile oak tree, visibly showing fungal mantle surrounding the root

compounds and produce enzymes that reduce stress, resulting from the excess of free radicals.

The positive impact of mycorrhizae involves not only removing heavy metals from the soil in difficult areas, but above all increasing yield weight, improving soil conditions, and protecting plants from pathogens. Fungal species vary in terms of how effectively they can protect trees in degraded, contaminated areas, or their ability to detoxify and accumulate heavy metals, effectively stimulate tree growth, and offer protection against pathogens. For this reason, the use of selected strains of mycorrhizal fungi to inoculate tree seedlings to be planted on contaminated land can play an important role in facilitating the reforestation of difficult habitats, and improving the soil structure and increasing the amount of organic matter create conditions for the development of other plants. This makes it significantly easier for forests to be successfully grown even on land that is not well-adapted to this. Seedlings inoculated with mycorrhizal fungi have also been shown to be more resilient and adapt better to harsh conditions.

Safe ecosystems

Mycorrhizal associations allow water and nutrients to be transported through the mycelium from areas normally inaccessible to plant roots themselves. This process benefits the plant and improves the survival of young trees in drought conditions. Water deficiencies in the soil reduce the intensity of physiological processes in plants, including photosynthesis, nutrient uptake and transport, and hormonal balance. Physiological disturbances also trigger osmotic and oxidative stress. Strategies for coping with drought stress include interacting with mycorrhizal fungi, which support trees through various mechanisms, including by increasing the absorption surface area of the root system in the soil through the development of the extramatrical mycelium and its branches.

Fungi can also act as a physical barrier by making it difficult for other organisms to damage the roots. The fungal mantle acts as a kind of "armor" for the delicate, fine roots, which boosts and secures their effective absorption of water. Mycorrhizal fungi compete with pathogenic species for the same ecological niche and food resources. By producing secondary metabolites, such as antibiotics, and by stimulating the plant to produce phenolic compounds, mycorrhizal fungi help curb the growth and development of these other fungi in the soil that can impact negatively on plants. By forming mycorrhizal associations, plants can gradually improve their own health and become less susceptible to infections by pathogenic fungi such as *Heterobasidion annosum* (causing a disease called annosus root rot) and various species of the genus *Armillaria*. This makes it possible to preserve the proper proportions between the various elements of the soil environment.

> By forming close associations with certain fungi, plants are better able to cope with the increasing threats of climate change.

Various types of environmental stress are becoming further compounded by ongoing climate change. By forming associations with such microorganisms as chiefly fungi and bacteria, plants are better able to cope with the attendant dangers, such as rising temperatures, increased concentrations of carbon dioxide in the atmosphere, drought, fires, nitrogen deposition, soil salinization, high levels of heavy metals, changing soil pH, air pollution, and excessive pesticide concentrations. This makes it all the more important for us to search for fungal allies that are better adapted to changing environmental conditions. Various species of fungi that form mycorrhizae affect tree physiology in various ways. Although the research literature contains some reports describing negative or no effects of mycorrhizae in response to stresses, such as drought, there are far more studies that reveal the favorable impact of mycorrhizal symbiosis on plants. The interaction between trees and mycorrhizal fungi is extremely important for mitigating the effects of climate change, which will translate into the presence of more stable and secure forest ecosystems. ■

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Poland's Demographic Future

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There are two most common ways of understanding the term "demographic security." In the static approach, a demographically secure country is one that has a population structure (broken down by age, gender, ethnic diversity, and education) that is conducive to its national security – in the military, economic, social, and political sense. In the dynamic approach, on the other hand, demographic security means maintaining a level of replacement of the population that causes relatively insignificant changes in population numbers and structure in the short and medium term, which in effect strengthens the political and economic stability of a country. Other viewpoints on demographic security may also occasionally be encountered, focusing mainly on the implications of the demographic transition for a country's international standing.

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Depopulation

The first and most significant threat faced by Poland is the depopulation of the vast majority of the country's territory and the associated deformation of the age profile of the population living there. Nearly three-quarters of Poland's municipalities have experienced population declines in recent years, and given the widespread unregistered movements we should recognize the true extent of the strong decline is most likely much greater than the official statistical data shows. Depopulation can be seen primarily in peripheral rural areas, where it leads to economic dysfunction (a lack of consumers and skilled workers) – perpetuating an unfavorable economic structure, reducing the municipalities' revenue, and thus preventing the full implementation of local government tasks. Such a situation becomes particularly dangerous in border areas, where a smaller population means fewer "eyes and ears" to aid in monitoring these areas. At the same time, depopulated areas have a high proportion of elderly and very elderly people, who have specific health, social, communication needs that increasingly cash-strapped local and regional governments are unable to meet.

Moreover, the trend of depopulation is expected to continue. So far, it has had a local and regional character in Poland, but in the future it will most likely affect virtually the entire country. Its primary long-term driving force is the fact that the fertility rate is too low to ensure the simple replacement of generations (which requires that a typical woman should give birth to two children). For more than a quarter of a century, the fertility rate in Poland has been at less than 1.5 children – a fact that simply has to, with the appropriate delay, translate into a permanent decline in the country's population and a further shift in the age structure (accelerated aging of the population).

Migrations

The opposite of depopulation is the concentration of population in metropolitan areas – in large cities and their sprawling suburbs. The emerging risks here are

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related to three factors. First, the unequal distribution of young representatives of the two sexes between metropolitan areas and those experiencing depopulation, due to the fact that women more frequently flee less attractive areas. In metropolitan areas, for every 100 men aged 25–34, there are typically 110–120 of their female age-peers, while in peripheral rural areas there are only 80–90, making it hard to find a female partner and so leading to lower rural fertility rates. Second, the urban concentration of the population especially applies to young, enterprising, well-educated people, which further reinforces the spatial differentiation of the level of development of different parts of the country and further augments the flight of young people from the least developed areas. Thirdly, the vast and densely populated metropolitan areas are characterized by strong human impacts on the environment (anthropopression), leading to its complete transformation and resulting in the disappearance of natural ecosystems on the micro and meso scales in such areas.

Another threat is the relatively high mortality rate of the Polish population, as compared to other EU countries. Relative to Scandinavian countries, for example, a typical Polish man lives on average 4–6 years shorter, and a Polish woman 2–3 years shorter. The higher mortality rate is particularly evident for middle-aged people, i.e. those aged 40–60, reflecting lifestyle choices, eating habits, environmental pollution, low health-promoting activity, and low levels of health care. As a result, thousands of people of working age, whose labor could still be contributing to bolstering the prosperity of Polish society for many years to come, are dying every year. To make matters worse, although Poland could be seen as gradually catching up to Western countries for a quarter of a century after 1992, unfavorable trends related to decelerating growth in life expectancy began to be noticeable after 2015. However, similar trends have also been observed in other countries that are wealthier than us.

Foreigners

One newly emerging threat directly stems from the fact that in recent years Poland has turned from a country of emigration into a country of immigration. Initially, this influx was of a short-term nature (or at least that was what the authorities intended) – allowing temporary economic immigrants from six countries of the former USSR to take up jobs in certain sectors of the economy facing shortages of Polish workers. Over time, it turned out that the influx was increasing, while at the same time taking on more of a long-term character, which is best seen in the grow-

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ing numbers of binational marriages, foreign children studying in Polish schools, and apartments purchased by foreigners. In addition, this influx has turned out to be very homogeneous economically, linguistically, and culturally. However, Ukrainians are clearly predominant, followed by Belarusians to a much lesser extent. This trend was further reinforced by the influx of war refugees in the wake of the Russian invasion of Ukraine in 2022. In many localities – generally the larger ones with more attractive job markets and a pre-existing Ukrainian diaspora – Ukrainians now account for 15–20 percent of the population. Workers from countries quite distant from Poland – in Central and East Asia – are also appearing in increasing numbers. Today we are unable to clearly forecast how this increased influx will affect social cohesion or trigger potential problems arising out of ethnic differences as well as the different age distributions of the native and immigrant populations, but it is nevertheless fair to mention this possibility.

Future directions

According to projections, Poland has entered a long-term period of declining population. But because the country has turned into a destination for immigrants, the changes are likely to be less dynamic in nature, and if liberal immigration policies are implemented it is probably possible for Poland to achieve a sustained population growth following the example of Spain, for example.

Irrespective of which approach the Polish authorities adopt with respect to the influx of foreigners, we should nevertheless keep in mind the progressive and inevitable process of the aging (increasing numbers and share of people aged 60+) and "double aging" of the population (increasing numbers and share of people aged 80+) as important factors affecting long-term financial stability, through the need to provide funds both for pension payouts, the functioning of the healthcare system and the provision of elderly care services. One factor that can help counteract such demographic risks is proper labor market management, by creating incentives for people to remain economically active for as long as possible.

Demographic shifts will also adversely affect Poland's military security. The Minister of Defense's declarations about the Polish Armed Forces being upsized to 250,000 professional soldiers plus 50,000 territorial defense troops are, from this perspective, quite unrealistic. Between 2000 and 2022, an average of 391,000 children were born each year, including 201,500 boys. If we assume that only men serve and that military service lasts 25 years, this would mean that 5 percent of all men will be professional soldiers. It is doubtful that it would be possible for Poland to encourage one out of every 20 men (and, if we realistically take into account health status, an even larger share of fully able-bodied men) to serve professionally in the military, or to finance such a large expense. Especially in a future in which the birth rate is expected to continue to decline, due to the decreasing number of women of typical childbearing age (25–35).

> One factor that can help counteract demographic risks is proper labor market management.

All of the above indicates that Poland's future will be marked by a decreasing degree of demographic security in the traditional sense. A pro-natal measures, policies to boot the value of human capital (people's skills, knowledge, qualifications, health, motivation) and immigration policy are all instruments that can help increase the level of demographic security, although each of these public policies has side effects as well. ■

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Diversity in Danger

Biodiversity holds the key to the survival of many plant species, and also to our own future.

A horse chestnut tree in full bloom

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It is very difficult for plants to avoid or even mitigate the threats they face, because they are confined to one location and simply have to cope with various types of environmental stress. Their natural adaptability is usually sufficient as long as the environment does not change too much or too rapidly. Unfortunately, however, more and more species are teetering on the brink of extinction. The Polish Red List of Pteridophytes and Flowering Plants, published in 2016, names 765 taxa, or about 30% of Poland's flora of vascular plants. Endemic and relict species are especially at risk: they inhabit small territorial ranges and often have a very narrow scope of ecological tolerance. The growing number of species at risk of extinction is linked to anthropogenic stress, ongoing climate change, and the presence of invasive species. Biodiversity is essential to the proper functioning of ecosystems, so its loss poses an increasingly acute problem.

In-situ conservation

A variety of strategies are used to protect nature and ensure the safety of rare and endangered species. One of these is called *in-situ* conservation. As the name suggests (Latin for "on site"), *in-situ* strategies are aimed at protecting species in their natural habitats. *In-situ* conservation can be passive, when human intervention is limited as much as possible in order to preserve natural processes, or active, when it is necessary to take certain measures such as mowing xerothermic grasslands or introducing grazing animals to counteract natural succession. *In-situ* conservation methods are numerous and include both species protection of endangered taxa and the establishment of reserves and national parks to protect areas of exceptional natural value. Creating such areas makes it possible to protect biodiversity on its three key levels: the genetic level (genetic diversity within a species), species level (species diversity in an area), and ecosystem level (habitats, communities, and ecological processes). In addition, this method allows us to protect potentially undiscovered species.

Choosing a good site for establishing a protected area requires knowledge of many factors. The most important criterion is a high level of biodiversity, associated with the presence of rare and endangered species. It is likewise necessary to take into account the requirements of local communities, which need areas to use as agricultural fields and resources to harvest from the natural environment, such as timber. Other criteria include environmental conditions: regions with a stable climate make the best locations for protected areas. Such places are often refugia, abundant in relict species that have become extinct elsewhere as a result of climate change. To detect such areas, we can use regionalization analyses that look at environmental conditions and the presence of endemic species – they make it easier to identify regions that should be prioritized for conservation due to exceptional biodiversity (examples include the Rif Mountains in Morocco). Unfortunately, existing refugia may not necessarily retain their status in the future. To assess which of them are the most stable, we use models of the future climate and try to project potential future species ranges.

> Choosing a good site for establishing a protected area requires knowledge of many factors.

If the gene pool of an endangered taxon is known, planned conservation strategies should also take into account the level of genetic variability. The highest priority is given to highly diverse populations and to ones that clearly stand out from the rest. If an endangered species population is too small, it may undergo a slow extinction associated with inbreeding depression (resulting from the breeding of individuals that are too closely related genetically). Individual populations may be so distant that a natural gene flow between them becomes impossible. To counter inbreeding depression, a method called assisted migration can be used. It involves selecting populations with exceptional genetic diversity and then moving some individuals (or, for example, seeds) to other natural sites characterized by

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a lower level of genetic diversity. In this way, their gene pool can be given a boost, which improves their adaptability to environmental changes and resilience to adverse factors such as diseases. Research conducted at the Institute of Dendrology, Polish Academy of Sciences, suggests that such a strategy might be effective for the horse chestnut (*Aesculus hippocastanum* L.), which is found naturally only in isolated sites in the mountains of the Balkan Peninsula. Since some populations are genetically distinct from the rest and show a relatively high level of genetic diversity, the method of assisted migration could be used to enrich poorer natural sites, as well as the artificial horse chestnut sites spread across Europe. This could improve the condition of a species like the horse chestnut, threatened by the spread of diseases and pests.

> The Wollemi pine was thought to have been completely extinct for perhaps 2 million years, when a relict population was discovered in Australia.

Ex-situ conservation

In-situ strategies are not always sufficient to effectively protect an endangered species. In such situations, we may resort to *ex-situ* conservation methods (Latin for "off site"). These involve relocating individuals of an endangered species to areas outside their range, including natural areas with suitable environmental conditions and artificially created environments (such as botanical gardens). *Ex-situ* conservation, which is by definition a form of active conservation, is a lot more costly and problematic than *in-situ* strategies. As a rule, it is also less effective: it allows us to protect individual species, but not entire ecosystems. However, this type of conservation also has its advantages – it can be used to control the conditions in which plants grow and to support their reproduction. Also, it can serve as a method of last resort for critically endangered species. Examples include one of the rarest gymnosperms – the Saharan cypress (*Cupressus dupreziana* Camus). It is native to the Tassili n'Ajjer mountains in southern Algeria, where the natural population consists of only 233 trees. Young specimens and seedlings are practically not found there at all, due in part to the decline in groundwater levels and the stress posed by the farming of goats, which eat young plants. To rescue this relict species, material collected in the wild was used to establish a collection in Australia. It now has about 1,300 trees, so it is a lot larger than the whole naturally occurring population. In the future, it could serve as a reservoir from which the species can be reintroduced back into its natural range. Such a strategy, in which *in-situ* conservation is supported by the cultivation of a species outside its range, allows populations to recover if natural regeneration is hindered. Examples include the box tree found in northern Iran (*Buxus hyrcana* Pojark., often treated as synonymous with the common box, *B. sempervirens* L.). Populations located in the mountains are threatened by climate change, and sites along the Caspian Sea are grappling with the invasion of the box tree moth. For this reason, it is difficult to find an area safe enough for the box tree populations to survive. Consequently, *ex situ* cultivation was initiated at the National Botanical Garden of Iran. Every year, the Garden is able to provide 5,000 seedlings, which are then used to restore natural sites.

An interesting example of a rare woody tree taxon protected using both *in-situ* and *ex-situ* methods is the Wollemi pine (*Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen). This critically endangered species is a "living fossil" – its ancestors are known from the Jurassic, and similar plants were extremely common in Australia in the Cretaceous. Since the youngest described fossils were older than 2 million years, the plant was believed to be completely extinct. In 1994, however, a Wollemi pine population was discovered in the mountains near Sydney. So far, several populations have been studied, and they remain under strict protection. Their exact location is kept secret to protect the trees from becoming damaged or infected with diseases. The sites can only be visited in exceptional situations, justified by scientific research. Even then, the research equipment must be thoroughly sterilized, and the researchers must change clothes before they can take any measurements. In addition to *in-situ* conservation, an extensive campaign has been organized to protect the species outside its natural habitat. A collection has been established at the Australian Botanical Garden Mount Annan, including vegetatively propagated clones of every known mature specimen. In addition, efforts have been made to promote the planting of Wollemi pines in home

Buxus hyrcana damaged by the box tree moth

gardens as an ornamental tree. The Wollemi pine is a well-known example of a species that has "made a successful comeback," but other such taxa continue to be discovered. Relatively recently, in 2022, a site with the tropical tree *Gasteranthus extinctus* L.E.Skog & L.P.Kvist was discovered in Ecuador. The species had been considered extinct for almost half a century. Unfortunately, it is by no means easy to ensure the safety of such taxa, and very few of them can be as successful as the Wollemi pine.

Biodiversity in danger

It is not only wildlife that is affected by biodiversity loss. Various crop plants are also at risk of gene pool depletion, with many old and traditional varieties sinking into oblivion. For example, an estimated 80% of the gene pool of the apple tree has been lost, and 88% of the gene pool of apricots. Cultivating only high-yielding varieties is of course profitable, but in the long term it can lead to genetic erosion and endanger the entire species (for example, if the most popular variety is not resistant to a new disease). For this reason, a crucial role in the future may be played by special collections focused on the preservation of former biodiversity. They serve as a protective measure for agriculture, as a sector of crucial importance. In the case of plants, it is relatively easy to create gene banks, which are simply collections of seeds. One of the most famous and most important of such collections is the Global Seed Vault, built in the permafrost of Svalbard. It stores the genetic material of crop plants from all over the world (by 2021, it was already safeguarding more than one million different samples). This collection has already been put to use: in 2015 and 2017, the International Center for Agricultural Research in the Dry Areas (ICARDA) took seeds from the bank and sowed them in Lebanon and Morocco.

Nature conservation currently stands as one of the most serious challenges facing humanity. Its significance extends beyond the preservation of natural ecosystems, intertwining with human well-being and the stability of the global economy, as biodiversity loss can have a major impact on multiple industries. Determining the best or most effective conservation strategies is not easy: the choice between *in-situ* or *ex-situ* methods depends largely on the particular characteristics of the species in need of protection and the environment it inhabits. Although a significant portion of former biodiversity has been lost beyond recovery, numerous conservation projects have proven successful. We can only hope that future efforts will embrace new, more holistic, and more effective strategies to safeguard our planet's priceless biological heritage. ■

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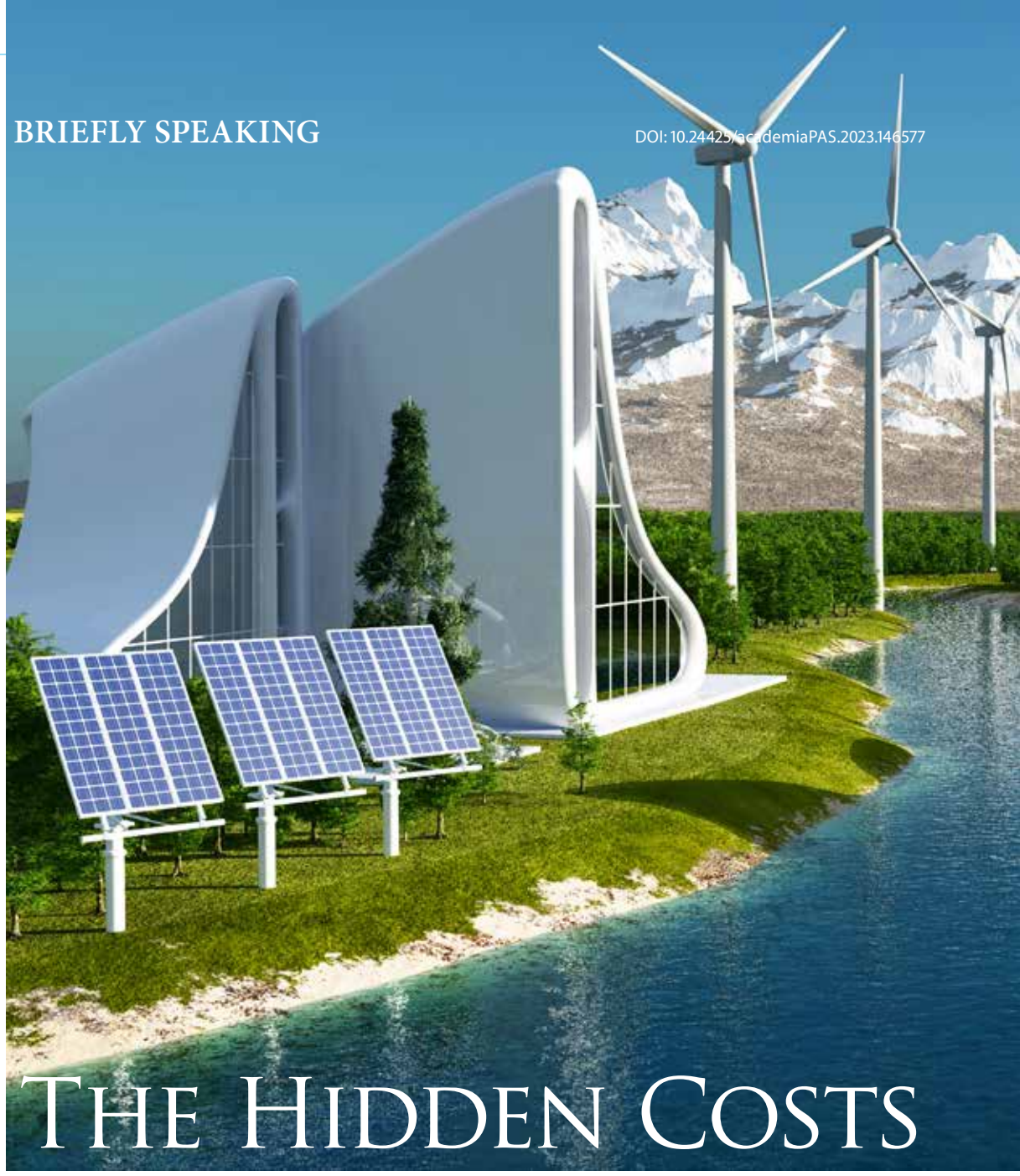


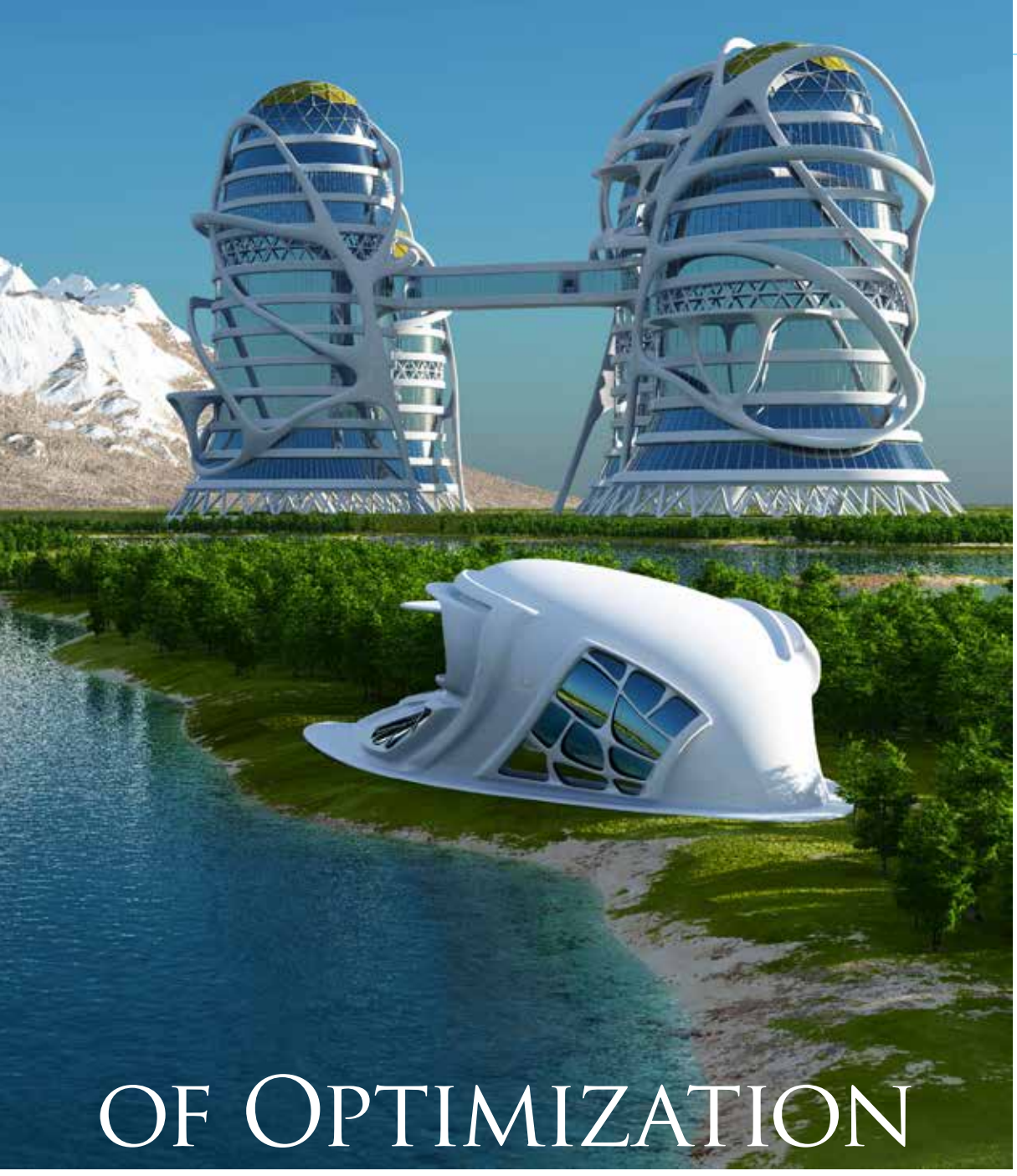
The Hidden Costs

Someday soon, autonomous vehicles could greatly improve our safety. But once we turn decision-making over to machines, will our cities still be ours? – wonders **Dr. Rafal Kucharski** from the Group of Machine Learning, Jagiellonian University in Kraków.

What does it mean to study the future of transportation?

RAFAŁ KUCHARSKI: A project funded by the European Research Council has to stretch beyond day-to-day research work; it requires the researcher to step into a new role. My work to date has looked at transportation systems in cities from the social, human perspective. That means I have not treated them as purely engineering systems, but as systems in which people make various decisions about how to get from place to place. Which routes they decide to take, at what times and by what means, determines whether there will be congestion or traffic jams. All of this contributes to the image of the particular city we live in, how efficient it is, whether it allows people to commute easily, whether it gives them a sense of safety, aesthetics, comfort.

In scientific terms, this subject has to be approached very interdisciplinarily. On the one hand, a city is a large engineering system with means of transport, infrastructure, and signal control systems, while on the other it consists of people who have their own



# of Optimization

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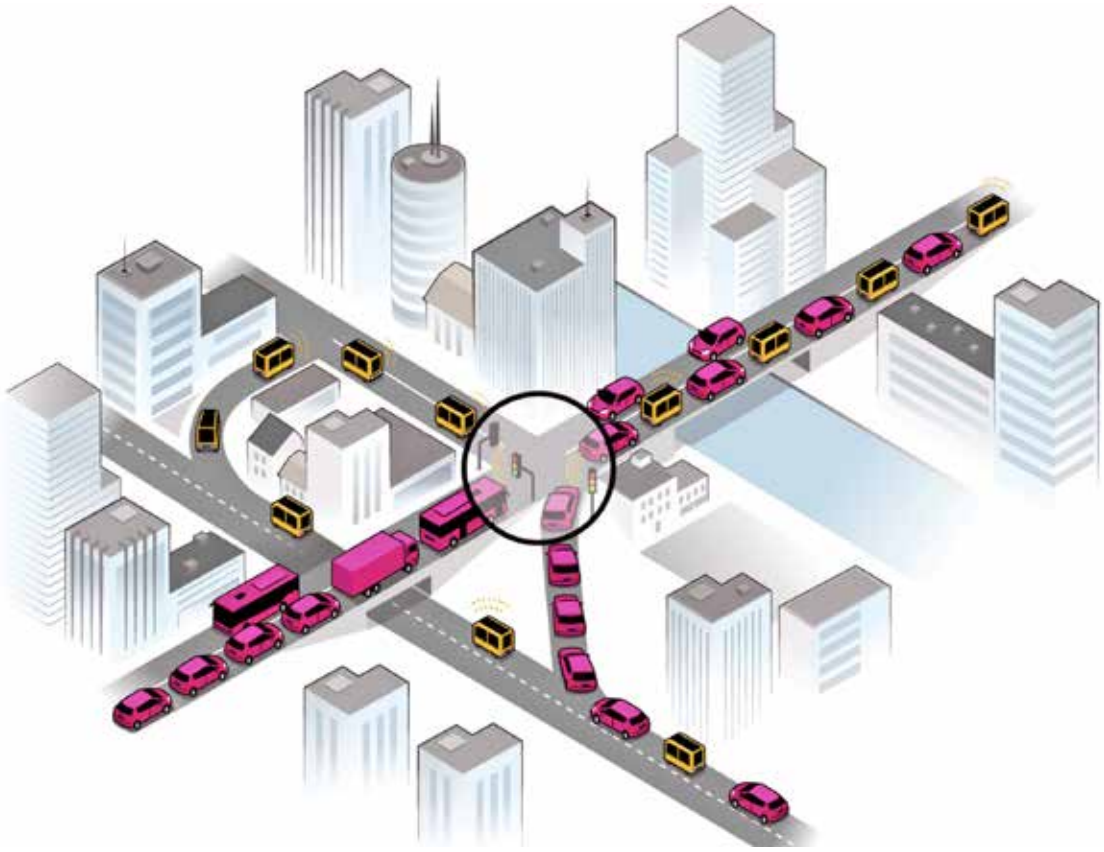
traits, preferences, are in various situations, and quite often make suboptimal decisions. Simulating how all of this might change over months and years is very difficult and interesting. I have built such models for the cities of Kraków and Warsaw, which can be used to anticipate what we can expect. Transportation systems need to be planned out well in advance – the projects we are working on today must also serve our children. In the paradigm I work in, the ideal city will function well without cars. More and more of us are dreaming of such cities, but few people today are ready to stop using this mode of transportation altogether.

What will your work under the ERC grant focus on?
I'll be looking at what will change in the next few years if artificial intelligence and, to some extent, automation starts making decisions affecting the transportation system for us. This means that the space of our cities will have to be shared between humans and machines, probably equipped with AI. The way things stand today, each and every decision related to car travel, for instance, is made by a human being: which way to go, at what time, by what route, at what speed, etc. What if these decisions are instead delegated to AI-based systems? Such a question opens up a Pandora's box of issues that I would like to unpack. We know for certain that the current systems are not optimal. We all say that we would like to streamline them, improve them from the perspective of sustainable transportation. If all our decisions were to be made by autonomous vehicles, transportation efficiency could be increased by 20–30 percent, which means less fuel burned, less harmful emissions, less noise and other side effects of transportation. This all sounds very tempting, but the question is whether such a city will continue to be a city, in the sense of a place created by people. I compare such an automated city to a warehouse, such as an Amazon or DHL hub – a large logistics



facility where optimization criteria trump everything else, in the quest to attain the most efficient operation of the system. This can be done with a city, too, but we have to bear in mind that such optimization will change it. A city is a mix of people who leave their homes, meet in public spaces, and interact with each other, there is a kind of creative hustle-and-bustle. Won't optimization destroy that?

Does your work require more mathematical or psychological expertise?

I work in the Department of Mathematics and I apply mathematical methods, but the decisions about whether to implement the solutions so developed will be philosophical or ethical, and in practice probably political. It is important that such decisions should be made on the basis of rigorous research results. In the ERC project I will use mathematical simulations comparing two variants, so it will be based on a transparent methodology. We can then compare two hypothetical scenarios: one for a city with autonomous vehicles only, in which decision-making is delegated to artificial intelligence, and another in which it is humans who choose how they use the vehicles. For the first scenario, the positive effects are fewer emissions and fewer accidents, but we also have to reckon with negative social impacts. The second version assumes that we do not harness artificial intelligence to improve our cities, but on the other hand, the cities still stay ours. And between these two extremes there lie a whole host of intermediate scenarios, where humans and machines share a common space.

Are machines actually less likely to make mistakes, will they make us safer on the roads?

My study deals with macro-level decisions, such as which route to take. The frequency of accidents, on the other hand, will be affected by how autonomous vehicles behave on a micro-scale – in interactions between two vehicles, or between a vehicle and a pedestrian or a bicycle. But I'm certain they are safer, they essentially do not make mistakes, and they also can't abuse alcohol. So while there remain ethical issues about how to choose the lesser of two evils, when, for example, a vehicle might collide with either a child or an elderly person, these are extreme cases. Such situations will actually occur very rarely.

Autonomous vehicles might fare very badly in spaces where the normal traffic rules do not apply – such as pedestrian zones, where cars, cyclists, and numerous pedestrians might all be moving. If people realize that vehicles are driven by an automated system that will always yield to them, they will take advantage of it. A car with a human driver will also let pedestrians pass, but after a while they will exert pressure and manage to get through. But if an automated driving system cannot

accept any risk, pedestrians may abuse that fact. Think of the situation with elevator doors: we simply know the door won't close and hurt us. If we were not sure there was a sensor in there, we would behave differently, and not go sticking our limb into a closing door.

How can you go from the level of individual people making decisions, up to simulating whole transport systems of the future?

Fortunately we have many models and empirically verified theories in this regard. For instance, discrete-choice models. A "discrete choice" is a situation in which someone decides between a number of distinct alternatives: for instance, I might decide to go somewhere either by car or by bike. If we look at this from the perspective of the individual making the choice, it seems simple enough. But from the perspective of an outside observer, without direct knowledge of the individual's personal preferences, trying to evaluate what decision he or she will make and why is quite complicated. Moreover, preferences can be classified as latent or revealed – in the theory of economist Paul Samuelson, people's personal convictions are not always in synch with their actual behavior, for instance on the part of a consumer. The data we have, gathered from measuring devices, navigation apps, etc., reflects revealed preferences – the outcomes of real individual decisions, in other words how someone *actually* chose to behave. Such data can be analyzed in terms of various variables. For instance, we can verify whether it is true that fewer people take public transport after ticket prices go up, or that fewer people use cars when fuel prices rise. When a tramway line becomes faster or more convenient, does it end up having more passengers? Such kinds of data are widely used in online and political marketing. In our research, we make use of extensive existing databases reflecting how people behave in various situations, and on this basis we try to forecast how they will behave the future. Of course, we do not know what the future will bring, and sometimes changing just a single parameter in these models can completely alter the outcome – for instance, from a scenario in which a city becomes even more traffic-congested to one in which there are no cars at all.

Caroline Criado-Perez's book *Invisible Women: Data Bias in a World Designed for Men* points out (among other things) how differently men and women tend to travel. Can your models be differentiated in terms of gender?

Yes, we always take gender into account, and doing so shows some differences between men and women. But it's not just women that we make sure are adequately represented in our samples. There are many transportation-excluded groups. We shouldn't kid ourselves: cars are primarily used by young, physically fit men who need to get somewhere quickly, whereas their children often have no good way to get to school by themselves, or their parents to get to the doctor. There are quite a few activists who would like to see cities without any cars at all, or at least with far fewer of them. But since they often lack solid arguments, their efforts have the opposite effect and provoke strong resentment among motorists. Studies like ours can help supply such arguments.

You compared Warsaw and Kraków. How do their transportation systems differ?

Although the layout of these cities is quite different, and Kraków has historically had a much higher share of pedestrian travel, their transportation systems actually look quite similar. In Kraków, as much as one-third of movement is on foot. This is a great starting point for putting the "15-minute city" concept into practice – the idea that if all the most important points for us, such as school, work, home, the doctor, are within 15 minutes on foot, cars will cease to be necessary. The layouts of Warsaw and Kraków are quite different, but the behavior is generally similar. In both of these cities, there has been a trend toward building large suburban roadways, and the new neighborhoods being developed near them are populated by young people very attached to their cars, because they represent one way to accrue social status. However, activist groups that promote a completely different approach are growing in strength. It seems to me that this trend may repeat itself in all large cities in Poland. The solutions that are ultimately implemented often depend on young active policymakers who are determined to make changes.

> There are quite a few activists who would like to see cities without any cars, or at least with far fewer.

So will we end up living in carless cities?

We'll have to be patient, but I do think our cities will become more sustainable. The shift away from cars will gain steam as more and more young people take a different approach. This is a trend that is not going to stop. Ultimately, in my opinion, it doesn't matter much whether the cars we drive are electric or autonomous. A significant improvement in the quality of life will happen only once we give up our dependence on the car, in favor of walking, biking, and public transportation.

Interviewed by **Justyna Orłowska, PhD**

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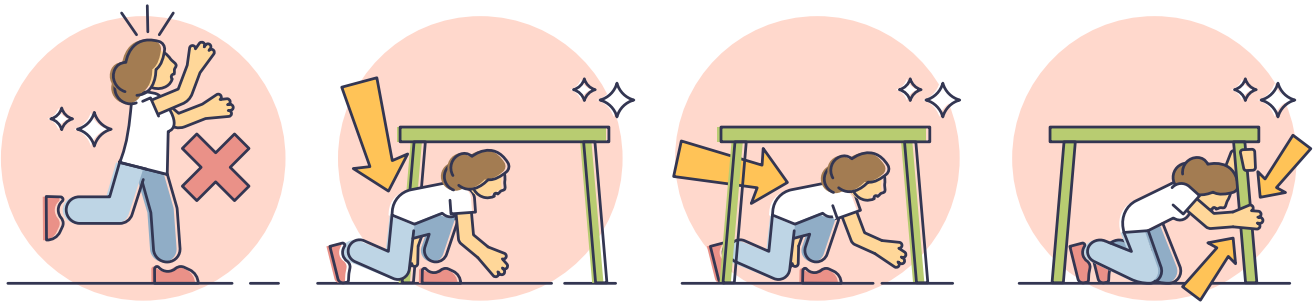
EARTHQUAKE SAFETY EARTHQUAKE SAFETY



DON'T PANIC DROP TAKE COVER HOLD ON

Grzegorz Lizurek
is an Associate Professor at the PAS Institute of Geophysics, working at the Institute's Seismology Department. He studies the processes that give rise to earthquakes as well as tremors caused by human activity.
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Dangers From the Depths

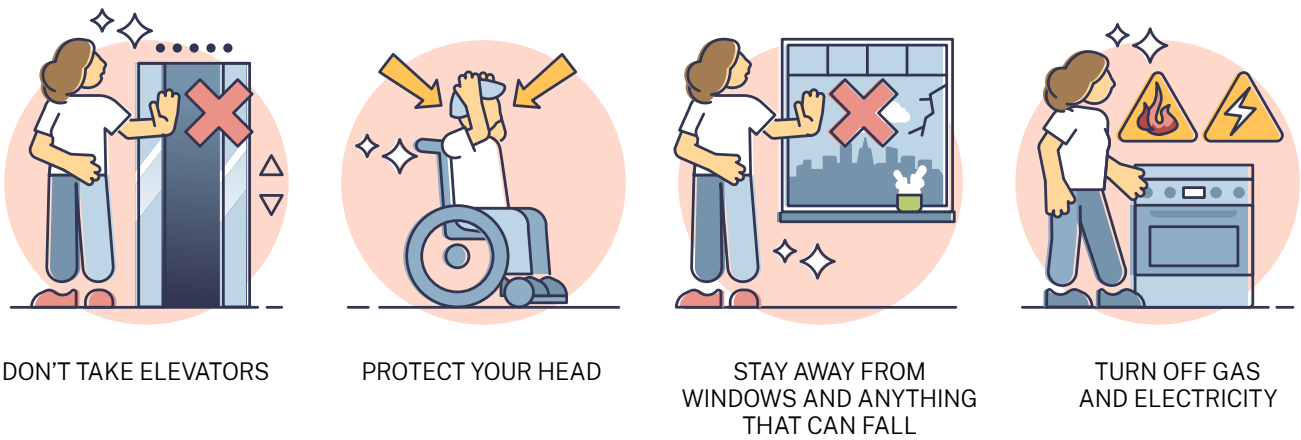
In populated regions, strong earthquakes are among the most devastating natural disasters. But minor tremors usually go unnoticed, as their existence is only detected with the aid of precise measuring instruments.

Grzegorz Lizurek

PAS Institute of Geophysics in Warsaw

Earthquakes are caused by natural processes taking place deep within our planet, more specifically the movement of the tectonic plates of the lithosphere, the Earth's outermost layer. These processes lead to the formation of mountains and changes in the distribution of continents. An earthquake is typically seen as a natural catastrophe and may have disastrous consequences. Humans have experienced earthquakes since the beginning of time, but their impacts became more dangerous in tandem with the rise of cities, which became more densely populated as civilizations developed. Earthquakes damage buildings and infrastructure and therefore pose a deadly threat to people, but they rarely kill wild animals and other living organisms in their natural environment.

Strong earthquakes, which may have catastrophic consequences, occur only along active fault lines, near the boundaries between tectonic plates. The Earth's crust is made of plates that move relative to one another at an average rate of 10–40 mm a year – the movement of these plates is decribed by plate tectonics. There are three types of plate movements. The first of these occurs when plates collide, and one plate sinks



under another. The second occurs when plates move apart, and the space between them is filled with material flowing out of the Earth's interior. Thirdly, the plates can slide horizontally past one another. The corresponding three types of plate boundaries are known as subduction zones, rift zones, and transform boundaries, respectively. Earthquakes occur because the movement of tectonic plates relative to one another is not continuous or constant. Friction prevents tectonic plates from sliding smoothly, leading to the buildup of pressure and stress along the boundary between them. Eventually, the plates press against each other so strongly that the resultant stress exceeds the friction along a smaller or larger section of the boundary between the plates, leading to a sudden fracture and one-time displacement of the rock masses, which causes an earthquake. The most powerful earthquakes occur in two regions: the Circum-Pacific Belt (also called the Pacific Ring of Fire) and the Asian-Mediterranean zone, which stretches from the Philippines, through the Himalayas and Asia Minor, to the Mediterranean basin. More than 100,000 earthquakes are recorded worldwide each year, and the number of small quakes recorded grows every year as a result of the growing number of seismic stations and increased sensitivity of the seismographic network.

Measurements

Most earthquakes are detectable only by sensitive measurement instruments. Only some of them are sizeable enough to be felt by people, and the catastrophic ones occur very rarely. Assessing the severity of seismic events has posed a key challenge since the early days of seismology. The concept of "magnitude" was introduced by Charles Richter in 1935 as an absolute measure of the size of an earthquake. At the time, it was a measure based on empirical data, in particular the observed maximum wave amplitude recorded by the Wood-Anderson seismograph, and called the Richter scale. In 1979, Hanks and Kanamori linked magnitude to the "seismic moment," which is the result of the multiplication of the average displacement of rock material during an earthquake, the area of the fault where the displacement occurred, and the rigidity of the rock fault. The seismic moment can be computed from modern seismic records. Magnitude is proportional to the logarithm of the seismic moment and is a dimensionless quantity. Each increase in magnitude by one unit means an approximately 30-fold rise in the energy released by the tremors, including a 10-fold rise in the movement during the earthquake, occurring over an area that is three times larger. An earthquake can have any magnitude, and it can even be represented by a negative number. The largest earthquake recorded instrumentally had a magnitude of 9.5; the smallest ones, recorded in laboratories, have negative values.

Aftermath

Most tremors, recorded only by measurement instruments, are so small that they essentially have no impact. To pose a threat, a seismic event has to be medium-sized or large. However, such events are quite rare and account for a negligible share of all earthquakes. The damage caused by an earthquake is not directly related to its size. Sometimes medium-sized quakes cause a catastrophe, while much larger ones cause no damage. The location of the earthquake is the most important factor here: densely populated areas sustain more damage than less populated ones.

An earthquake may have catastrophic consequences, which include ground shaking, landslides, ground liquefaction, and tsunamis. Shaking is the first and usually the most spectacular consequence: it destroys

buildings, and the falling debris may kill people. Those who are unaccustomed to earthquakes often panic and want to get out of a shaking building as fast as possible. But being outside is typically even more dangerous due to falling pieces of façade and fragments of glass. In addition, a building is more likely to collapse in an outward direction than into itself. When the tremors stop, the danger does not go away: the most significant threat is then posed by damaged electrical, water, and gas installations. Rescue operations are hindered by damaged roads and secondary earthquake-induced phenomena such as aftershocks and landslides.

Aftershocks are smaller earthquakes that occur in an area recently affected by a more powerful one. A strong earthquake causes a shift in rock masses and releases built-up stress, but never brings it down to zero. A rock mass torn apart by a large earthquake must have time to adjust to the new situation, which proceeds in part through smaller earthquakes. After extremely large earthquakes, aftershocks can continue for years, but their number and strength dwindle over time. After the 9.5 magnitude earthquake in Japan in March 2011, aftershocks continued to be recorded for the following 10 years.

The consequences may also include tsunamis. These occur in the aftermath of earthquakes whose hypocenter is situated not too deeply under the seafloor. The vertical movement of the seabed uplifts the water above it, giving rise to major waves. Out in the deep ocean, a tsunami can move at a speed of 300 km to 850 km per hour. In the open sea, it is a relatively harmless, very long wave. But when it reaches the coast, it slows down significantly and the water surges.

Earthquake causing a tsunami

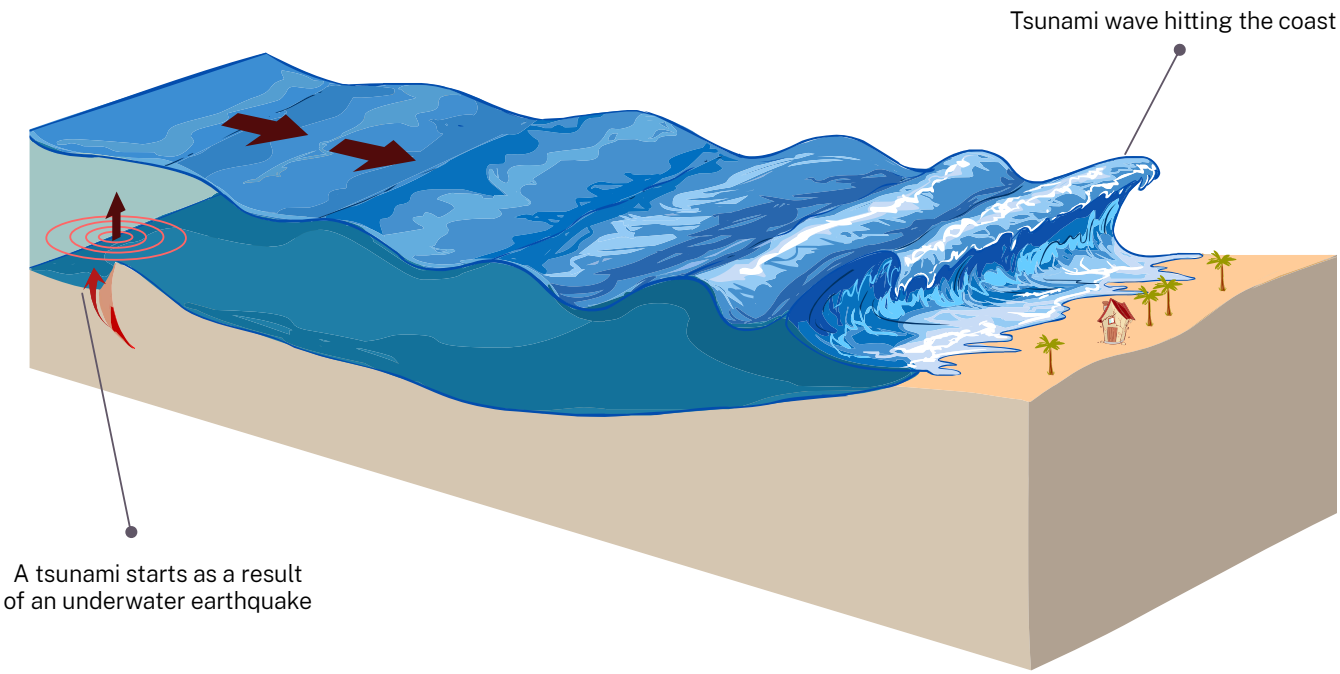
The devastating power of tsunamis made themselves evident following the Sumatra earthquake in 2004 and the earthquake in Japan in 2011. In both cases, the tsunamis were the direct cause of most of the 200,000 and 20,000 deaths, respectively, and the tsunami following the earthquake in Japan moreover led to the failure of the Fukushima nuclear power plant.

The final stage of a seismic disaster involves further delayed effects, mainly famine and disease. Famine can result from the destruction of food supplies, agricultural fields, irrigation systems, and the food processing industry, as well as the infrastructure needed to transport goods. Diseases, on the other hand, result from the contamination of water sources and the decomposition of animal and plant remains.

Risk assessment

Despite decades of scientific advances, it is currently not technologically possible to accurately predict the location and time of strong earthquakes. However, a probability-based forecast can be made based on information about the locations, frequency, and magnitude of known earthquakes. We can compare such forecasting to weather forecasting, which is also not perfectly predictive but generally regarded as functional and useful.

One major difference is that seismology deals with a much larger time scale. For example, large earthquakes may occur in the same area every several hundred years. Seismologists continually generate statistical forecasts called seismic hazard assessments. This enables them to calculate the probability that an earth-



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A devastating magnitude 7.8 earthquake hit the Turkish province of Kahramanmaraş in 2023

quake of an assumed magnitude will occur at a specific location over a specific timeframe. Right now, the occurrence of a large earthquake in a given place in the next 30 years can be predicted with roughly the same level of accuracy as a daily rain forecast. Unfortunately, such a prediction is worthless from the point of view of everyday life. A vast earthquake-prone region cannot be simply evacuated for an entire generation. Were this to be done, the economic and social losses would be many times greater than the damage caused by the quake.

Statistical forecasts are more likely to be used to determine the probability that tremors of certain intensity will occur at a specific place and within a specific period of time. Such forecasts are used by civil engineers to design buildings that should withstand specific conditions, including ground shaking caused by earthquakes. Such forecasts exist for many regions of the world – the larger the statistical database (the more earthquakes that occurred and were recorded in a specific area), the more accurate such forecasts are. Assessing the hazards related to the phenomena caused by an earthquake is the first step towards estimating the seismic risk, or determining the probability of harmful effects, including human casualties. This risk depends on the seismic hazard and such factors as the age and type of buildings and infrastructure, population density, the type of land and land use, and the time of day when an earthquake may occur. To put it in simple terms, a large earthquake in an uninhibited area poses a high seismic hazard but a low seismic risk.

Minimizing the effects of earthquakes requires that seismic hazards and geological conditions be taken into account during the design and construction of infrastructure in earthquake-prone areas. This is particularly true for strategic facilities like nuclear power plants, dams, toxic waste tanks, and so on. Such goals are often accomplished by complying with construction standards that conform to guidelines based on seismological and engineering knowledge. Examples include the EU standard called Eurocode 8, which is used for the design of structures for earthquake resistance. Sometimes such standards are ignored, as demonstrated by what happened in Türkiye this year. Buildings outside the city of Gaziantep did not meet the stricter building standards despite the 90% probability that a strong earthquake would occur in the region in the following 20 years. In Türkiye's case, the construction standards could be legally ignored following the payment of an additional fee during the process of obtaining relevant permits. This probably resulted in the faster and less expensive construction of houses and office buildings, but also to thousands of deaths in the February 2023 earthquakes. ■

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Revitalizing a Minority Language

On the past and future of the Upper Sorbian minority language in Germany.

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Cultural security is a multidimensional concept that first emerged in the social sciences back in the 1970s. John Burton, a scholar of conflict and conflict resolution, considers cultural security to be one of the most important human needs (alongside physical security, equal access to goods, a sense of belonging, self-esteem, personal fulfillment, freedom and participation), the fulfillment of which can contribute to the prevention of violent conflicts, especially national and ethnic ones. Although the concept of cultural security is invoked in various contexts (e.g. securing material heritage sites during conflicts, or the westernization of the academic world), its most important dimension concerns the rights and protection of ethnic and linguistic minorities.

Cultural security therefore entails minorities' right to self-determination, to enjoy access to and make use of all public services. It also means people's abil-

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The historic city of Bautzen/Budyšin in Upper Lusatia, in the southeastern part of the state of Saxony in Germany. In the city and surrounding Sorb-inhabited areas, bilingual signage is used

ity to use their own language in all realms of life, not only private but also public. Ensuring the cultural security of minorities thus takes the form of a right to "linguistic security," a concept which entails a certain duty on the part of the state and dominant society to ensure, safeguard, and promote the continuity of the minority group's language. In the context of the French-speaking minority in Canada, for instance, Denise Réaume has defined linguistic security as the right to pursue the normal process of language transmission and preservation.

In today's world, however, legal regulations alone are not enough to make a minority language safe. Indeed, the danger posed to such languages does not primarily stem from possible bans or legal restrictions on minority language use and transmission. Opting not to use a minority language is often the result of negative attitudes of the dominant community towards the minority language, a perception that it is of no practical use, as well as the loosening up of the boundaries separating the minority and the dominant group. Minorities therefore employ various strategies to secure themselves culturally and linguistically. However, these strategies are not always successful.

Maintenance strategies

The Upper Sorbs are a cultural and linguistic minority residing in Upper Lusatia, a region in southeastern Germany. It is estimated that there are about 40,000 people who identify as Upper Sorbs, of whom about 15,000 speak the Upper Sorbian language to varying degrees. Upper Sorbs have their rights as a minority guaranteed in the constitution of the state of Saxony and in international documents, such as the Framework Convention for the Protection of National Minorities and the European Charter for Regional or Minority Languages. In legal terms, therefore, the Upper Sorbs have their cultural and linguistic security ensured. However, this does not mean that their situation is stable and their language is secure.

Some Upper Sorbs are Protestants, others are Catholics. The Protestant Upper Sorbs predominantly underwent linguistic assimilation into the German community over the centuries, whereas Catholic Upper Sorbs largely maintained the intergenerational transmission of the language. Indeed, they formed a group that was separated from the Germans around them by a triple boundary: a linguistic boundary (Sorbs/Germans), an ethnic boundary (Slavs/Germans), and a religious boundary (Catholics/Protestants). It is also significant that Catholic Upper Sorbs see their identity, the cultivation of Sorbian customs, and the use of the language as inseparably interconnected. Thus, they find it difficult to allow outsiders into their group and,

whenever dealing with German speakers, they invariably choose to adapt linguistically to them – switching to German, while reserving their own language and culture to be manifested only when exclusively among Sorbs.

This strategy, which has worked excellently for centuries, has nevertheless become less and less successful today, as exclusively Sorbian-speaking places have become almost non-existent. There are more and more mixed-language families, Sorbs are working professionally alongside German speakers, the German and Sorbian worlds are intertwined at almost all levels. So the strategy of reserving the language exclusively for in-group use no longer works. Upper Sorbs realize that in order for their language to survive, steps must be taken to "revitalize" the language – not only to reinforce the language where it still functions, but also to expand the domains of its use and bring in "new speakers," people who were not raised in Sorbian-speaking homes and did not learn the language in family transmission, but learned it in the process of education and began to actively use it. For this to happen, people from Sorbian-speaking homes must accept such new speakers and be willing to share the language with them. However, simply creating an educational system conducive to the emergence of new speakers is not enough. This is demonstrated by the case of the Upper Sorbian Grammar School in Bautzen/Budyšin, which applies a "2 plus" teaching system (teaching in two languages, Upper Sorbian and German, plus learning an additional language).

In my recent book *Upper Sorbian Language Policy in Education* (Brill, 2023), I analyze how the official language policy of the state of Saxony, which aims to ensure that all learners can achieve active bilingualism, diverges from the actual language practices at the level of social interaction among students and teachers at this school. There are three language groups studying side-by-side in each year group: those from Sorbian-speaking families, those who have had previous contact with the Sorbian language (e.g. in kindergarten and elementary school), and those who came to the grammar school with no or very little knowledge of the Sorbian language. However, the situation of having people with varying levels of Upper Sorbian proficiency is not exploited at the school so that those learning Sorbian have the best possible chance to become accustomed to the language. At the level of linguistic practices, both the Upper Sorbian and German communities follow the accepted rules and prevailing linguistic ideologies (ingrained beliefs about languages and speakers). Upper Sorbs follow a strategy of keeping the language to themselves and cordoning it off culturally and linguistically from those outside the community (continuing the age-old strategy of language maintenance), while those from German-speaking homes either feel that they are being kept away from the Upper Sorbian language and have no chance to practice it, or they feel discouraged and resentful towards the Upper Sorbs. And so, despite the existence of a bilingual school, actual revitalization of Upper Sorbian in the education system therefore turns out not to be proceeding very successfully – although there are certain exceptions.

Photo 1
A "Bird Wedding" – a traditional Upper Sorbian folk custom that combines elements of folklore, music, dance, and storytelling

Photo 2
A "Jolka" Christmas Festival in Upper Lusatia, 2018

Closer scrutiny

Our research at the school using ethnographic methods (in-depth interviews, focus-group discussions, participatory and non-participatory observations in and out of classes) has shown that young Upper Sorbs belonging to the Catholic community share very strong ties. These are based on a common language (a minority language amidst the surrounding German language) as well as on cultural practices related to community life marked by a calendar of religious holidays. This means that Catholic youth from Sorbian villages constantly meet outside of school, and their world there is also separate from the German world. The boundaries so demarcated are what give rise to their communal cultural and linguistic security: they

can converse in Sorbian among their own community, and cultivate customs while deepening already existing in-group ties. Since these young people also stick together at school, rarely coming into closer contact with people from German-speaking homes, their sense that it is a strategy of cordoning themselves off that will allow them to preserve their language is reinforced.

My fellow researcher, Dr. Cordula Ratajczak, and I engaged in research work at the school and under the SMiLE project ("Sustaining Minoritized Languages in Europe," Smithsonian Center for Folklife and Cultural Heritage, 2018–2019), which was dedicated to the state of revitalization of both of the Sorbian languages (perhaps here I should point out that in addition to Upper Sorbian, there is also the closely related Lower Sorbian language, which is spoken in Brandenburg, near Cottbus/Chóśebuz, and much more seriously endangered than Upper Sorbian). We did not focus solely on so-called native speakers of Upper Sorbian. Rather, we were also interested in other ways one might become a speaker of Upper Sorbian (e.g. via education or integration into the community), as well as what obstacles hamper motivated individuals from gaining recognition as legitimate speakers of the language. Our most important observation was that the Sorbian and German worlds remain greatly divided. Students at the bilingual grammar school who come from German-speaking homes are officially told at the beginning of the educational process that they will learn to speak Sorbian fluently over the next few years and achieve active Sorbian-German bilingualism. As the year pass, however, it turns out that just learning Sorbian as a foreign language does not yield much progress (as is generally characteristic of any foreign language teaching solely in school lessons). What's more, they come to realize that their Sorbian-speaking classmates do not really want to talk to them in Sorbian, explaining this in terms of being courteous (the so-called "rule of politeness") or a desire for efficient communication. Frustrated by their lack of progress in acquiring linguistic competence, many young people learning Sorbian end up not wanting to hear the minority language used in their presence.

A glimpse into the future

One of our interviewees, who, despite being from a German-speaking family nevertheless studied in a class designed for Sorbian speakers and quickly, without problems, achieved fluency in Sorbian, referred to the educational strategy at school as *Schubkastendenken* – "pigeonholing." She explained that once a child ends up in one of the three groups, "Sorbian," "German," or "bilingual," there is no escaping the classification. At the same time, belonging to one of the pigeonholes determines the choice of language and language practices in the group. Only those in the first group are considered legitimate speakers of Upper Sorbian, while the others must be addressed in German. Thus, the opportunity for learners to gain even passive competence in Upper Sorbian is lost. And yet, successful revitalization of Upper Sorbian, intended both to prevent the loss of active speakers and to open up a space for those who do not yet speak the language, requires the involvement of people who are not connected to the Sorbian group by primordial ties (of blood and kinship). This is because potential speakers of Sorbian include everyone who is willing and able to learn the language – including, first and foremost, German speakers from the immediate social surroundings of Sorbian speakers.

The creation of bilingual education, as a place where young people from Sorbian and German-speaking homes meet, was the first step toward tearing down the wall dividing the Sorbian and German worlds. It has not yet been dismantled, however, because students from the two disjoint worlds have not been actively encouraged to form a community and to communicate in Sorbian or bilingually regardless of their initial language level. What was lacking was an active language policy at the grassroots level, a policy that promoted Sorbian over German and encouraged students from German-speaking homes to become involved in Sorbian-language school and extracurricular life. Nonetheless, the first step toward Sorbian-German bilingualism has been taken, and recent years have seen more and more signs of the divide in Upper Lusatia being broken down. It seems that precisely such an opening up of the community – while of course taking care to ensure Sorbian cultural survival – is needed today to ensure the linguistic security of the Sorbs. A minority language is only safe if it can be spoken everywhere and with all people in the region (alternatively: in the presence of all people in the region) regardless of whether they identify as a member of the (Sorbian) minority or (German) majority. ■

NICOLE DOŁOWY-RYBIŃSKA

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Safety in Today's World

Associate Professor Robert Balas of the PAS Institute of Psychology talks about how the traditional patterns of human behavior are breaking down, causing growing frustration.

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How could we describe the sense of safety?

ROBERT BALAS: The easiest way to define it is by negation: it is a state in which we feel no danger. In other words, when we are calm and free from worries and concerns. It is accompanied by a feeling of harmony and mental comfort.

In Maslow's hierarchy of needs, it is one of the basic human needs. It provides the basis for the fulfillment of other, higher-order needs, such as acceptance and self-actualization. The only level below the need for safety is made up by physiological needs that, when deprived, pose a danger to our physical existence – such as sleep, food, and water. They need to be satisfied for us to live.

How can we develop a sense of safety? Where does it come from?

This is a very complex matter, but I would start by saying that the sense of safety is based on the ability to predict what will happen to us in the near or distant future. We can do so thanks to patterns of thought called schemas, which we use to explain the world around us. These schemas describe how the world is organized and what rules govern it. When such a pattern is broken, it offers a dose of novelty that directs our attention to what will happen in the future. As long as we are able to predict this, our sense of safety is not threatened. But when we find ourselves in an environment that is unpredictable, changeable, and difficult to grasp and understand, this causes obvious stress. In moderate doses, such tension may be good for us; it spurs us into action. But persistent stress related to the unpredictability of the external environment can be very harmful. Numerous studies show that prolonged tension contributes to the development of depression, increases anxiety levels, causes memory and attention disorders, and these are just some of its psychological consequences.

Recent years have surprised us with events that were difficult to predict, such as the COVID-19 pandemic. Don't we just have to somehow get used to this unpredictability?

Even if we can tame unpredictability to some extent, this certainly does not come without a cost. Many studies around the world have demonstrated severe mental-health costs associated with the COVID-19 pandemic. These include symptoms of depression and elements of PTSD, sleep disturbances, and an observed increase in the use of psychoactive substances. On top of this, there are the consequences of hindered social and professional contacts during the pandemic, which resulted in an increased sense of loneliness, among other things. The unpredictability of the situation was also further compounded by the sometimes chaotic measures taken by lawmakers.

In such a situation, we need to find at least one domain of life that remains safe and stable despite the changing and unpredictable world. A domain that either does not take us by surprise, or gives us mostly pleasant surprises. Examples include social networks: friends, family, acquaintances. Social support helps us to cope with various unpredictable situations without creating a persistent sense of danger.

Is it possible to be better prepared in this regard, through the process of socialization?

This is influenced to some extent by attachment styles, which we develop in childhood. Secure attachment allows for easier adaptation to unexpected, difficult conditions that may arise in adult life. Children, and later adults, who feel safe are curious about the world, and they seek support from their loved ones in difficult moments, when their sense of security becomes shaken. This is a healthy model. Other attachment patterns include ambivalent attachment and disorganized attachment. These, in turn, intensify the sense of the loss of safety. People who have developed these attachment patterns may feel frustrated even when minor changes occur.

> Many studies around the world have demonstrated severe mental-health costs associated with the COVID-19 pandemic.

But it's not just our upbringing that influences how we react to danger and unexpected events. Personality traits also play a significant role. Psychology has long recognized a personality trait called "openness to experience." It is unique to each person, and there is a whole spectrum of openness to change and novelty. People with a low level of this trait actively seek stability. They react more strongly to the loss of predictability and are more severely affected by the loss of the sense of safety. Conversely, those who are highly open to all kinds of change and adventure react less strongly to various changes, are better adapted, and even seek to be surprised. In addition to openness to experience, a person's reaction to the loss of the sense of safety is determined by another personality trait called "neuroticism." Neurotic personality is characterized by a greater tendency to experience negative emotional states, such as anxiety and stress. Neuroticism

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is a risk factor for phobias and other anxiety disorders. Therefore, highly neurotic individuals will react strongly to losing their sense of safety. This is influenced not only by social and personality-related factors, but also by other traits. Examples include what is called the "need for cognitive closure," which refers to a person's preference for following established patterns of thought. Unforeseen changes in the environment break these patterns. In people with a high need for cognitive closure, this triggers many reactions, which can be maladaptive (such as a sense of being threatened and the related stress) or adaptive (adjustment of these patterns to new conditions). To recap, there are many factors behind human reactions to unpredictability, and we don't necessarily all react with a sense of being in danger or by losing our sense of safety. But many people do.

Is society's level of security declining? Did people feel safer a hundred years ago?

In a sense, they obviously did. Even a hundred years ago, the world was probably more predictable than it is today. If we look at the world in which our grandparents and great-grandparents lived, it was a lot less complex. Of course, many of them survived a war, but when we compare our lives and the lives, say, of the inhabitants of a Subcarpathian village back in the 17th century, the latter were incomparably less complicated. Today, everything is in flux, everything is changing constantly. In the modern-day world, old patterns of human behavior are falling apart because the world is a lot more globalized and complex. This is influenced by at least two factors: first, the development of technology, and second, the related access to information.

But shouldn't better education and access to knowledge reduce the sense of insecurity?

Yes, on the condition that the information that we receive is consistent and creates a clear picture of the surrounding world. I have the feeling that this is not the case at all. Fifty years ago, people would go to a doctor and get a single, binding and indisputable diagnosis. Today, we double-check everything with various sources, and the varying information we find is often not only inconsistent, but even impossible to reconcile. This leads to growing frustration and a lost sense of safety.

What can we do to feel safer in today's world?

I think no one knows the answer to this question. One way could be to look for stable spaces or to focus on an aspect of reality that we can control, one that depends solely on us.

Interviewed by **Justyna Orłowska, PhD**

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Entomology

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Playing It Safe in the Forest

An experiment studying tick infestation in a pine forest

When ordinary people visit Poland's forests, they are most afraid of encountering a big mammal – a wolf, boar, or bear. But the greatest dangers are actually posed by more inconspicuous animals: ticks and snakes.

Anna Wierzbicka

Poznań University of Life Sciences

Are people in Poland are actually reluctant to go into the forest because of the potential risk of tick-bites? To find out, the Polish Institute for Patients' Rights and Health Education (IPPEZ) commissioned a nationwide survey in 2018. Three-quarters of those surveyed indicated that they had indeed, at least once, opted out of going for a stroll in the woods or park out of a fear of being bitten by a tick, while one in three respondents (37 percent) reported that they were "definitely" afraid of ticks. Moreover, the most prevalent reason the survey participants cited for fearing ticks was the disease risk associated with getting bitten – indicated by 94 percent of respondents. Lyme disease was named by 87 percent of survey participants as the main disease transmitted by ticks, while tick-borne encephalitis (TBE) was indicated by not quite half as many (42 percent). Lyme disease is indeed the most frequently diagnosed and registered disease (17,338 cases in 2022) and as such it provokes considerable anxiety. However, it is worth bearing in mind that Lyme disease is a curable disease that responds well to antibiotics, and so from a public health perspective it is not as dangerous as TBE, which can lead to death or permanent disability. There is no known cure for TBE, the number

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of diagnosed cases of the disease doubled last year, and a very robust upward trend has been recorded since 2020 in countries neighboring on Poland. So it turns out it is actually TBE that we should fear more. We should also take steps to protect ourselves from the latter disease – preferably by getting vaccinated. Unfortunately, only foresters and soldiers in Poland receive mandatory TBE vaccinations, whereas only 2 percent of the general population is currently vaccinated.

Ticks lying in wait

For more than 10 years now, the Department of Game Management and Forest Protection at the Poznań University of Life Sciences has been conducting research into tick biology and ecology. One interesting experiment sought to identify when people spending time in the forest are most likely to become tick hosts. An equal number of men and women of different ages (students and faculty members) performed various activities typical for forest visitors in Poland (e.g. walking, sitting by a tree trunk, sitting on undergrowth, collecting firewood, sitting on a fallen log). The activity "gathering firewood" was included even though Poles do not currently gather brushwood or do so occasionally, because it was intended to mimic mushroom-gathering (i.e., slowly wandering in different directions, frequently stopping to bend over) as the experiment was conducted in the spring, when mushrooms are not present in the forest. The participants wore white beekeeping suits, white gloves and socks, sports shoes or below-the-ankle hiking boots. Their sleeves and pant legs were further secured with silver adhesive tape. We repeated the experiment in May and September (traditionally considered to be the months of highest tick activity in the forest) in coniferous (boreal) and mixed forest at the experimental forestry sites of the university's Faculty of Forestry and Wood Technology. The forests differed primarily in terms of the undergrowth vegetation – there were not many plants on the forest floor in the boreal forest, whereas berry bushes, grasses, and shrubs made up the undergrowth in the mixed forest. After the activities, all ticks present on the suits were collected and then analyzed for tick-borne diseases.

> One interesting experiment sought to identify when people spending time in the forest are most likely to become tick hosts.

Forest visitors were found to be at greater risk of tick infestation in the more fertile mixed-forest habitats, with lush undergrowth, as compared to the boreal habitats, with relatively impoverished undergrowth. Nymphs (1.5 mm in size, akin to a pinhead or single poppy seed) are the most common form of tick that attacks human. They lurk on low vegetation (the aforementioned grasses and berry bushes) and when we brush against these plants as we walk, the ticks get onto our clothing or skin. They then begin searching for a warm place with thin skin and significant blood vessels: most often the armpits, groin, elbow-bends, knee-bends and spots behind the ears. The experiment found that ticks landed most predominantly on the calves (more than 56 percent of all ticks), followed next by the thighs. Therefore, an important way to protect against tick-borne diseases is to wear appropriate ankle-length shoes and tuck your pant legs into your shoes or socks. That way, any ticks that do get on your clothes will not be able to reach your skin.

The ticks collected during the experiment and also from various parks in the city of Poznań were tested for the presence of protozoa of the genus *Babesia*, which causes a disease that affects animals and humans, sometimes known as the "malaria of the north." We found that ticks in forests are much more likely to carry the protozoan than those collected in city parks (11% and 2.6% of the animals examined, respectively). The reverse is true for ticks carrying Lyme disease bacteria, which are more common in cities than in forests. However, it should be borne in mind that we are much less likely to encounter a tick in urban parks than in forests (up to 18 times less likely), but if we do, we are more likely to end up infected with Lyme disease.

May is traditionally considered the month of peak tick activity (it is warm and humid, and tick host animals are also highly active). However, as a result of climate change, ticks are now also active in the winter months in large parts of Poland. If the temperature is above freezing, we can find ticks in the Greater Poland

Nymph of the common tick (*Ixodes ricinus*)

ANNA WIERZBICKA

(Wielkopolska) region even in January and February, on vegetation in the forest and on forest animals (studies have looked at roe deer, red deer, and foxes).

All the research described above entails some practical guidelines for people who spend time outdoors (which means virtually everyone): no matter what time of year it is, when you go out into a park or forest you should wear long pants, high-topped shoes or boots covering the ankle, and after coming back home and having a bath or shower, you should look your body over for ticks. This goes even for the autumn and winter months. Anyone who spends a significant amount of time outdoors (who likes to run, has a dog, goes mushroom-hunting) should also consider getting vaccinated against TBE. It's also a good idea to learn how to pull ticks out of the skin yourself – a video posted on the YouTube channel of the University of Life Sciences in Poznań shows how to do this properly. Each of us should hone our knowledge and skills in this respect: only one in four (29%) Polish respondents in the survey mentioned above declared that they were well informed (both in theory and in practice) on how to deal with a tick in the event of a bite.

RADOSŁAW WITKOWSKI

A common tick (*Ixodes ricinus*) compared to a pinhead

Adders also await

For people who often spend time in Polish forests, another noteworthy danger is posed by snakes. However, people are generally not aware of this risk, considering snakes to be present only in the mountain regions. There is only one venomous snake species in Poland, the adder, but it can be found throughout the country and is under strict protection. It is particularly numerous in the areas of Białystok, Pomerania, and the Bieszczady Mountains. It is active during the day and at dusk, especially on warm days and after prolonged cold spells. In October it goes into hibernation, which last until late April or early May. The adder does not attack without reason and only bites when it feels directly threatened – this often happens when someone is trying to catch it, or steps on it accidentally. In Europe, the frequency of snakebites, mainly from the Viperidae family, is estimated at 15,000–25,000 per year, and the number of deaths caused by bites at about 30 per year. Bites are most dangerous for children, the elderly, and people with cardiovascular disease. Bites most often affect an upper limb (51–60 percent) or lower limb (38–40 percent). Most bites occur during the spring and summer months. When mild winters and warm summers lead to an increase in the snake population, this is correlated with a higher incidence of bites. Bite victims are predominantly children and adult males.

Viper venom can cause a wide range of clinical symptoms. Poisoning depends on the dose of venom per kilogram of body weight, the site of the bite, physical activity after the bite (exertion, movement, alcohol consumption accelerate the absorption of venom), the particular person's sensitivity age and body weight, the type of bite (whether it was a dry bite, how deep it was, whether it was through clothing/footwear, and how long the snake remained adhered to the victim), secondary infections and treatment (nature of first aid given, time between bite and hospital admission, time elapsed before antitoxin administration). The most common symptoms are swelling and subcutaneous hemorrhaging, vomiting, abdominal pain, diarrhea, decreased blood pressure, sweating, cardiac disturbances, and fever. Others, such as losing consciousness, occur rarely, in about 5 percent of cases. The primary local symptom of poisoning is swelling, which can appear within minutes or after a longer delay. It most often occurs within the first two hours of the bite. The skin exhibits a reddish-blue color and a bite mark – two symmetrical holes spaced 1 cm apart. What should we do if someone is bitten by an adder? Never suck out the venom – the methods shown in Wild West movies are long outdated from a medical point of view! The person needs get to a hospital as soon as possible. The bitten limb should be immobilized and placed below the level of the heart for transport to the hospital, as this reduces the speed and degree of venom absorption. But above all, we can protect ourselves from getting bitten in the first place, by wearing high boots and long pants and showing caution when walking in the woods.

In the forest environment, people are exposed to many dangers. In Poland's forests, the main ones are associated with certain animals, although they turn out to be smaller animals than we might imagine. But regardless of the season, the best protection against these dangers is provided by the same very simple measures: long pants and high boots. ■

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ACADEMIA INSIGHT Economics

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Economic Security Faces Challenges

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For a considerable period of time, we lived under conditions in which we paid little heed to the state of our security in its various aspects: military, economic, social, or health-related.

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The "economic security" of a country can be defined as a situation in which its citizens are able, without much difficulty, to consistently enjoy conditions in which they can meet their needs. The concept can be viewed in various ways: in terms of micro-level (individual) and macro-level (national, regional) significance, in the shorter or longer term, as well as in a narrow and broad sense (whether we consider the satisfaction of only basic needs or a broader range).

The concept of economic security is important to both individuals and nations, as it is one of the factors contributing to national security. In addition, it is directly related to the term "economic prosperity," which encompasses a variety of phenomena that influence people's political opinions and choices. In addition, the threats to economic security that may occur are also taken into account, as well as the means to address them or instruments used to mitigate and safeguard against them. The most important aspects

that determine economic security include the following: education, employment/unemployment levels, energy, sources of generation, costs, the environment (the extent of its pollution), health, human rights, income levels, leisure and rest, infrastructure, national security, public safety, shelters, etc.

We can approach economic security in the narrow sense of the term, which will include food (consumption and products), living conditions, income, and the ability of social and government organizations to meet the needs of individuals. In the context of national security, economic security should enable the attainment of the country's development goals – this has a direct bearing on national security, as it can either support or hinder the maintenance and development of the defense potential that a country has at its disposal. In a broader sense, economic security takes into account the balance of trade with foreign countries, the level of investment, including the level of money transfers, public-private partnerships (cooperation between the government and the business sector), and education.

Economic security is one of the most important components of national security; however, any model of state security includes several additional activities and levels. Among the most important are the national security strategy (setting such strategy is, in Poland for instance, the responsibility of the President),

the process of establishing the state budget (the legal and institutional powers exercised by Parliament), and diplomacy in the military and non-military realms – including cooperation with the UN and military alliances, military strategy and industrial defense programs, and ensuring access to appropriate technology.

As can be seen, on the one hand, there is a strong connection between the economic situation in a country and its economic security – and, by extension, its national security. On the other hand, the capacity to form coalitions and engage in international cooperation facilitates guaranteeing economic and national security. This means that international cooperation reduces the need for self-sufficiency in security, which is both costly and unrealistic for individual states, especially small and medium-sized ones. In addition, international cooperation reduces the number of potential threats when it comes to economic and national security.

Effects of the pandemic

In considering the issue of the security of Poland as a country, and of each individual Polish citizen, in the current conditions we can mention several factors that have clearly contributed to reducing our sense of security in connection with the growing threats. These are of varying nature and sources. Listing them chronologically, we can start with the COVID-19 pandemic, which arrived in Europe in late 2019. In early 2020, European countries, including Poland, began to apply lockdown measures, restricting people from forming in larger gatherings, which in practice meant shutting down shopping malls, restaurants, cinemas, theaters and cancelling sports events. Subsequent measures taken as part of the policy to prevent the spread of the epidemic and curb the number of cases of the disease were grounded in law. Over the period of 14–20 March 2020, a state of epidemic emergency was in force in our country, from mid-March 2020 a sanitary cordon was introduced on Polish borders, which restricted border traffic. In the latter half of March, an epidemic state was introduced, and in mid-May it was transformed into an epidemic emergency. The pandemic had a direct and indirect impact on the security of Poles. By April 2023, more than 6.5 million cases of COVID-19 had been reported in Poland; people died in 120,000 of them, meaning that 2% of all cases ended tragically. Statistics, however, do not tell us what percentage of those who recovered from the disease continued to face significant long-term consequences or even subsequently died (estimates here are around 0.5%). The pandemic pointed out the bottlenecks in the Polish healthcare system – the limited number of beds in hospitals and the staff shortages that deprived people waiting in queues with other diseases of the chance to receive treatment.

The pandemic also had an indirect impact on Poland's economic security, significantly decreasing budget revenues (to take just the example of VAT revenues). We still do not have a fully clear picture of the pandemic's effects on state budget revenues and expenditures, as the budget was revised more than once, striving to adapt it to the changing conditions. For example, a balanced budget was initially assumed for 2020, with revenues and expenditures were planned at 435 billion zlotys. Revenues ultimately came in at 420 billion zlotys, while expenditures were 502 billion zlotys, resulting in a deficit of 85 billion zlotys. The financial report on budget implementation states that, compared to 2019, revenues increased by 4.8% in nominal terms, or 1.4% in real terms. This is the result of the pandemic, which undercut budget revenues while necessitating various intervention measures. The budget was also affected by the increased number of bankruptcies of companies that sank into debt during the lockdowns, starved for revenues. In the first quarter of 2020 alone, there were about 300 such bankruptcies, with the indebtedness of the bankrupt companies estimated at 50 million zlotys. In 2020–2022, 38% of Polish construction companies

Headquarters of the National Bank of Poland in Warsaw

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declared insolvency. In 2023, another 12% of bankruptcies in the industry are being forecast.

Restricted border traffic reduced the supply of essential goods, raw materials, semi-finished products or services. International supply chains that normally provided competitive prices for manufactured goods have become fragmented.

Other sources of risks

The consequences of the COVID-19 pandemic on Poland's economic security were soon overlaid in the short term by the consequences of the war touched off by Russia's attack on Ukraine (24 February 2022). Its impact has also proved to be complex and multifaceted, including both direct consequences of the war (higher energy prices, the influx of refugees) and indirect consequences (the imposed sanctions, the support for Ukraine).

Since the war began, 11.523 million Ukrainians have come to Poland and 9.758 million have left the country. The on-balance significant influx of refugees from Ukraine entails certain effects on local budgets, as a result of support including food, housing, health, and education services, etc.

Western countries (the United States, the EU member states, Canada, the UK, Japan, Australia, New Zealand) had imposed the first sanctions on Russia in 2014 after the annexation of Crimea, and followed this up with subsequent packages after the 2002 military attack on Ukraine. Russia retaliated with its own measures. Both lead to shifts in import and export trade directions, which entail certain costs. This means that the imposition of sanctions has its costs for the countries that apply them, as well as consequences for the Russian economy (inflation, supply shortages, a decline in revenue to the budget, which is heavily dependent on revenues from energy exports). The decline in Russia's economic growth in April 2023 was estimated at 2.7 percent, the ruble exchange rate is weakening, the current account surplus in its balance of payments is decreasing. Certain import bans are being violated by countries in the Caucasus and Central Asia (Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan). Often Russian expatriates then re-export the goods or commodities, without being prevented from doing so. Such illegal practices were brought to light in the context of preparations for the G7 summit in May, at which the possibility of a total embargo on trade with Russia was probed.

Other developments threatening Poland's economic security include the impact of inflation, one of the highest rates in the region, as well as strained relations with its neighbors – the European Union and NATO.

The scale of the current, already diagnosed risks is very large, and in addition, it is difficult to see any symptoms suggesting that they will abate anytime soon. There are certain signs of inflation rates declining, but the magnitude of the budget deficit and growing public debt do not inspire much optimism in this regard. This is particularly important in the context of the extreme passivity – if not to say ineptitude – of Poland's diplomacy and in the failures to apply appropriate internal solutions. This was evident, for example, in the case of the crisis caused by the seizure of grain and other agricultural products exported from Ukraine, which were meant to reach target markets in Africa but got stuck in the Polish warehouses.

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For the future

Poland is not a self-sufficient country; its development depends to a large extent on what is happening in the nearer and farther international environment and the relations with the countries there. Economic security can be easily undermined, both by certain internal regulations and by foreign relations. This is especially true when the aftermath of a *force majeure* – e.g. the COVID-19 pandemic – overlaps with that of other events that further compound these negative consequences. All this requires swift and effective action, and on several fronts at once: externally, in relations with neighbors and in cooperation with international structures that can help solve problems of the economy and economic security, but also internally, in decisions relating to the country's domestic policies. The Polish experience shows that an effective growth strategy requires financial support for education, scientific research, the health sector, modernization of energy sources, etc. ■

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The Virus of Oblivion

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A nearby war. Weather anomalies. Inflation. Cyberattacks waged by Internet trolls. A whole litany of worries and fears – made even worse by the latest generation of artificial intelligence, which humanity had so far thought would be an ally. Will it soon take away our jobs, eliminate human creativity, take over the world? All in all, a sense of security certainly seems to be a very scarce commodity in these uncertain times.

But let's recall how hopeless a situation we found ourselves in just three years ago – not fully aware of what the worldwide pandemic crisis would entail for humanity. Who could have guessed (not even the most eminent experts were then making such predictions) that an inconspicuous virus would swiftly kill nearly 10 million people worldwide, drive numerous companies into bankruptcy, and coop us all up in our homes for months on end? The pandemic made it painfully clear – irrespective of wars and economic crises, the pace of scientific development or the advancement of medicine – that a sense of secure health is among the most crucial factors in everyone's life. Losing that sense has consequences that we simply do not realize when there seems to be nothing to fear.

Rafał Olbiński, "Safe Distance"

As the COVID-19 pandemic began to spread rapidly in Europe in the early spring of 2020, a chart was already circulating online, showing the recently released 2019 Global Health Security Index ranking. The report evaluated the ability of 195 countries to confront outbreaks of infectious diseases. Was it because it was prepared by American experts from the John Hopkins Center for Health Security that the United States ranked first and the United Kingdom second? Poland ranked 32nd, China came in 51st, and most African countries brought up the rear. The subsequent real response to COVID-19 verified these abstract ratings. The chaotic responses of the US and UK governments proved to be among the worst. It turned out that in order to effectively respond to such a virus, a country had to be prepared in advance, have potential scenarios laid out and have warehouses full of protective gear, medical equipment and, preferably, virological tests, vaccines, and drugs. In the case of the SARS-CoV-2 coronavirus, meeting this last demand obviously required some time to find the right tools for diagnosing infection (in the form of tests), providing protection (vaccines), and delivering targeted treatment. However, all this was achieved much more quickly than for similar threats of the past – such as HIV and AIDS, for example. Today, the COVID-19 pandemic, which could have caused even more damage, is fortunately slowly petering out (as the WHO is set to confirm later this year by formally declaring it over).

Does this mean that we will revert to a sense of unthreatened safety, like before the pandemic? Will we again treat all infections carelessly and forget the rules that applied during the lockdown (don't leave

home with symptoms of a cold, wear a mask during larger gatherings, wash your hands often, sneeze into a bent elbow)? It's time to decide: will we go back to our old habits, disregarding the need for cautious coexistence with dangerous viruses? And more globally: will we start taking care not to disturb their natural breeding grounds?

Because of widespread trading of food products between ecologically distant regions of the world and, above all, the intensive exploitation of the natural environment, as many as 70 percent of all infectious diseases are zoonotic in origin. Pathogens are circulating in the ecosystem much more quickly, partly due to ill-considered actions on the part of mankind that contribute to the decay of natural ecosystems.

How are infections and ecosystems related? Urbanization and high population growth are among the main causes of deforestation. The West's insatiable appetite for high-quality exotic timber and growing demand for food are also accelerating the destruction of natural wildlife. Mass tourism has also become a part of the plundering economy. The ambition to take a selfie on a pristine island first by a few, then by a few dozen, and finally by a few hundred Instagram users eventually prompts tour operators to decide to build a grand hotel in a formerly seldom-visited location, attracting in even larger throngs of tourists. Tourism provides a source of livelihood for local communities, but wild animals – such as bats, which are reservoirs of coronaviruses – are forced to move out of their natural territories. They end up foraging in areas much smaller than before, forced to coexist with species they had never naturally come into contact with. Moreover, they often live in close proximity to humans (typically not having anywhere else to go), becoming targets for hunting, trading, and even just plain entertainment. And in the process, they become another nexus of infections, caused by germs that had previously lived far from humans. This shortening of ecological distance facilitates the exchange of pathogens, and this always accelerates their evolution. Each of the major epidemics of the twentieth and twenty-first centuries – HIV, Ebola, SARS, MERS, avian flu, and more recently, SARS-CoV-2 – thus ultimately share a common source: violating the stability of local ecosystems.

As a result of globalization, the ecological barriers that previously occurred naturally have crumbled. Of course, older epidemics – the plague, cholera, leprosy – did decimate humanity back in times when no one spared a thought to how the plundering of natural resources that accompanies the advancement of civilization. It took the modern COVID-19 pandemic to remind people that such plagues do not materialize out of thin air – in fact, we largely create them for ourselves.

Rafał Olbiński, "Subjective Destiny"

Back in 2018, when the WHO included a then-mysterious, unnamed "Disease X" on its list of greatest dangers to humanity, few people were concerned. Its grim diagnosis that the world lacked effective ways to prevent a major epidemic was also trivialized. The security of people's health seemed so certain that no one was much concerned about infectious diseases; the focus was instead on the growing threat posed by diseases wrought by modern civilization itself: obesity, diabetes, and cancer.

It is now clear how perilous such an approach is. That's why we cannot afford to be exclusively concerned about wars, natural disasters, and cyberattacks, while remaining oblivious to threats to global health security. Because one thing about viruses is that even when they are successfully defeated, they still continue to lurk in the environment, waiting to return sooner or later in another guise. ■

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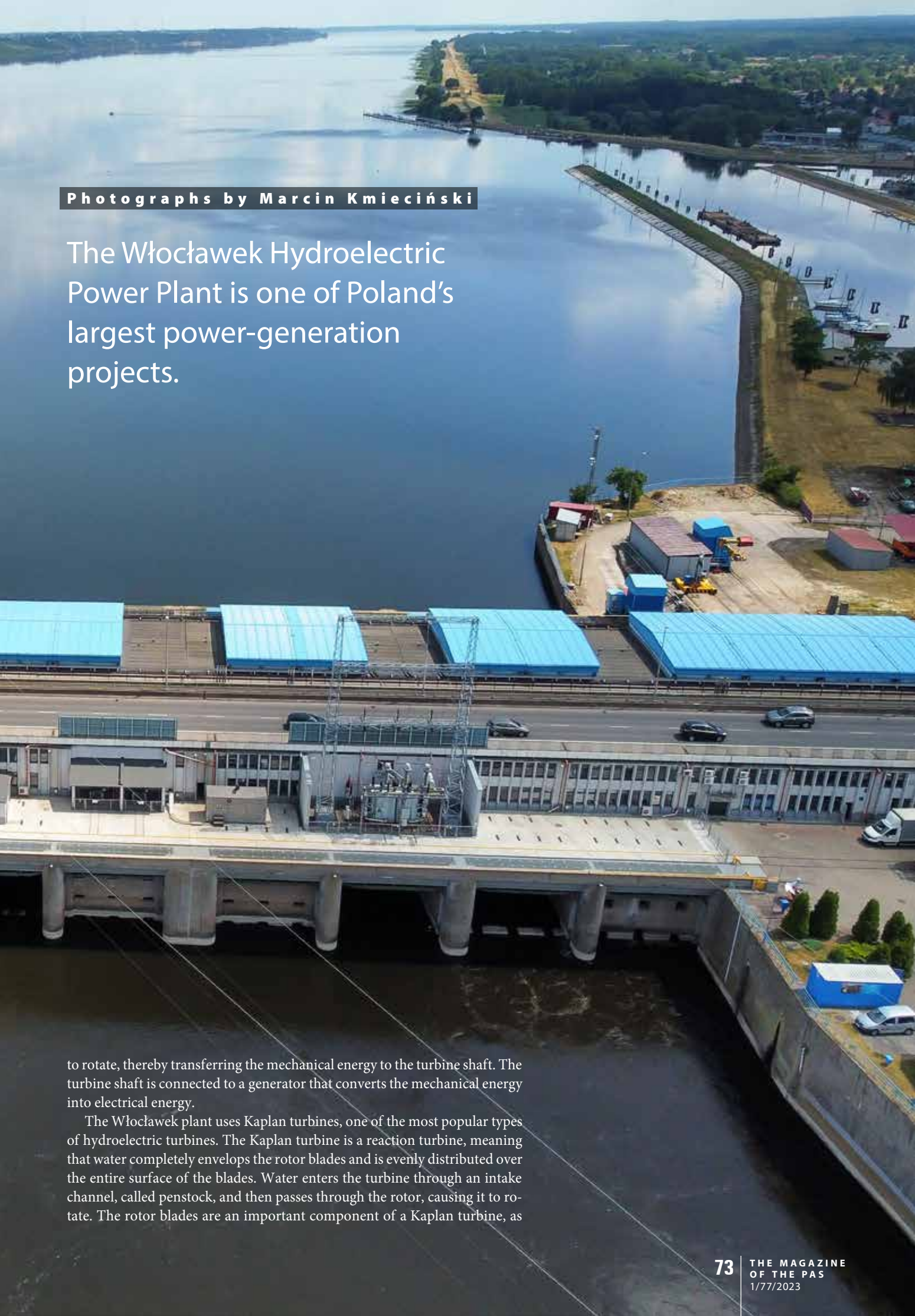
Flowing energy

The Włocławek Hydroelectric Power Plant, the largest run-of-river power plant in Poland, has a significant role to play in ensuring the country's energy security. By harnessing the power of the water flowing in the Vistula – Poland's mightiest river – the power plant contributes to the production of electricity in a sustainable, reliable, and environmentally friendly manner.

At the heart of the power plant are six hydroelectric turbines that utilize the potential of a nearly 13-meter drop to generate electricity. Water flows into the turbine and then onto the rotor blades. The flow of water causes the rotor



Photographs by Marcin Kmieciński

The Włocławek Hydroelectric Power Plant is one of Poland's largest power-generation projects.

to rotate, thereby transferring the mechanical energy to the turbine shaft. The turbine shaft is connected to a generator that converts the mechanical energy into electrical energy.

The Włocławek plant uses Kaplan turbines, one of the most popular types of hydroelectric turbines. The Kaplan turbine is a reaction turbine, meaning that water completely envelops the rotor blades and is evenly distributed over the entire surface of the blades. Water enters the turbine through an intake channel, called penstock, and then passes through the rotor, causing it to rotate. The rotor blades are an important component of a Kaplan turbine, as

Photo 1
A working hydropower unit (showing the support bearings and generator rotor)

they can be oriented to optimize water flow and ensure maximum efficiency. Each turbine has a set of blades on the rotor, as well as guide vanes. The blades on the rotor transfer the water's energy to the turbine shaft, while the guide vanes adjust the flow of water into the turbine.

An important feature of such turbines is that their power can be regulated, allowing output to be adjusted to the current demand for electrical energy. This makes it possible to effectively manage the power grid, to prevent overloads, and to maintain a stable power supply. The average annual output of the Włocławek Hydroelectric Power Plant is 739 GWh/year.

The initial construction of Włocławek plant was completed in 1970. During the most recent refurbishment of the dam in 2015, a fish pass (also known as a "fish ladder") was constructed, allowing certain species of fish to migrate through it to upper stretches of the Vistula River. Moreover, a monitoring system scans and records all fish passing through the bypass, collecting data on their numbers and species.

One of the key advantages of hydropower is its renewable source: it harnesses the kinetic energy of water, which is continually available, making it independent of depletable resources such as fossil fuels. Another important aspect of hydroelectric power generation is that it does not emit greenhouse gases or other harmful substances into the atmosphere. This is certainly significant in the context of efforts to combat climate change.

Advanced monitoring and security systems have been implemented to secure the Włocławek plant, ensuring continuous monitoring of technical parameters and swift detection of potential failures. Regular inspections and maintenance help keep the infrastructure running smoothly. The power plant collaborates with nearby emergency services to ensure an effective response in the event of a crisis situation. Thanks to these preventive measures, the plant guarantees safe operation and minimizes the risk of failures.

The Włocławek Hydroelectric Power Plant is an important component of Poland's energy system. The use of hydropower contributes to the provision of reliable, sustainable, and environmentally friendly supply of electricity. The power plant's renewable, energy source, low greenhouse gas emissions, and ability to flexibly adjust its output are all factors that contribute to its importance in the context of Poland's energy security.

Investments to further develop hydropower are essential for boosting Poland's energy independence, reducing greenhouse gas emissions, and protecting the natural environment. The Włocławek plant serves as an example of how the potential of hydropower is harnessed in Poland and is important for the country's sustainable development.

Hanna Kowalczyk
Communications Office of Energa Wytwarzanie
(part of the Orlen Group)

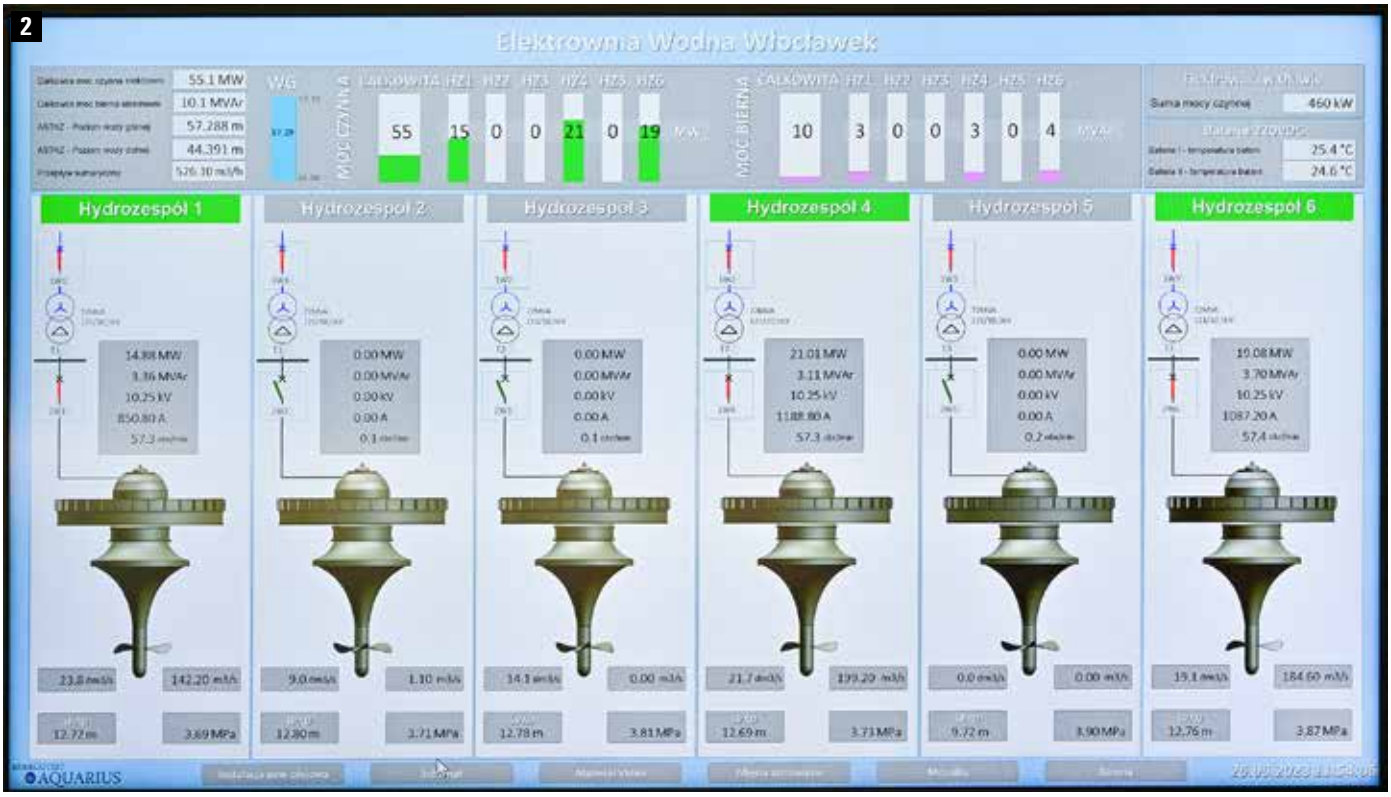


Photo 2
Synoptic panel, showing which generation units are in operation

Photo 3
A view of the downstream portion of the plant

Photo 4
Cross-section diagram of the hydropower plant

Photo 6
Repair tools used at the plant

Photo 7
10.5/110 kV step-up transformers

Photo 8
Power-generation machinery

Photo 9
Generation unit control panels

Photo 10
Technical-water installations

Photo 11
Diagram of the reservoir and dam

Photo 12
A view of the upstream portion of the plant – turbine inlets

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Keeping Archives Safe and Sound

"People are more important than such stuffy old papers. Maybe they have been around for ages, but they'll just rot away someday anyway, and are of no use to anyone."

Anita Chodkowska

Deputy Director, PAS Archives in Warsaw, graduated from the Institute of Library Science at the University of Warsaw and also completed a post-graduate program at the Institute of History and Archival Sciences at Nicolaus Copernicus University in Toruń. She is interested in the methodology of curating and preserving private archives, the history of science, and the history of Poland in the interwar years.

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Anita Chodkowska

PAS Archives in Warsaw

The above opinion was once voiced to Piotr Bańkowski – an archivist who, during the Warsaw Uprising, near the end of WWII, by happenstance became the caretaker of the national collection of books and archives that had been deposited at Warsaw's Sokolnicki Fort for safekeeping. The provocative assertion Bańkowski recalls in his memoirs raises the question: How important is it to protect the national heritage, to pass records of the national identity on to future generations?

At the Archives of the Polish Academy of Sciences, we believe this is a very important task, indeed. Formally called into being by a resolution passed by the Academy's Scientific Secretariate on 1 December 1953, the Archives are officially tasked with gathering, indexing, curating, and preserving archival materials, as well as providing access to them. Each stage of this work entails certain risks that need to be precluded or mitigated.

The most significant challenge in day-to-day archival work is preventing potential damage by various phytochemical, biological, and mechanical factors. As such, we make certain that the archive storage facilities are properly lit, that the right temperature and humidity levels are maintained, and that the collections are properly protected against bacteria, fungi, insects, and rodents. All storage rooms must be carefully monitored, especially in the case of collections that – like ours – have been preserved in the same conditions for 70 years.

Mechanical factors, in particular, pose a significant danger to the longevity and integrity of archival materials – including how they are stored and how access to them is granted. Here we strive to be as pro-active as we can with our prevention efforts. The archives are organized and filed in keeping with current standards, and the materials themselves physically protected in acid-free folders, enclosures, and boxes. At each stage, materials are carefully cataloged and marked as belonging to the PAS Archives, in case they might become dispersed in the wake of some unforeseen event. The safest method of granting access to archival materials is now recognized to be repography (reproduction photography), which ensures safe preservation of the original materials, facilitates repeated non-invasive access, and moreover protects against theft.

In all cases, we are guided by the two overarching principles of archival methodology: the "principle of provenance", which holds that records created within or outside a given territory, but in the course of the exercise of authority over it, should belong to that territory, and the "principle of original order," recognizing that any interference, i.e., for example, a change in internal order or rearrangement of organic whole, is inappropriate. These principles are extremely helpful in keeping archival resources properly secured.

The most destructive events that can befall an archival resource are natural disasters such as fires or floods, and the devastation of war. The immense problems such events entail is a topic for a separate article. ■

JAN MALARSKI (2)

The Monument to Nicolaus Copernicus in Warsaw, before and after its conservation. From the collection of Zbigniew Wasiutyński, PAS Archives, ref. III-449

Further reading:

Bańkowski P., *Archiwista na powstańczym Żoliborzu: Wspomnienia sierpień–wrzesień 1944* [An Archivist in Insurgent Żoliborz: Memoirs August-September 1944], Warszawa 2014, p. 132.

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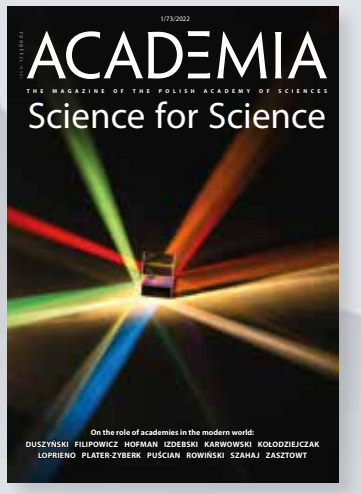

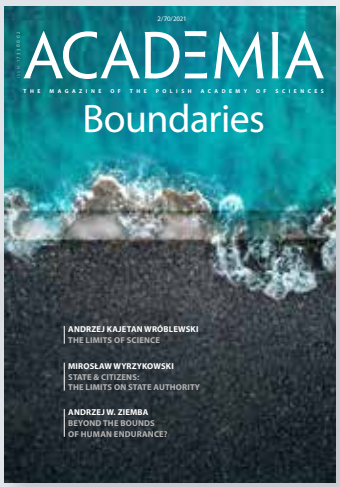

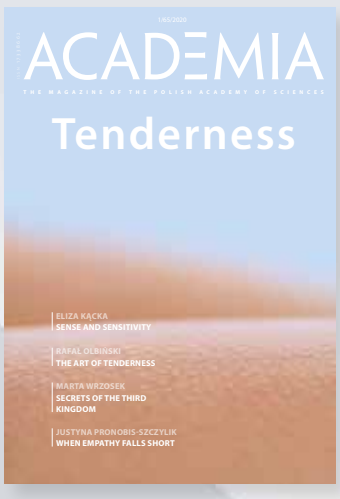

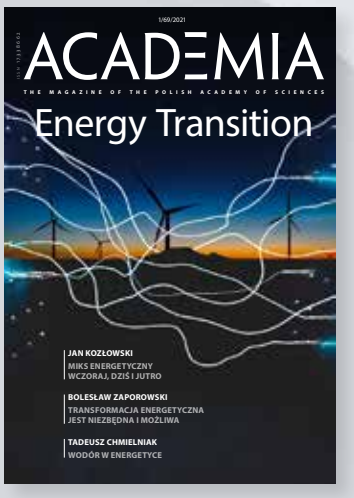

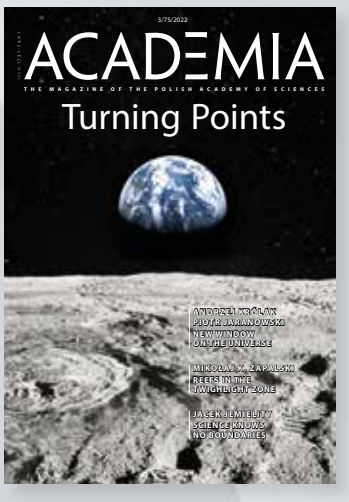

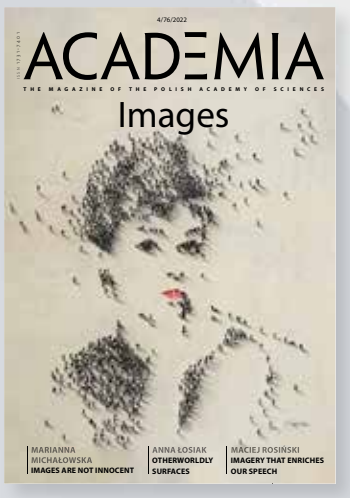

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