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From mines to meadows: how science is reviving Europe's forgotten landscapes

EU-funded researchers are transforming former coal-mining sites across Europe into thriving areas that provide lasting environmental and social benefits.

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When Professor Alicja Krzemień set out to turn one of Poland's largest coal-mining waste heaps into a thriving meadow, she faced an uphill battle.

Together with fellow researchers in an EU-funded collaboration called RECOVERY, her team revitalised the barren terrain at the Janina mine in Libiąż, southern Poland.

They applied soil substitutes, aiming to provide suitable structure, pH, nutrients and organic matter to support life. One of the first things they sowed was white mustard, as part of controlled tests to assess the effectiveness of the new soil mixtures.

"First, we waited for the white mustard to grow, to see if it germinates or not," Krzemień recalled. "Then we saw that some plants were feeling really good in our soil substitutes, growing and flowering."

Once they had reshaped the soil, life started returning. Rabbits came to nibble young shoots, smaller insects buzzed in, and finally bees appeared – unmistakeable signs that life had returned around Janina, all in just two years.

Krzemień said that none of this work would have been possible without the support of the Research Fund for Coal and Steel (RFCS). She believes that, although investing in mining research may not be popular, it remains vital to developing practical solutions for the energy transition.

"At the moment, RFCS is the only funding scheme that is supporting our work in finding tangible solutions that could really have a long-term impact on society," she said.

Looking ahead

As Europe moves to renewable energy to meet its ambitious climate goals, researchers are devising innovative ways to restore land affected by coal mining.

Once the soil is rehabilitated, the next question is how best to use the area. Should it become a forest or a meadow? A community space or a solar farm?

To address this, the RECOVERY team developed a methodology to help experts and communities make environmentally sound and financially viable decisions.

“There has to be a good justification for why you’re planning a certain solution after closing the mine,” said Krzemień, who coordinated the researchers’ work. “The question was: which ecosystem would give the highest value?”

The value of nature

To determine this, they turned to the concept of ecosystem services, which links the environment with society and the economy by quantifying how nature provides people with value.

This includes tangible products such as timber, water and crops – called provisioning services – but also less visible benefits such as clean air, carbon storage and recreation space.

Professor Pedro Riesgo Fernández from the University of Oviedo in Spain explained that the team had devised a way to put a price on these indirect services. They used carbon sequestration – the process of capturing and storing CO_2 from the atmosphere – as a reference point.

The price is based on the EU Emissions Trading System, where companies must buy or are given permits to emit greenhouse gases, with the overall cap on emissions getting smaller every year. This system sets a price for carbon, which can then be used to measure the value of restoration work.

With six case studies and partners from Germany, Spain, Poland and Czechia, the researchers showed how their approach accounts for local differences and allows systematic ecosystem assessment.

“The location of each mine is different, so the same approach has different outcomes in different contexts,” said Krzemień.

Location-specific solutions

At Figaredo mine in northern Spain, six scenarios were considered after consultation with local neighbourhood associations, mining experts, trade unions and environmental NGOs. The scenarios ranged from a pine tree plantation and cattle farming to solar panels and a recreational area.

After evaluating the ecosystem services, local conditions and costs, the team found that turning the area into a cow pasture offered the best balance.

“Nowadays they have cows there, as well as horses,” said Riesgo Fernández. “Our methodology allows us to perfectly determine the most interesting scenario for a specific place, taking into consideration its characteristics and using as a reference the value of emitting one tonne of CO_2.”

New foundations

But before deciding what ecosystem would be best at a particular location, Krzemień explained that the degraded land needs to be restored.

Her team found a way to make the hard, acidic waste heaps – a typical feature of post-coal mining areas across Europe – suitable for plants. They achieved this by mixing in leftover materials from other industries, like treated waste, crushed stone, or lime to reduce acidity, and natural compost from mushrooms.

These ingredients transformed barren ground into soil where plants can grow again.

This soil reclamation approach is now being used at the Velenje mine in Slovenia as part of GreenJOBS, a new EU-funded project coordinated by Riesgo Fernández that runs until the end of 2025.

The researchers made all their findings available on the project website, including detailed best practice guidelines.

Their approach can now extend beyond coal regions, offering solutions wherever land restoration is needed.

“Our methodology is not only for post-mining areas. It is valid for any area in need of restoration, regardless of the reason,” said Riesgo Fernández.

Initiatives like RECOVERY mark a shift in how Europe handles the legacy of coal mining. They demonstrate that innovative nature restoration can deliver social and environmental benefits for local communities and beyond.

As the continent advances towards climate neutrality, these new methods are helping lay the groundwork for a greener, more resilient future.

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More info

- RECOVERY
- RECOVERY project website
- European Green Deal
- European Research Fund for Coal and Steel