

Lignite Mining in the Rhineland

GARZWEILER II

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Garzweiler opencast mine

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Lignite – boon or bane? The geological history of lignite began millions of years ago, while the relatively short period of human usage is negligible in comparison. Yet no other encroachment on nature and landscape results in such wide-ranging consequences.

With mining extraction of 90,45 million metric tonnes in 2016 alone, the Rhineland constitutes Germany's most important lignite area. More than half the total lignite production in all four mining regions is concentrated here.

The destructive exploitation of domestic natural resources explains the unrelenting resistance by BUND against lignite mining in the Rhineland.

The Rhineland lignite basin – geological basics

The Lower Rhine basin ("Niederrheinische Bucht") has an eventful geological history. Beginning in the Paleozoic Era, the lignite seams have been formed by prolonged depression of the region. The greatest transformation occurred during more recent periods, namely 65 million years ago in the Tertiary Era. The depression process allowed ancient oceans to flow repeatedly into the southerly regions.

Particularly during the Miocene Era – just 5 - 25 million years ago – widespread coastal swamplands reached the edges of the southern expanses. Climate conditions similar to today's tropics supported lush vegetation growth. As plant litter accumulated, it was prevented from rotting by overlying water that blocked contact with the air. The coalification process could thus begin. Initial layers of peat were covered by later geological depositions. The combination of pressure and temperature caused lignite to be formed. Lignite reserves of 50 billion tonnes have been determined in

the Rhineland basin. The lignite is deposited in three overlying beds with a total average thickness of 40 meters. In the Garzweiler mine, the deposits lie between 40 and 210 meters beneath the surface.

The recent formation of lignite also explains its inferior energetic properties. Whereas the much older and more highly compacted hard coal contains nearly no water, the moisture content of lignite typically lies between 55 and 60 percent, resulting in a thermal grade ranging from 7,800 to 10,500 kJ/kg. In the Paleogen (late Tertiary) Era, mainly sand, gravel and clay covered the dead organic substance. During the Quaternary period, especially during the glacial ages, sand and broken stones from the Rhine and other rivers dominated. Airborne sand and loess – which is comprised of particles released by moraines and Ice Age outwash



The Rhineland lignite basin
(Source: Flinspach)

– were deposited in layers above the lignite.

During the last 25 million years, the typical present-day patterns of sequentially arranged lignite seams, loose sediment and clay along the Lower Rhine basin evolved.

Characteristically layered patterns of porous stones evolved into distinct multi-aquifer formations. Complex structures emerged along numerous northwest-southeast tectonic faults and proceeded along the surface of the Lower Rhine basin, distinguishable by layers of different soils. Some regions like Jackerather Horst or Villerücken were elevated above the surroundings, while other areas conversely sank. Occasional recent earthquakes have confirmed that this region remains tectonically active.

These complex geologic relationships determine the mining techniques employed. To extract the lignite from the multiple seams of opencast mines, huge quantities of groundwater must first be drained by enormous pumps, after which layers of overburden are removed. The resulting impacts are considerable (see below).

The Rhineland lignite deposits are estimated at 50 billion tonnes, with 35 billion tonnes considered extractable. The opencast mines currently licensed and developed comprise about 2.9 billion tonnes.

Development of opencast mines in the Rhineland

The Rhineland lignite region extends to Cologne, Aachen and Mönchengladbach – a total area of 2,500 km².

Local lignite was first mentioned in 58 A.D. by the Roman historian Tacitus in a report on a seam fire that was not accurately identified at the time: "But the (...) people of the Ubier were struck by a dreadful catastrophe. Fire erupted from the ground and destroyed warehouses, grain including the growing crops, even villages and the wall of the newly established settlement of Cologne." This contemporary account confirms that the relationship between humans and lignite has been difficult right from the start. In the following centuries, it would eventually be used as highly combustible peat in medieval times. Yet during the same period, lignite gained more importance as "Cöllnische Erde" or "Cöllnisch Umbra", a terracotta pigment. Fuel scarcity in the middle of the 17th century ultimately led to intensified exploitation of the lignite resources.

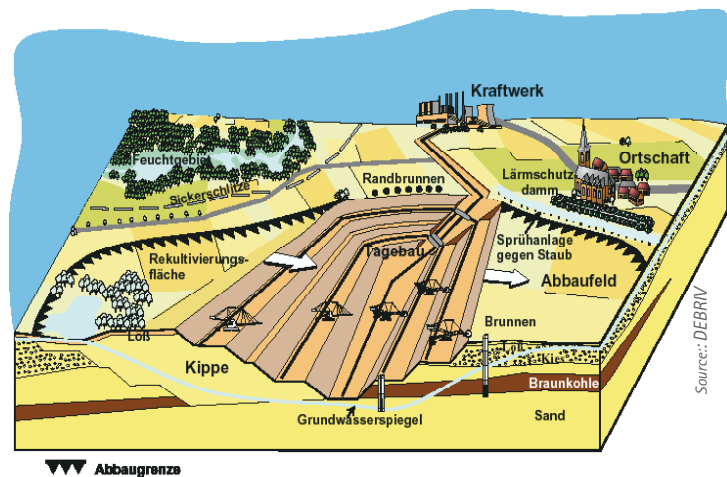
Because lignite was not considered a so-called royal mineral belonging to the nobility, small peat pits were operated throughout the region to provide the local population with fuel.

At the end of the 18th century, lignite extraction became so widespread that elector Maximilian Friedrich enacted the first reclamation directive: "that after promulgation of this order every municipality or other owner, landlord, or tenant of the peat pits (...) must fill them up and replant the soil or use it in another best possible way after its clea-

rance. But in cases where it is more useful to fill them up with water than with soil, there the municipalities should endorse that."

Lignite extraction during this period was conducted mainly throughout the southern expanses between Hürth, Liblar and Brühl, where lignite can easily be extracted from shallow fields. In the second half of the 19th century, the first mills were built here. The western area between Eschweiler, Buir, Elsdorf and Jülich has been exploited since the beginning of the 19th century. Today, there are opencast mines at Hambach and Inden. In the north near Neurath, lignite was accidentally discovered in 1858 by the blacksmith Peter Hansen. Digging a hole to determine the cause of a persistent heavy fogbank near a forest, he discovered lignite instead. Numerous mining concessions were subsequently granted. Licenses for resource exploitation have been issued since 1812, when lignite was declared a regal mineral by French decree. Lignite was thereupon subject to the Napoleonic mining law of 1810 that granted landed gentry the right of lignite exploitation. This initiated an ongoing practice of compulsory expropriations in the Rhineland that has evoked repeated resistance against lignite mining.

Schema eines Braunkohlentagebaues im Rheinischen Revier



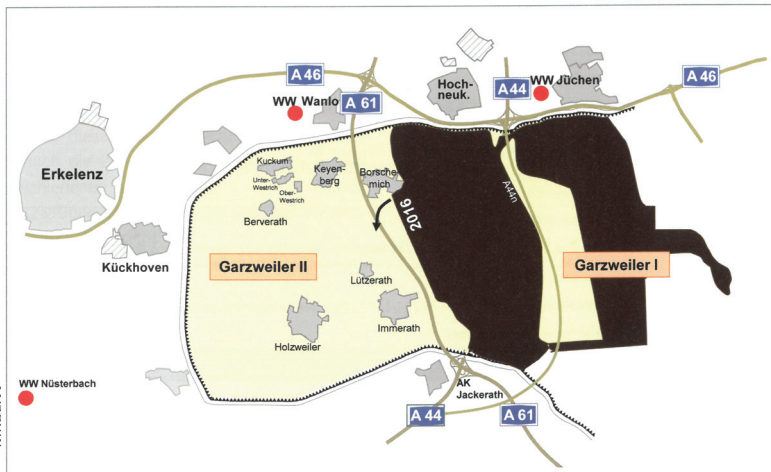
Impacts of opencast mining on nature, environment and human welfare

Surface coal mining disfigures entire regions. Groundwater remains affected for hundreds of years, and human settlements are devastated. When lignite is transformed into thermal energy, huge amounts of climate destabilizing carbon dioxide are emitted, while surface water temperatures are increased by cooling water discharges. Gigantic

abandoned open pits remain that are gradually filled with production water over the course of decades. Instead of fertile soils, recultivated landscapes follow with inherently limited options for agricultural utilization. Wetlands dependent on adequate groundwater levels become artificial habitats requiring engineered irrigation. There is no greater intrusion into nature than by lignite opencast mining, constituting an "ecological disaster beyond the power of imagination".

been developed over 12,000 years on a large loess expanse remaining from the last Ice Age. Restoration to the original state cannot be realized. Substitute soils provide only limited agricultural usage options, with organic farming nearly impossible. Farming is thus burdened by enduring deficits following lignite usage.

In the Garzweiler II mining area comprising 48 square kilometers, there were 7,618 inhabitants living in 11 vil-



The village of Immerath is going to get totally destroyed. Once more than 1.200 people were living there.

Devastated homeland

By the end of 2015, 32,500 hectares of land had been claimed by the excavation of lignite in the Rhineland. This equaled 1 ½ times the area of the regional capital Düsseldorf. The surface actually devastated covers more than 9,540 hectares.

The lower Rhine basin has a particularly long history of cultivation. Settlements established over the last 7,000 years have been confirmed in archeological investigations. The fertile soils formed the basis for the productive agriculture of the Bandkeramik civilization, the Romans and more recent societies. Villages like Holzweiler in the Garzweiler II mining area have a history extending back more than 1,200 years.

The future looks no more promising: 10,000 hectares of this traditional landscape including its villages and historic edifices are to be erased from the map by the miners of RWE Power AG. Since the mid-1950s, more than 40,000 inhabitants have already lost their homes in the Rhineland. By the middle of the 21st century, around 42,000 people will have been displaced if current planning of the energy corporation is realized. Dozens of villages, hamlets and farm buildings are threatened by this prospect.

As settlements disappear, the cultivated landscape of the Lower Rhine basin is likewise being destroyed. Exceptionally fertile soils are characteristic of this region, which has

lages, two hamlets and four single farm buildings on the assessment date of January 31, 1992. All of them - except around 1,200 people living in Holzweiler - will have been forced to leave their homeland by 2045, at the latest. One third live in the municipality of Jüchen in the Rhine district Neuss, while Erkelenz in the Heinsberg district accounts for the remaining two thirds. 28 inhabitants reside in the Titz (Rhine Erft district).

Independent investigations have repeatedly confirmed the impossibility of achieving socially acceptable resettlement. Additionally, the possibilities for legally contesting compulsory expulsion have remained deficient under regulations favorable to mining.

Cultural heritages also erode as landscape is removed. Archeological evidence from the long history of settlement have only partially been charted and secured. According to official records, 95 percent of all registered historic structures will be lost forever.

Depletion of valuable water

To extract coal at depths of up to 450 meters (Hambach opencast mine), an enormous amount of overlying material must first be removed as a result of site geology. Since loose ground predominates, lignite must be excavated from opencast mines. The high permeability of the sediments makes it necessary to drain groundwater to beneath

the coal beds. Historically, water withdrawal of 1.4 billion cubic meters annually had accompanied Rhineland lignite mining. In the scheduling year 2015/2016 it was still 554.5 million cubic meters. A portion thereof was used for replenishing the water table and for substitute water supplies, but the major amount of 2787.5 million cubic meters was withdrawn unused.

For Garzweiler II, a maximum withdrawal quantity of 150 million cubic meters per year has been allocated. This opencast mine has been in operation since September 2006. At present (2015/2016, a total of about 124 million cubic meters is being drained annually. In contrast to other groundwater users, RWE Power AG had been exempted until 2011 from water withdrawal fees. In effect, groundwater depletion was being subsidized by the government.

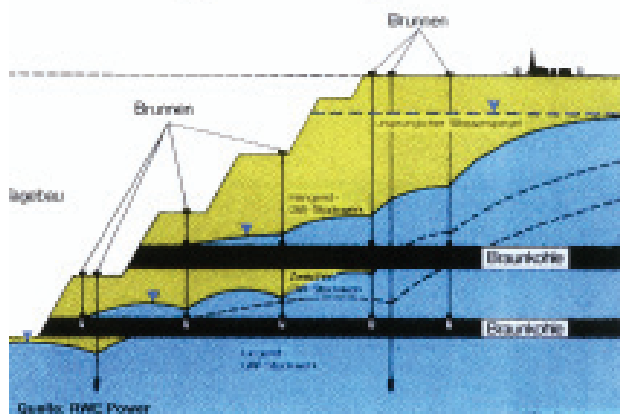
Withdrawals lead to irreversible consequences for the watershed of the entire region. Not only are strictly protected and groundwater-critical wetlands like Schwalm and Nette endangered by the opencast mines, but also drinking water supplies and groundwater balances will be affected for centuries. Surface waterways are severed from subterranean aquifers, natural springs are shifted, or mock springs appear.

By now, about 10 percent of the entire state area of

More than 1,000 pumps are installed around the opencast mines



Tagebauentwässerungsschema



North-Rhine Westphalia (about 3,000 square kilometers) had already been affected by groundwater losses due to the opencast mines. The impacts of mining withdrawal are by no means limited to the immediate vicinity; instead, a wide-ranging groundwater cone has been drained. In the area known as Venloer Scholle, it extends from the Garzweiler opencast mine far into the neighboring Netherlands. Sinking of the water table due to Garzweiler II has decreased the pressure of lower groundwater aquifers, exhausting them as water sources. Large-scale shifting of the phreatic divides can be observed even now.

Degradation of water quality

In addition to groundwater depletion, detriments in water quality are of special significance. The impacts of opencast mines on groundwater purity have become particularly apparent in alternations of the watershed and local intensified mineralization of the remaining water.

The natural geologic supporting formations are destroyed irretrievably by the direct influence of mining operations. Furthermore, the depletion of lower groundwater levels results in pressure redistribution. This leads to a "hydraulic shunt fault", allowing harmful substances like nitrates and pesticides to migrate unimpeded along subterranean paths created by barrier disruptions.

Expansive disturbances present the prospect of qualitative degradation of previously unaffected groundwater. Owing to disruptions of natural horizontal patterns by the opencast mine, sulfides leached at low depths rise to the surface and are diffused. If these highly soluble sulfur compounds react with oxygen and the residues are propagated after the end of mining, a steady stream of harmful substances will flow into the subsoil. About three quarters of the lignite and associated mining rubble from the Garzweiler II region reduce soil pH values to pH 5 – pH 2. Acidic compounds, sulfates and other harmful substances are thereby released in highly water-soluble forms. The corresponding mechanisms have far-reaching consequences for surface water and for deeper aquifers. Despite remedial measures such as dump management and the dispersal of buffering materials (power plant ash, DeSOx gypsum), the fundamental problem remains unsolvable.

Biotope on drip therapy

Groundwater-dependent wetlands in the northern sectors of the Rhineland lignite region are already irreversibly affected by water table decline. To reduce damage from the Garzweiler opencast mine in the trans-border wetland preserves at Schwalm and Nette, mining proposals recommend the infusion of 100 million cubic meters water per year into the depleted aquifers. During the water resources year 2016, 92.5 million cubic meters of water were devoted to groundwater replenishment in the Rhineland lignite area. In the water resources year 2016, 84.5 million cubic meters

of so-called eco-water were introduced for sustaining the wetlands in the area influenced by the Garzweiler II mine. Drainage water filtered of ferrites and manganese is transported to the wetlands through a 160 kilometer pipeline system. It is conveyed along numerous infiltration ditches, infiltration wells and vertical infiltration systems for sub-surface infusion.

To this day, it remains questionable whether temporal and spatial parameters can be maintained to centimeter tolerances in horizontal and vertical planes within the various biotope types in the wetlands. The fulfillment of decisive sustainability criteria has yet to be demonstrated. The Garzweiler II opencast mine will not attain its maximum mining depth before 2024/2025, at which time it will extend particularly close to legally protected Europe wetlands.

It will be likewise difficult to ensure permanent filtrate quality differing as little as possible from prescribed wetland water parameters. Any self-sustaining preservation of the wetlands and quasi-natural biotic communities appears principally incompatible with projected development. Nature preserves have already become "biotopes on drip therapy" dependent on drainage water and on technical compensation measures – in fact for centuries.

Gigantic artificial lakes emerge

Due to land inventory deficiencies in the aftermath of lignite mining, huge holes remain in the excavated region. These pits would normally fill with water over several decades after the end of extraction. Since planning does not consider such long-term perspectives, however, artificial flooding will be employed.

The post-extraction Garzweiler lake with a depth of about 180 meters, a surface area of 2,300 hectares and a volume of more than two billion cubic meters must be filled continuously with up to 60 million cubic meters water per year for over 40 years to reach its projected depth. For this purpose, treated water from the Rhine River is to flow through accesses in the foundation rocks well below the opencast mine sole to the mining area.

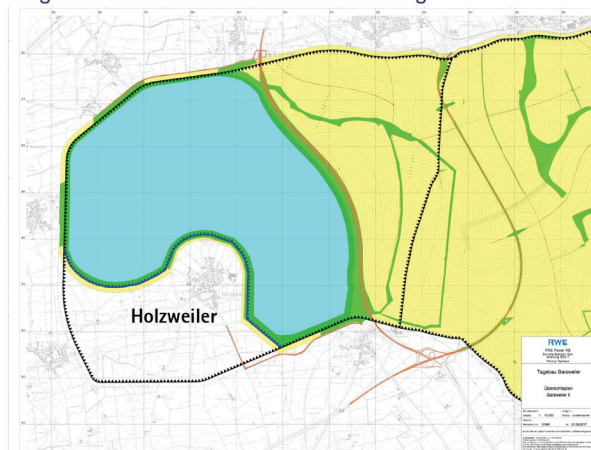
However, the technical feasibility of this configuration has not been rigorously verified. Examples of these systems do not yet exist. Under the anticipated conditions of climate change, it appears questionable whether the Rhine River would be able to provide the needed amount of water. In addition, the even larger opencast Hambach mine is also intended for post-extraction flooding. The more stringent restrictions of EU water framework policy actually prohibit such large-scale withdrawal from the Rhine River.

Permanently maintaining the planned water level around 2080 will subsequently require an external water supply for an indefinite period of time. RWE Power anticipates feeding in 25 million cubic meters until 2100 and 30 million cubic meters thereafter to compensate for dispersal into the adjacent Erftscholle region. These discharges can be termi-



D. Jansen

Änderungsvorhaben Tagebausee und Wiedernutzbarmachung



Source: RWE Power AG



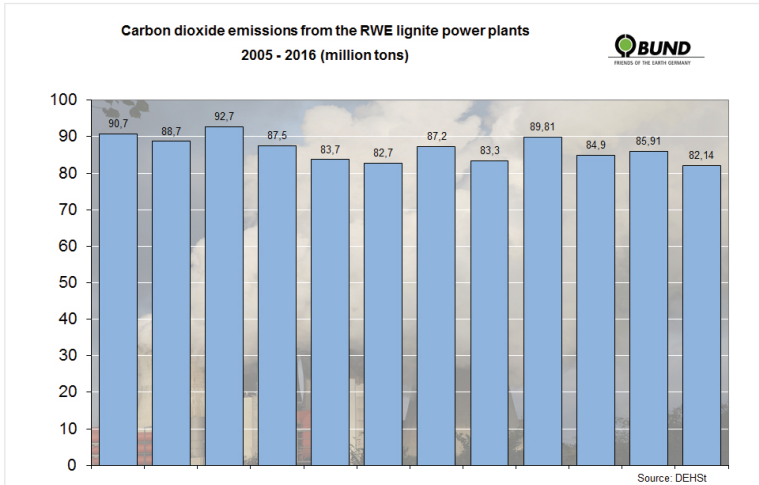
RWE Power delivers many millions of cubic metres of well water every year. Without artificial infusion the Schwalm river and the surrounding meadows would be dry.

The post-extraction Garzweiler lake is planned to have a depth of about 190 meters and a surface area of 2,300 hectares.

nated only when the groundwater in the Erftscholle - which is dedicated to the Hambach opencast mine – has been raised sufficiently in about 300 to 400 years.

Lignite and the global climate

Lignite provides the highest specific contribution to climate destabilization among all energy sources. Regardless of power plant efficiency, every tonne of lignite burned releases a tonne of carbon dioxide. In North-Rhine Westphalia, the lignite power plants and installations of RWE Power AG are responsible for the release of about 90 million tonnes of carbon dioxide per year. The two power plants at



D. Jansen

*The carbon dioxide emissions from the lignite power plants remain on a high level.
The power plant in Neurath is responsible for 31 million tonnes of carbon dioxide - every year.*

Frimmersdorf and Neurath that are mainly fired with Garzweiler lignite were responsible for 35.7 million tonnes of carbon dioxide in 2016.

In addition, the specific carbon dioxide emissions of lignite power stations in the Rhineland rank them as most detrimental. Up to 1,200 grams of carbon dioxide per kilowatt-hour electrical energy are emitted by plants that are partially over 50 years old. At the end of October 2017, the last 300 megawatt generating units in Frimmersdorf that dated from the 1960s were finally shut down.

Yet also the purported "most advanced lignite power plants in the world" – the so-called "lignite power plants with optimized systems engineering (BoA)" in Niederaußem and Neurath – still release about 950 grams of carbon dioxide per kilowatt-hour, equivalent to nearly three times the emissions of modern gas-fired power plants. The new

power plants will continue to burden the climate balances of coming generations due to their planned service life of 40 – 50 years.

Another major disadvantage has become increasingly apparent: Lignite power plants are not sufficiently flexible. As classic base load power plants, they preferably should be operated 24 hours a day due to inadequate control variability. In contrast to modern gas-fired power plants, they cannot regulate electrical grid fluctuations. These outdated power plants are incapable of complementing (separately) volatile renewable energy generation. In addition, the newly developed BoA generating units are inappropriate for bridging the technological gap with comprehensive renewable energy generation in Germany. While their power can be reduced more rapidly compared with earlier designs, they do not possess the flexibility of modern gas-fired power plants.

In addition, combined heat and power generation remains largely neglected for lignite power plants. Lignite is generally not transportable owing to its 55 percent water content. The power plants are therefore located in the countryside, where there are few customers for process heat except for scattered horticultural farms. On average, therefore, these power plants are extremely wasteful. The efficiency factors of older plants are about 30 percent, while the new BoA generating units barely exceed 43 percent. Modern gas-fired power plants with combined heat and power, such as one currently being built in Düsseldorf, attain a total combined efficiency of 85 percent.

In North-Rhine Westphalia, the energy sector releases annually (2016) about 155 million metric tons of carbon dioxide. Rhineland lignite is responsible for nearly two third of these emissions. Despite all claimed efforts toward climate protection, greenhouse gases from lignite combustion have increased by 10 percent from 87.7 million tonnes in 1990 to 96.2 million tonnes in 2005. Now around 82 million tonnes are released. RWE planning promises little change in the future, because the company plans to build a new power plant (BoAplus) at Niederaußem. A political climate zero-sum game is being played: higher efficiency factors and a constant amount of burned lignite lead to equal carbon dioxide emissions with greater electricity sales.

If Garzweiler II is operated until 2045 according to plan, 0,8 billion metric tons of the climate killer carbon dioxide will be cumulatively released into the atmosphere.

Fine dust particles and radioactivity from opencast mines

Before BUND investigations were publicized in 2003, one problem of lignite opencast mines had been widely disregarded: dust particles and radioactivity. Previously, each mine had been regarded as a "black box". Only large and visible particles had troubled generations of near-field residents. In September 2003, however, BUND and the citizens' group Bürgergemeinschaft e.V. alerted the district government to fine airborne dust in the municipality Niederzier. It

was recognized that the opencast mines were the dominant regional source of extremely harmful microscopic particles. After the responsible energy authorities as well as the mining agency and RWE Power AG persistently attempted to deny the problem, the ministry of the environment instituted particulate measurements at the opencast mines for the first time. The worst suspicions of BUND had thereby been confirmed. The government has since taken action: the fine dust levels in the vicinity of the opencast mines Hambach and Garzweiler are being measured continuously, while clean air plans have been issued due to illegally exceeded threshold values. Nevertheless, no reliable results were attained until BUND successfully called for conse-

studied for a long time. On the other hand, the potential radiation hazards of lignite opencast mines remains widely disregarded. It is known that both the fuel and the mining rubble contain appreciable amounts of uranium and thorium. The radioactive decay products can enter into the human organism by way of airborne particles and drainage water. BUND and the Niederzier citizens' group have reported these circumstances to the Federal Environment Ministry and the Federal Office for Radiation Protection – so far without appropriate consequences.

Mining subsidence damages

Besides mining damages documented for the Ruhr coal regions, thousands of mining subsidence incidences related to lignite extraction are also on record.

The soil layers in the Lower Rhine basin are comprised of loess, gravel, sand, clay and lignite. This subsoil is naturally permeated with groundwater. The water is pumped from within the boundaries of the mining depression, but a far-reaching drainage cone is created as well. Due to the irregular development and structure of the aquifer layers and their intersection with geologic faults, the groundwater depression generally does not extend uniformly in all directions. Within the physical context of the depression, the subsurface recedes slowly but steadily. The water content is reduced in the affected loose rock layers that can cause the entire layer profile to settle, especially in layers with high clay and humus content. In the area of Elsdorf – which is the area exerting the greatest influence on the drainage – the subsurface is depressed by more than 4 meters.

Particularly in areas with geological characteristics involving non-uniform soil depression, mining subsidence damage occurs in buildings, streets and other parts of the infrastructure. This is mostly the case in regions with tectonic faults or beneath flood plains, in other words, wherever different subsurface formations are found on either side of a geological fault, or where the geologic formation changes within a small space.

Further, mining subsidence damages can be caused by seismic disturbances induced by the opencast mines. The large-scale mines lead to alterations of surface tension that may cause micro earthquakes with negative consequences for buildings. Furthermore, when the groundwater later rises after the cessation of mining, erratic compensation displacements may accompany repeated shifting motion. Sufficiently documented are also the ensuing damages, for example in the area of Korschenbroich, ascribed to rising subsurface water following the completion of groundwater withdrawal.

After the disastrous opencast mine landslides in Nachterstedt (Saxony-Anhalt) in July 2009, the possibility of recurrent land instabilities gained widespread public attention. Contrary to RWE and the government, BUND likewise sees the potential threat as not negligible in the Rhineland. Past events of destruction have been documented. For the-



Several monitoring stations like this one in Grenbroich-Gustorf have been installed for the measurement of particulate matter.

quential measures. Our demand for establishing a coherent clean air plan for the entire Rhineland lignite mining region was implemented in 2013.

Yet opencast mines are not the only dominant source of harmful particulate emissions. The lignite power plants are real "dirt catapults". The large-scale lignite power plants and industrial installations in the Rhineland region alone emit about 1,200 tonnes annually. These particles are in great measure responsible for regional background pollution. A toxic mixture of airborne heavy metals like mercury, lead, cadmium, arsenic, etc. likewise prevails. Just the power plants at Frimmersdorf and Neurath already emit more than 800 kg of the nerve poison mercury per year.

While the problem of fine dust pollution from opencast mines has now been recognized, the accompanying radioactivity continues to meet with indecisiveness. It is widely known that coal power plants emit remarkable amounts of radioactive isotopes. In addition, the issue of radioactively contaminated mining water in hard coal mines has been

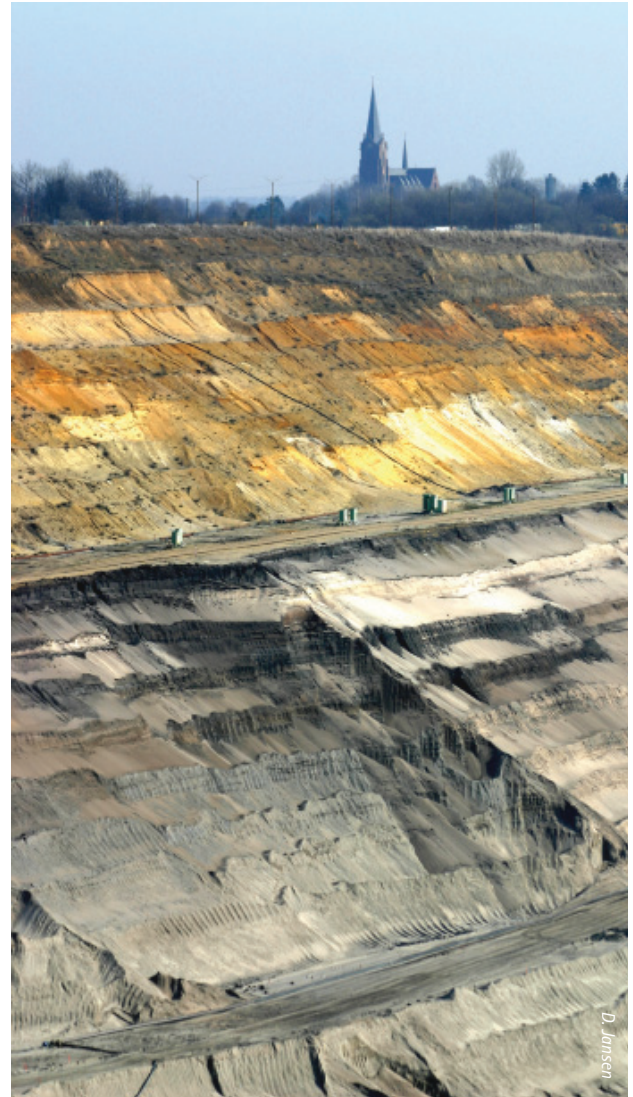
se reasons, BUND has called for significant widening of the security zones around the opencast mines, or for downscaling to provide a greater security buffer with nearby settlements. Wherever possible, exhausted open pits should be refilled.

Scarcely any mining subsidence damages are acknowledged and reimbursed today. The perpetrator, RWE Power AG, provides no transparency on the issue. The main difficulty is that the claimant – in contrast to underground coal mining – bears the sole burden of proof. An appropriate reversal of these obligations in the Federal Mining Law has long been overdue. In North-Rhine Westphalia, an office for lignite mining subsidence damage was established in 2010 by the lignite commission. The affected people now expect more equitable treatment in regard to RWE Power AG.

High external costs

Lignite is considered an inexpensive and locally available energy source. However, the high external costs of lignite extraction and usage continue to be ignored. The Federal Environment Agency assumes that the price of one kilowatt-hour of lignite electricity would be at least 10 cents higher if all indirect costs were included. The European Environment Agency (EEA) has calculated the unpaid external costs of air pollution ascribed to RWE from the Garzweiler power plants Frimmersdorf and Neurath at 1,051 and 1,091 billion euros per year, respectively. Even greater are the collateral costs inherent to the RWE power plants Niederau-Bem (up to 1.56 billion euros per year) and Weisweiler (up to 1.135 billion euros per year).

An overall assessment of the environmental and economic costs of lignite usage has been persistently neglected. If all follow-up costs and all enduring damages were included, RWE could not promote lignite as an economical energy source with only local impacts.

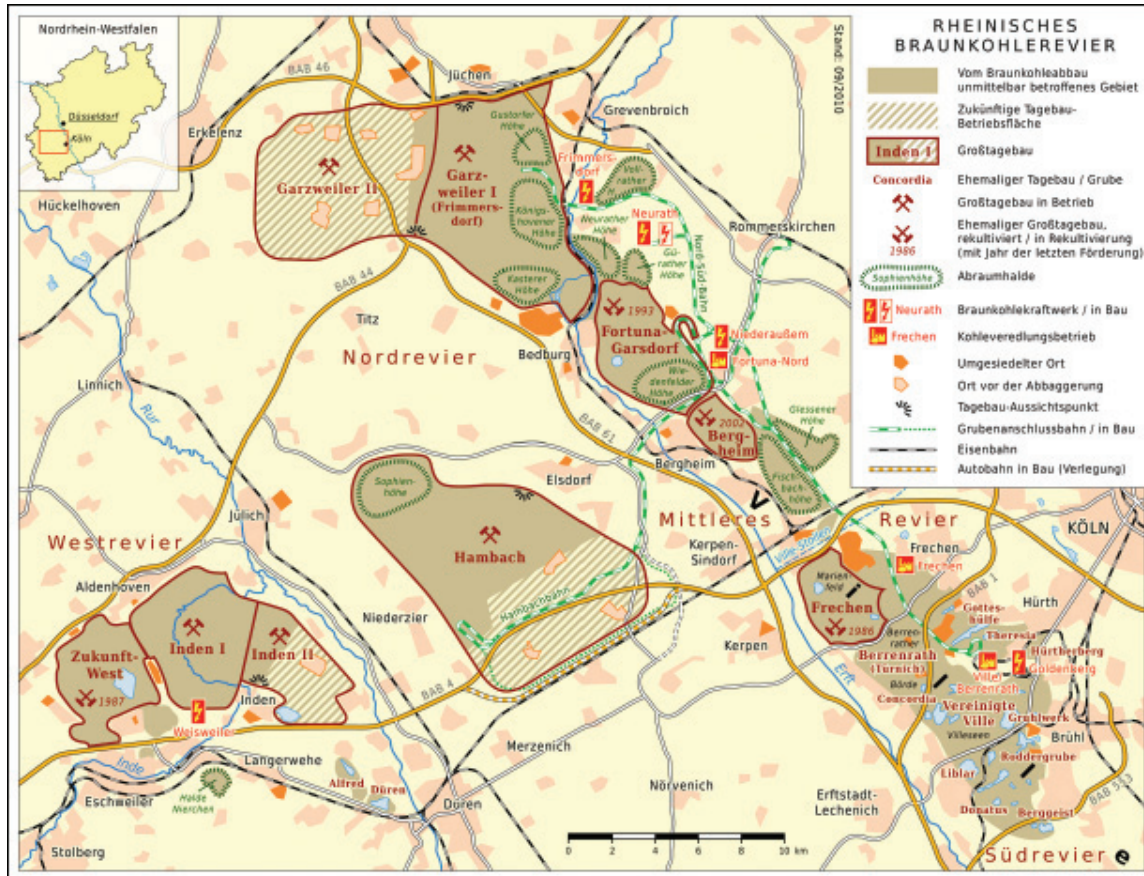


„Villages on the Edge“: Mining communities as Juechen have to deal with many stresses such as noise, dust, light and mining subsidence.

Useful link: www.bund-nrw.de/braunkohle

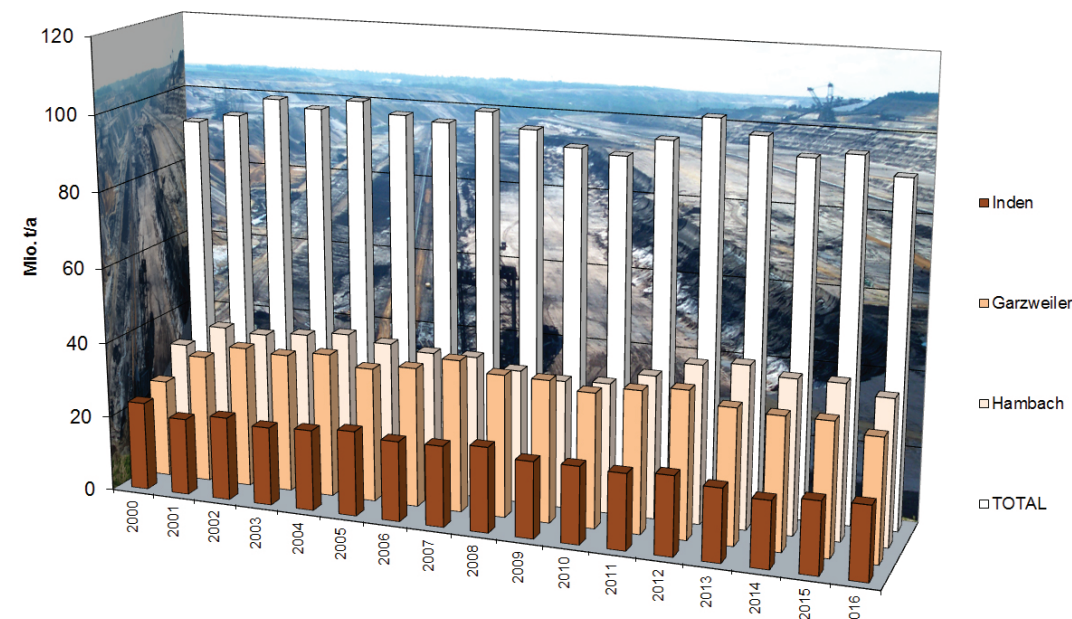
Fact file Garzweiler opencast mine

total surface opencast mine Garzweiler I and II	110 km²	total lignite content	3 Mrd. t
dredged by the end of 2014	71 km²	overburden (sand, gravel, loess)	11,4 Mrd. t
total surface of recultivation	44 km²	produced by 2014	1,825 Mrd. t
of which		• lignite	
• for agriculture	33 km ²	reach	1,175 Mrd. t
• for forests	9 km ²	• lignite	
• others	1,3 km ²		

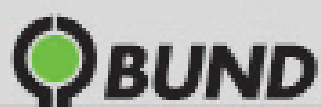


Lignite production in the Rhineland

Quelle: Statistik der Kohlenwirtschaft e.V., RWE, DEBRIV



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
■ Inden	23,6	20,5	22,2	20,9	21,5	22,6	21,3	21,5	22,6	20,3	20,5	20,1	21	19,3	17,65	19,05	19,49
■ Garzweiler	26	34	37,6	36,9	38,3	35,7	37,1	40,4	37,8	35,7	37,6	39	36,8	35,05	35,13	32,46	
■ Hambach	32,9	38,9	38,1	39,2	40,5	39,1	37,8	37,9	35,5	34	34,6	37,9	42	43,2	40,93	41,03	38,5
□ TOTAL	91,9	94,3	99,4	97,5	100,3	97,4	96,2	99,8	95,9	92	90,8	95,6	102	98,3	93,6	95,21	90,45



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