The True Cost of Coal

How people and the planet are paying the price for the world's dirtiest fuel

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cover image Close-up view of coal unloaded from bulk carriers in the port of Gijon, northern Spain.

image Stockpiles of coal unloaded from bulk carriers in the port of Gijon, northern Spain.

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Introduction

Coal burning has existed for centuries, and its use as a fuel has been recorded since the 1100s. It powered the Industrial Revolution, changing the course of first Britain, and then the world, in the process. In the US, the first coal-fired power plant – Pearl Street Station – opened on the shores of the lower East River in New York City in September 1882.[1] Shortly thereafter, coal became the staple diet for power plants across the world.

Today, coal is used to produce nearly 40% of the world's electricity.[2] However, burning coal is one of the most harmful practices on the planet. It causes irreparable damage to the environment, people's health and communities around the world. The coal industry isn't paying for the damage it causes, but the world at large is. It's this cost – the true cost of coal – that this report reveals, showing and quantifying its effects on people and the environment around the world.

Spiralling energy demand means that the use of coal is on the rise– and at an alarming rate. Between 1999 and 2006, coal use around the world grew by 30%. Similar increases are predicted for the future if we do not reduce our dependence on this dirtiest of fossil fuels.

The single greatest threat facing our climate

The fact is that coal is the most polluting energy source around, and the dominant source of the world's carbon dioxide (CO_2) emissions. Across the planet, 11 billion tonnes[3] of CO_2 come from coal-fired power generation every year.[4] In 2005, this made up just about 41% of all fossil fuel CO_2 emissions.[5] If plans to build new coal-fired power plants go ahead, CO_2 emissions from coal will increase 60% by 2030.[6]

Climate change is the greatest environmental threat and humanitarian and economic challenge the world has ever faced. Millions of people are already feeling the impacts of climate change and an estimated 150,000 people die each year from its effects.[7] To avoid the worst impacts of climate change, including widespread drought, flooding and massive population displacement caused by rising sea levels, temperature increases *must* peak as far below 2ºC (compared to pre-industrial levels) as possible. To do this, the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report indicates that global greenhouse gas emissions must peak at the latest by 2015.

How we deal with the coal question will make or break whether we get there. Indeed, James Hansen, the top NASA scientist, has stated that the 'single most important action' needed to tackle the climate crisis is to reduce CO_2 emissions from coal– an opinion repeated by experts around the world.[8]

Why is revealing the true cost of coal important?

Coal may be the cheapest fossil fuel on the market, but its market price is only half the story. The financial price includes a range of factors, from mining and retailing costs to government taxes and, of course, profit, but it ignores some of the biggest taxes, and costs of coal: the tremendous human and environmental damage it causes. If the true cost of coal to governments and people around the world were reflected in its market price, the viability of building ever more coal plants would be very different.

This damage doesn't start and finish with the CO_2 emissions caused during coal burning. The entire process – or chain of custody – from mining, through combustion to waste disposal, and in some cases recultivation, has a dire impact on the environment, human health and the social fabric of communities living near mines, plants and waste sites. It severely disrupts ecosystems and contaminates water supplies. It emits other greenhouse gases like nitrogen oxide and methane, as well as black carbon and toxic chemicals like mercury and arsenic. Leaking waste ruins fish stocks and agriculture, and therefore also livelihoods. It directly contributes to health problems like black lung disease. Because none of these are reflected in the price of coal, they're referred to "external costs".

These external costs are inevitably paid by society – often by its poorest members. In Jharia, India, thousands of people living around the area's decaying coal mine endure horrendous living conditions caused by uncontrollable coal fires.[9] In Russia, unsafe mining conditions have meant injury and death for scores of workers.[10] In the Kuyavia-Pomerania region of Poland, mining activities have caused the water level of Lake Ostrowskie to drop dramatically.[11] This list of examples could go on indefinitely.

In purely economic terms, the continued use of coal is also a ticking time-bomb. Greenpeace's own preliminary analysis of the true costs of coal, conducted by the Dutch Research Institute CE Delft, shows that damages attributable to the coal chain of custody amount to roughly €360 billion in 2007 (See *The True Cost of Coal*, page 9). This figure is most certainly an underestimation, as it doesn't account for all damages caused by coal. Nevertheless, it gives an idea of the scale of harm we subject ourselves and our environment to by continuing to mine and burn coal.

As more coal-fired power plants are built, external costs will increase dramatically. We're talking vast sums – particularly when it comes to fighting global warming caused by burning coal. In 2006, the Stern Review on the Economics of Climate Change insisted that 1% of global Gross Domestic Product (GDP) each year needs to be invested to combat climate change[12] – Stern increased the estimate to 2% in June 2008.[13] What's more, according to the review, costs required to tackle the effects of climate change could reach between 5% and 20% of the global GDP by 2100.[14]

An urgent need for action

The true cost of coal underlines the urgent need for action to avoid the disastrous consequences of a coal-powered future. While most governments so far have been slow to react, community movements are forming across the globe and demanding an end to coal. These movements are strong and gaining momentum.

The good news is that a future without coal is possible: the world already has enough technically accessible renewable energy to meet current energy demands six times over. For example, it is estimated that the world's wind resources alone could generate enough power to supply twice the projected electricity consumption in 2020.[15]

Greenpeace's Energy [R]evolution[16] blueprint shows how renewable sources of energy, combined with greater energy efficiency, can cut global CO_2 emissions from fossil fuels by 50% and deliver half the world's energy needs by 2050. Moving to a renewable future would save the world up to US$ 180 billion a year in comparison to business as usual.[17] This is the exact amount needed in extra aid to reach the Millennium Development Goals (MDGs) by their target date of 2015.

Coal powered the Industrial Revolution. Now, clean energy technologies need to take over and power a new revolution in energy to help the world escape the clutches of climate change.

image Coal fired powerstation

'There is now almost 40% more carbon dioxide in the atmosphere than before the Industrial Revolution. Current CO_2 levels are higher than at any point in the last 650,000 years.'*

* See National Oceanic Atmospheric Administration Available at: www.esrl.noaa.gov/gmd/ccgg/trends.

image Close-up view of imported coal on the quayside in the port of Gijon, northern Spain.

The True Cost of Coal

Traditionally considered the cheapest fuel around, the market price for coal ignores its most significant impacts. These so-called "external costs" manifests themselves as damages such as respiratory diseases, mining accidents, acid rain, smog pollution, reduced agricultural yields and climate change.

The harm caused by mining and burning coal is not reflected in its price per tonne or its costs for a kWh of electricity, but the world at large is nevertheless paying for it. This report seeks to answer the question: *just how much are we paying*? While it currently isn't possible to account for all the devastation coal wreaks on a global scale, it is possible to approximate the annual damage costs for some of its more conspicuous impacts.

At the request of Greenpeace, the Dutch research institute CE Delft conducted a preliminary analysis of the external costs of impacts to human health and the environment caused by coal mining and combustion. This evaluation focused on the external costs in 2007 of damages attributable to climate change, human health impacts from air pollution and fatalities due to major mining accidents – factors for which reasonably reliable global data is currently available.

Based on the factors examined, the analysis reveals:

- Coal-fired power stations caused an estimated **€356** billion worth of damage in 2007;
- Accidents in the global coal power chain cost at least **€161** million in 2007; and
- Mining carries with it hidden damage costs, which came to at least **€674** million in 2007.

Combining all the costs listed above, CE Delft arrived at a global figure of roughly **€360 billion**. Over the next ten years, this could mean costs in excess of **€3,6 trillion** – a sum of money equal to more than six times the price of the 2008 economic bailout of troubled financial institutions in the US ($US 700 billion, October 2008).

This figure estimates a lower limit for the annual costs coal exacts on humans and the environment. To do the calculation, CE Delft used International Energy Agency data to assemble coal combustion emission figures for the largest coal-power producing countries – US, China, India, Japan, Germany, South Africa, Australia, Russia and Poland – which together account for 85% of global coal combustion emissions. Together with emissions from other EU countries, 91% of global coal combustion emissions were included in the final calculation. Additionally, emissions attributable to coal mining operations globally were collected along with data related to major accidents in the coal power chain.[18]

This staggering number is most likely an underestimation of the yearly damages caused by coal around the world, as not all the impacts was assessed, while costs for climate change are expected to increase dramatically in the future. In many ways, the true cost of coal on a global scale defies calculation, largely due to the absence of data that reliably catalogues coal's every negative effect. What's more, quantifying social impacts, such as community displacement, loss of cultural heritage and human rights violations in a credible manner is virtually impossible. While the figure presented above does not precisely quantify coal's every cost, it does provide a sense of the scale of harm we subject ourselves and our environment to by continuing to mine and burn coal.

In an age of high energy prices and seemingly insatiable energy appetites, the lowest-cost energy sources tend to be the most favoured. While coal might be comparatively cheap in the marketplace, in reality the cost of coal is far too high and the world simply cannot afford to continue using it. Given the availability of alternatives such as renewable energy and energy efficiency, which can meet our energy needs in a safe and climate-friendly way, there is no need to continue relying on coal. We must reduce our dependence on this dirty fuel and abandon plans to build new coal-fired power stations. The true cost of failing to do this – and not harnessing instead the potential of a clean, sustainable energy – is something we dare not contemplate.

image A coal miner hard at work at Rajapur Mining Project in Jharia. This is one of the most important coal mines in India as well as one of the largest in Asia.

2

Coal – a dirty fuel that's destroying our climate

Coal burning contributes more to climate change than any other fossil fuel. Coal-fired power stations pump vast amounts of CO_2 into the atmosphere each year, 11 billion tonnes to be precise.[19] This amounts to 72% of CO_2 emissions from power generation and 41% of total global emissions of CO_2 from fossil fuels.[20]

Climate change is the greatest environmental threat and humanitarian and economic challenge the world has ever faced. Millions of people are already feeling the impacts of sea-level rise and coastal erosion and the increasing intensity of natural disasters such as floods, droughts, severe storms and forest fires. Such effects will only get worse as temperatures rise. More frequent severe weather will also affect agriculture and further undermine food security. A warming world could also see diseases like dengue fever and malaria spreading. If nothing is done to reduce emissions of carbon dioxide, the main global warming gas, one-quarter of plant and animal species face increased risk of extinction.[21]

In Bangladesh and India alone, the impacts of climate change such as sea-level rise and drought could force 125 million people from their homes. Up to 1.2 billion people in Asia could suffer increased water shortages by 2020, according to the United Nations climate panel. Wheat production could disappear from the African continent.[22]

Society as we know it is at risk if CO_2 emissions are not rapidly cut. Coal use lies at the root of the problem.

As the single largest source of CO_2 emissions, the manner in which we deal with coal in the coming years will determine whether we can respond adequately to the climate crisis. The urgency in this matter simply cannot be understated. As former US Vice President Al Gore recently remarked, "We've reached the stage where it is time for civil disobedience to prevent the construction of new coal plants."[23] A coal plant built today will emit CO_2 pollution for at least the next 40 years.

In the power sector, the coming two decades will witness the largest turnover in electricity generating technology the world has ever seen. Existing plants will need to be retired. Decisions made by nations and power utilities on how to manage this turnover will define our energy supply for the next generation. In contrast, a business-as-usual approach would allow CO_2 emissions from coal to rise by 60% by 2030.

Those peddling technological fixes – such as carbon capture and storage (See *Carbon Capture and Storage (CCS) – the flawed case for business as usual,* page 12), which claims to make coal clean and safe for the climate – create a dangerous distraction as the world seeks truly sustainable solutions that will reduce emissions and protect our climate. It is only by quitting coal and increasing energy efficiency and production of renewable energy that we will prevent catastrophic climate change.

image Coal-fired power station
©GREENPEACE / STEVE MORGAN

Carbon Capture and Storage (CCS) – the flawed case for business as usual

CCS aims to reduce the climate impact of burning fossil fuels by capturing CO_2 from power plant smokestacks and dumping it underground.

Its future development has been widely promoted by the coal industry as a justification for the construction of new coal-fired power plants and 'business as usual'. But CCS cannot deliver in time to avoid dangerous climate change – the earliest possibility for deployment of CCS at a useful scale is not expected until at least 2030, while global greenhouse gas emissions must start falling after 2015 to avoid the worst impacts of climate change.

Concerns about the feasibility, costs, safety, and liability of CCS also make it a massive gamble – one that risks taking attention and investment away from the deployment of renewable energy sources. A recent survey of 1,000 'climate decision-makers and influencers' around the world revealed substantial doubt in the ability of CCS to deliver. Just 34% were confident that retrofitting 'clean coal technology' to existing power plants could reduce CO_2 emissions over the next 25 years without unacceptable side effects, and only 36% were confident in its ability to deliver low-carbon energy from new power plants.[24] In short, CCS won't be ready in time to save the climate, and should not be used as an excuse to continue burning coal.

For more information about CCS, see the 2008 Greenpeace report 'False Hope: Why carbon capture and storage won't save the climate' – www.greenpeace.org/ccs.

Climate Impacts

Reng Zong gathers water from a local well, situated on the Rongbuk River bed. According to local people, until recent times the river was abundant with water. Now it is dry for most of the year. The Rongbuk Glaciers are one of the prime sources of water feeding into the major rivers of China and India.

Sophit Sataporn, holding her child, stands in front of her house in Laem Talumphuk cape. Her family, house and village are being threatened by rising sea levels. A climate-change-induced wind pattern has intensified the speed of coastal erosion in both the Gulf of Thailand and the Andaman Sea. On average, five meters of coastal lands in the region are lost each year.

A young man sits despondently amidst the wreckage after Hurricane Stan slammed into Mexico in October 2005. 2005 was an outstanding year in terms of heavy weather events. Hurricane Stan was one in a row of hurricanes resulting in economic losses of 162 billion US Dollars in total. It is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and heavier precipitation.

Climate change is already having a serious social, ecological and economical impact. We are already close to the threshold of irreversible change for certain parts of the climate system, such as the Arctic sea ice. Preventing dangerous climate change means halting the growth in CO_2 emissions by 2015, and then more than halving CO_2 output by 2050. The inescapable conclusion is that we have to phase out use of coal.

Drought in Australia has forced grazers already facing economic hardship to re-evaluate stock numbers, prompting large livestock sales throughout the country. Climate change will only make this worse. Rising temperatures will likely increase the occurrence and severity of droughts in southern and eastern Australia, exacerbating security problems. Production from agriculture and forestry is projected to decline by 2030 over much of the region as a result.

An elderly woman looks out from her balcony on to the floods in Arles, France. Climate change is projected to make extreme river floods even more frequent in some areas, especially in central, northern and northeastern Europe. From 1998-2002, Europe suffered about 100 damaging floods causing some 700 fatalities, the displacement of about half a million people, and at least 25 billion Euros in insured economic losses.

A winter drought caused crop losses of around 80% amongst corn farmers in the Rio Grande do Sul in 2005. Carlos Barbosa, pictured here, normally harvests 120 sacks per hectare but in 2005 he only harvested 28. The agricultural sector is extremely sensitive to climate variability. Decreases in precipitation are predicted by the end of the 21st century for the Northern and Southern Tropics. In some African countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020.

The Chain of Custody

Coal's journey from the ground to the waste heap is often called its chain of custody. The chain has three main links – mining coal, burning coal and disposing of coal's waste. When you look at the facts, one thing very quickly becomes obvious: each part of the chain causes irreparable damage to our planet and the health of the people on it. In the next section, Coal first hand, we share the stories of people who are feeling these effects of coal today.

Mining coal

Mining causes **widespread deforestation, soil erosion, water shortages** and **pollution**, smouldering **coal fires** and the emission of greenhouse gases. Massive excavation operations strip land bare, lower water tables, generate huge waste mountains and blanket surrounding communities with dust particles and debris. Mining leads to the loss of fertile soils through erosion, while runoff into nearby water bodies clogs rivers and smothers aquatic life. It kills miners quickly through **accidents,** or more slowly with **black lung disease**. And it also **displaces whole communities**, forced to abandon their homes because of coal mines, coal fires, landslides and contaminated water supplies.

Burning coal

Coal combustion leaves a similar trail of destruction in its wake. The huge volumes of water needed to "wash" coal and cool operating power stations cause **water shortages** in many areas. Pollutants spewed from smokestacks threaten public health and the environment – fine dust particles are a major cause of **pulmonary (lung) disease**; mercury harms neurological development in children and the unborn; and coal-fired power plants are the biggest single source of **polluting emissions**, such as carbon dioxide, sulphur dioxide, nitrogen oxides and methane, contributing to **climate change** and causing **acid rain** and **smog**.

Coal's legacy

The damage caused by coal doesn't end once it's burnt. At the end of the chain are **coal combustion wastes** (known collectively as CCW), abandoned mines, **devastated communities** and **ravaged landscapes**. CCWs are toxic and often laced with lead, arsenic and cadmium that can cause poisoning, kidney diseases and cancer respectively. **Acid mine drainage** (AMD) damages soils and makes water unsafe for consumption. **Collapsing mines** cause land to subside, resulting in structural damage to homes and buildings and infrastructure like highways, buildings and bridges. Attempts to mitigate the devastation left once coal is removed are inadequate at best. "Reclaimed" land never quite recovers; poisoned communities remain contaminated; and no matter how hard you scrub, the social fabric of human societies is forever dirtied with coal dust.

Every link in the chain of custody contributes to the overall damage caused by coal – each in its own particular way. This damage is real. It will only get worse in the future if nothing is done. And it all forms part of the true cost of coal.

image Stockpiles of coal unloaded from bulk carriers in the port of Gijon.

image Coal miners carry coal into lorries as excavators make new space for more coal filled earth.

©GREENPEACE / PETER CATON

3

Coal first hand

When calculating the true cost of coal, we can assess much of the damage - like the cost of health care, harm caused by climate change, and mining accidents in - financial terms. But it's impossible to put a cost on everything.

How do you calculate every single instance of environmental damage? How do you quantify human rights abuses suffered by workers in the coal industry? How can you put a price on communities seeing their culture eroded?

The following stories come from those directly affected by coal, right now, shedding light on these unquantifiable issues. They all come from countries particularly afflicted by coal, showing its effects at each stage of its lifecycle: from mining to combustion and coal's dirty legacy.

In Columbia, indigenous communities are threatened and forced off their lands to make way for coal mines; thousands in Jharia, India, suffer from horrendous living conditions because of uncontrollable coal fires; in Russia, unsafe mining conditions have meant injury and death for scores of workers

In places like Indonesia, China and Thailand air pollution from coal combustion is destroying livelihoods, damaging ancient relics, reducing crop yields and killing people. The legacy of mining ensures that land in South Africa will continue to be poisoned by acid mine drainage long after mines are closed, while in the Kuyavia-Pomerania region of Poland, mining activities have caused the water level of Lake Ostrowskie to drop dramatically. In the United States coal has meant blowing up mountains, burying streams and contaminating nearby communities. In Germany, reclaiming opencast mines has created dead lakes with water as acid as vinegar.

However, in response to the unmitigated destruction and harm caused by coal, communities are rising up. In Australia, winemakers, horsebreeders, local residents and miners are saying no to mine expansion and yes to a just transition to renewable energy. In the Philippines, a diverse group has united to oppose a new coal-fired power station, calling instead for clean energy development. Stories such as these inspire, provide hope and point the direction towards a better future – one not marred by dirty coal but fuelled by energy sources that are safe, sustainable and will protect our climate.

Colombia

Communities cleared away for coal

One of the few remaining members of the Wayuu communities. Collective displacements have been carried out, under threats and unjust treatments. Some families have even been fenced in when refusing to follow the company's demands about relocation. Mine security prevents access to fishing and drinking waters and hunting grounds.

The Cerrejón mine will soon forcibly evict this elderly Wayuu of Tamaquito, where she has lived here whole life. Mining operations have not only transformed the traditional life of Wayuu people but also severely contaminated their environment.

A farmer near the Cerrejón mine. His livelihood, primarily based on small-scale crop and livestock farming, has been totally disrupted by mining operations. The soil on his land is so contaminated that it is difficult to grow crops necessary for survival while water supplies are contaminated and unfit for consumption.

Colombia is the fourth largest coal exporting country in the world.[25] The Cerrejón Zona Norte (CZN) mine on the Guajira peninsula is the largest opencast coal mine in the world. The site is also infamous for widespread human rights violations against indigenous and Afro-Colombian people.

Trucks loaded with coal at the Cerrejón coal mine in Colombia. The mine itself occupies a 30-mile by 5-mile swathe of land in the southern Guajira region. Mining operations have rendered much of the surrounding land uninhabitable.

The Cerrejón coal mine. The environment at the mine is filled with fly ash, sulphur and methane fumes while the waters are contaminated by waste sludge and noxious chemicals.

A 5-year-old boy in Tamaquito. Like many he suffers skin rashes from the effects of the mine dust. Local health provisions are woefully inadequate and many residents rely on insufficient handouts provided by the Cerrejón mine.

CZN was run as a joint venture between ExxonMobil and the Colombian government from the 1980s until 2001, when it was taken over by a consortium of European-based mining companies including BHP Billiton, Glencore, and Anglo-American.[26] Covering 150 square miles in southern Guajira, the site consists of an integrated mine, railroad, and coastal export terminal.[27] While it currently produces about 30 million tonnes of coal per year, the mining company is investing US$1 billion to increase production to 40 million tonnes per year by 2011.[28]

The Colombian government claims that the mine brings progress to the poverty-stricken region of La Guajira. But the reality is that Afro-Colombian and indigenous communities are under siege by the mine (see *Violated,* p.23 *)*. Much of the land close to the mine is uninhabitable due to blasting, dust and contamination. Miners and local communities suffer from poor health and the loss of land, homes, livelihoods and even life. The surrounding air is polluted by fly ash and methane, and the water is contaminated by waste sludge and a cocktail of other chemicals.[29]

The effects of CZN first hand

False promises

The Wayuu indigenous people from Tamaquito are some of the worst affected by the mine. Initially, they were promised something very different: *"On arrival, the mining company offered the Wayuu participation in the benefits of the coal mining. This implied 'development' and 'progress', which for the Wayuu meant a solution to the problems of poor water supplies, education, and health care,"* said Remedios Fajardo Gómez.[30] "The contamination arrived as mining operations advanced. Coal dust and noise from the equipment and the explosions have affected human, animal and plant life in the communities near the mine. Several Wayuu died and others were permanently injured by poisoning, after eating contaminated garbage from the mining company's dumps."[31]

Jairo Dionisio Fuentes Epiayu, the governor of Tamaquito, told us what happened next:

"As time passed, the relationship with the mining companies went from bad to worse, and we started to see the bad implications of the [mining] proposal… the companies continuously violate our rights, they do not respect our traditional laws that must be applied to compensate the irreversible damage they have caused to the communities and to nature." [32]

Today, Tamaquito is isolated, without employment, and without access to schooling, health services and transport links. The villagers' livelihoods are threatened, as they are left without any means of subsistence. "We realised we had made a mistake," Jairo said. "The mine has completely surrounded us. We do not have access to roads to leave our village, our children cannot access schools, we have to walk on trails, and it takes us four hours to go to the nearest village... CZN does not even allow us on its property to hunt, and our hunting grounds are depleted because of the mine. We need to support ourselves by hunting, by planting, but now Cerrejón has bought all the land, so we have no chance of surviving."[33]

Forced displacement and isolation

In 1980, the community Media Luna was chosen as the spot to construct the port needed to ship coal from CZN around the world.[34] Next to the port, the mining company also built an airport, a train terminal and a complete industry complex.

At the time, 750 Wayuu lived at Media Luna. Initially, the company and residents of Media Luna started negotiations towards a resettlement programme. However, community members were threatened and shouted at by company representatives in the process and the negotiations eventually broke down.

The Wayuu were forced to relocate to an area nearby, but it didn't take long for their new home to become heavily contaminated with air and water pollution from the mine. The company ordered the Wayuu to move again, but 42 people from seven families refused to leave. The mining company's response? They put a chain-linked fence around the families living there. They put locks on the gate to the fence and armed guards patrolled the area to report the movements of the residents. The residents were also harassed, prevented from building new houses, and even denied access to water. Still they stayed, and they continue to do so today.

Demolition and destitution

The Wayuu are not the only community to have been displaced by force. A number of Afro-Colombian communities were dispersed without compensation when the mine was first being developed.

image Even the health of those not working in the mines is affected by mining operations. Air pollution drifts into nearby villages, causing respiratory problems and skin rashes in the communities there.

One of these was Tabaco, which was wiped off the map in 2002 to allow for the expansion of the Cerrejón mine. On that occasion, employees of the mine, armed security guards, and even the army, forced residents to leave under threat. Some were even literally dragged out from their homes before the village was levelled with bulldozers.[35] Today, Tabaco lies buried in the middle of the coal mine. Its residents have been scattered, with about 60 families still living in inadequate provisional dwellings in the coal town Albania.

Emilio Pérez, a former resident of Tabaco, spoke of life there before the mine. *"Life was rich. We shared, and no one suffered because we shared what we had,"* he explained. *"There was a river near the town. We had land. We walked freely all over the territory. But the last six years we have had no land to work. We are displaced, and we have no lodging."* [36] Under Colombian law, indigenous and Afro-Colombian communities can claim collective land titles that they identify as ancestral lands. However, although the Tabaco community has farmed their lands for centuries, they cannot pursue legal titles because the land quite literally isn't there anymore; it has been swallowed up by the mine and completely destroyed.[37]

Illegal negotiation tactics

Another community threatened with the same fate as Tabaco is nearby Chancleta. Here, the mine company has been putting pressure on the inhabitants in a new and sinister way, using "divide and rule" tactics to weaken and ultimately break up local communities. Chancleta residents were intimidated if they sought collective negotiation, they were told that they must agree to individual settlements – or get nothing. The president of the Chancleta neighbourhood council, Wilman Palmezano explains more:

"From the beginning, the mining companies chose to negotiate with the villagers on an individual basis to assess compensation for land and houses. However, most communities want to conduct collective negotiations to obtain a new area to rebuild their village with houses, land and an infrastructure of roads, schools and churches." [38]

The company is now negotiating collectively with Chancleta. In the past the company refused to do this, but now it has changed tactics, partly as a result of intensified pressure applied to it, both nationally and internationally.

The outlook

Forced displacement of hundreds of families from their homes and lands, destruction of collective and family relationships, damage to health, death of flora and fauna – no mining company can justify so many violations.

What makes the situation even more tragic is that the residents of Chancleta, Media Luna and Tabaco did not realise the coming of the mine would mean the end of their community. By the time they did, it was too late. It's likely that they won't be the last communities to suffer the same fate.

Story By: Erika Bjureby

Violated

Claims about the benefits coal brings to the world - such as employment and cheap electricity - do not take account of the people that actually reside in mining regions. Mining operations regularly displace whole communities and can force people off their land because of coal fires, subsidence, contaminated water supplies, air pollution and other damage.

The Colombian case study clearly shows the dire impact of coal mining on communities living next to mines. The villagers in this story were seeking only to enhance the quality of their existence, and instead wound up having to defend their lives and their land.

As if this was not enough, the struggle of the workers against conditions in the mines has resulted in the murder of four trade unionists in Colombia. Four leaders of the Sintamienergética miners' union, who worked for the Drummond mine - a US-based coal company - in northern Colombia, were murdered in 2001 by right-wing paramilitary forces near the firm's La Loma operation. The case was brought to court in the USA to expose Drummond's involvement with the paramilitary and violence against workers in Colombia. However, in the end, Drummond was found "not liable" in the deaths of the trade unionists. This ruling, of course, further worsened conditions for the workers and exacerbated the conflict between the union and the company. This is just one example of how coal's impact on human rights in Colombia, and elsewhere in the world, worsens day by day.

India

A living pyre

The largest coal belt in India at Jharia, Jharkhand. Before coal mining commenced here, Jharia was a belt of dense forests inhabited by tribes.

Early morning at Bokahapadi Village at the other side of the valley from the Rajapur Mining Project. The ignited coal burning underneath the village causes the release of toxic fumes. The town is slowly cooking underneath its surface.

Security from the Central Industrial Security Force in Rajapur Mining Project guard against the illegal miners. A guard explains: “After my posting in nice places like Shillong and Sikkin, this place seems like hell on Earth.”

Jharia is one of the most important coal mines in India and one of the largest in Asia. Once a treasure trove of high-quality coking coal, uncontrollable coal fires have turned the mine into a slow-burning inferno.

Illegal coal pickers cautiously collect coal during the day while keeping one eye on the security forces that patrol the area.

An illegal coal picker stabs at the ground in search of coal under the surface. The coal she collects will be sold at the local market to pay for her food.

Collecting coal is a family effort – every able body is expected to help. As a result, many children form a part of the illegal coal picking workforce.

A loading truck at the Rajapur Mining Project. Smoke and noxious fumes from the underground coal fires escape into the atmosphere. Smoke from the fires contains poisonous gases including carbon monoxide, carbon dioxide, sulphur dioxide and nitrogen oxide.

Coal miners lift coal upon their heads from dawn till dusk in sweltering temperatures. It's a miserable existence, but few other options are available to make a living.

A child plays with his kite amongst the toxic fumes and burning ground caused by the underground coal fires around Bokahapadi Village in Jharia.

‘India accounts for the world’s greatest concentration of coal fires. Rising surface temperatures, and toxic by-products in groundwater, soil and air have turned the densely populated Raniganj, Singareni and Jharia coal fields into wastelands.’*

*Krajick, K. 2005. Fires in the Hole. Smithsonian magazine, May 2005.

Crumbling under fire and subsidence, Jharia is a place of smouldering land and noxious fumes that make breathing difficult. Yet thousands of inhabitants cling to this collapsing town, eking out a living. Many of them are illegal coal collectors, who spend their days frantically picking up pieces of coal from the mine dump to sell at the local market for 50 Rupees (US$1.20) a basket.

It's a miserable existence. To make matters worse, the threat of displacement hovers over their heads on a daily basis as the fires continue to spread (see *Burning Just Below the Surface*, p 29)

How did it come to this?

Before coal was unearthed in this area, Jharia was a belt of dense forests inhabited by tribes. Agriculture and cattle rearing were the basic forms of livelihood.

Lore has it that King Raja Shiv Prasad Singh, who reigned over Jharia and surrounding areas, first leased 200 acres of land to a Gujarati merchant for just Rs 200 (US$5) to start mining.

The mine grew, and soon the fires started – smouldering coal seams and waste heaps set alight by neglect and poor mining techniques. Since the first fire was seen in Jharia in 1916 (in a colliery called Bohra), unscientific mining[39] has been the prime reason behind the spread of fire and subsidence. One particularly bad period was just after 1971, when the mines were nationalised and a public sector company called Bharat Coking Coal Limited (BCCL) took over Jharia. These new owners started to dig huge opencast mines to get to seams of coal near the surface – a cheaper way of mining. Once used, these enormous coal pits were then abandoned, leaving the coal seams exposed to the atmosphere. This caused the seams to ignite. Once alight, these fires are virtually impossible to put out. According to BCCL, there are 67 active fire zones in Jharia today.

Jharia first hand

Horrendous living conditions

Thousands of poor, mostly unskilled, migrants from neighbouring states have settled in Jharia over the years. Most of them collect coal illegally to pay for their two meals a day. This has put huge pressure on the existing infrastructure. Gayatri Devi, a 50-year-old illegal coal collector, lives in a one-room house in one of the active fire zones called Bokapahadi. The floor of her house has a huge crack running through it, and fumes from underneath fill the house. She told us:

"I have lived here for 40 years. Last year, the floor cracked and since then my house is on fire. When we walk barefoot, our feet burn. At night, my children feel suffocated due to the pungent fumes. Eight of us sleep in this room. We have nowhere to go, neither do we have the money to make another house. Probably we will die here."[40]

Lung and skin disease

Ill health adds to the sense of despair in the town. Pollution invades everything – air, water and land. Smoke from the fires contains poisonous gases including carbon monoxide, carbon dioxide, sulphur dioxide and nitrogen oxide. These fumes, along with fine coal dust from the fires, cause several lung and skin diseases.

The problem is made worse by the fact that most mine workers, including shovel drivers, do not wear masks, boots or overalls. It's no surprise that the most common diseases in this area are pneumoconiosis, tuberculosis, asthma and other chronic lung disorders. Dr Rajiv Agarwal, a local doctor in Jharia, told us that, *"Most patients who are mine workers suffer from pneumoconiosis here. Once it is detected, there is not much one can do. A film of coal soot covers the lungs. Anaemia and malnutrition are also very common, a fall out of abject poverty and extreme labour in mining areas."* [41]

Miners bear the brunt of it, but everyone is affected. Shanti lives in Lodhna, also a fire zone. She told us, "I have continuing headaches due to the noxious gases around. It lasts for days. My children are also down with headache most of the time. At times, there is no one to go to work because my husband has TB. He coughs blood and is very sick. I hope we get over these troubled times soon." [42]

Despite the obvious evidence to the contrary, when asked about safety provisions, Mr Subrata Chowdhury, ex-chairman and managing director of BCCL, completely denied the fact that workers suffer from respiratory disorders.

image Illegal coal pickers from Bokahapadi village successfully negotiate a daylight raid on a local coal mine and hurry home to prepare the coal for sale.

Displacement

In spite of all these issues, what people worry about most is displacement. Technical director of BCCL, T.K.Lahiry, recently announced:

"Loss of good quality coking coal is a national loss. It is in a way degradation of environment. BCCL is losing its profitability and people are living in extremely unsafe conditions. The only solution is to rehabilitate people inhabiting such hazardous areas."[43]

This rehabilitation comes in the form of the Jharia Action Plan – a Rs 60 billion (US$1.5 billion) initiative to re-house inhabitants and get the coal fires under control. In response to the plan, India's Ministry of Coal has also released Rs 600 million (US$15 million) for a pilot project to build housing for the residents of Bokapahari, one of the worst affected areas.

These plans are good in principle but they don't address the complexity of the problem. In fact, in Bokapahari there is widespread and strong resistance to the forthcoming displacement. According to the residents, huge families of eight to ten people are being given one-room structures. Belagaria (where the new housing is being built) is far away from the city, and has hardly any employment opportunities. Given the gloomy choice of living in fire zones or losing their livelihood, most people have no choice but to try to stay put.

Ashok Agarwal, president of Jharia Bachao Sangharsh Samiti – a local resistance body currently fighting BCCL's plans in the Supreme Court – sums up the no-win situation as follows:

"The company started opencast and slaughter mining because it is cheaper and can be easily done. Once the fire spread, almost nothing was done to extinguish it. Sand stowing[44] *is avoided because it is expensive. Fire zones are left open. Now they want to remove all the people and extract more coal. However, their compensation is useless compared to the damage done. What will people do where there are no jobs?"*[45]

As Jharia burns, people continue to put up with the horrendous conditions, the disease, pollution and threat of displacement. Why? Because they have no other choice.

Story by: Jayashree Nandi

Burning Just Below the Surface

Coal seams, storage piles or waste piles that have started to burn and can't be put out are known as coal fires. Their cause is spontaneous combustion – a process whereby the interaction of oxygen with coal creates heat. Mining operations accelerate this process because they expose formerly covered coal piles to oxygen and additionally lead to the accumulation of large coal waste and storage piles. Coal fires can also be ignited by lightning or forest fires. For example, in Indonesia the same fires used to clear large tracts of rainforest for mining have lit over 300 coal fires since the 1980s.[46]

Coal fires contribute to climate change by releasing huge amounts of greenhouse gases into the atmosphere. Health and environmental impacts from coal mine fires can be also be quite severe. Coal fires release toxic elements, such as arsenic, mercury and selenium, into the atmosphere where they can be inhaled, settle on crops and foods, be taken up by livestock or build up in the tissues of birds and fish. Additional harmful emissions from these fires also include high benzene, toluene, xylene, and ethylbenzene.[47]

Their long-term impacts are immense – once a mine has created a path for oxygen to reach a coal seam, coal fires can burn underground for hundreds of years. The world's oldest known coal fire has been smouldering in Australia for more than 2,000 years.[48]

Russia

The human cost of coal

Striking mine workers blockade the Vorkuta-Moscow railway, permitting only passenger trains and cargo trains of liquid fuel to go by. Unrest amongst these workers is the result of poor working conditions and owed wages.

A group of miners at the Komsomolskaya coal mine in Vorkuta. A career in Russian mines means many of these men will suffer from chronic injuries and severe illnesses.

Mining is perhaps the most dangerous profession in Russia. Tragic mining accidents are not uncommon. This miner survived a methane blast that killed several people at the Komsomolskaya mine.

The Russian coal industry employs 200,000 people, producing 309 million tonnes of coal in 2006.[49] Mining is perhaps the most dangerous profession in the country. But official statistics on mining accidents and health impacts are not easy to come by.

This miner suffered grave burns when a methane explosion ripped through the Vorkutinskaya coal mine in northern Russia. Five miners died in this blast and 12 others were badly injured.

Vorkuta miners protesting against wage arrears managed to close down the biggest mine in Russia, Vorgashorskaya, for a period of two months.

The workers want their wage arrears for many months to be paid in full. Nowadays they have no money to buy essentials like food and medicine. Their families live in horrible ramshackle houses, the 50-year-old former barracks used to house prisoners' escort servicemen.

Russian coal mines are hazardous and chronically underfunded. As a result, accidents are frequent and the human cost is shockingly large. In 2003, a mine blast in Kemerovoin in southern Siberia killed 13 people. The following April, 45 more miners were killed in an explosion in the same region. One year later, in 2005, a methane explosion claimed the lives of another 21.[50] Two years later, Russia suffered its worst mining disaster in more than 60 years when 110 coal miners perished in a blast at the Ulyanovskaya mine. This tragic accident was shortly followed by another in which 38 more miners died.[51]

A national report commissioned in 2006 found that the Komi Republic (one of the leaders in coal production) had an overall occupational disease rate of 8.3 per 10,000 employees – five times the national average. These figures make the coal industry the most dangerous profession in Russia, with 26.05 work-related diseases for every 10,000 employees.[52] While these numbers are big enough to raise alarm, they do not reflect the whole picture of coal mining in Russia, where thousands of workers suffer from chronic and severe illnesses (see *Health Risk*, page 33)

Vorkuta – a town ruled by coal

Located 160 km inside the Arctic Circle, Vorkuta is a mining city with a population of more than 100,000. It was originally built in the early 20th century, and has grown with the success of its coal industry. However, recent mine closures - and the health problems that result from a career in the mines - mean that few in the town have been left untouched by mining's negative effects.

Pay and employment problems

During the 1990s and the early part of the 21st century, several mines started to close because high operation costs plagued the mine operators. The result was that 1% of Vorkuta's coal mine workers lost their jobs in 1993, followed by a further 9% the following year.[53]

At the same time, the workers who remained employed found themselves in an unenviable position. Pressures on mine owners' budgets meant that, at several times during the late 1980s and 1990s, many workers simply weren't paid – sometimes for up to a year. This led to several outbursts of union activity. In one case, things got so bad that the workers resorted to locking mining company directors and local officials in their buildings in order to get the money they were owed.[54]

Health issues

Today, five mines in Vorkuta employ about eight thousand people. Out of 114 cases of occupational disease reported in the town in 2007, 101 were in the coal mines.[55] The most common illnesses are the chronic diseases associated with using industrial equipment, physical overwork, strained organs and systems. In 2008, there were also around 30 cases of chronic bronchitis, 10 cases of cochlear neuritis, five cases of dust disease, two cases of pneumatic hammer disease, and two cases of lung cancer.[56]

The impact of Russian mining first hand

One miner who has suffered greatly for his work is Ainiyatulla Tukhfatullin. He was born in 1949 in a village in Tatarstan, a province in the Volga basin. In 1971, after service in the army, he came to Vorkuta and was employed in the Zapolyarnaya mine. For 34 years, he worked with primitive tools in mines between 250 to 750 metres underground – breeding grounds for disease and illness.

Injuries

Injuries were part of his life: "At the beginning of the 1970s, we didn't even have rock-drills. We mined coal with saws, axes, shovels. There were also electric drills: they said they weighed 32 kg. I have fractures head-to-toe. If I start telling you my medical history, your notebook won't be long enough to write it all down."[57]

He spoke about one incident in 1987 when he was hit by a falling rock. It left him hospitalised and in agony for two months with a fractured clavicle. In 2004, Ainiyatulla was diagnosed with pneumatic hammer disease: "You see, my hands are shaking – that's pneumatic hammer disease," he explains.[58]

In 2005, Ainiyatulla was injured in an underground accident. He fell, causing a knee ligament to rupture on his left leg. He needed a serious and painful operation – with a seven-month stay in a hospital bed.

It ended his career and he now gets invalidity benefit. It comes to about 7,500 roubles a month, plus compensation of about 10,000 roubles. That's only about US$ 700 dollars a month, hardly enough to live on.

image Train loaded with coal from Russian mines in Moscow.

A lack of care

Today, Ainiyatulla spends lots of his life at the centre for occupational pathology, making the journey there for treatment courses five times per year. Each course lasts about three weeks. He tells us: “Sometimes I also have to go by taxi. But it is very expensive, 300 roubles one way.”[59]

To make matters worse, a lack of public funding has forced the centre for pathology to cut back on services so people like Ainiyatulla can no longer stay there overnight. The source of the funding problem is Vorkuta’s chronic deficit, which is caused in part by the fact that tax revenues from the Vorkutaugol coal company are sent to Moscow, not Vorkuta. Things are so bad in the city that there’s even talk of closing the centre altogether.

“As soon as we heard about that in April, we just couldn’t believe our ears. This is a mining city, and there will be no place where the miners’ diseases are treated,” he added. “Write about that. Maybe then we'll get help to restore the day and night clinic." [60]

Story written by: Ernest Mezak

Health Risk

Removing coal from the ground can be arduous, dirty and dangerous. Accidental explosions and sudden mine collapses are only a few of the many perils facing the world’s coal miners. This high risk profession also comes with long working hours under strenuous conditions. It carries with it many health hazards from exposure to noxious fumes, toxic metals and dust particles.

Black lung disease, also known as pneumoconiosis or CWP, is perhaps the most infamous health problem impact resulting from a career in the coal mines. It has been associated with coal mining for centuries. CWP is caused by repeated exposure to dust containing crystalline silica, which settles in the lungs causing them to harden. This in turn reduces the efficiency with which inhaled oxygen is transferred to the bloodstream. The severity of the disease varies, but it is chronic, progressive and often fatal. Although some symptoms can be alleviated, there is no known cure. Individuals with CWP suffer from shortness of breath, tiredness, emphysema and coughs, heart problems and ultimately respiratory failure.[61]

Black lung takes a much heavier toll on miners in developing countries. In China, about 600,000 coal miners suffer from the disease – a number that is going up by about 70,000 each year.[62] In the US, the prevalence of the disease has fallen since federal mining legislation was passed but 1,200 people still die from it every year. [63]

Indonesia

Coal power – the arrogant neighbour

The Cilacap coal-fired power plant commenced operation in May 2006, with two units of 600 MW. The plant is located very close to several villages.

The incessant humming and dust pollution from the power plant has driven dozens of residents in the Griya Kencana Permai housing away from their homes.

Local children play outside their homes while the cooling tower of the power station looms in the background. These children have one thing in common: persistent coughing, which could very well be due to the air pollution from the plant.

In 2006, the bustling industrial town of Cilacap was filled with optimism. President Susilo Bambang Yudhoyono had announced the opening of a new coal-fired power plant in the area. But despite the initial hope for local economic growth, the real cost to the Southeast Java town soon became shockingly clear.

The Cilacap power station is located in a coastal community situated in central java. Here almost 80% of the local community make a living from fishing. However, the power station has severely affected the waters from which these people fish and many have seen their livelihoods lost.

Jono is a 50-year-old fisherman who catches fish in the waters around the coal plant. Since the plant started operating, he has seen his fishing catch decrease by 50%.

Diagnosed with Chronic Obstructive Pulmonary Disease, 48-year-old Munjiah spends her days in her home. She cannot afford to work in her field anymore because she is too weak. A huge number of villagers in the vicinity of the power plant suffer from respiratory-related diseases.

The original aim of building the power plant was to encourage local economic growth. In turn, this would help expand Cilacap's industrial area to around 2,000 hectares – more than ten times its former size.[64] At the beginning of the project, the government watched proudly. The plant was delivering 600 megawatts of electricity to the Java-Bali electricity grid. Many new jobs had been created, causing a booming trade in building materials. Other locals earned money by renting their houses to construction engineers.

Soon the reality hit home – and it all started with a black cloud of dust that covered the local town.

The effects of the Cilacap power plant first hand

Health

Alia is four and lives with her parents and two older siblings. An abandoned rice field is the only thing separating their home from the coal-fired power plant, 300 metres away. In the early days of the power plant being opened, Alia played happily with her friends outside her house. The only small sign of danger was the persistent coughing that all the children began to pick up.

It was an early sign of something far more serious: seven months ago, Alia was diagnosed with bronchitis. Her father has been affected, too. He worked at the plant for over a year, unloading the coal trucks without a breathing mask, inhaling the soot and fumes. Now he has lung spots.

Another local girl who suffers is three-year-old Safira. She's small for her age and has had coughs and colds at least twice a month since she was born. Her mother, Rohimah, can't afford to take her to the doctor. The only medication Safira gets is over-the-counter fever tablets and cough syrup.

Purwanto, a local doctor, told us:

"A lack of nutrition caused many of the mothers in the area to be unable to nurse their children, reducing their babies' resistance to infections. I have seen a shift to more cases of respiratory infections in children than adults in the area since the plant started operating." [65]

Purwanto is all too familiar with the suffering of children caused by the power station. He was forced to leave his own home in a nearby complex after two of his children developed bronchitis.

Air pollution

Unlike Purwanto, Imam Sarjono, a 59-year-old pensioner, chose to stay in his home. He worked hard to buy it for his retirement, after a long career as a warden in a high security prison. When he bought it, he was one of 200 buyers in the complex, all attracted by the prime location, fresh air, and distance from the hustle and bustle of the city centre.

Now, black soot covers Sarjono's white orchids and the jasmine he planted in front of his house. Trees around the area have layers of black dust on their leaves. Dozens of people have been driven away by the coal dust and constant humming coming from the plant.

"We pay double our water bill to clean our houses. Dust keeps us sweeping the floors many times a day," Sarjono tells us. "Many of my neighbours have moved away. Who can stand living like this?"[66]

Job losses

The pollution from the plant has had a devastating effect on the ability of many to make a living from the land. About 12 hectares of productive rice fields in two villages were effectively ruined after the plant flooded them with a mixture of hot salt water and effluent from the plant.

This incident forced one farmer, Noto, and his son off their land. Now, to earn money, they dig sand and transport it back to his village in a small boat. With a 10-hour day starting at 6 a.m. it's backbreaking work just to fill a small truck. Noto's tiny earnings are never more than about 80,000 rupiah a day, about US$8.[67]

Along with many of his neighbours, losing his rice field meant Noto had no choice. In fact, Noto and his son are among the lucky ones – many of his neighbours have no work at all.

image Subsistence fishermen are severely affected by Indonesia's reliance on coal. On many days they are completely unable to fish because ships carrrying coal are anchored in their local fishing grounds.

A local uprising

The illnesses, pollution and deterioration in quality of life have taken their toll on the locals living near the power station. One day at dawn, in late 2005, the neighbourhood was woken by a loud noise from the plant. Residents said it sounded like a plane taking off nearby.

"The noise kept coming on and off every five minutes. We couldn't even hear ourselves talking. Later we found out it was the plant cleaning their pipes," said Sugriyatno, who also lives in the complex.[68]

The incident drove the people of the housing complex, and three surrounding villages, to gather together and protest about the many problems by the plant. They formed a committee so they could take their complaints to the local government and the power plant.

Sugriyatno, who led the effort, said:

"We are negotiating compensation for the damage in the three villages and Griya Kencana Permai complex caused by the plant's operation. There has been a lot of damage already. However, we are still hopeful that a positive solution will come out of this." [69]

He also pointed out that the power plant's owners had never showed sympathy or offered support to the neighbourhood they destroyed. The locals won't back down; but neither, it seems, will the polluters.

Story by: Nabiha Shahab

Burning up Borneo – deforestation and coal

The deforestation caused by coal mining is readily apparent in Indonesia, the world's second largest coal exporter. Coal extracted from Indonesian mines is shipped all over the planet to countries such as Japan and Italy. Kalimantan is the centre of Indonesia's coal mining sector, with an estimated 21 billion tonnes of coal reserves. Of the 76 million tonnes of coal produced by Indonesia in 2000, 85% came from Kalimantan.[70]

In East Kalimantan, mining companies have been land grabbing and securing deals for coal concessions, and now millions of hectares overlap with areas of remaining rainforests. Deforestation maps for the period 2000-2007 show recent clearance inside active mining concessions, indicating that strip mining activities are expanding.[71]

One forecast by the Japanese Institute of Energy Economics estimates that Kalimantan's production could triple by 2020. If this expansion happens, the coal industry will become one of the leading causes of deforestation in Borneo. [72]

China

Journey through Shanxi

Mentougou district, Beijing City, China. Coal is moved from coal mines in the north and the west to power the booming mega cities in the south and the east. This creates a huge stress on the transportation system and causes serious environmental pollution along the routes.

Crumbling away – a Buddhist statue covered by coal dust in the Yungang Grottoes, Datong city, Shanxi Province, China. Despite restoration efforts, the carvings crumble away at the lightest touch.

A herder with his sheep near a coal power plant at the border between Shanxi and Inner Mongolia. Shanxi Province is the country's great coal producer with about a third of the nation's coal reserves.

Shanxi Province, located in the heart of China, is the country's greatest coal producer, with about a third of the nation's coal reserves.[73] Every day, an endless stream of trucks flows out of the region carrying the 'black gold' that keeps Chinese factories, the heart of the economy, up and running. This reliance on coal is not without its consequences, however. A journey through Shanxi Province reveals the trail of destruction that coal has left in its wake.

Plant life along coal transport roads is choked with dust. It is estimated that 60 million tons of coal dust are lost from trucks and deposited along roadsides each year.

A bleak future – Xiaoyi's dependency on coal has resulted in huge problems: a homogenous industry structure, declining employment, severe pollution, and endless disputes caused by careless and unbridled economic growth.

The coal mine, coking factory and power plant in Hanjiashan village have had a major impact on the surrounding environment and village life. Over the years, the water-intensive operations dried up the local river and wells; that and heavy pollution have lowered crop yields significantly.

A city transformed – in the 1980s, Linfen in Shanxi Province was known as the "City of Flowers and Fruit" because of its plentiful fruit trees. Today it is infamous for its dirty air. In 2003, Linfen topped the national list of most polluted cities.

This coking factory is the worst kind of neighbour. The factory makes noise day and night while smoke and pollution choke residents and kill crops.

Massive coal deposits have brought economic prosperity to China. But relying so heavily on coal is not without its consequences.

"China is a big energy producer and consumer, and most of our energy is derived from coal. China must take on the responsibility to reduce pollution and emissions."*

* Wen Jiabao, Prime Minister of the People's Republic of China. Television / telephone conference on energy efficiency and emission reduction, 27 April 2007.

Datong – "The Coal Capital"

History on the brink of destruction

Datong, in northern Shanxi Province, is a city that both benefits, and suffers from, coal. Massive, high-quality coal deposits have brought economic prosperity to the area but at the same time are leading to its decline. Large-scale, intense exploitation means that the once-abundant coal reserves are now on the verge of exhaustion; subsequently, unemployment is rising. Coal also threatens the survival of the area's cultural heritage. Air pollution from coal combustion is causing damage to a nearby ancient landmark and UNESCO world heritage site, the Yungang Grottoes (see *Particularly Polluting*, page 43) [74]

The Yungang Grottoes are an archaeological site dating back more than 1,500 years. The Buddhist stone carvings and cave art preserved here are priceless. Up until 1998, not more than 350 metres in front of the Yungang Grottoes, lay State Highway 109, a necessary route for all coal shipments. Countless numbers of coal trucks would pass by — as many as 16,000 trucks per day.[75] Dust stirred up by these trucks would settle and gradually accumulate on the surface of the stone carvings and form an acidic coat of dust. This caused severe damage to the Yungang Grottoes, as the connective material in the Grottoes' sandstone blocks is mostly calcium, which corrodes easily in an acidic environment. Now, the surface of many stone carvings or sculptures simply crumbles away at the lightest touch.

Struggling to protect the Grottoes is Dr Huang Jizhong, secretary of the Yungang Grottoes Research Institute, who has worked at the site for more than twenty years. He is deeply grieved that such a precious and treasured work of art is being sacrificed to the city's industrial pollution. A thick layer of ash covers many of the stone carvings and people often ask why the Institute does not conduct a restoration. To this Dr Huang replies, *"Due to extremely severe weathering on the surface, while some of the ash that we see is coal ash, another portion of it is a product of weathering on the sandstone. Even if we used the gentlest cleaning methods, it would have an effect on the Grottoes. All we can do now is try to think of ways to strengthen and lengthen the life of these cultural relics without affecting them negatively."*[76]

Xiaoyi – a city of "grey mountains, black water and yellow smoke".

Wasted Water

Xiaoyi is ranked as one of the top ten coal producing areas in Shanxi Province.[77] But coal mining, processing and combustion have taken their toll on the health and well-being of residents and the surrounding environment. Driving into the city, smokestacks from a coal-fired power plant are readily visible. They rise high into the air, belching out clouds of pollution. The area alongside the road bears the scars of this power plant: the water in a nearby creek runs yellow-black; piles of coal sludge litter the adjacent landscape, which is used by local sheepherders for grazing.

One local herder expresses his outrage and sense of helplessness:

"Because of this power plant, the water is like this every day, too dirty, all black. I can't say what kind of pollution there is, but if you put this water into the ground, there's no crop. Once the water touches the crops they die. Our loss is huge. I try not to let the sheep drink this water, since it's polluted water by the plant. If they drink it they'll get sick. I use the groundwater in the village myself, and the sheep do, too."[78]

Although the village's well-water has not been affected by pollution, the village now suffers from water shortages. "It's all the fault of the power plant, it pumps out the water. We used to have plenty of water beneath our village, now it's no good, there's too little water."[79] When asked about the coal sludge piling up by the roadside, the man says that it is from coal ash tossed out by the power plant. "It's all black and everywhere... The ash and gas floating around chokes me so bad I can hardly go on living…"[80] The man mops his forehead with a towel on his shoulder, so angry and agitated he cannot go on. The sheep at his side begin bleating, seemingly echoing the anger of their master.

image China's coal resources are extensive. The country derives 70% of its energy from it.

Linfen – no longer the "City of Flowers and Fruit"

Agriculture on the decline

Linfen, located in the southwest region of Shanxi Province, is better known today for its excessive air pollution than anything else. According to China's State Environmental Protection Agency, Linfen has the worst air pollution in the country.[81] Abundant coal resources, which once held a clear advantage for the city economically, led to the development of large and small coking and iron smelting factories in the 1980s. Now, a forest of smokestacks surrounds the city, and the pollution generated by them has severely affected local farmers.

Mr Shi, Mrs Chang and their four-year-old grandson, Shi Gaoxiong, live in a small mountainside courtyard just a wall's width away from one of the city's coking plants. Life here isn't easy.

"*Day and night the coking plant makes a racket, but nothing can be done. When you go out the door, everything is covered in dust… and the crops and fruit don't grow as well as before. We used to be able to gather about 1,000 jin (500 kg) of corn, and now we only get 700 or 800; potatoes used to get about 500 jin (250 kg), and now it's only 150 or 200. The smoke is so bad that everybody in the village gets dizzy, an itchy throat and cough. When we wake up early in the morning, the wall and road are all covered in black. If you come out and take a little walk around your whole body gets covered in black*." [82]

With little other choice, they are forced to try and eke out a living on polluted land. These villagers and millions of others like them live in the shadow of coal.

As this brief glimpse of Shanxi Province shows, the true cost of coal in China is borne heavily by the local people and the environment. Industries have profited from coal and reaped economic benefits, but those hardest hit are left to bear the darker side of coal-driven progress.

Story by: Iris Cheng and Meng Wei

Particularly Polluting

In the US, air pollution is believed to cut short the lives of 30,000 people every year.[83] In India, a study in 2001 found that people in 14 of the country's 20 largest cities breathe air that the government deems 'dangerous'. In China, pulmonary (lung) disease is the second largest cause of adult deaths – 13.9% of the total.[84]

Unsurprisingly, one of the main reasons for this is coal – or rather the fine particles that come from burning it. Particulate pollution, also called particulate matter or soot, is one of the many nasty by-products of coal combustion. It can be released either directly from smokestacks or formed indirectly through the reactions of pollutants like sulphur dioxide with air. Particles have a diameter that is 40 times smaller than a human hair and they contain sulphates, nitrates, ammonium, sodium chloride, carbon and mineral dust.[85] Particulate matter is especially dangerous because the smallest of particles can be inhaled deep inside the lungs and have the potential to cross directly into the bloodstream. It affects human health through increased rates of heart attacks and strokes, lung and cardiovascular disease and even premature death.[86]

Particulate matter exacts a toll on the environment as well. Aside from contributing to haze and visibility issues, the acidity of these particles can leach precious nutrients from soils, contaminate water and damage forests and crops.

Thailand

The human price of sulphur dioxide

Mae Moh coal plant started operation in 1978 with one unit of 75 MW and reached 13 units of 2,625 MW in 1996. This power station pumps over 7 million tons of carbon dioxide into the atmosphere each year.

Sulphur dioxide pollution from Mae Moh coal plant burns plants and reduces crop yields. This local farmer has witnessed a decline in her pineapple plantation and crop production over the years.

Close up of the leaves of a lychee tree damaged by the effects of acid rain, caused by emissions from the nearby Mae Moh power plant.

Secluded in the mountains of northern Thailand lies Southeast Asia's largest lignite coal-fired power plant, which is fed by the country's largest opencast mine next door. The plant has 13 generating units, a capacity of 2,625 MW, and a track record of pollution and death stretching back to the day it was first switched on.

Worker pointing to a read out panel in the Mae Moh power plants. He claims that air pollution from the power station is no longer a problem.

Victims of power plant pollution are treated at a hospital in the Mae Moh District. Scores of people continue to suffer from major respiratory complications, and most villagers continue to be unable to afford medical treatment.

Diagnosed with Chronic Obstructive Pulmonary Disease, Khun Duong Panyaraew spends his days in a hospital bed in Mae Moh, Lampang district, Thailand. An abnormal number of villagers in the vicinity of the power plant are dying of respiratory related illnesses.

A lethal start

On 3 October 1992, the Electricity Generating Authority of Thailand (EGAT) switched on the first 11 units at Mae Moh without any sulphur dioxide control equipment.[87] Immediately, SO_2 generated by the plant started to float above Mae Moh, mixing with air and water to create a highly toxic acid rain. The rainwater contained sulphate concentration levels 50% higher than acceptable international standards (see *Hazy Horizons*, page 47) [88]

Within days, more than a thousand people from 40 different villages within seven kilometres of the plant fell ill. Exposure to the sulphur dioxide gas caused breathing difficulties, nausea, dizziness and inflammation of eyes and nasal cavities.[89] Within two months, more than 50% of the rice fields near the plant were also damaged by acid rain. Domestic livestock started dying. At least 42,000 local people were found to be suffering from breathing problems.

After this disastrous start, the plant installed some desulphurisation devices. However, Egat continued to operate the plant while some of the devices were out of service or shut down for maintenance. As a result, pollution problems recurred in 1996, resulting in the death of six villagers in the Mae Moh valley from blood poisoning.[90]

Disaster struck again in 1998, when severe SO_2 pollution was trapped in the valley. The toxic clouds destroyed plants and crop yields overnight, leaving hundreds sick.[91] Out of the more than 8,200 patients visiting inspection clinics organised by EGAT in the first six months of that year, almost 3,500 were suffering from respiratory illnesses.

Any improvements?

The owners of the power plant claim to have cleaned up their act. When questioned on the issue, company engineer Khun Ponlit Sesth-Kamnerd pointed at blinking red LED indicators on the map in front of him saying, “They are all showing zero. You can see that there is no longer any problem with air pollution.”[92]

However, that’s simply not true. For a start, the plant still spews out seven tons of SO_2 every hour. A study conducted by Greenpeace Research Laboratories in 2002 also showed that the Mae Moh power plant produces 4 million tonnes of fly ash and 39 tonnes of mercury every year. Fly ash samples taken from the power plant site contained arsenic and mercury concentrations up to 14 times higher than those typically found in uncontaminated soil.[93] In 2003, the State Natural Resources and Environmental Policy and Planning Office found critically high levels of toxic heavy metals in almost all water sources around the plant and coal mine.[94]

Mae Moh first hand

You only need to go to nearby villages and hospitals to see the damage Mae Moh is causing. In one village, 70-year-old Khun Siributr Wongchana has sold most of his belongings and even part of his house to pay for the cost of treating his acute respiratory problems. Every few hours he sucks on plastic inhalers to try and soothe the asthmatic irritation that burns his lungs. Opening a photo album, he flicks through pages of images showing fellow villagers and friends who are either sick or have already passed away.

In the local hospital of Mae Moh, two more elderly villagers lie hooked up to oxygen tanks. The hospital’s director, Khun Prasert Kijsuwanaratana, just smiles when asked to comment on the link between health issues and the nearby power plant. “You may take pictures in the wards if you like,” she said, “but I am not authorised to talk about this issue.”[95]

Estimates suggest that some 300 villagers have lost their lives as a direct result of pollution from the plant, and thousands more suffer from respiratory problems. A scientific study published in 2000 concluded that, even with sulphur control equipment installed, people living near Mae Moh are three times more likely to suffer from chronic coughing.[96] To date, over 30,000 people have also been displaced from their homes. Those that continue to live in the area face the effect of acid rain on their farmland.

image On the road to Mae Moh, Southeast Asia's largest lignite-fired power station. Environmental activists in Thailand see the plant as an example of a dirty energy technology that should be phased out and replaced with clean, renewable resources.

The outlook

Over the years, communities around the Mae Moh power plant have filed several lawsuits against EGAT, seeking compensation for mental and physical health deterioration, medical expenses, and damage to crops and land.

In May 2004, the Thai Provincial court awarded 5.7 million Baht (US$142,500) to the villagers for crop damage caused by the sulphur emissions from the power plant. This was a pretty small victory considering the scores of people affected, many of whom just couldn't afford medical treatment.

The villagers won a more substantial victory in 2006, when the energy minister promised the area 300 million Baht (US$ 87,100) per year to cover treatment for their health problems caused by the plant.[97] Two years on, however, the villagers haven't seen any of it. Only time will tell whether the government lives up to its promise.

After decades of struggles, countless protests and much suffering, Mae Moh's Patients' Right Network did secure a small victory in the form of a land grant consisting of approximately 200 rais (34 hectares) and local government funding to relocate those affected by the power station. They now plan to create an eco-community beyond the 5 km radius of the power station, which is considered a dead zone, where villagers can rebuild their lives.

The hope is that moving out from under the shadow of Mae Moh will allow villagers to regain their strength and spirit, and help keep the struggle against the power plant going.[98]

Story adapted from. *Mae Moh: Coal Kills*, Greenpeace Southeast Asia, May 2006

Hazy Horizons

Coal-fired power plants are major sources of sulphur dioxide and nitrogen oxides, which cause acid rain and ground-level ozone (smog). Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form sulphuric acid and nitric acid.

Smog forms when nitrogen oxides react with the chemicals in the air or sunlight. Similarly to soot, smog causes serious damage to the environment – it can destroy whole ecosystems by harming plants and trees, making them vulnerable to disease and extreme weather. Further, it can cause a wide range of symptoms in humans, such as increased risk of asthma, lung damage and premature deaths.[99]

The environmental impact of acid rain has been well documented – largely because of the shocking visible damage it has done to so many forests around the world, particularly in Scandinavia.

Pollution control devices, such as flue gas scrubbers, have been developed to reduce these pollutants from coming out of the smokestacks. However, the fact remains that coal is still by far the single biggest source of sulphur emissions caused by power generation. In 2004, 95% of the 10.3 million tons of SO_2, and 90% of 3.9 million tons of NO_x, released by US power plants came from coal.[100] The cost of the harm caused by acid rain, smog and the other effects of these gases is huge, and makes a big contribution to the true cost of coal.

South Africa

Disused coal mines – gone, but not forgotten

Veteran environmental activist, Matthews Hlabane, explains how the acid mine drainage (AMD) water flows into this pool. The children from the local community of Maguqa, located about 2 kilometre away, like to swim in the pool as the water is nice and warm. But the warm pools hide a sinister reality. The water is heated by coal fires in abandoned mines – many of which have been burning since the 1940s.

AMD seeps down hill into the Brugspruit stream. The polluted Brugspruit then joins the Olifants River and eventually flows into the Loskop Dam, where large-scale dying off of fish, crocodiles and turtles has been attributed to the contaminated water from coal mines.

Water draining from the mines is filled with sulphate salts, heavy metals and carcinogenic substances like benzene and toluene. The salt in AMD precipitates out, covering impacted areas with a thick, white crust as shown here.

South Africa is the world's sixth largest producer of coal – and the seventh largest consumer.[101] With shallow coal seams and cheap labour, coal mines have sprung up all over the country. However, there's a hidden cost to mining that only starts when the mine has served its purpose.

Adelphi Magatha and Tebogo Letsulo stand on a field of white salt precipitate from the AMD. They do not know exactly what the precipitate is. They just know that it tastes salty and stings their eyes when the wind blows.

This bright blue-green water flows into the Olifants River and eventually the Loskop Dam. The water contains a mixture of AMD from local coal mines and sewage from the local municipality's dysfunctional sewage works.

Ponds of AMD water are hidden between eucalyptus trees in the hills above the dysfunctional water treatment plant in the Brugspruit Valley near Emalahleni. The full extent of these ponds – about a 15 kilometre stretch according to a local guide – can only be appreciated from the air.

‘South Africa is the world's sixth largest producer of coal and seventh largest consumer.* In 2006, about 80% of South Africa’s coal exports landed up in European power stations.’**

* www.eia.doe.gov/emeu/cabs/South_Africa/pdf.pdf. The figures for 2007 are production of 269.365 million and consumption of 194.611 million short tons.

** See www.platts.com/Coal/highlights/2006/coalp_ee_091106.xml, Accessed 10 October 2008.

The polluted water turns a yellow orange colour as a result of iron oxide, known to miners as “yellow boy” from the yellow precipitates it forms. This water is highly acid, mobilising heavy metals from the sediments over which it flows.

AMD leaching from a working open pit coal mine in the Brugspruit Valley. According to locals, the mine is not permitted and therefore operating illegally. AMD, together with failing sewage works, poses the biggest threat to the quality of South Africa's limited water resources.

Young boys from the Maguqa township play in and around a stinking stream, the result of untreated sewerage from the municipality. Their parents say the stream is dangerous. The children strip to their underpants when they jump over it to keep their clothes dry in case they fall in. That way there is no evidence of their adventures.

There are hundreds of unused, abandoned coal mines around South Africa. Each one is a ticking time-bomb for the environment, mainly due to AMD – water draining from the mines filled with sulphate salts, heavy metals and carcinogenic substances like benzene and toluene. This AMD damages wildlife and spreads illness and disease. According to the Department of Water Affairs and Forestry, coupled with failing sewage works, AMD also poses the biggest threat to the quality of South Africa's limited water resources (see *Coal's Aftermath*, page 53) [102]

The effects of disused mines, first hand

One place that feels these effects most shockingly is Emalahleni.[103] The name means 'place of coal', hardly surprising considering that it is surrounded by 22 collieries – plus steel, vanadium and manganese plants.

One of the biggest abandoned mines in the area is the Transvaal and Delagoa Bay (T&DB) mine. It was opened in 1896. When it closed in 1953, it was left ownerless and abandoned – and free to pollute.

Health problems

Among the most vulnerable in Emalahleni are the children of Nyerere Street, in Maguqa. Their soccer field lies in a small floodplain on the side of a small stream. The stream is dirty and dangerous, filled with untreated sewage from the municipality.[104]

Last summer, a surge in the water level deposited white salts over their soccer field[105] – all from AMD from the surrounding mines. They were forced to move their field when the salts started stinging their eyes.

When not playing soccer (among other things), the children of Maguqa swim in the warm water two kilometres upstream. The warm pools hide a sinister reality – the water is heated by coal fires still burning in the abandoned mines, many of which have been burning since the 1940s.

Shockingly, the pool is easily accessible and there are no warning signs. This is despite the fact that the water is so poisonous, it can't be used for irrigation, let alone for swimming and bathing.[106]

Damaged water supplies

In 2006 and 2007, there were three separate incidents around the Loskop Dam, about 60 kilometres downstream from Emalahleni. AMD leaked into the water supply, killing thousands of fish, crocodiles and freshwater turtles. As it travelled down the river, it also damaged farms and poisoned the water used by communities along the way.

Dr Jan Myburgh, veterinarian and academic at the University of Pretoria, called the situation "an ecological catastrophe". [107] Worse, is that the nature of AMD means the damage to the water supply is set to continue in the long term, because once the mine has breached the water table, underground rocks are exposed to oxygen and rainwater. This exposure sets off chemical reactions that release the toxic substances in AMD.

Moving further up the river, there are hundreds of AMD dams over a stretch of more than 10 kilometres. The water is stained red and gold by dissolved iron. Everywhere the landscape dips, you'll find AMD leakage. It scorches the soil and kills off all the vegetation it touches. One look at the Brugspruit River, and you'd be forgiven for thinking it had been snowed over – but it's actually salt from the white salt residue.

"This place is hell on Earth", says veteran environmental campaigner Matthews Hlabane. "The soil is burning and full of salt, the water is contaminated, the air is dangerous. And we don't see it being fixed."[108]

Action was taken about ten years ago, when activists from the local community were making a lot of noise. Even so, Matthews points out a worrying truth: "As soon as we stop making a noise, the interest dies down."

It seems like an impossible challenge to resolve. In Emalahleni itself, the sewerage system is already inadequate and unfit for the job – not to mention that it pollutes the river. The treatment plant at Brugspruit, just upstream, is ten years old, but for more than a year it has been out of action. It's due for major refurbishment,[109] but also suffers from other problems: electric cable theft, severe staff shortages, industrial effluent and and untreated sewage releases.

image The eMalahleni Local Municipal Council sewage system is a mess. The Klarinet 2 & 3 pump station was flooded by over two metres of raw sewage which it spilled into the nearby river. Dysfunctional municipal sewage works add to the pollution threats from AMD.

Air pollution

Emalahleni is in the Mpumalanga province – and the air pollution from coal fires in the disused mines is having an impact on the entire region. Nobody has calculated the costs yet, but as health suffers the reality is beginning to hit home. Officials in the Mpumalanga province have talked about "a definite trend towards increased lower respiratory tract infections in children under five years of age in Mpumalanga in the winter months".[110]

In November 2007, the national government declared an area of Mpumalanga – over 301,106 square kilometres – as a national pollution priority area.[111] Having measured the ambient air pollution, it is thought to be worse than that in the former East Germany.[112]

The outlook

South Africa is betting on unproven clean coal technologies and expensive nuclear power plants to deal with climate change challenges, while at the same time planning to double its electricity production by 2050 in the face of an electricity supply crisis that sees regular blackouts. Coal-fired electricity generation and coal mining are expanding, while dealing with the pollution from abandoned mines is a low priority.

The Geosciences Council, an advisory body to the Department of Minerals and Energy (DME), is putting together a list of 6,000 ownerless mines that need urgent action.[113] The T&DB mine tops the list, with an estimated clean-up cost of around R100 million (US$ 10.7 million). This represents a small part of the much larger total clean-up cost for all mines of R30-100 billion.

Clearly, the financial cost is huge. While some mine owners – like Anglo Coal and BHP Billiton- are now treating their own AMD at a cost of R300 million (US$32.5 million),[114] these are isolated cases. The majority of the cost for the clean-ups will be borne by the public, either as ongoing environmental damage, or as treatment from the public purse.

Story by: Victor Munnik

Coal's Aftermath

The legacy issues associated with coal include a great deal of water pollution. AMD is just one of them. It can cover rivers, estuaries and sea beds in an orange blanket of iron hydroxide, killing all plant and animal life in its path. Water that has come into contact with AMD is undrinkable for humans, and too toxic for use in irrigation and agriculture.[115]

It is difficult to make an accurate estimate of the scale of the pollution caused by AMD. However, by 1989 it was estimated that about 19,300 kilometres of streams and rivers (nearly three times the length of the Nile) and about 72,000 hectares of lakes and reservoirs across the world had been seriously damaged.[116] As sources of AMD remain toxic for hundreds of years, these numbers will only have gone up since then.

Coal combustion wastes (CCW) are another part of coal's legacy that often degrades water resources. Left over after coal is burned, they contain toxic substances like arsenic, cadmium, chromium and lead, which can destroy ecosystems completely. Typically, the solid portion of CCW is disposed of in landfill, while the liquid fraction is pumped into natural depressions or diked basins (referred to as impoundments).[117] Old mines are also used to store CCW, alongside waste from the mine itself. Left unregulated, as these dumping grounds often are, there is a high risk of leakages and contamination of local groundwater, leading to contamination of drinking water, arable land and livestock.

Poland

Bełchatów and beyond – the destruction of opencast mining

Bełchatów power plant in the Łódź Region is the largest in Poland, supplying almost 20% of the nation's energy. Each year its chimneys belch more than 31 million tonnes of carbon dioxide into the atmosphere.

A large portion of the coal that supplies Bełchatów comes from the nearby opencast mine. Mines such as these in Poland have caused the water levels of nearby lakes to drop dramatically.

Mining operations occur in Poland at a massive scale. The depression pit for this mine covers an area that is approximately 500 square metres.

Bełchatów power plant in the Łódź Region is the largest in Poland, supplying almost 20% of the nation's energy. It's also the largest brown-coal power plant in Europe.[118] Each year its chimneys belch more than 31 million tonnes of carbon dioxide into the atmosphere.[119]

Plans to expand mining in Poland are underway. One of the big worries is how this expansion may affect local water bodies, such Lake Gopło. The fragile ecosystem around this lake is home to a bird sanctuary of Europe-wide significance.

In Eastern Europe, Poland is the largest producer and consumer of coal; in fact, it is the second largest coal producer and consumer in all of Europe, outranked only by Germany.

The Bełchatów lignite open pit mine is the biggest man-made hole in Europe. Poland generates more than 90% of its electricity from coal. The wind park in the background shows that there is the potential for Poland to better harness the power of clean energy.

A large portion of the coal that supplies Bełchatów comes from the nearby opencast mine. The changes in the landscape already caused by this mine are plain to see. Located just a dozen kilometres from Bełchatów town, the mining area covers 2,500 hectares – the same as 3,300 football pitches. The mine itself is promoted as Europe's biggest opencast coal mine.[120] The burnt-out landscape surrounding it is littered with heaps of coal waste, trucks and excavators. Deep in the mine, conveyor belts slither along, laden with earth and rock. On the observation deck built around the hole, people fall silent; the view has a sobering effect.

More damage to come

Plans to expand mining in Poland are underway in several other areas – some of which are dangerously near Poland's famous Lake Gopło, the cradle of the state. One of the big worries is the effect mining will have on the water levels in these lakes, along with the fragile ecosystems and the valuable tourism trade that relies on them. (see *Disappearing Act,* page 57)

Przyjezierze

Przyjezierze is a village that has already witnessed these damaging effects first hand. The village is located along Lake Ostrowskie in the Kuyavia-Pomerania region, and is heavily dependent on tourism. Or rather, it *was* dependent on tourism. Over the last few years, ponds have disappeared, wells have dried up, trees have died, and the water level of the lake has gone down by almost two metres.[121] As the lake begins to dry up, so does the flow of tourists.

Most people blame the local coal mine for the falling water levels. The coal mine denies any responsibility, instead arguing that the dramatic developments are merely the result of drought and lack of rain. This argument doesn't stand up. As the bitter inhabitants of the area have pointed out, lakes that aren't near coal mines haven't dried up as drastically as those that are.[122]

Kleczew

A similar situation has unfolded near Kleczew, a few kilometres from Przyjezierze. Here, the Jóźwin II B mine began operating ten years ago and is still running at full steam today.

In the intervening decade, the mine has created a dark grey desert landscape that stretches as far as the horizon. Experts at Poznań's University of Agriculture have found that, "water drainage around the brown coal mining areas in the Kleczew region has led to the formation of expansive craters of depression. As mining has expanded northward since the late 1980s, the water levels of lakes across the Powidzki Landscape Park have begun to fall."[123]

Kruszwica

Another location set to suffer is Lake Gopło. Situated near the town of Kruszwica, it is home to Gopło Millennium Park (Nadgoplański Park Tysiąclecia). This park is protected by the EU Natura 2000 programme and contains a bird sanctuary of Europe-wide significance. It was also along the banks of Lake Gopło that the history of the Polish tribe first started. Now this valuable and delicate area is under threat.

This threat comes from excavation rights for the Tomisławice opencast mine (less than 10 kilometres away from Kruszwica), which were signed on 2 February 2008. The mine is due to open in 2009.

Two months after this announcement, local residents organised a protest against the plans – one of the first protests of its type in Poland. About five thousand people demonstrated along the streets of Kruszwica.[124] One of them was Józef Drzazgowski, of the Przyjezierze Association for Protecting the Natural Environment. "If Tomisławice starts mining" he argued, "Lake Gopło´s water level will shrink over the coming decades similarly to the developments at Lake Ostrowskie."[125]

image Conveyor belt and stockpiles of coal unloaded from bulk carriers.

It should come as no surprise that this claim is not backed up by the Tomisławice Opencast Environmental Impact Report, commissioned by the coal mine itself. According to this report, an advance decision to start depositing coal mine water in Lake Gopło from 2017 would: "permit hitherto water levels in the Lake to be maintained". If this is not the case, a substantial change in water levels could have devastating effects. This could occur immediately, if too much or too little water is fed into the lake. Devastating effects could also occur years later, when the mine stops operating and the lake starts to dry up. Lake Gopło is an important part of the trophic chain of all the surrounding lakes. Many species of birds would be in danger, including the little bittern, the bearded reedling and the greylag goose – the symbol of Gopło Millennium Park. Marshes and peat bogs would also dry up, causing irreversible destruction to the richest amphibian reproduction areas in the Kuyavia region.

Despite this, the mining company refuses to look these facts in the face. "I can't understand why Kruszwica has become so involved. It's located in an area where future mining won't have the slightest impact on it," Arkadiusz Michalski, chief environment protection engineer at KWB Konin has stated. [126]

Dr Michał Kupczyk, ornithologist at Poznań's Adam Mickiewicz University disagrees. "We're not talking about the area immediately next to the mining operations," he states. "We're talking about an impact on regions tens, if not hundreds of kilometres away." [127] If he's right, the damage in Poland caused by opencast mining has only just begun.

Story written by: Marta Kaźmierska

Disappearing Act

Coal mining has wide-reaching effects on local water resources. Tremendous volumes of water are required for mining operations. Often, land areas as well as rivers are drained to get coal out of the ground and consequently whole water bodies disappear.

When coal is excavated from deep underground, groundwater is pumped out to dry up the areas being mined. Removing vast amounts of water often drains water from an area beyond the immediate coal-mining environment. As a consequence, water tables are lowered, natural ecosystems are damaged, the growth and reproduction of aquatic plants and animals is disrupted, valued recreational fish or bird species are diminished, and whole regions are endangered – often across national boundaries.[128]

Surface mining operations, such as Mountain Top Removal (MTR), can cause water resources to disappear in another way – by covering them under mounds of dirt. MTR operations literally dump mountains into streams. In what the industry terms as "valley fills", rubble generated by blowing up the mountains is dumped into neighbouring valleys, burying acres of wildlife habitat and permanently destroying the ecological functions of the affected streams. In the US, over 1,200 miles of streams have already been buried and permanently destroyed in the central region of Appalachia while local communities have been drastically affected. By themselves, these valley fills are expected to bury and permanently destroy at least 2,400 miles of streams located in central Appalachia by 2013.[129]

US: Eastern Kentucky

Turning mountain tops into mine waste

MTR operations literally dump mountains into streams. In what the industry terms as "valley fills", rubble generated by blowing up the mountains is dumped into neighbouring valleys, burying acres of wildlife habitat and permanently destroying the ecological functions of the affected streams.

Largely hidden from most Americans, MTR is a highly destructive form of coal mining. In the US, about a million acres have been destroyed by MTR in the central and southern Appalachian Mountains.

As shown here, mountain top removal systematically blasts apart and dismantles entire mountain tops to access multiple seams of coal (top left). The remaining rock is dumped into valleys below (bottom right).

The central Appalachian Mountain region in the US provides much of the country's coal. In the early 1980s, coal companies operating there started using a form of opencast mining called mountain top removal. In the process, they have utterly devastated the land and communities of the Appalachian coalfields, particularly those of eastern Kentucky. Why? Because it's the cheapest way of getting their hands on coal.

Discarded sign near surface mining on Island Creek in Pike County, Kentucky. On occasion, blasts from the nearby mining site have sent rocks flying on to the Urias's property and engulfed their home in dust.

Dry ditch on a "reclaimed" site near Erica and Raul Urias's home on Island Creek in Pike County, Kentucky. There is little evidence to show that reclamation efforts undo all of the environmental harm caused during the mining process.

"When I was a kid it was beautiful over here," Raul explains. "Now there's nothing... Now what you have is 100-foot-high walls, areas they say are 'reclaimed' but they're not... just dead brown stuff lying there. The wildlife's gone. There's just nothing left."

MTR works exactly as it sounds – miners blow up whole sections of mountains to get to the coal below the surface. Once that coal is removed, the vast amount of loose rock and dirt caused by the explosions (called "overburden") is dumped into nearby valleys.

This devastating method of mining has already buried hundreds of miles of streams in Kentucky and decimated hundreds of thousands of acres of ancient forest. MTR is wreaking havoc across large swathes of this mountain region – one of the richest temperate forest ecosystems in the world. The physical impact of dumping thousands of tonnes of overburden into mountain valleys is bad enough. But this waste rock and dirt also contains toxic metals such as selenium, arsenic, and mercury that leach into ground and surface water, poisoning everything in their path – streams, fish, flora, fauna, even people.

The effects of MTR first hand

Thousands of people living in the eastern Kentucky coalfields have been directly affected by MTR and can bear witness to the neglect, denial and greed of the coal companies.

Toxic poisoning

Erica and Raul Urias live in what was once a verdant, bowl-shaped valley in Pike County. Their home is now surrounded by the moonscape of mountain top removal and their property has been pelted with flying rocks and engulfed by sulphur-rich dust from mining blasts, but what they worry about most is their four-year-old daughter, Makayla.

In 2006, they discovered that the water in which they had been bathing Makayla, and which she sometimes drank for the first three years of her life, contained 130 times the concentration of arsenic allowed by the EPA, as well as higher than normal levels of mercury (see *Mercury*, page 61). At the moment Makayla is fine, but Erica and Raul are still worried about the future. "I've got fears. I worry about my daughter," Raul told us. "I know that prolonged exposure to arsenic can cause internal organ damage".[130]

During his own childhood, Raul knew this valley as a different place altogether. "When I was a kid it was beautiful over here," he explained. "The streams ran clear, never black. There were minnows and crawdads, a large amount of frogs. Now there's nothing... Now what you have is 100-foot-high walls, areas they say are 'reclaimed' but they're not... just dead brown stuff lying there. The wildlife's gone. There's just nothing left."[131]

Sheer ignorance

"We found showy orchids; we found trilliums... pipsissewa... just all kinds of wonderful little wildflowers in there.... But, it's gone, it's gone. I mean, they completely denuded the whole entire hollow and made it a valley fill."[132]

Decades ago, Mary Jane used to lead nature hikes in the part of Leslie County in which she and her husband Raleigh now live. Since 2007, the couple have been fighting the MTR operation of Whymore Coal. During their struggle, they've witnessed the complete degradation of this once-pristine ecology.

What makes matters worse is that some of this destruction is due to needless mistakes on the part of the coal company. Mary Jane Adams revealed to us that Whymore Coal recklessly slashed a a 100-foot-wide swathe right along the mountain, cutting away priceless forest habitat for the endangered Indiana Indiana brown bat. Yet, as the Adamses later found out, the company had slashed the strip in the wrong place. "They didn't know where the coal seam was," Mary Jane told us.[133] An important wildlife habitat eliminated for absolutely nothing.[134]

Inadequate restoration

"I don't care how much grassland they put here, [the animals have] to have the nuts to survive on during the winter. The turkey, the grouse, the squirrels, the deer, everything. They're taking all this big timber out and not replacing it with anything in the future."[135]

In Floyd County, Kentucky, Rick Handshoe has witnessed the woeful inadequacy of the post-mining reclamation process.

The main problem, Rick points out, is that coal companies most commonly reclaim mine sites as pastureland, planting a mix of seven crops. Not only do these crops need replanting every now and then, they only grow with

image The extent to which impacted land can be repaired after mining is open for debate. Mountain tops cannot be replaced once blown apart, valleys and streams buried under millions of tonnes of earth won't be restored. Mining so fundamentally alters natural systems that what is lost can never truly be regained.

the help of strong fertiliser. Once the coal company's bond money is returned by the state, the fertilising stops, and everything dies out.[136]

These inadequate efforts are completely destroying surface and ground water resources along with the ecosystem upon which the local wildlife depend. Rick's first-hand observations are confirmed by a 2003 report distributed by the Environmental Protection Agency (EPA). This report stated that "lands reclaimed in this manner will take much longer than observed in old field succession to return to pre-mining forest vegetation".[137] Or, as Rick puts it, "There will never be trees here." [138]

In 2003, the company mining near Rick's property killed an entire stream. According to Rick, the water in the creek ran orange. He describes what happened next:

"There were no fish in the creek. When you kill what you can't see with your eyes in the creek, then the salamanders can't live there, the crawfish can't live there, the fish can't live there. Then how about the raccoons that come down and feed on the minnows and the crawfish? They're not there for them. You kill that one; you kill the chain, their food chain."[139]

This incident was labelled an accident, although there was nothing accidental about the mining company illegally draining an abandoned underground mine without first building a catchment pond. 'Accidents' like this have been occurring for decades. The environmental devastation they have caused in Floyd County can be seen across the region.

The outlook?

As long as MTR mining continues, and as long as companies continue to put profit before the health of the land and the people, the outlook for eastern Kentucky and the central Appalachian coalfields is bleak. As the price of a ton of coal has skyrocketed, the rush to mine 'cheap coal' by MTR is making matters worse, increasing the likelihood of human sickness, contaminated water, and degraded ecosystems -costs that are considered 'external' by the mining company. These costs are being paid by the coalfield residents and all those who live downstream. It's a price they shouldn't have to pay.

Story by: Sara Pennington

Mercury

The coal industry is the single largest source of mercury emissions in the world.[140] Of the 2,190 tonnes of mercury pumped into the atmosphere each year, over half comes from the chimneys of coal-fired power plants.[141]

Burning coal releases large amounts of mercury present in raw coal into the air. This mercury eventually gets into rivers, streams and lakes, either through rain, dust, or simply by gravity.[142] Once in the water, it finds its way into the food chain – starting in algae and working its way up through fish, then birds and mammals. Concentrations of mercury increase the further up the food chain you go.[143]

Can mercury harm humans? Yes. It's a neurotoxin that can be passed on from mothers to unborn babies, causing brain damage, blindness, seizures and many other problems. Exposure comes mainly from eating contaminated fish.

In the US, 8% of women of childbearing age have more mercury in their blood than is deemed safe by the US Environmental Protection Agency.[144] This results in about 410,000 children born each year having been exposed to dangerous levels of mercury in the womb.

Germany

Lake Zwenkau – the challenges of recultivation

The 50-year-old passenger ship *Santa Barbara*, named after the patroness of miners, cruises around Lake Zwenkau in East Germany. The former opencast mine is being transformed into a tourist hotspot based on water. Nature conservation only makes up a small percentage of recultivation projects.

Until the end of 2009, about 14.5 million cubic metres of soil will be moved – to create embankment systems during the flooding of the lake. At 10 square kilometres, Lake Zwenkau will be the biggest lake of its kind in the 'New Central German Lake District'.

The colour of the water is crystal clear like black tea. The pH level of 2.6 is the same acidity as vinegar. The effect of this acid mine drainage: aquatic plants and animals can't survive, water supplies can become contaminated, and structures like wastewater pipes can be corroded.

"Without the miners, we could not cruise on this lake today", explains Captain Thomas Nagel as he slowly navigates his ship across Lake Zwenkau in East Germany. The water looks like clear, black tea and smells of sulphide. Its pH level is 2.6 – the same acidity as vinegar.[145] In the southeastern corner of the lake, the two grey towers of the coal-fired power station Böhlen-Lippendorf pierce high into the air.[146]

In the southeastern corner of the lake, the two grey towers of the coal-fired power station Böhlen-Lippendorf pierce high into the air. Böhlen-Lippendorf emits almost 14 million tonnes of CO_2 per year and is the seventh biggest CO_2 emitter in the league of coal-fired power stations in Germany.

The opencast mine in Profen supplies the water for the flooding of Lake Zwenkau. Since March 2007, around 10 million cubic metres of water have been re-routed into the lake. This drains other areas besides the immediate coal-mining environment; this results in lowered water tables and damaged natural ecosystems.

"Without the miners, we could not cruise on this lake today", explains Captain Thomas Nagel. So far, the recultivation of Lake Zwenkau has cost €145.6 million. While millions of Euros in public funds are invested in recultivation, scientists state: "it is still not clear whether these approaches are sustainable."

Lake Zwenkau sits on a former opencast mine, 20 minutes' drive from Leipzig in Saxony. Open from 1921 to 1999, the mine covered 2,863 hectares – the size of more than 4,000 football pitches.[147] Now, thanks to recultivation, the site is being transformed into a tourist hotspot, complete with a marina, swimming apartments and an aerial railway across the lake to the nearby amusement park, Belantis. At 10 kilometres^2, it will be the biggest lake of its kind in the so-called 'New Central German Lake District'.[148]

Lake Zwenkau is one of many projects set up to recultivate the scarred surface of former opencast mines in Germany. However, it also highlights some of the many challenges that come with recultivating land desecrated by opencast mining, along with the flaws in the way governments are currently going about it (see *Reclaiming What's Lost*, page 65).

Recultivation – problems and flaws

Who pays for it?

The recultivation of Lake Zwenkau has so far cost €145.6 million.[149] In the Central German and Lusatian region alone, €8.3 billion have been spent on the restoration of former opencast mines since 1990.[150]

The way Germany pays for this recultivation is relatively unique: in the former German Democratic Republic (GDR), opencast mining was run by the government. As a result, recultivation, through the LMBV. [151]

Philipp Steuer, from the environmental organisation Ökolöwe in Leipzig, explains the problem with this:

"Recultivation is associated with tremendous costs. Usually, the mining companies need to bear the costs, which is the only acceptable option. But in the East German case, the costs for recultivation have been taken on by the public authorities. This is only justifiable with respect to the governmental organisation of lignite surface mining in the former GDR… That further costs are currently covered by the European Union (EU), in the framework of so-called 'regional aid', is a non-justifiable cross-subsidisation of landscape-wrecking surface mining."[152]

Of course, the problem doesn't go away if recultivation is left to mining companies. The tremendous costs involved mean the bare minimum is done, with very little chance of an area ever fully recovering (See *US: Eastern Kentucky – Turning mountain tops into mine waste, page 58*).

Acid mine drainage

There are 172 post-coal-mining lakes in East Germany, and most of them suffer from a similar problem – acid mine drainage. The consequences are easy to see: aquatic plants and animals can't survive, water supplies can become contaminated, and structures like waste-water pipes can be hit by acid corrosion.[153]

Lake Zwenkau is no exception. Only last year, Jörg Hagelganz of the environmental department at the regional council of Saxony publicly declared, "Lake Zwenkau will turn into the most acidic lake in Germany, if we don't do anything."[154]

Damage to water levels

To dilute the acidification of Lake Zwenkau, the LMBV currently relies on 'active flooding'. Since March 2007, around 10 million cubic meters of water have been re-routed into the lake[155] from the drainage of the opencast mine in Profen.[156] Removing such vast amounts of water drains other areas besides the immediate coal-mining environment. The result is lowered water tables and damage to natural ecosystems.[157]

Another example is the Lusatian region, where recultivation projects also rely on active flooding with river water. Here, the flooding of the Lusatian Lake District severely affected the surrounding rivers Spree, Neiße and Schwarze Elster. In 2003, so little water from the Spree reached Berlin that the discharge of the capital's wastewater actually changed the direction of the river.[158]

As if that wasn't enough, the Lusatian region now struggles with another problem with water levels – after the drainage pumps were switched off in 18 of the region's closed-down opencast mines, groundwater levels rose dramatically.

The effect of this rise? Harvests failed, basements were flooded and buildings cracked apart. Sewage treatment plants and cemeteries may be affected in the future.[159] "This is a new phenomenon. None of us had water in our basements before," stated Siegmar Kugler, deputy district mayor of Zerre and member of the "Watergroup" Spreetal, a group that documents the rise of groundwater in the municipality.[160] Despite the fact that 100-year old houses had never flooded before surface mining started, the LMBV only accepted responsibility in late 2008.[161] Until then, residents had to install pumps themselves to keep the water under control.

image The soil continues to tell the story of coal mining. "With the continuation of surface mining, we delay and displace the restoration of whole landscapes," says Dr Werban, former head of the UNESCO-Biosphereresevoir Spreewald.

Skirting the real issue

No-one knows whether landscapes can ever be restored to resemble their natural state.[162] While millions of Euros in public funds are invested in recultivation, scientists state that "it is still not clear whether these approaches are sustainable".[163]

Of course, one of the biggest issues with recultivation is that, in one sense, it's a dangerous diversion – it takes people's eyes off the fact that opencast coal mining still happens. No matter how effective recultivation is, these gigantic projects do not legitimise opencast mining – the most damaging of mining techniques.

All the while the public pays for recultivation, the German government is still subsidising coal. Contrary to all declarations by the coal industry, the 2004 study of the Federal Environment Agency showed that taking the effects of lignite into account, as well as direct state subsidies, amounts to €4.5 billion a year.[164]

The outlook

The mining continues

In August 2008, Saxony's Prime Minister Stanislaw Tillich announced that he continues to stand for an energy-mix that includes lignite, the dirtiest type of coal (see *Appendix I: Coal Basics,* page 78). [165] Dr Joachim Geisler, chairman of the Central German Lignite Company MIBRAG stated that the company will invest €28 million to modernise surface mining machinery in 2008. That's in addition to talking intensely with partners "about a new development of a coal-fired power station in Profen".[166]

This all means that the massive mining machines will continue to cut through the country. People are still being resettled. Forests and whole ecosystems are still being destroyed.

"With the continuation of surface mining, we delay and displace the restoration of whole landscapes," says Dr Werban, former head of the UNESCO-Biosphereresevoir Spreewald.[167] "We could save millions in recultivation, if we would respect nature more and not try to force everything through with raw violence. Everything is geared towards commerce, and only an infinitesimal percentage of recultivation is dedicated to nature conservation. There is too little left for nature."[168] It seems nothing has been learnt from the past. "But nature is reclaiming its share back", Dr Werban predicts.

Story by: Nina Schulz

Reclaiming what's lost

Mining takes functioning ecosystems and reduces them to piles of sand tailings, overburden and rock. At just a single mining site, millions of cubic metres of soil can be moved over the life of the mine. The devastation is so complete that much of the land never recovers.

In some parts of the world, reclamation (also known as recultivation or rehabilitation) activities attempt to return some ravaged areas to productive land. However, the extent to which impacted land can be repaired after mining is open for debate. Mountain tops cannot be replaced once blown apart, valleys and streams buried under millions of tonnes of earth won't be restored, and cavernous pits created by opencast mining are likely to remain that way. Mining so fundamentally alters natural systems that what is lost can never truly be regained.

In places like the US, there is little evidence to show that any effort can undo all of the environmental harm caused during the mining process. This is because of the poor quality of the soil on reclaimed sites. Soil in an undisturbed system is a dynamic medium, varying in its composition and teeming with life. Soils found at reclaimed sites lack structure, are largely bankrupt from a nutrient perspective, and devoid of the insect and plant life. As a result, planting success rates tend to hover around 20-30% in some areas, while in others only 10% of new seedlings survive.[169]

Australia

King Coal's dirty throne

The port of Newcastle is the world's largest coal export point, currently exporting 80 million tonnes of coal annually. Plans are underway to expand capacity over the next five years to at least 120 million tonnes annually, and even as much as 200 million tonnes per annum.

Australia is heavily dependent on coal, with over 80% of electricity sourced from coal-fired power. But this comes with a heavy cost. A Greenpeace report demonstrates how Australia can reduce reliance on coal and generate over 40% of its electricity from renewable energy by 2020.

While coal companies and governments cannot get Hunter Valley coal out fast enough, local farmers and residents are alarmed at the environmental and social impacts of coal dependency. There is a growing community belief that the costs of the region's coal industry vastly outweigh any perceived benefits.

Coal is king in Australia, and the Hunter Valley region in New South Wales (NSW) is its throne. Most coal mining in Australia is opencast, meaning a journey through the Hunter Valley can often be mistaken for a trip to the moon, with massive mines stretching out over the horizon.

Local residents protesting about the proposed opencast mine at Anvil Hill. The mine would cover more than 3,500 hectares and destroy vast areas of the local environment.

There is every reason to stop Mangoola from going ahead. Not only would an expansion of mining exacerbate existing water scarcity issues, but it would force more than 200 residents to relocate.

This wind turbine at Kooragang is a reminder that a more sustainable solution is possible. Research has shown that the Hunter Valley could provide 40% of New South Wales's energy from renewable sources by 2020, creating more than 10,700 jobs in the process.

Nearly a third of all exported coal travelling around the world comes from Australia.[170] Newcastle, in New South Wales, is the world's largest coal-exporting port, shipping out over twice as much coal as the US..[171]

This coal releases enormous amounts of greenhouse gases when it's burnt. Because this happens outside Australia, these emissions don't count towards Australia's emissions quota – so Australia can ramp up its coal production with impunity. But aside from being a perfect example of how to cause catastrophic climate change, Australia's mining is responsible for myriad local environmental damages, many of which are now running out of control.

The impact of coal first hand: Hunter Valley

The Hunter Valley is world-renowned for its wine production and thoroughbred racehorse stud farms. Yet the environment on which they rely is at risk from mining (see *Land Destruction*, page 69). There's a very real threat that these multi-million-dollar industries could be destroyed by the spread of coal mining across the Hunter Valley, a view shared by many in the region:

"*As much as the mining industry would like to believe that mining and wine tourism can co-exist, that is certainly not the view of the wine tourism industry*".[172]

Water shortages

Competition for limited resources is just one manifestation of the impact of mining on the agricultural activities in the region. The Hunter Valley region is seriously short of water – a situation made worse by ongoing drought. The opencast mines in the area require tremendous quantities of water to operate, largely to damp down hazardous dust clouds generated by the large-scale excavations. The battle over the finite water supply so far has farming interests on the losing end – water-guzzling coal mines and power stations continue to get priority access to water. In fact, when the New South Wales government announced in 2007 that parts of the state would receive zero water allocations, coal mines continued to operate normally, further draining the region's water supplies. These cuts have seriously threatened the financial health of some of the long-established farms in the region.[173]

Continuing the destruction: Anvil Hill

Despite the obvious and dramatic damage coal is inflicting on Hunter Valley, plans are in place to double the export capacity of Newcastle and several new coal mines are proposed to supply this extra coal.

One of these new mines is the proposed 'Mangoola' opencast mine at Anvil Hill. The plan for the mine is massive – with a project area of more than 3,500 hectares and seeking to extract more than 220 million tonnes of coal over two decades.[174] Just a single year's worth of coal from the mine would produce as much CO_2 as the entire transport sector in New South Wales. The mine would operate 24 hours a day, seven days a week, with a noise impact "almost five times greater than the impact of any approved mining project in NSW".[175]

Local bushland facing extinction

Anvil Hill contains some of the last remaining bushland in the Hunter Valley. It is home to 440 flora and fauna species – 25 of which are listed as threatened.[176] The area is sufficiently sensitive and ecologically unique that a report in 2005 recommended that Anvil Hill should be protected by making it a nature reserve or managed trust reserve.[177] If Mangoola and other proposed mines go ahead the expansion of mining will threaten some 1, 300 hectares of this high quality habitat. Mitigation measures outlined in the Environmental Assessment conducted for the proposed mine would not adequately compensate for this loss.[178]

Threat to industry and community

There is every reason to stop Mangoola from going ahead. Not only would an expansion of mining exacerbate existing water scarcity issues, but it would force more than 200 residents to relocate. The horsebreeding and wine-growing industries have been vocal in their opposition to the mine, concerned about their own relocation – no mean feat for vineyards that take years to establish. In registering their opposition to the Mangoola mine, the Upper Hunters Winemakers' Association noted:

"Many longstanding, sustainable agricultural enterprises will be displaced by this mine, impacting the existing communities and families that have, in some cases, been in operation for generations."[179]

image There are more than fifty coal mines in the Hunter Valley region, mostly opencast mines. It estimated that over 600 square kilometres of the Hunter Valley has been affected by coal mining.

Other constituencies, including local residents, have grave concerns about the proposed mines at Anvil Hill. To argue their case, the Anvil Hill alliance was formed in 2005. This local action group has gained support from a number of NGOs (non-governmental organisations) and has been actively campaigning to have the plans for the mine rejected since its inception. In June 2007, more than 400 people spent the weekend camped out on the proposed site, spelling out the words "Save Anvil Hill" in a clear message to the state government.

Even people who have worked in the coal industry think opening up new mines is going a step too far. One example is Graham Brown, a retired miner who supports a shift away from coal in the Hunter Valley. He's keen to see jobs and the local economy protected by a move to a low-carbon economy, telling us that "We need a transition mechanism in place, fully funded by the coal companies."[180]

The future

A more sustainable solution is possible – and it's one that local people and environmental groups have been fighting for. Research has shown that the Hunter Valley could provide 40% of New South Wales's energy from renewable sources by 2020, creating more than 10,700 jobs in the process.[181] In fact, with the help of the existing infrastructure, Hunter Valley could actually become a renewable energy-*exporting* region, sending emission-free electricity around the state, while developing clean energy technologies for the rest of the world.

Sadly, the reality is not so positive. Shortly after World Environment Day in June 2007, the New South Wales government approved Anvil Hill's transformation into a coal mine, despite the many reasons not to go ahead with the plan. The mine has since been sold to Swiss multinational, Xtrata, in late 2007, having become too much of a liability for its previous owners Centennial Coal. The good news is that the mine remains undeveloped. Whether that stays the case in the future is as yet unclear.

Story by: Julien Vincent

Land Destruction

Massive excavations and huge waste mountains are among the most visible leftovers from mining. Mining activities also lead to deforestation of large tracts of land, the loss of fertile top soils through erosion, and land subsidence. Much of this land remains barren and contaminated long after coal mining operations cease.[182]

Land disrupted and stripped bare by mining is much more susceptible to erosion. Soil loss from surface-mined areas can be one to two thousand times greater than in than forested areas, and ten times that of grazing land.[183] This soil run-off finds its way to streams, especially during heavy rain and snow melts, wreaking havoc on aquatic ecosystems. In large quantities, this soil run-off can so thoroughly pollute water bodies that it stops fish from spawning, kills fish eggs and larvae, suffocates small aquatic life and blocks out light, preventing photosynthesis.[184]

Sedimentation also reduces the capacity of downstream reservoirs and alters water courses, causing water shortages, flooding and cloudiness.[185] If the sediment is contaminated, it can also make water undrinkable and, in many cases, unfit for use in agriculture and industry.[186]

Subsiding land from collapsing mines can also cause soil erosion as well as disrupt surface and subsurface drainage and the creation of wet or ponded areas. When occurring in agricultural areas, these phenomena can decrease the productivity of crops.[187] For example, in parts of the US, land classified as moderately and severely affected by subsidence, and where nothing had been done to repair the land, has experienced corn yield reductions anywhere between 42% and 95%.[188]

Philippines

Iloilo City – standing up to 'big coal'

Hundreds of people take part in a renewable energy parade on the Global Day of Action against climate change. They are calling for the immediate passage of a renewable energy bill in the Philippines to help catalyse a shift away from fossil fuels.

Greenpeace activists dump 20 sacks of charcoal in front of a Metrobank branch. Metrobank, one of the largest banks in the Philippines is behind the plans to build the coal-fired power plant in Iloilo City.

Iloilo residents of all ages visit the Climate Defenders' Camp to learn about climate change and how clean energy sources can provide electricity for the Philippines.

Iloilo City, whose province is better known as the "heart of the Philippines", is a city divided. The reason? A new coal-fired power station currently on the planning table.

On World Environment Day, Greenpeace volunteers install solar panels as part of the construction of a Climate Defender's Camp in the grounds of one of the city's biggest cathedrals.

Hundreds of students from St Paul's University in Iloilo City form a human banner that spells out 'QUIT COAL'. These students are part of the movement that is calling on local and national government officials to reject new coal-fired power plants.

Thousands join an ecumenical prayer rally in Iloilo City. They are protesting against the proposed coal-fired power plant while supporting more sustainable energy solutions.

The Catholic Church is one of the leading opponents of new coal-fired power plants in the Philippines. The president of the Catholic Bishops' Council of the Philippines, Archbishop Angel Lagdameo, leads an interfaith rally to show proponents of the coal-fired power plant that they are not welcome in Iloilo.

As part of the activities in the Climate Defender's Camp, Greenpeace volunteers plant around a hundred windsocks at the site of the proposed power plant. The windsocks represent the massive renewable energy potential on the island that is waiting to be tapped.

Greenpeace demands that Metrobank invests in renewable energy instead of coal to enable sustainable development. In protest at the bank's investment strategies, many people in Iloilo City close their bank accounts at Metrobank.

"As long as there are dedicated and selfless citizens who are for sustainable development, RISE will continue campaigning and serve as watchdogs for the environment."*

* Interview with Aurora Alerta Lim, co-convener of RISE. Iloilo City, Philippines. 12 September 2008.

As you enter the city, the division is easy to see. Hundreds of banners have been hung up around the city. Half say "yes to coal". The other half say "no to coal". A closer look at the banners shows that the "Yes" banners are expensive and professionally printed. The "No" ones are almost all hand painted. Here lies part of the problem: support for the new power station comes from government officials and rich business groups. In contrast, the fierce opposition comes from a vast and diverse alliance of citizens including the influential Catholic Church, doctors, professors, engineers, enlightened businessmen, civic leaders, and students. Overall, one thing becomes clear: instead of seriously addressing the issue of climate change and its effects on the poor, the Arroyo government is promoting privatisation and expansion of Philippine coal-power plants. But the opposition is growing (see *Growing Resistance*, page 75).[189]

Opposition RISEs up

Despite their diversity, the opposition has become organised. In 2003, this group of citizens founded Responsible Ilongos for Sustainable Energy (RISE). Their first aim was to stop the construction of a coal-fired power plant in the fishing village of Ajuy in Northern Iloilo, and to promote sustainable development through renewable energy.

RISE was immediately effective. It was able to delay the power plant in Ajuv until the funder, KEPCO, eventually pulled out and transferred the project further south to the coastal town of Banate in the hope of facing less opposition. Here again, RISE convinced the Provincial Board to turn down the proposal.

Sadly, this wasn't the end of it. The plan for a coal-fired power plant was moved again, this time to Iloilo City, and RISE moved with it.

Aurora – a story of resistance

Aurora Alerta Lim is a determined lady. Recently retired assistant to the Central Philippine University president of environmental concerns, she produces and co-hosts an environmental talk show on the university TV channel and is one of the leaders of the RISE campaign. "The greatest challenge," she told us, "is the apathy of the national and city government to global warming. They endorse the use of coal for energy generation despite our warning against the severe impact of climate change."[190]

This concern over the effects of climate change is a serious issue for the Philippines. The archipelago was listed in 2007 by the NGO Germanwatch as the country most at risk from the effects of climate change.[191] The country is already hit by more severe and frequent typhoons, as in November 2007 when more than 200,000 people were evacuated.[192] It also suffers droughts, and the 7,107 islands are threatened by rising sea levels. Yet in spite of this, the government perseveres with coal.

Fighting lies

Much of the work of Aurora (or Tita Au, as friends call her) and her group of environmental advocates is centred around countering the lies and half-truths spread by the coal supporters. She says that much of the enthusiasm for coal in Iloilo City is based on falsehoods:

"There is a ground swelling of support for coal-fired power plants in the country due to misinformation that includes 'clean coal technology' and the misleading argument that coal is cheap." [193]

It is easy to see why these claims seduce. Iloilo's main energy source is an off-grid 72 MW diesel power plant. Because diesel is so expensive the electricity rate in the city is among, if not the most expensive in the country. What's more, the city also experiences frequent power outages. The power station proponents attribute this to a lack of supply, but the truth is that a new coal-fired power station in Illoilo City will not solve these problems. Too little power is not the issue. Disruptions in electricity are actually due to problems in transmission and distribution.[194] Any electricity price drop that might come after a new power station is built will be paid for in its impact on those living in the community. Aurora remarks,

"It will be the people who will have to bear the health and environmental costs of burning coal."[195]

Despite their uphill battle and the power and influence of coal plant proponents, Aurora isn't intimidated. She, and others like her, work ceaselessly to call attention to the urgency of the climate crisis and our global need for more sustainable energy sources.

image A second Climate Defender's Camp is established on the site of the proposed coal-fired power plant in Iloilo City. For the gathering of local communities and pro-renewable energy groups who pledge to continue work to help stopping climate change, a Greenpeace volunteer cooks noodles using a solar cooker.

Fighting for a sustainable future

Thanks to the work of people like Aurora, RISE is gaining momentum. In March 2008, thousands followed a call by the Catholic Bishops' Conference of the Philippines (CBCP) to take part in an ecumenical prayer rally in Iloilo. The rally demonstrated against coal, and campaigned for the right to choose a sustainable development path. Even the governors of neighbouring provinces have spoken out against coal, and have set examples by securing their provinces' future energy supply with small-scale hydro and wind turbines.

Yet Iloilo officials are still falling for the industry's claim that coal is the best possible source of energy for Iloilo, despite the availability of affordable alternatives. As Aurora pointed out to us, "There are several sources of energy which Iloilo can tap. We are campaigning for an increase in the transmission of geothermal energy, solar, wind, hydropower, and biomass for cogeneration."[196]

The outlook

The protests in the last year did have some effect, as the Department of Environment and Natural Resources (DENR) froze the environmental certificate of compliance (ECC) for the planned power plant for several months. But it wasn't enough to stop it completely. Despite a strong and organised opposition, the certificate was granted this past September.

While this condemns the region to an as-yet unknown human cost, it's not the end of it. RISE doesn't even think about giving up:

"As long as there are dedicated and selfless citizens who are for sustainable development, RISE will continue campaigning and serve as watchdogs for the environment."[197]

In Iloilo, a dedicated local group of activists fully understand the impact coal will have on their community, damaging human health, ecosystems, and quality of life. In their fight, they are also defending all the planet's inhabitants from devastating, runaway climate change.

Story by: Mareike Britten

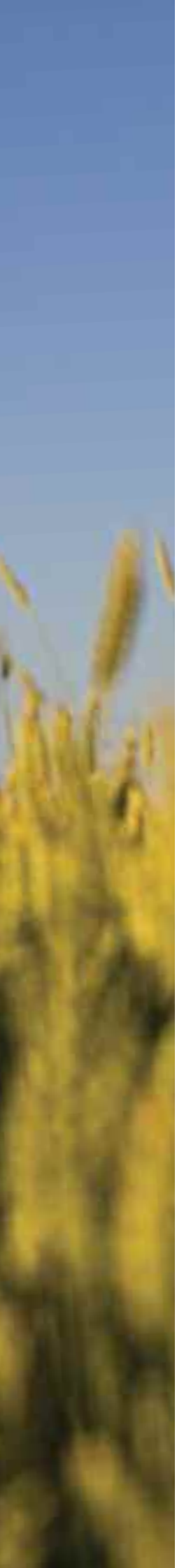
Growing Resistance

In 1844, legendary social theorist Friedrich Engels spoke of: "an industrial revolution, a revolution which at the same time changed the whole of civil society".[198] Coal played a central part in this. Today, coal powers a different kind of revolution, one where resistance movements are forming against its continued use. In the places profiled in this report and elsewhere, communities around the globe are rising up and saying no to coal – organising protests against proposed power plants and opencast mines, occupying building sites and blockading coal trains and shipments.

In Poland, about 5,000 people took to the streets in Kruszwica in April 2008, to oppose the plans for an opencast mine near Poland's cradle of cultural heritage and nature reserve, Lake Gopło.[199] This was the first protest of its kind in the country's history. In Australia, an alliance between thoroughbred horsebreeders, vineyard owners and local residents formed to oppose a new opencast mine in Anvil Hill. Disguised as railway workers, protesters in the UK stopped a coal train on its way to the nation's largest power plant, Drax Power Station, in June 2008. Some climbed onto the train and unloaded almost 20 tonnes of coal on to the tracks. Others chained themselves to it. "Leave it in the ground" read the banner, which activists unfurled during their action.[200] In the autumn of 2008, anti-coal activists in Germany started a petition for a referendum to stop further site developments of surface mines in the federal state of Brandenburg.[201]

All of these actions demonstrate that resistance against inhumane, climate-destructive and harmful practices such as burning coal is growing and set only to get stronger.

image Fields of grain stand with wind turbines behind. The Maranchon Wind Farm is the largest in Europe, with 104 generators, and is operated by Iberdrola, the largest wind energy company in the world.



4

Leaving coal behind

That coal wreaks havoc and destruction on the planet and our health could be the understatement of the century. Coal is causing our planet harm. That is easy to see. In this report, we've looked at the damage caused right along its chain of custody – from digging it out of the ground to what remains after it has been burnt.

We've exposed the destruction caused by mining – from black lung disease to coal fires and acid mine drainage. We've uncovered the effects of coal-fired power plants locally and globally, including the urgent threat of greenhouse gases building up in the atmosphere. We've also spotlighted coal's legacy – the often-forgotten harm caused by abandoned mines and the reclamation attempts that never really work.

Finally, with the analysis of CE Delft, we've put a price tag on some of the more conspicuous 'external' costs associated with coal's chain of custody on a global scale. The total came to roughly €360 billion a year- a staggering number that nevertheless is likely to be an underestimation. It is simply impossible today to assess all potential emissions and precisely quantify every incidence of damage induced by coal around the world.

The true cost of coal underlines the urgent need for action to avoid the disastrous consequences of a coal-powered future. Indeed, coal must be phased out if we are to keep global temperature rises as far below 2°C as possible (compared to pre-industrial levels) and avoid catastrophic climate change. However, even in the face of climate change and all the other costs that come with coal, many countries still harbour plans to build new coal-fired power stations . If all current plans are realised, CO_2 emissions from coal will increase 60% by 2030.[202] Not only is this a totally unsustainable plan for the future, it's an unnecessary and dangerous one.

There are options available to us other than coal – options that work. Greenpeace's Energy [R]evolution provides a practical blueprint that shows how renewable energy, combined with greater energy efficiency, can cut global CO_2 emissions from fossil fuels by 50%.[203] This solution provides the same level of energy "services" while phasing out reliance on coal.

This is possible because decades of technological progress have moved renewable energy technologies into the mainstream – technologies like wind turbines, solar photovoltaic panels, biomass power plants and solar thermal collectors. The market for renewable energy is also growing dramatically; in 2007, global annual investment in renewable energy exceeded US$100 billion.[204] At the same time, our use of energy is shamefully inefficient: a large proportion of the coal being burned is just wasted, something which can easily be avoided through available technology measures.

Leaving coal behind is the only way forward. The world simply cannot to afford to continue with it – the costs to the climate, our planet and ourselves is much too high. Coal may have been essential in powering the Industrial Revolution, but now its time has passed. It is time to bring about a revolution of another sort – one powered by clean, sustainable energy solutions that will protect our climate, health and environment now and for generations to come.

Appendix I
Coal Basics

Assembled here are the basics on coal: its different types, how it is mined, technologies used to burn it and how much countries have, produce and consume every year.

Coal types

Coal is a fossil fuel. This means it was originally organic matter (wood and leaves) that was subjected to pressure and heat, taking on a compacted, carbon-rich form over millions of years.

The quality of coal depends on its carbon content, which in turn depends on what temperatures and pressures the coal formed under. The higher the carbon content of coal, the higher its energy value and the more heat it produces when burned. This energy value is usually measured in British Thermal Units (Btu value). The Btu value of different coals can vary enormously. For example, peat has a Btu value of 4,500, while the value for the hardest coal can be over 14,000.[205]

There are many different types of coal, but most fall into one of four main categories:[206]

Lignite (also known as brown coal) has the lowest carbon content and the highest amount of moisture. It's geologically younger than other forms of coal, and mostly used in power generation. Brown coal is the dirtiest coal type as the process converting it into usable energy is very intensive. For example, it takes five tonnes of lignite to yield the equivalent energy level of one tonne of hard coal.

Sub-bituminous coal contains more carbon and less moisture than lignite. Like lignite, it is used for power generation. It is also used for other purposes, including making cement.

Bituminous coal is considered a hard coal, with up to 86% of its weight in fixed carbon (the carbon that remains in the coal after volatile material is taken out before burning). As well as being used in power generation, it's often turned into coke to be used in iron and steel manufacturing.[207]

Anthracite is the hardest type of coal – often with more than 90% of its weight in fixed carbon. Because of this higher energy value, it's used in heating.

Coal mining

Coal is mined in either opencast (also called mountain top, surface or strip mining) or underground mining. Each approach carries with it different costs, health and safety, as well as environmental issues.

Opencast mining

Opencast mining is used if coal seams are found near the surface of the earth. It's cheaper than underground mining and arguably more "efficient", as coal recovery rates are 90%. In opencast mining, the earth and rock above the coal seam (called overburden) are broken up by explosives and taken away. The exposed coal seam is drilled so it fractures, and then the loose coal is removed.[208] Globally, about 40% of coal mines are opencast. But in some countries the percentage is much higher. Opencast mines make up 80% of mines in Australia, and 67% in the US.[209]

Opencast mining destroys landscapes, forests and wildlife habitats by literally blowing the tops off of mountains and tearing apart landscapes. This method of mining leads to deforestation, erosion, subsidence, lowering of water tables and the destruction of agricultural land. The public health of miners and local communities is threatened by the dust generated by the explosions and drilling.[210]

Underground mining

Underground mining is used to reach coal buried too deep for opencast techniques. It's less efficient, more labour intensive and more expensive than opencast mining. But since most of the world's coal is buried deep, the majority of the world's coal mines are underground.[211]

There are two main underground mining methods – *Room and pillar* and *Longwall* mining. *Room and pillar* mining is used for shallower coal seams. It involves cutting rooms into the coal seams and leaving *pillars* of coal to support the roof (hence the lower recovery rate). *Longwall* mining has a higher recovery rate because it uses mechanical shearers to mine the coal, and power supports to keep the mine stable. After the support structures are removed, the mine collapses.[212]

Underground mining brings huge amounts of waste earth and rock to the surface – waste that often becomes toxic when it comes into contact with air and water. Underground mining also causes subsidence as mines collapse and the land above it starts to sink. Subsidence can cause serious structural damage to homes and buildings and can tear up infrastructure like highways, buildings and bridges. In Australia an earthquake caused by underground mining in 1989 destroyed hundreds of homes, killing 13 people and injuring another 165. The costs caused by the disaster were higher than the profit the mine had generated since its opening 90 years earlier.[213]

Less catastrophic effects attributable to subsidence include soil erosion, disruption of surface and subsurface drainage, and wet or ponded areas. It also lowers the water table, changing the flow of groundwater and streams.[214]

Coal combustion technologies

There are three types of coal power plant currently in use to create electricity:

Pulverised coal-fired (PCF) power plants. In these plants, coal is ground into a fine powder and blown into a boiler. It burns at between 1,300°C and 1,700°C, creating steam that drives a generator and turbine.[215] This method is by far the most established and common of the three. PCF plants account for over 90% of the electricity produced from coal, and about 38% of the power generated from any source around the world.[216]

The bad news is that PCF plants are also horribly inefficient. While it's true that new, so-called super-critical and ultra-critical plants can reach thermal efficiencies of up to 50%, the worldwide average thermal efficiency of PCF plants is less than 32%.[217, 218]

Fluidised bed combustion (FBC) plants. Here, coal is burned with air in a fluid bed mixing gas and solids. This is done either at ambient pressure (called Atmospheric FBC) or under pressure (called Pressurised FBC) and at temperatures lower than those in PCF plants.

FBC technology can be used with low quality coal or coal mixed with other fuels like biomass. Thermal efficiencies range between 40% and 44%. The lower combustion temperatures in FBC systems cuts the amount of nitrogen oxide (NOx) produced.[219] Finally, because more than 95% of sulphur pollutants from the coal can be captured inside the boiler, FBC plants produce far less sulphur dioxide (SO_2) [220]

Integrated gasification combined cycle (IGCC) plants. IGCC plants are the newest of the three, with average thermal efficiency percentages in the 40s. At present, the use of IGCC for coal-based electricity production is limited, with only four coal-based IGCC demonstration plants in operation globally, two located in the US, one in Spain and one in the Netherlands.[221] The process they use involves two separate steps: first, coal is turned into gas through a controlled "shortage" of air in an enclosed pressurised reactor. The resulting gas – a mixture of carbon monoxide (CO) and Hydrogen (H_2) called Syngas – is then burnt to drive a gas turbine. In the second step, the exhaust gas from step one is used to create steam that drives a separate steam turbine. Typically, the gas turbine in step one generates between 60% and 70% of the power, with the steam turbine generating the rest.

Coal by country

Top 5 producers of coal (as of 2006 in million tonnes) [222, 223]

	% of total	Production
China	39.4%	2,380.0
US	19.3%	1,053.6
India	6.8%	447.3
Australia	6.6%	373.8
Russia	4.7%	309.2
Other	23.2%	1,631.2
World	100%	6,195.1

Top 5 consumers of coal (as of 2006 in million tonnes) [224]

	% of total	Production
China	38.6%	1191.3
US	18.4%	567.3
India	7.1%	237.7
Australia	3.9%	119.1
Russia	3.6%	112.5
Other	28.5%	862
World	100.0%	3090.1

Appendix II

True Cost of Coal Calculation

The true cost of coal figure presented in this report is a preliminary calculation that evaluates some of the hidden costs of coal - those costs not included in the price per tonne of coal or the coal-based electricity that powers our society.

To approximate a true cost for coal, the independent Dutch research institute CE Delft conservatively evaluated the external costs in 2007 of the human health impacts from air pollution from coal, damages attributable to climate change and fatalities due to major accidents resulting from mining operations. These costs were separately compiled and then combined to arrive at a figure which estimates a lower limit for the costs that coal exacted on humans and the environment in 2007.

The analysis reveals that:

- The approximate **annual damage burden of coal combustion in power plants**, from the factors examined, is roughly **€355.75 billion.**
- the approximate **global damage burden related to accidents in the coal power chain**, from the factors examined, is **€161.28 million.**
- the approximate **annual damage costs of mining**, from the factors examined, is **€674million.**

The cost of coal presented in this report does not represent a comprehensive evaluation of all the external impacts attributable to the coal chain of custody. Accurate and reliable data for many parts of this chain, i.e. economic damages attributable to acid mine drainage, simply do not exist on a global scale. Quantifying many social impacts, such as community displacement, loss of cultural heritage and human rights violations, in a credible manner, is virtually impossible.

It is with these caveats that the methodology for this analysis is provided below. To access the full report for this assessment, please go to: www.greenpeace.org.

Scope of analysis

The calculation for the true cost of coal examined the following factors:

- Costs for society attributable to climate change
- Human health impact that result from air pollution
- Fatalities due to major accidents resulting from mining operations

Data collection

Determining global emissions from coal

For this analysis, emissions are primarily derived from existing data on a national level, for the largest coal-power producing countries. Emissions are separately assessed for power generation (plant level) and for mining. As the aim of this study is to derive an estimate of global damages, it is not necessary to link exact flows of coal from mines to power plants. Instead, all emissions related to mining are assessed, and approximately 91% of emissions related to global power generation (based on International Energy Agency data). It is important to note here that direct assessments of damage costs are unavailable for many countries around the world.

1. Primary emissions from coal combustion

Carbon dioxide (CO_2)

Based on global CO_2 emissions from power generation, a ranking of the ten polluters was compiled – the US, China, India, Japan, Germany, South Africa, Australia, Russia and Poland. These countries account for 85% of global coal combustion emissions. Together with emissions from other EU countries[225], 91% of global coal combustion emissions are covered. These are the countries that are assessed further for polluting emissions, referred to as "classical pollutants"[226] in this analysis (See Table II.1).

Sulphur dioxide (SO_2)

The EU was assessed in the aggregate, with country-specific data derived for the US, China, India, Japan, South Africa, Australia, Russia (See Table II.1).

Nitrogen oxides (NO_x)

The EU was assessed in the aggregate, with country-specific data derived for the US, China, India, Japan, South Africa, Australia, Russia (See Table II.1).

Particulate Matter (PM) 2.5

Data for China, Japan, South Africa, the EU and US are included (See Table II.1).

Methane (CH_4)

An aggregate global figure was generated, which was based on a generic emission factor of kg CH_4 generated per tonne of coal equivalent for methane emissions from coal storage at power stations (See Table II.1).

2. Emissions from coal mining

Global emissions related to mining were included in this analysis by relying on data from EcoInvent 2007. For several regions (East Asia, Eastern Europe, Western Europe and North America), average emission data was used. Pollutants assessed for economic analysis were CO_2, CH_4, PM 2.5, SO_2 and NO_x (See Table II.2).

Table II.1 – **Annual emissions of classical pollutants from coal mining**

	Emissions per year (ktonnes)				
COUNTRY/region	**SO_2**	**NO_x**	**PM 2.5**	**CO_2**	**CH_4**
EU	1.470,00	1.200,00	43,46	889.531,52	
People's Republic of China	20.567,00	7.434,00	2.537,00	2.341.616,45	
United States	10.068,00	3.595,00	87,07	1.973.502,42	
India	2.959,00	1.580,00		562.840,07	
Russia	1.056,00	511,00	1,00	215.089,87	
Japan	23,00	21,00	11,00	212.647,68	
South Africa	1.177,00	526,00	51,00	199.634,09	
Australia	605,00	614,00	20,50	204.131,85	
Total	**37.925,00**	**15.481,00**	**2.751,03**	**6.598.993,94**	**725**

Table II.2 – **Emissions from power plants used for damage cost calculations**

	CO_2	**CH_4**	**PM 2.5**	**SO_2**	**NO_x**
Emissions in kilotonnes	13555	209	4	44	29

Calculations

1. Damages attributable to climate change

Annual damage costs in the year 2007 for coal-derived CO_2 and CH_4 emissions were estimated for this analysis. This included emissions from both coal combustion and mining operations. A prevention cost assessment was performed by using a figure of €20/tonne. This value is based on the approximate prevention costs for CO_2, which were estimated by using the average price for carbon credits in the European Union Emission Trading Scheme (EU ETS). [227] This was done in lieu of using figures for actual damage costs caused by CO_2 emissions as there is a great deal of uncertainty associated with such figures. It is important to note that CO_2 prevention costs will increase sharply. Some studies show the price may very well double in the next decade and as much as ten times by mid-century. While future costs for CO_2 prevention were not considered in the context of this analysis, a review of projected costs are provided in the table below.

For CH_4, a factor of 23 was applied to reflect the impact of methane on global warming as compared to CO_2 and to estimate damage costs – €460/tonne. These values were then multiplied by the estimated annual emissions (See Table II.1) to calculate overall climate change-related damage costs attributable to these pollutants.

2. Human health impacts that result from air pollution

For non-CO_2 pollutants, or "classical pollutants", a calculation of damage costs per tonne of emissions was performed. The basis of the damage costs for this calculation was the European-Union-based NEEDS (Network of Europeans for Electoral and Democracy Support) project (the last stage of the ExternE series), which has attached a monetary estimate to health impacts resulting from emissions of specific air pollutants. These estimates are available for emissions in 39 European and non-European countries and five sea regions. The results also include estimates of EU-average damage costs per tonne of specific pollutants.

The figures used in the NEEDS project were based primarily on willingness to pay (WTP) values from empirical studies on evaluation of mortality and morbidity effects. These figures were adjusted using purchasing power parity (PPP) factors and consequently, an average value weighted with respect to population was calculated to provide more representative figures for a global calculation. [228]

Without being able to run a full model including background pollution, dispersion pattern, population affected, meteorological conditions etc, only very rough estimates could be produced.

Table II.3 – **Recommended values for GHG (Euro 2005 per tonne CO_2)**

Scenario	2005	2010	2015	2025	2035	2045	2050	2055
MDC_NoEW[1]	7	9	11	14	15	17	22	27
PP_MAC_Kyoto plus[2]	–	23.5	27	32	37	66	77	–
PP_MAC_2°[3]	–	23.5	31	51	87	146	198	–

[1]Pure economic cost-benefit analysis with no equity weighting.

[2]Use of agreed objectives (20% reduction of greenhouse gases by 2020)

[3]Ambitious coal of 2 degree centigrade increase as compared to pre-industrial levels

Source: NEEDS, 2008

3. Fatalities due to major accidents resulting from mining operations

Damage costs for mining accidents per unit of electricity generation have been previously calculated by Hirschberg at al., 2004 (See Table II.4). These figures include only accidents with more than five fatalities.

Results

Combustion

The analysis reveals that the approximate annual external costs of coal combustion, from the factors examined, is **€355.75 billion.**

Mining

The analysis reveals that the approximate annual external costs of coal mining, from the factors examined, is **€673.87 million.** The total value is significantly lower than those values related to coal combustion. However, it is worth noting that this analysis is incomplete. Factors such as ecosystem destruction, water and soil contamination etc. were not included in this analysis due to the lack of reliable global data for these kinds of impacts.

Accidents

The analysis reveals that the approximate annual external costs of mining accidents, from the factors examined, is **€161.28 million.**

Conclusion

Combining all damages listed above, CE Delft arrived at a total damage figure of roughly **€360 billion**. As discussed previously, this estimate does not include all possible emissions or all possible damages and should therefore be considered lower limits. This is true even for the factors considered in this analysis as not all the data was complete, however the analysis still covered 91% of all emissions. For example, including emissions of particulate matter from Russia and India might have increased the estimate considerably. In the context of the parameters considered, this analysis shows that coal combustion in power plants accounts for the greatest level of damage. It is responsible for more than 99% of the total. Damage burden due to mining emissions is estimated to be about **€674 million** per year, and damage burden due to accidents – about **€161 million** per year.

Table II.4 – **External damages: accidents in the coal power chain (Euro per MWh)**

	Occupational	Public	Total
China	0.061		0.061
OECD	0.0034	0.000061	0.003
Non-OECD (other)	0.032	0.00035	0.032

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[227] Although country-specific marginal abatement costs are available, these cannot be taken as a proxy for society's willingness to pay (WTP) per country, unless more evidence to support such values is available, see ExternE 2005.

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image The sun rises behind wind turbines. The Maranchon Wind Farm is the largest in Europe, with 104 generators, and is operated by Iberdrola, the largest wind energy company in the world.

GREENPEACE

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

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