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A coal mine in the Metropolitan Region of Porto Alegre, southern Brazil: the social fight that prevented unprecedented risks to human health, the environment, and the climate

Uma mina de carvão na Região Metropolitana de Porto Alegre, Sul do Brasil: a luta social que preveniu riscos sem precedentes para a saúde humana, o meio ambiente e o clima

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ABSTRACT | Coal, a widely used energy source, is also a major contributor to pollution, negatively impacting the environment, human health, and the climate. Despite international restrictions on its use, a proposal to build Brazil's largest coal mine in the Metropolitan Region of Porto Alegre (MRPA) was submitted. The proposed mining area would affect the entire MRPA and lie just 9 km from Eldorado do Sul, 16 km from downtown Porto Alegre, 20 km from Canoas, and 11 km from Guaíba. Moreover, the mine would be located only 900 meters from Jacuí Delta State Park, a significant environmental preservation area, and was projected to produce 166 million tons of coal over 23 years. The project posed a high risk to the environmental, ecological, and hydrological heritage of the region and threatened the water supply of 4.5 million people. A strong community-led social movement — formed by local residents, university research centers, labor unions, associations, and social organizations — was mobilized to study the project's harmful effects and oppose its implementation. This collective effort ultimately led to the project's cancellation by judicial decision, demonstrating the power of organized civil action. The mine would have brought approximately 2.5 million tons of sulfur to the surface, resulting in acidic mine drainage containing heavy metals that could contaminate the Jacuí River, the primary water source for several cities, including densely populated Porto Alegre. Projections indicated the project would generate 412 kg of particulate matter over 23 years, adding an estimated 30,000 tons of pollutants to the MRPA's atmospheric basin. The project's Environmental Impact Report (EIR) was found to contain several technical flaws and omissions, underscoring the inadequacy of the assessment and the project's environmental infeasibility. The Medicina em Alerta Group, supported by nine scientific medical organizations, played a crucial role in the campaign, providing vital information about air quality and the health risks posed by the coal mine. After two years of sustained effort, the combination of social mobilization, interdisciplinary collaboration, and scientific expertise proved essential in securing the project's cancellation by the Federal Court and the environmental agency of the state of Rio Grande do Sul. The case underscored the urgent need to abandon fossil fuels and highlighted the dangers of establishing coal mines in metropolitan areas. It also reinforced the critical importance of enforcing national laws that require comprehensive environmental and human health impact studies before approving licenses for coal mining and other potentially hazardous developments.

Keywords | Coal environmental pollution; air pollution; environmental monitoring; climate change; public health.

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RESUMO | O carvão, uma fonte de energia amplamente utilizada, é também um dos maiores contribuintes para a poluição, impactando negativamente o meio ambiente, a saúde humana e o clima. Apesar das restrições internacionais ao seu uso, em 2018, foi proposta a construção, na Região Metropolitana de Porto Alegre, da maior mina de carvão do Brasil. A área planejada para mineração afetaria toda a região, estando localizada a apenas 9 km de Eldorado do Sul, 16 km do centro de Porto Alegre, 20 km de Canoas e 11 km da cidade de Guaíba. Além disso, a mina ficaria a apenas 900 metros do Parque Estadual do Delta do Jacuí, uma importante área de preservação ambiental, e produziria 166 milhões de toneladas de carvão ao longo de 23 anos. Esse projeto apresentava alto potencial de impacto ao patrimônio ambiental, ecológico e hidrológico, bem como ao abastecimento de água para uma região de 4,5 milhões de pessoas. Um movimento social robusto, liderado pela comunidade e composto por centros de pesquisa universitários, sindicatos e movimentos sociais, foi organizado para estudar os impactos negativos do projeto e agir contra ele. Esse esforço comunitário resultou no cancelamento do projeto pela Justiça, evidenciando o poder da ação coletiva. A mineração teria exposto cerca de 2,5 milhões de toneladas de enxofre, resultando em drenagem ácida contendo metais pesados que poderiam contaminar o Rio Jacuí, o que afetaria o abastecimento de água de várias cidades, incluindo Porto Alegre. Previsões indicavam que o projeto geraria 412 kg de material particulado por hora ao longo de 23 anos, adicionando 30 mil toneladas à contaminação da bacia atmosférica da Região Metropolitana de Porto Alegre. O Relatório de Impacto Ambiental do projeto apresentou diversas lacunas e omissões técnicas, destacando a inadequação dos estudos realizados e a inviabilidade ambiental da proposta. O grupo Medicina em Alerta, com o apoio de nove organizações médicas científicas, desempenhou um papel crucial, fornecendo informações sobre a qualidade do ar e os riscos à saúde representados pelo projeto. Após 2 anos de esforço contínuo, a abordagem social, interdisciplinar e científica foi fundamental para o cancelamento do projeto pelo Tribunal Regional Federal e pela Fundação de Meio Ambiente do Estado do Rio Grande do Sul. Ficou evidente que os combustíveis fósseis devem ser abandonados, que a abertura de uma mina de carvão em uma área metropolitana é perigosa, e que leis nacionais que exijam estudos sobre o impacto ambiental na saúde humana antes da concessão de licenças para minas de carvão ou outros empreendimentos potencialmente perigosos não são apenas necessárias, mas cruciais para a proteção do meio ambiente e da saúde humana.

Palavras-chave | Poluição ambiental por carvão; poluição do ar; monitoramento ambiental; mudanças climáticas; saúde pública.

> "*The modern addiction to fossil fuels is not just an act of environmental vandalism. From the health perspective, it is an act of self-sabotage*."
> Dr. Tedros Adhanom Ghebreyesus, Director-General of the World Health Organization (WHO) (1)

Introduction

Several international organizations, including both scientific and financial institutions, have emphasized the urgent need to phase out coal use (1,2). Extensive evidence highlights the harmful effects of coal mining and coal-fired power generation on the environment and public health, as well as their substantial contribution to greenhouse gas emissions that drive global warming. The urgency of this situation cannot be overstated, and entrepreneurs in the sector must promptly explore alternatives to redirect their operations. Achieving these goals requires public policies that promote a just transition for workers and communities affected by these activities, reinforcing the importance of social justice and the need for clear plans to decommission coal mines and coal-fired power plants.

However, between 2016 and 2022, this approach was disregarded in the state of Rio Grande do Sul (RS), Brazil's southernmost state. The absence of government-led public policies, combined with active lobbying by the business sector to expand coal mining, led to the proposal of the Guaíba Coal Mine Project (GCMP) in the heart of the Metropolitan Region of Porto Alegre (MRPA).

The open-pit mine project aimed to extract 166 million tons of coal over 23 years from a 4,373-hectare area located between the cities of Charqueadas and Eldorado do Sul (Figure 1). Producing seven million tons per year, the project would account for half of Brazil's annual coal production — approximately 14 million tons — and nearly double the output of Rio Grande do Sul, estimated at four million tons (3). Undoubtedly, the GCMP would represent a major shift in the scale of coal production and become the largest coal mine in Brazil. Its

impacts would simultaneously threaten the water supply, air quality, green belt, and the ecological and hydrological heritage of the MRPA, home to approximately 4.5 million people. Moreover, the project would be economically unviable, as coal from the Guaíba deposit is characterized by low calorific value (3,600 kcal/kg) and high ash (48%) and sulfur (1.5%) content (4). In comparison, coal from San Juan, Colombia, has a calorific value of 6,300 kcal/kg, with only 1.8% ash and 0.3% sulfur.

The proposed mining area would be located just 9 km from the city of Eldorado do Sul, 16 km from downtown Porto Alegre, 20 km from Canoas, and 11 km from Guaíba. In addition, the mine would lie only 900 meters from Jacuí Delta State Park, the main conservation area in the metropolitan region. The park encompasses the deltaic region formed by four rivers flowing into Guaíba Lake, which supplies water to Porto Alegre (Figure 1).

The significant risks posed to the health of approximately 4.5 million inhabitants — as well as to the environment and climate — mobilized public opinion. More than 100 organizations, along with several public figures, formed a strong social coalition known as the Committee to Combat Mega-Mining in the State of Rio

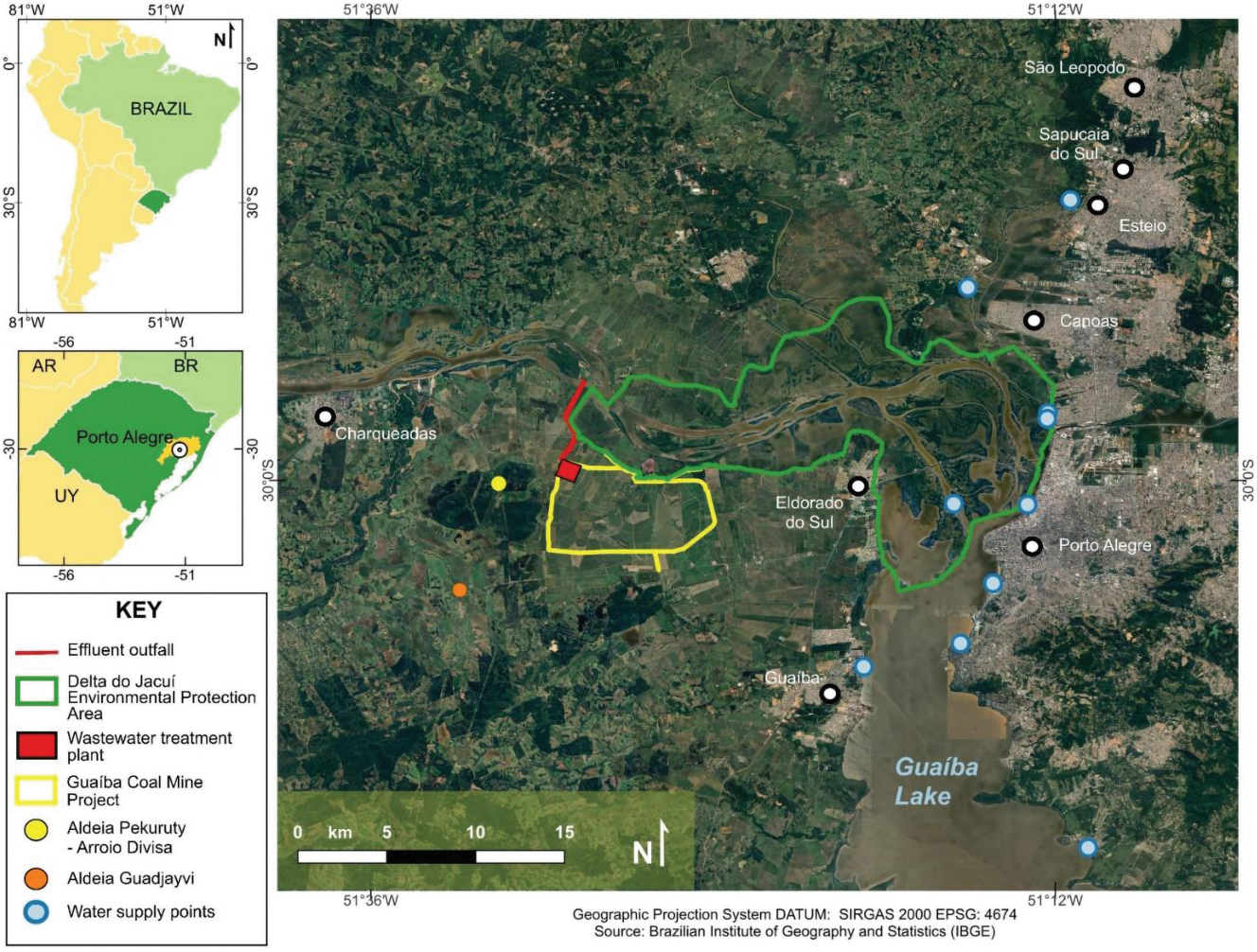

Figure 1. Location of the Metropolitan Region of Porto Alegre (MRPA) and Guaíba Coal Mine Project (GCMP).

Grande do Sul (CCM-RS). This group actively worked to stop the project from 2018 to 2021 and ultimately succeeded in February 2022.

This paper highlights the potential environmental impacts of the GCMP that prompted strong public opposition and celebrates the remarkable success of community activism. Particular attention is given to the specific criticisms and gaps identified by the CCM-RS in the project's Environmental Impact Study and Environmental Impact Report (EIS-EIR) (4), with a focus on public health, especially air pollution. Additionally, the paper analyzes in detail the tactics and strategies employed by the CCM-RS to successfully halt the GCMP. It also emphasizes the potential health risks associated with the proposed project and explores how the health sector — particularly the Medicina em Alerta Group (MAG) — addressed these risks, offering a model of hope for future environmental activism.

The GCMP: an undesirable neighbor

Coal is unquestionably one of the most complex geological materials. It contains carbon, nitrogen, oxygen, hydrogen, sulfur, minerals, volatiles, water, and inorganic matter, comprising more than 76 elements from the periodic table, including heavy metals. Its composition varies according to its geological formation, meaning each deposit is unique (5,6). Any coal mining project must include a detailed analysis of the elemental geochemical composition of the total coal sample (7,8). The EIS-EIR for such projects should present this data, which is essential for determining the coal's technological applications and the necessary treatment measures for effluents and waste generated by mining operations. This critical study was not included in the GCMP's EIS-EIR, despite being fundamental for assessing and communicating the potential risks and impacts of coal mining to the public.

Coal is dangerous: acid drainage and heavy metal contamination

The primary impacts of coal mining affect water, air, and soil. Water pollution occurs mainly through acid mine drainage (AMD), which mobilizes highly toxic heavy metals such as Pb, Cd, Cu, Zn, Hg, As, Be, and others (9,10). Mines located in humid environments, such as the area proposed for the GCMP, have a high potential for continuous AMD production due to groundwater and rainwater infiltration into the mining pit (11,12). In the case of the Guaíba deposit, the coal contains between 1.5% and 2.4% sulfur. Mining would bring approximately 2.5 million tons of sulfur to the surface. When in contact with water, this sulfur has a high potential to generate AMD containing heavy metals, which could be discharged into the Jacuí River. The proposed effluent disposal site was located just 22 km from the Jacuí Delta and from water supply intake points serving several cities, including densely populated Porto Alegre and Canoas (13) (see Figure 1).

In general, treated effluents are discharged into a river's flow under the assumption that the pollutant load will be progressively diluted downstream (9). However, the local hydrographic conditions contradict this assumption. Just downstream lies the Jacuí Delta, a floodplain and sedimentation zone that retains clay particles (14), and consequently, may also retain pollutant loads carried by the Jacuí River. The miner's EIS-EIR failed to consider these regional hydrological characteristics when proposing the project—one of several major oversights in the study (13).

Potential impacts on agriculture across the region could arise if contaminated water from the Jacuí River were to spill into the floodplains, where crops such as rice are cultivated. Rice

is known to accumulate cadmium, a heavy metal associated with cancer risks (14-16). Additionally, heavy metals could compromise the water supply if the wastewater treatment plant were to overflow into the Jacuí River during periods of flooding and intense rainfall (see Figure 1). These concerns highlight serious risks to food safety and public health associated with the proposed project.

Particulate matter (PM) everywhere

PM refers to tiny particles suspended in the air and constitutes a major component of air pollution. The EIS-EIR projected the generation of 412 kg of PM per hour over a 23-year period, totaling approximately 30,000 tons (4). Contamination of the MRPA's atmospheric basin would be inevitable. During the summer, PM tends to form a dust dome, which is later washed away by rainfall (17,18). Since the dust would contain coal particles, chemical reactions could occur, potentially resulting in acid rain (19). The finer particulate matter may also carry heavy metals such as Be, a highly carcinogenic element. In winter, this dust would become trapped in the fog generated by thermal inversion (20-23). This phenomenon creates a dense air layer, approximately 30 meters thick, close to the ground and covering the low-lying areas of Charqueadas, Eldorado do Sul, Guaíba, Porto Alegre, Canoas, and neighboring municipalities. The sulfur in coal could react to form an acidic mist, posing serious health risks to millions of people, particularly through respiratory diseases. Furthermore, silica particles are also expected to be present in the PM, raising the risk of pulmonary silicosis — a severe occupational disease commonly found in coal-producing regions.

Project scale, risk management, and governance

Porto Alegre relies on a single water source to supply its population: the Jacuí Delta and Guaíba Lake. There is no alternative or emergency source available to supply hospitals and other critical services. If the waters of Guaíba Lake were to become contaminated, the supply would need to be suspended, potentially causing a systemic collapse in the capital and its surrounding metropolitan region. The GCMP posed a substantial risk to the city of Porto Alegre and the broader state of RS (13).

A solid environmental movement: get coal out of here!

The GCMP, a key component of a broader mining expansion in Rio Grande do Sul, was proposed in 2018. That same year, more than 22,000 areas were designated for mining projects — many of which exceeded the size limits established by state legislation and surpassed the state's historical average in mining volume. This scenario highlighted the urgent need for a strong civil society response to counter the threat of unrestricted mineral extraction.

RS has long been a cradle of pioneering environmental movements in Brazil. Since the 1970s, organizations such as the Associação Gaúcha de Proteção ao Ambiente Natural (AGAPAN) and the Ação Democrática Feminina Gaúcha (ADFG) — which later became Friends of the Earth Brazil — have fostered a critical environmental consciousness. However, confronting what came to be known as Brazil's "new mining frontier" required civil society to extend beyond traditional environmentalist circles. The new strategy brought together diverse sectors of society, including university research centers, labor unions and associations, and social movements. Among these were the Landless Rural Workers' Movement (MST), the Movement for Popular Sovereignty in Mining (MAM), Indigenous and traditional peoples and communities,

communication collectives, networks of community lawyers, local residents' associations, religious organizations, political party sectors, and the medical community. This broad coalition of organizations and movements culminated in the creation of the CCM-RS on June 18, 2019 (23), which now includes more than 100 member organizations.

The CCM-RS is organized through a central coordinating body responsible for convening general assemblies, guiding the work of action fronts, making strategic decisions — such as initiating legal actions or organizing public demonstrations — and formulating and disseminating the collective's official positions and scientific information. The action fronts are specialized groups tasked with specific responsibilities. The Mobilization Front coordinates direct actions, public interventions to raise awareness, and mobilizes participation in meetings and public hearings. The Communication Front manages the website and social media platforms, produces outreach materials, and liaises with media outlets to publicize the collective's positions. The Legal Front engages with the Federal and State Public Prosecutor's Offices, initiates and monitors legal proceedings, and employs tools such as strategic litigation and advocacy. The Technical Front brings together researchers and professionals from various disciplines — including biology, engineering, geology, geography, social sciences, and economics — to critically assess the EIS-EIR submitted by mining companies, and to produce technical and scientific reports used in public communication, debate, and legal or administrative proceedings. Additional territorial or thematic fronts are created as needed, based on specific demands.

Opposition to the GCMP gained momentum as the movement broadened the space for public dialogue. Initially, only one official public hearing was scheduled to discuss the environmental licensing process, in the municipality of Charqueadas, where the western portion of the mine would be located. However, due to pressure from civil society, a second official hearing was held in Eldorado do Sul, where the eastern portion of the mine was planned. At both hearings, the majority of participants expressed strong opposition to the project. According to research by Luz & Flores (24), key debates took place, and approximately 70% of interventions during the public hearings and throughout the environmental licensing process were against the GCMP. This clear expression of public opposition compelled the mining company to shift its communication strategy. Initially, the company promoted the project in the media with exaggerated claims about its benefits; however, it eventually withdrew from public debate and ceased participating in discussions altogether (25).

The project's EIS-EIR contained numerous gaps and technical omissions identified by the Committee, which underscored the inadequacy of the studies and the environmental unfeasibility of the project. This critical assessment was published in the book *Panel of Experts* (11). In response, the Fundação Estadual de Proteção Ambiental (FEPAM), the state environmental agency, requested that the mining company clarify and supplement more than 100 technical items. The deadline for submission was set for December 2019, but the company failed to respond.

Over time, the proposal for what would have been Brazil's largest open-pit coal mine lost momentum due to widespread public criticism voiced at hearings, in the local media, and through the symbolic disapproval of the governor of RS. Although initially supportive of the project, the governor later expressed opposition in secondary media outlets, following intense backlash from public opinion. Attempts to circumvent legislation were also observed, such as the amendment of Eldorado do Sul's Master Plan

to permit mining within the municipality. These unlawful strategies were later overturned in court, further discouraging potential investors. Ultimately, the Fourth Regional Federal Court (TRF4) declared the EIS-EIR null and void due to the absence of free, prior, and informed consultation with the affected Mbyá Guarani communities (26,27) (see Figure 1), in violation of Convention 169 of the International Labour Organization (ILO).

Finally, on March 4, 2022, the environmental licensing process for the Guaíba Mine project was officially suspended by FEPAM. This decision reflected the recognition that the studies submitted for environmental licensing were inconclusive and unsatisfactory, and that the company had failed to respond to the concerns raised by both CCM-RS and FEPAM. This outcome marked a significant political and technical victory for organized civil society, demonstrating the power of collective action in defending the environment and offering renewed hope for future environmental struggles.

Air pollution, public health, and MAG

MAG (see http://medicinaemalerta.com.br/) (28) is an independent network of physicians established in 2019 to study the health risks associated with the GCMP. The group joined CCM-RS, contributing its scientific expertise on the health impacts of air pollution. It promoted scientific discussions on the topic, including presentations at prominent forums such as the Grand Rounds of the University Hospital de Clínicas de Porto Alegre. In addition, MAG encouraged medical societies to take a public stance on the issue, thereby expanding the movement's scientific reach and institutional support. Nine scientific organizations responded with formal letters of support, providing evidence-based assessments of the health risks linked to air pollution. These organizations also highlighted the importance of incorporating a health impact assessment (HIA) into the licensing process for large-scale projects, in line with recommendations from the World Health Organization (WHO).

The nine scientific organizations that supported the initiative were: the Associação de Psiquiatria do Rio Grande do Sul (APRS – Psychiatry), Associação Gaúcha de Medicina de Família e Comunidade (AGMFC – Family Medicine), Sociedade Brasileira de Genética Médica e Genômica (SBGM – Genetics), Sociedade de Cardiologia do Estado do Rio Grande do Sul (SOCERGS – Cardiology), Sociedade de Neurologia e Neurocirurgia do Rio Grande do Sul (SNNRS – Neurology and Neurosurgery), Sociedade de Pediatria do Rio Grande do Sul (SPRS – Pediatrics), Associação Brasileira de Saúde do Trabalhador e da Trabalhadora (ABRASTT – Occupational Medicine), Sociedade Rio-Grandense de Bioética (SORBI – Bioethics), and the Rio Grande do Sul section of the Sociedade Brasileira de Bioética (SBB – Bioethics). Additionally, the Associação Médica do Rio Grande do Sul (AMRIGS – Medicine) supported the movement by publishing related news (29). The complete dossier, including all scientific statements, is available on the MAG website (28).

The health risks — supported by scientific evidence and endorsements from medical associations — strengthened CCM-RS's position and motivated numerous public meetings and actions against the mining project. The Federal Public Prosecutor's Office also became involved, initiating proceedings against the GCMP. MAG contributed scientific data during the pre-trial phase to support the legal case. Although the Federal Court ruled in February 2022 that the project was inadequate, CCM-RS and its partners remain alert, as the company may attempt to submit a revised proposal for the same area.

MAG has also undertaken a new challenge: opposing the construction of a thermoelectric power plant in the city of Candiota (Nova Seival Thermoelectric Power Plant). The group prepared a second dossier for CCM-RS, detailing the human health risks associated with the project. It also advocated for the inclusion of a Health Impact Assessment (HIA) in the licensing process. As a result of continued civil society efforts, the licensing process for the thermoelectric plant was suspended. Moreover, a judicial ruling now requires that any future licensing procedures for thermal power plants must include an HIA, recognizing the significant health impacts of air pollution.

Why air pollution?

MAG chose to focus its research on air pollution because it is the environmental health issue most strongly supported by scientific evidence linking it to human health risks and climate change. Air pollution directly affects human health, primarily through the inhalation of fine particulate matter (PM2.5), and indirectly by increasing greenhouse gas emissions, which drive climate change and lead to environmental disasters.

The State of Global Air 2024 report estimated that 8.1 million deaths worldwide in 2021 were attributable to air pollution (30), making it the second leading risk factor for death globally — including among children under the age of five. Alarmingly, noncommunicable diseases such as heart disease, stroke, diabetes, lung cancer, and chronic obstructive pulmonary disease account for nearly 90% of the disease burden caused by air pollution. In 2021 alone, more than 700,000 deaths in children under five were linked to air pollution, representing 15% of all global deaths in that age group. PM2.5, a major component of air pollution, is small enough to penetrate deep into the lung alveoli and enter the bloodstream, triggering a cascade of harmful physiological responses that pose serious health risks.

Climate emergency and human health

The climate emergency is the most significant threat to human health in this century (31). The burning of fossil fuels and biomass — across sectors such as transportation, residential energy use, coal-fired power plants, industrial operations, and wildfires — has intensified air pollution, which in turn contributes to the rise of chronic non-communicable diseases. These include cardiovascular, respiratory, oncological, and neuropsychiatric conditions, as well as heat-related illnesses and infectious diseases. Additionally, extreme climate events — such as droughts and floods — are causing widespread destruction, displacement, and food insecurity. The current food system, which is heavily reliant on red meat consumption, also plays a significant role in greenhouse gas emissions. Urgent action is needed to mitigate these threats.

Despite contributing the least to global environmental change, vulnerable populations and low-income countries suffer the greatest impacts from climate disasters and polluted air. This reality underscores the urgent need for both adaptation and mitigation efforts, especially in the context of the global temperature increase approaching 1.5 °C.

MAG is also concerned about the growing burden on health systems and professionals as well as the economic losses associated with climate change. In 2018, the global cost of illnesses, premature deaths, healthcare expenditures, and lost workdays due to air pollution from fossil fuels was estimated at $2.9 trillion (32).

Coal and the WHO

It is well established that energy generation — particularly the extraction and use of coal — is one of the primary sources of air pollution.

The Lancet Countdown global report estimated that coal combustion was responsible for over 440,000 premature deaths worldwide in 2016. The report recommends that Brazil phase out coal as an energy source, identifying this as a critical step toward mitigating climate change and reducing morbidity and mortality associated with air pollution (33,34).

Several countries have adopted policies aimed at phasing out coal. Since 2022, the Fossil Fuel Non-Proliferation Treaty (35), a global initiative advocating for the elimination of coal, oil, and natural gas, has gained traction. It also calls for a just transition to renewable and low-impact energy sources. The treaty has been endorsed by over 1,000 health professionals and 200 health organizations, including the WHO, the International Pediatric Association (IPA), the World Medical Association (WMA), the Alliance of Nurses for Healthy Environments (ANHE), and the World Federation of Public Health Associations (WFPHA) (1).

The WHO's core governance recommendations emphasize tax incentives for renewable energy adoption, the abandonment of fossil fuels, and the integration of health-based criteria in decision-making. These go beyond traditional environmental principles — such as the precautionary principle, prevention, and the polluter pays principle — by focusing on the protection and strengthening of national health systems in response to the climate crisis (36).

Lessons and proposals

The GCMP presented numerous shortcomings and contradictions, failing to comply with essential legal licensing procedures — a fact clearly demonstrated by the actions of organized civil society. The project failed to consider the environmental, social, and metropolitan complexity of its proposed location.

The social movement also highlighted the project's serious risks to urban water supply, air quality, and protected environmental areas. Despite claims to the contrary, "clean" coal mining has never been successfully achieved in the history of global mining. The company failed to conduct legally required consultations with Indigenous communities and did not propose adequate environmental control measures for the mining operation. Moreover, the project lacked a viable economic rationale, particularly given the low quality of the coal and the proposed location within a densely populated metropolitan region. Potential applications in coal-chemical or thermoelectric plants were not supported by detailed studies and would likely result in significant environmental impacts and the consumption of vital natural resources, especially water.

The robust organizational structure of civil society in RS has enabled critical debate on the GCMP and other mining proposals. This proactive, coordinated approach has successfully prevented the implementation of projects such as the GCMP and the Nova Seival Thermoelectric Plant in Candiota. These outcomes underscore the power of collective action and its potential to shape a more just and sustainable future.

From a public health perspective, this social mobilization highlights the urgent need for national legislation mandating the assessment of environmental impacts on human health prior to licensing coal mines and other potentially hazardous enterprises, in accordance with WHO recommendations.

The successful prevention of what would have been Brazil's largest coal mine aligns with global efforts to reduce dependence on fossil fuels and protect sensitive ecosystems such as those in the MRPA. This achievement gains even greater significance in light of recent

climate-related events. On May 4, 2024, Rio Grande do Sul experienced the most severe hydro-geo-climatic disaster in its history, which left more than 600,000 people homeless. The Jacuí River overflowed by approximately 20 kilometers on each side, reaching 11.32 meters above its normal level, according to data from the Civil Defense of the Municipality of Triunfo — a level consistent with a 10,000-year recurrence interval. The GCMP's EIS-EIR stated that the protective dike designed to shield the mine from flooding was 10 meters high. Had the mine been operational, the pit would have been inundated. Such flooding would have released AMD and heavy metals into the surrounding environment. The resulting contamination would have had significant, though difficult-to-quantify, consequences for the environment and public health across the MRPA.

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