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Air Quality and Health Impacts of the Proposed EMBA Hunutlu Coal Power Project

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Summary

The Iskenderun Bay area on Turkey's Mediterranean coast is a major target for coal power expansion, with three operating coal power plants and four new projects (Global Energy Monitor 2020). Out of these, the one closest to realization is the EMBA Hunutlu project, a planned 2 x 660MW coal power plant in Yumurtalik, district of Adana in Turkey. The project is a joint venture between China's Shanghai Electric Power (SEP, 50.01%), Avic-International Project Engineering Company (2.99%), and two local Turkish investors (47%).

This briefing presents results from detailed air quality simulations and health impact assessment for the project and the existing coal-fired plants in the area, following the methodology of the study "The Real Costs of Coal in Mugla" (CAN Europe 2019).

The air pollutant emissions from the EMBA Hunutlu project increase air pollution exposure across the entire Iskenderun Bay region, including in the city of Adana with a population of two million. Combined with the operating coal-fired power plants, the emissions would put approximately 100,000 people in the Iskenderun Bay area at risk of air pollution concentrations exceeding the World Health Organization guidelines, and directly expose

[1] All input data and results in the report have been updated in August 2020 to reflect a public statement by the project proponent indicating that the plant's flue gas would be discharged through the cooling towers, instead of a dedicated smokestack. A section analysing the implications of this change has been added.

3,000 people to exceedances of the guidelines, even without considering other sources of air pollution in the region.

The currently operating plants are responsible for an estimated 200 deaths per year (95% confidence interval: 120-250). If all plants are operated until the end of their remaining operating life, assumed to be 40 years, this would mean approximately 5,400 future air-pollution related deaths from the existing plants. The addition of the EMBA Hunutlu plant would add a projected 2,000 cumulative deaths, assuming an operating life of 40 years, bringing the future total to an estimated 7,400 deaths (95% confidence interval: 4,800 - 10,100). Other projected health impacts from the studied plants include 15.8 million sickness days, including 1.9 million lost working days, 240,000 days of asthmatic and bronchitic symptoms in children, 27,000 cases of bronchitis in children, 4,500 new cases of chronic bronchitis in adults, 10,000 hospital admissions and 3,300 low birth weight births.

The project would also increase mercury deposition into cropland and fisheries, increasing mercury exposure for people consuming food produced in the region. Mercury emissions from the existing plants and the EMBA Hunutlu project are projected to cause potentially dangerous levels of mercury deposition in an area with approximately 580,000 inhabitants in the bay area.

Emissions

Assessment of the health impacts of the project requires data on air pollutant emissions and stack and flue gas properties. For the EMBA Hunutlu project, this data was available from the EIA of the project. Annual emissions were calculated assuming 85% average utilization, as per the EIA. The pollutant concentrations in the plant's flue gas are 2-3 as high as allowed in China, where emissions limits of 35, 50 and 10mg/Nm3 apply to SO2, NOx and dust emissions from new power plants (MEE 2015; see Table 1 for comparison).

The company has later stated publicly that, in contrast with the information presented in the EIA, the plant would discharge its pollution through the cooling towers, instead of a smokestack. This is a material change that is discussed further in section "Effects of pollutant discharge through cooling towers" below. To account for the thermal plume rise, the properties of the cooling towers were estimated from a graphical illustration of the plant (Figure 6), in the absence of more precise information.

For the existing coal-fired plants, emission information was compiled from publicly available sources, including the Diler Holding company website for Atlas TES[2], a company presentation for Tufanbeyli Enerjisa[3] and marketing materials from companies involved in engineering and retrofitting the Sugözü İsken plant[4]. Flue gas flow rates were estimated based on plant efficiency, reported annual power generation and coal calorific value. For Tufanbeyli, information on calorific value of lignite was available from a company presentation; the hard coal plants were assumed to fire 6000 kcal/kg bituminous coal. A specific flue gas volume of 350Nm3/GJ was assumed for the hard coal plants.

Since information on mercury emissions was completely omitted in the Hunutlu EIA and was not available for the other plants either, these emissions were estimated using the UNEP Mercury Toolkit (UNEP 2017). For hard coal plants, the average of the mercury contents for Colombian and South African bituminous coal was used; for Tufanbeyli the default mercury content for Turkish lignite was assumed. Default mercury capture rates for plants equipped with SO2 scrubbers and particle controls were used.

Table 1 *Flue gas concentrations of air pollutants and flue gas volume flow (mg/Nm3).*

Plant	SO2	NOx	Dust	Flue gas volume, Nm3/h
EMBA Hunutlu	135.6	123	21	4601770
Sugözü İsken TPP	400	200	30	4012105
Tufanbeyli Enerjisa	200	200	30	1696335
Atlas TES	200	200	10	3600000

[2] http://www.dilerhld.com/grup.asp?anagrup_no=4
[3] http://www.tki.gov.tr/depo/%C5%9E%C3%BCkr%C3%BC%20%C5%9Ei%C5%9Fman.pdf
[4] https://www.modernpowersystems.com/features/featurebringing-german-ipp-experience-to-turkey/

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Table 2 Emission mass rates and plant utilization.

Plant	SO2	NOx	Dust	Utilization
EMBA Hunutlu	624	567	97	85.0%
Sugözü İsken TPP	1605	802	120	87.0%
Tufanbeyli Enerjisa	339	339	51	85.6%
Atlas TES	720	720	36	80.9%

Table 3 *Emission source characteristics.*

Source	Latitude	Longitude	stack height, m	exit temperature, K	diameter	exit velocity, m/s	MW
EMBA Hunutlu	36.816	35.855	170	ambient+15	2x80m	5.0	1320
Sugözü İsken	36.816	35.855	180	328	2 x 7m	20	1320
Tufanbeyli Enerjisa	38.186	36.270	158	ambient+15	80m	5.0	450
Atlas TES	36.691	36.209	210	334	9.8m	16.7	1200

Table 4 *Mercury emissions.*

	EMBA Hunutlu	Sugözü İsken	Tufanbeyli Enerjisa	Atlas TES	unit
coal consumption	2.87	3.48	6.53	2.90	Mt/year
coal mercury content	0.175	0.175	0.11	0.175	ppm
capture efficiency	65%	65%	20%	65%	
emissions	175.5	213.0	574	178	kg/year

Air quality modeling results

The air quality impacts of emissions from the plants were modeled using the CALPUFF dispersion model, which uses detailed hourly data on wind and other atmospheric conditions to track the transport, chemical transformation and deposition of pollutants, and is widely used to assess the short and long range impacts of emissions from industrial point sources and area sources. The model predicts the increases in hourly, daily and annual pollutant concentrations caused by emissions from the studied source. A full-year simulation using the emissions input data given above.

Emissions from the power plant would elevate the concentrations of health-harming pollutants across the entire Iskenderun Bay region, over an area with 7.5 million inhabitants. There would also be a transboundary impact on Cyprus, some 300km away from the power plant. Figures 1-3 show how the mountains around the bay trap pollution, increasing the impact on the densely populated coastal areas.

Even without considering other emissions sources in the region, the four power plants are estimated to cause exceedances of the World Health Organization air quality guidelines for SO2 and NO2: the guideline for 24-hour average SO2 concentration (20µg/m3) is exceeded in areas around the Hunutlu and Sugözü plants and around the Atlas TES plant (Figure 1). The guideline for 1-hour NO2 concentration (200µg/m3) is exceeded in an area near the Atlas TES plant (Figure 2). In total, the plants expose approximately 3,000 people to exceedances of the WHO guidelines. The highest predicted 24-hour average PM2.5 concentrations exceed 10µg/m3, or 40% of the WHO guideline level, in an area with 100,000 people (Figure 3). Considering the background pollution concentrations from all other sources, it is very likely that the plants contribute to exceedances of the WHO guideline for PM2.5 as well.

Out of the modeled mercury emissions of 1140kg/year from the four power plants, approximately 370kg would be deposited into land and freshwater ecosystems, and 30kg into the Iskenderun Bay, with potential impacts on mercury concentrations in fish and seafood caught in the region. Mercury deposition rates as low as 125mg/ha/year can lead to accumulation of unsafe levels of mercury in fish (Swain et al 1992). The plants are estimated to cause mercury deposition above 125mg/ha/yr in an area of 2,500km2 to the north and northeast of the plants, with a population of approximately 580,000 people (Figure 4). While actual mercury uptake and biomagnification depends very strongly on local chemistry, hydrology and biology, the predicted mercury deposition rates are a cause for serious concern.

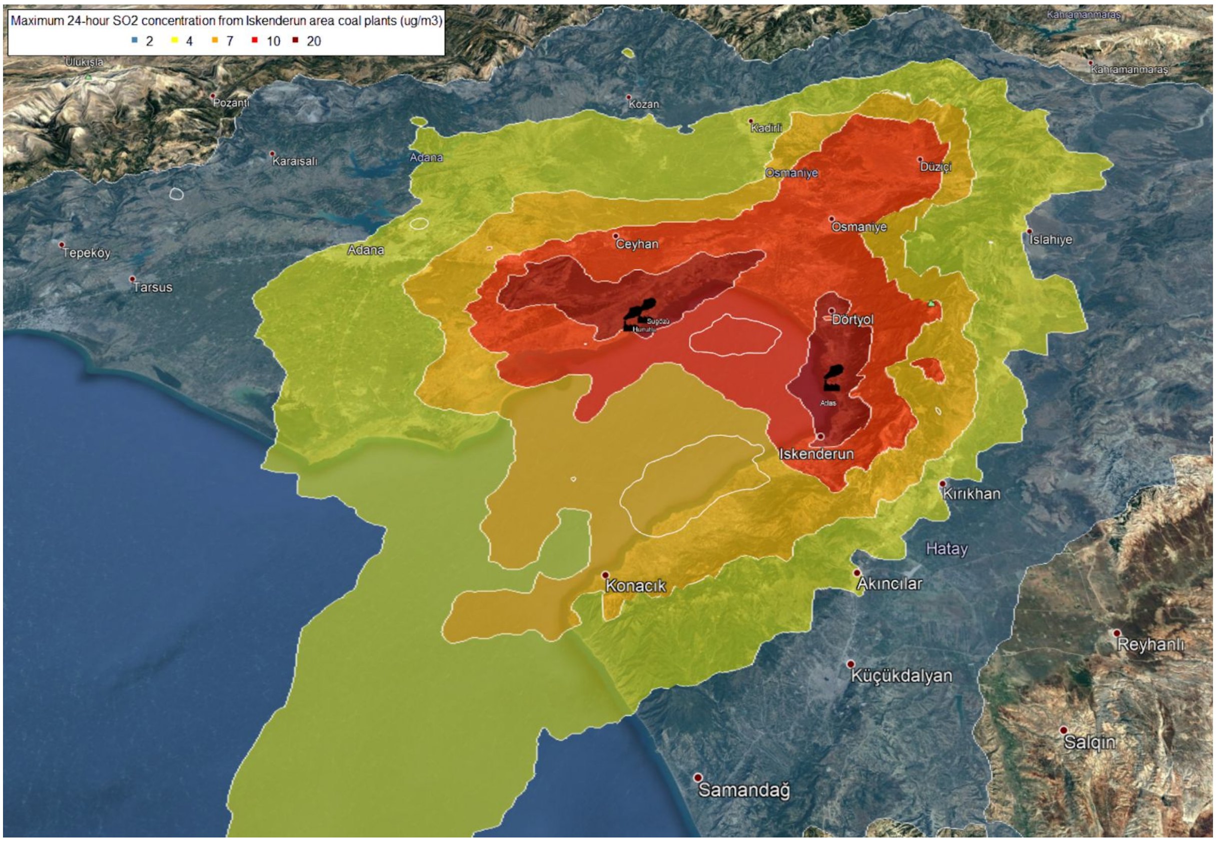

Figure 1 *Projected maximum 24-hour SO2 concentrations from the plants.*

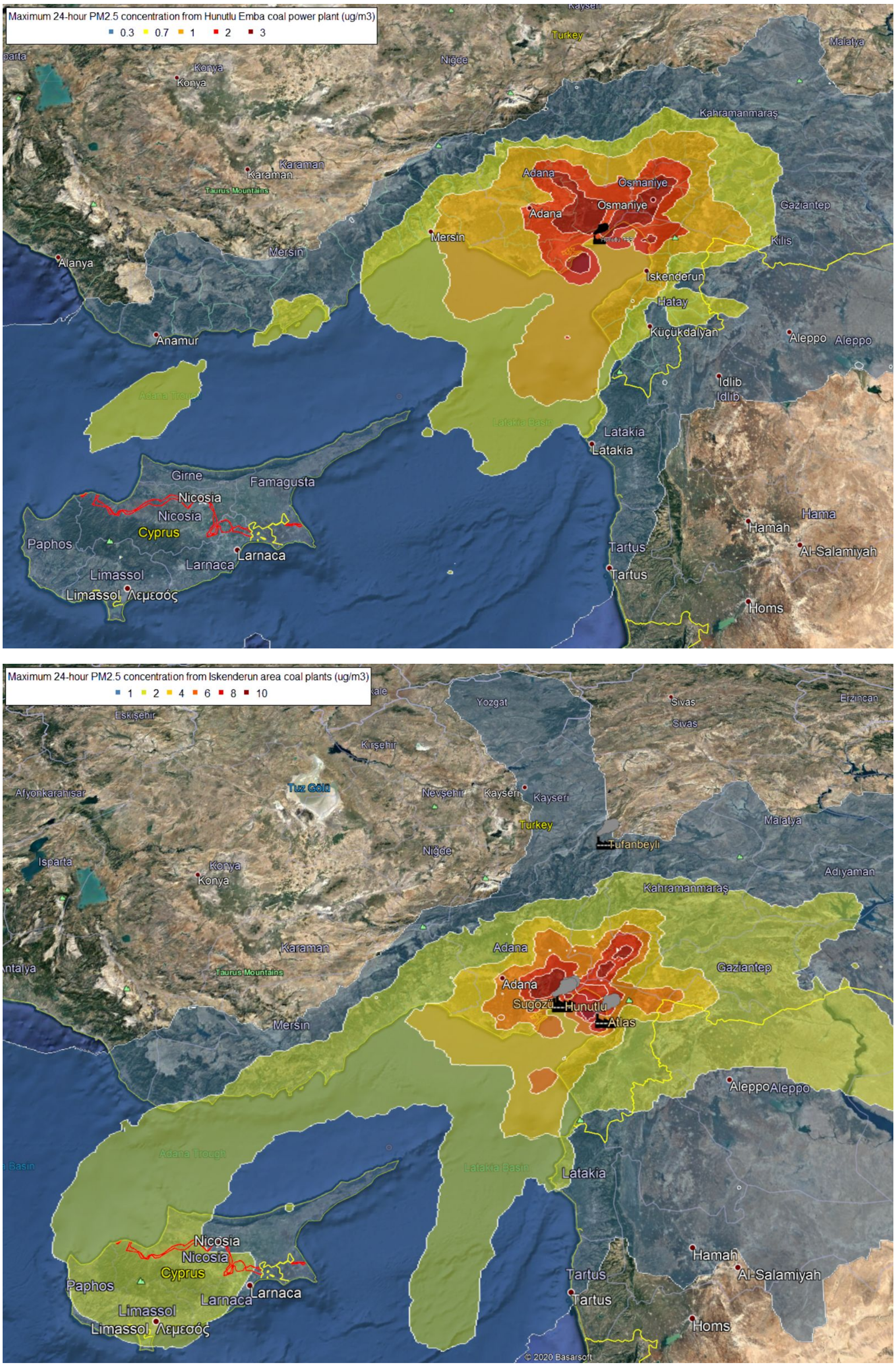

Figure 2 *Projected maximum 24-hour PM2.5 concentrations from the plants.*

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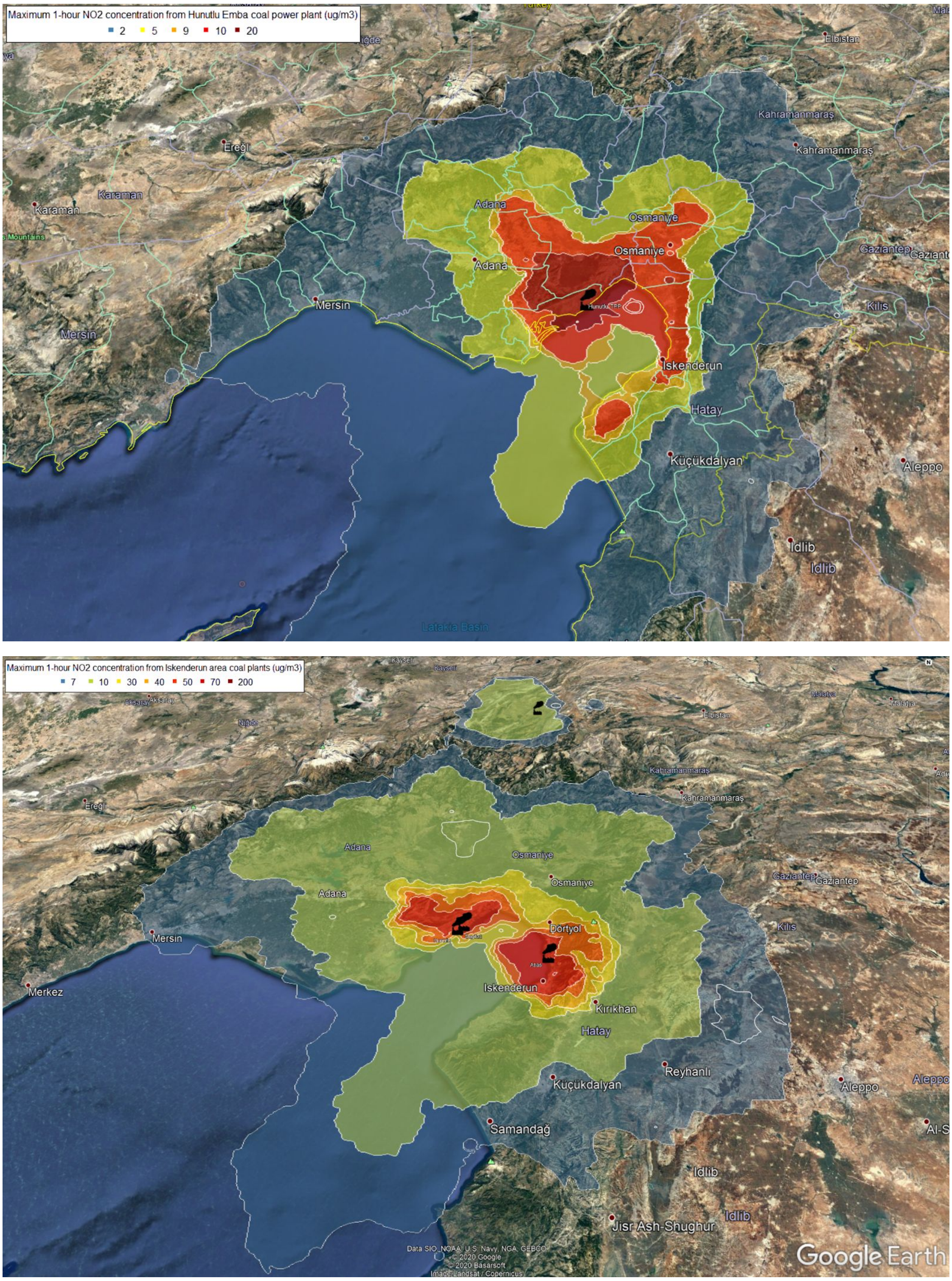

Figure 3 *Projected maximum 1-hour NO2 concentrations from the plants.*

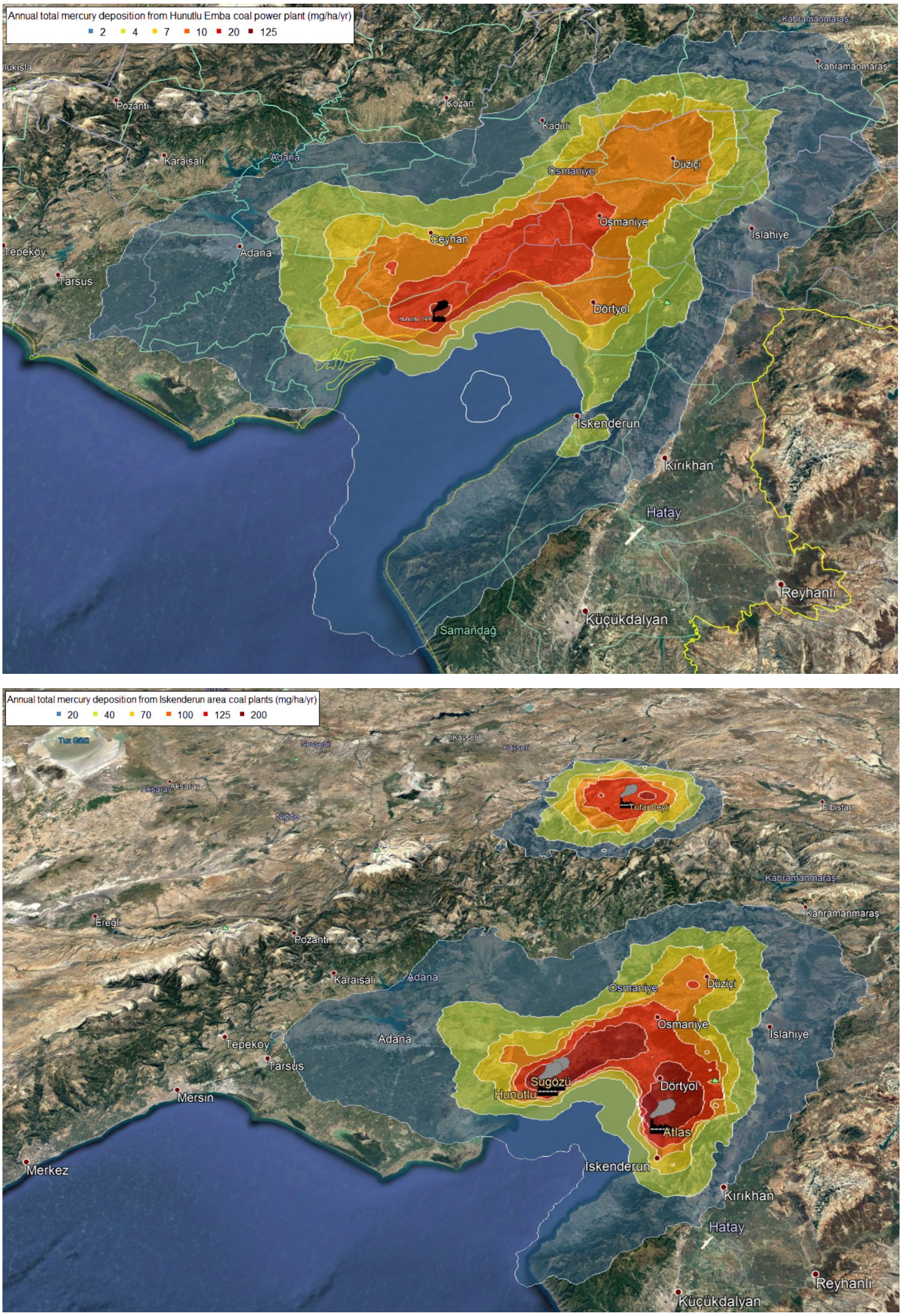

Figure 4 *Projected annual mercury deposition from the plants.*

Health impacts

The health impacts of the projected increases in air pollutant levels were evaluated following WHO (2013) recommendations for health impact assessment and national-level health data (IHME 2018) and high-resolution population data (CIESIN 2017) for Turkey. The implementation of the health impact assessment follows Huescher, Gierens & Myllyvirta (2017). The increase in low birth weight births was assessed based on Dadvand et al (2016).

The emissions from the EMBA Hunutlu power plant would be responsible for a projected 50 deaths per year (95% confidence interval: 30-70). Over an operating life of 40 years, this would mean approximately 2,000 air-pollution related deaths. The four plants, if operated to a lifetime of 40 years before retirement, would be responsible for a projected future toll of 7,400 deaths.

Table 5 *Projected cumulative lifetime impacts of the EMBA Hunutlu project.*

Effect	Pollutant	Value	Confidence interval
asthmatic and bronchitic symptoms in children, days	PM10	69,700	(15,100 - 126,000)
bronchitis in children, cases	PM10	7,750	(-2,040 - 17,500)
chronic bronchitis in adults, cases	PM10	1,280	(454 - 2,000)
hospital admissions	NO2	727	(466 - 986)
hospital admissions	PM2.5	2,160	(88 - 4,240)
lost working days	PM2.5	509,000	(433,000 - 585,000)
low birth weight	PM2.5	936	(290 - 1,630)
premature deaths	NO2	139	(80 - 201)
premature deaths	PM2.5	1,990	(1,300 - 2,640)
premature deaths	Total	2,080	(1,350 - 2,840)
sickness days	PM2.5	4,460,000	(3,990,000 - 5,010,000)

Table 6 *Projected cumulative future impacts of the four Iskenderun area coal power plants.*

Effect	Pollutant	Value	Confidence interval
asthmatic and bronchitic symptoms in children	PM10	244,000	(52,800 - 439,000)
bronchitis in children	PM10	27,100	(-7,100 - 61,200)
chronic bronchitis in adults	PM10	4,540	(1,610 - 7,100)
hospital admissions	NO2	2,140	(1,370 - 2,910)
hospital admissions	PM2.5	7,680	(313 - 15,100)
lost working days	PM2.5	1,850,000	(1,570,000 - 2,120,000)
low birth weight	PM2.5	3,330	(1,030 - 5,780)
premature deaths	NO2	457	(261 - 657)
premature deaths	PM2.5	7,130	(4,650 - 9,450)
premature deaths	Total	7,430	(4,820 - 10,100)
sickness days	PM2.5	15,800,000	(14,200,000 - 17,800,000)

Effects of pollutant discharge through cooling towers

Public statements by representatives of companies involved in the EMBA Hunutlu project in July 2020 indicated that the flue gas from the coal boilers of the power plant would not be discharged through smokestacks but injected into the cooling towers of the plant. This change was presented in an environmentally beneficial light, and as a novel solution - the plant was described as the first one in Turkey to deploy this approach.

In reality, flue gas injection into cooling towers has been occasionally chosen by thermal plant developers for a long time, due to cost savings stemming from eliminating the need for a separate smokestack. The environmental effects are much more mixed: the increased thermal lift from the turbine waste heat can aid with pollutant dispersion, but under some atmospheric and operating conditions, the lower discharge velocity, temperature and height of the cooling towers can offset these impacts, resulting in higher ground-level pollutant concentrations, particularly during warm and windy summer conditions (Hinneburg et al 2009), which are common in Adana. Furthermore, the warm and humid conditions in the cooling tower plume promote secondary particle formation inside the plume, which can also increase ground-level pollutant concentrations - this implication was already recognized and studied in the early 1980s (Meagher et al 1982).

To address the project proponent's claims about the environmental benefits of cooling tower discharge, two different CALPUFF simulations were carried out, one with a smokestack as originally specified in the EIA, and one with cooling tower discharge. CALPUFF includes a detailed plume rise model that predicts the behavior of buoyant plumes, taking into account height and diameter of the stack or cooling tower, gas temperature and velocity as well as hour-by-hour atmospheric conditions.

However, the standard versions of CALPUFF cannot model in-plume chemical reactions, meaning that the increased formation of PM2.5 particles in the cooling tower plume is not accounted for in these results - this effect is likely to make the cooling tower discharge option significantly worse from air quality and public health perspective than pollutant discharge through a smokestack.

Figure 5 shows the day-by-day results for the highest average local ground-level pollutant concentrations predicted in the two cases. While the annual average pollutant concentrations were almost unchanged between smokestack and cooling tower, there are a lot of situations in which discharge through the cooling tower in fact results in higher daily pollutant concentrations. Therefore it's not valid to say that the change is a straightforward improvement, as there are situations and locations at which the cooling tower option is worse.

In conclusion, the air quality and other environmental implications of the change in flue gas discharge are complex and far from one-directional. Therefore, the need for a new environmental impact assessment to evaluate the impacts of the plant as it is currently envisioned is obvious.

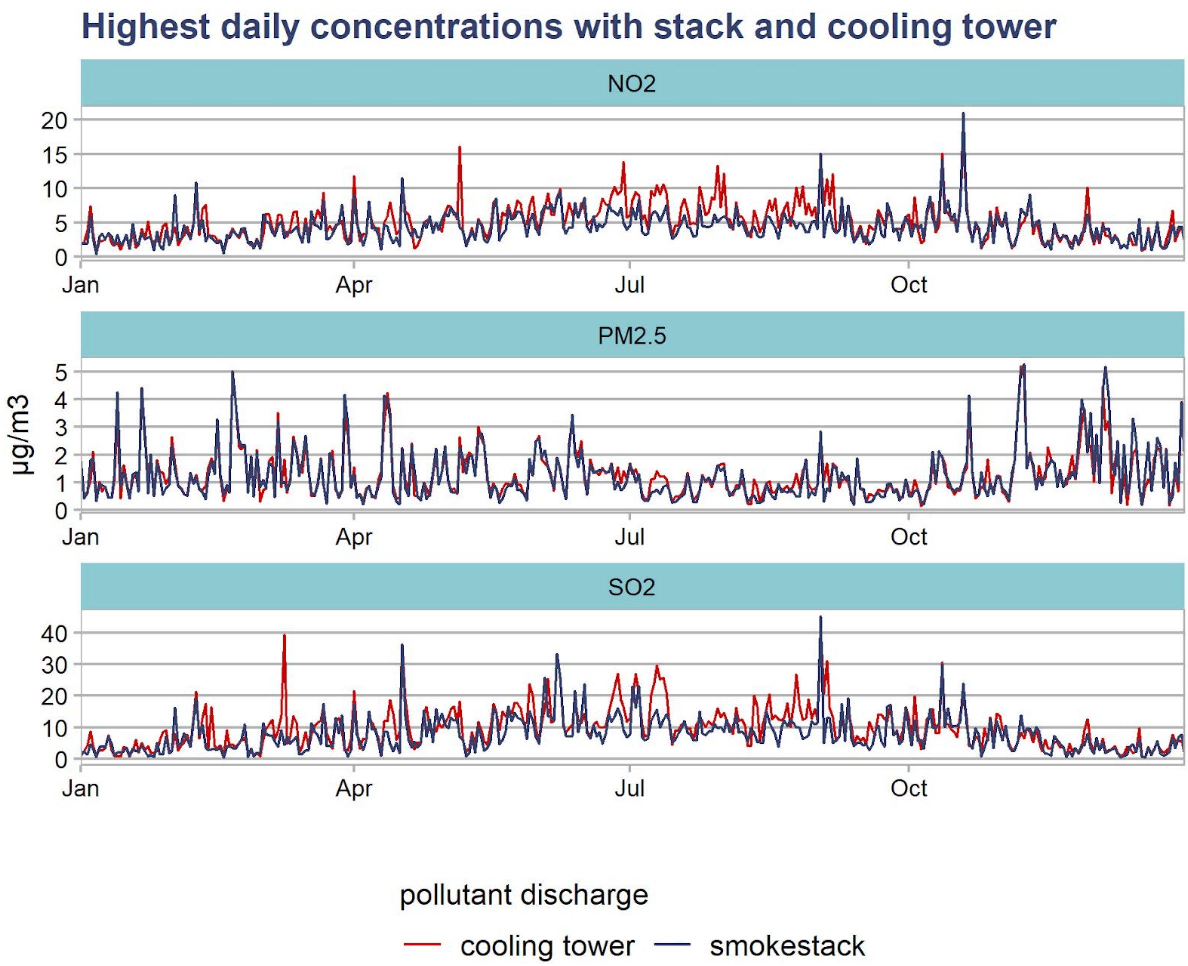

Figure 5. *Maximum local daily concentration of pollutants in the cooling tower and smokestack discharge cases. For each day, the concentration for the location with highest daily average is shown.*

Figure 6. *A graphical illustration of the planned power plant with the cooling towers.*

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