YEMEN
FSO Safer: Overview impact assessment

This update builds upon and refines the methodology of the ACAPS FSO Safer assessment from April 2021 (ACAPS 07/04/2021). It uses the International Maritime Organization (IMO) modelling for oil spill risk. The model includes four possible scenarios, but this update includes only the impact of the worst-case scenario. It uses Catapult and Riskaware modelling for the risk of an explosion on board the vessel.

The report also follows the 5 March 2022 announcement of the signing of a memorandum of understanding between the de-facto authority (DFA) in the north of Yemen (also known as the Houthis) and the UN. The memorandum states an agreement to shift the oil from the FSO Safer tanker to another ship, although no further plans or details have been publicly released (Reuters 06/03/2022).

THE RISK FROM FSO SAFER

FSO Safer is a vessel that was used to store and export oil from Yemen's inland oil fields around Marib. In 2015, the vessel fell under the control of the DFA. It has since been neglected. Before the conflict, the Safer Exploration & Production Operation Company spent USD 20 million a year on maintenance. As at October 2021, the company could only afford to make minor repairs on the vessel (The New Yorker 04/10/2021). The DFA has repeatedly rejected requests by the UN for a vessel inspection. In November 2020, the DFA agreed to grant a UN team permission to begin checks. They initially planned inspections for February 2021 but got indefinitely delayed (The Maritime Executive 28/01/2021; NYT 02/02/2021). Following the 5 March 2022 announcement of the signing of a memorandum of understanding between the DFA and the UN (Reuters 06/03/2022), in April 2022 the UN Resident Coordinator for Yemen, David Gressly, outlined the UN-coordinated plan to address the threat with an overall cost of USD 80 million (UN News 11/04/2022).

The coastlines of Yemen's Red Sea and of neighbouring countries are at risk of an environmental disaster that could happen any day with substantial humanitarian and economic impacts. With the passage of time, the possibility increases of an immense oil leakage from or an explosion of the FSO Safer, which is anchored in the Red Sea 60km north of Al Hodeidah port. If disaster strikes, the vessel could release four times the amount of crude oil spilled in the Exxon Valdez catastrophe of 1989, which majorly affected the environment, people, and their livelihoods in surrounding areas (UNEP 16/07/2020).

The lack of maintenance of the FSO Safer – with its estimated cargo of 1.148 million barrels of Marib light crude oil – makes two scenarios increasingly likely:

1. Oil spill: corrosion and a lack of maintenance of the vessel for an extended period could lead to some of the oil leaking into the sea. Any leak in the engine room and water uncontrollably flowing in could destabilise and potentially sink the entire structure, likely causing a severe oil spill (Green Bee Insights 06/06/2021).

2. An explosion and fire on board the unit: this scenario could result from the accidental ignition of gas that has accumulated in cargo tanks and consecutive leakage of most or all of the oil into the sea (UNEP 16/07/2020).

Further in-depth humanitarian, economic and environmental analysis can be found in the recent FSO Safer impact report from Greenpeace (Greenpeace, 27/01/2021). Analysis on the wider public health impacts of an oil spill from the vessel is available in Nature Sustainability (Nature Sustainability, 11/10/2021).

TABLE OF CONTENTS

Projected impacts of an explosion on the FSO Safer

Oil spill

This worst-case scenario models the release of the entire inventory of FSO Safer (around 186,000m3 of oil) over a few days. Using historical meteorological and marine current data, the model assesses where the probability of an oil spill having sufficient concentrations to trigger shoreline oiling is greater than 25%. Actual events could unfold very differently depending on actual conditions.

Affected population

- Affected populations would include those whose livelihoods are affected by the spill and subsequent clean-up operations, through damage to coastal industries and factory and port closures, as well as damage to fisheries and marine resources.
- An oil spill would severely disrupt the livelihoods of those in the fishing industry throughout the Red Sea, including fishermen, workers, and dependents.
- People living within 10km of the coast, including people in need and IDPs, would also be vulnerable to the impacts of an oil spill.

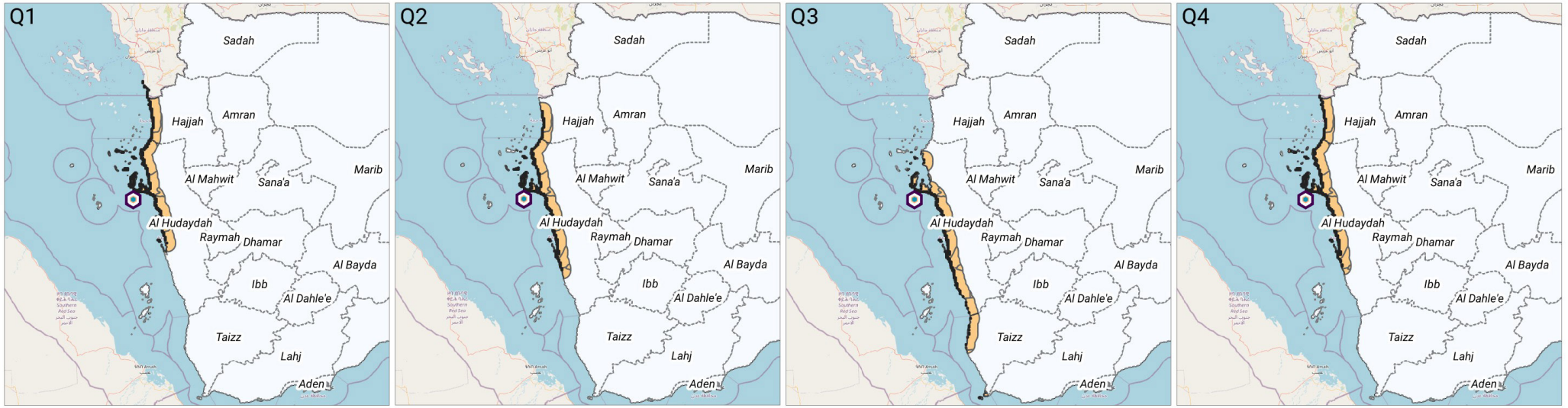
Economic impact

- Port operations interrupted: an oil spill would affect operations in Al Hodeidah and Saleef ports, which would likely have to close for two to three months. This closure would limit fuel and food imports and put the jobs of port workers at risk.
- Fuel imports and supply routes altered: the disruption of port operations would further reduce the already restricted fuel supply through Al Hodeidah, affecting electricity production, health services, and transportation provisions across the country. The ports would also see heavy oil contamination. Vessels that have been waiting for months in the coalition holding area but which have not yet been allowed to unload would need cleaning. More fuel might be brought in through Aden and Mukalla to offset the shortfall, altering fuel supply chains in the country. As a result, more fuel would likely be sold through the black market, and prices would likely rise.
- Food imports and supply routes altered: bulk food imports through Al Hodeidah and Saleef have been consistent and at healthy volumes. The redirection of food imports to Aden and Mukalla could lead to congestion and delays in those ports. Consequently, the onward transport of wheat to mills out of these two ports would increase, with capacities unknown. Food prices would likely rise.
- Fishery operations disrupted: the oil spill would likely block fishing activities and put the livelihoods of fishermen and workers in the fishing and related industries (ice-making, packaging, and transportation) at risk. There would also be a wider impact on dependents. Impacts would be devastating, with 21% of fishing communities already considered poor and 71% very poor even before any disasters (Oxfam 12/2017). The cost to the fishing industry could reach USD 750 million (at USD 30 million per year for 25 years).
- Closure of desalination plants and ports in Yemen and Saudi Arabia could affect the drinking water for up to 10 million people (Greenpeace 27/01/2022).
- High general impact and clean-up costs: an oil spill into the water would have far greater and longer-lasting impacts than the release of particulates through fire.

Table 1. Impact assessment of an oil spill from FSO Safer per quarter.

	QUARTER 1 (JAN–MAR)	QUARTER 2 (APR–JUN)	QUARTER 3 (JUL–SEP)	QUARTER 4 (OCT–DEC)
Number of Red Sea fisheries affected	7/18	8/18	13/18	8/18
Fishermen and dependents affected	11,800 fishermen 35,400 dependents	12,200 fishermen 36,600 dependents	24,400 fishermen 73,100 dependents	12,200 fishermen 36,600 dependents
People living within 10km of the coast	330,000	340,000	460,000	340,000
People in need (PiN) living within 10km of the coast	300,000	300,000	400,000	308,000
IDPs living within 10km of the coast	77,000	78,000	105,000	79,000
People affected in the wider fishing industry	87,600 workers 262,600 dependents	90,600 workers 271,500 dependents	181,200 workers 543,100 dependents	90,600 workers 271,500 dependents

Figure 1. Modelling of the population affected by the oil spill.



Disclaimer: The boundaries, names, and designations used on this map do not imply official endorsement or acceptance by ACAPS.
Sources: ACAPS using data from IMO and Oil Spill Response 07/2021; OCHA 21/02/2021; Meta 2018, OpenStreetMap accessed 18/02/2022.

Projected impacts of a fire on the FSO Safer

Air pollution

These models use three years of historical meteorological and marine current data. Actual events could unfold very differently depending on actual conditions.

Table 2. Impact assessment of air pollution per quarter following a fire on FSO Safer.

	QUARTER 1 (JAN–MAR)	QUARTER 2 (APR–JUN)	QUARTER 3 (JUL–SEP)	QUARTER 4 (OCT–DEC)
Districts exposed to very high pollution levels (71ug)	60	82	69	28
People exposed to very high pollution levels (71ug)	4.2 million	6.2 million	4.8 million	2.4 million

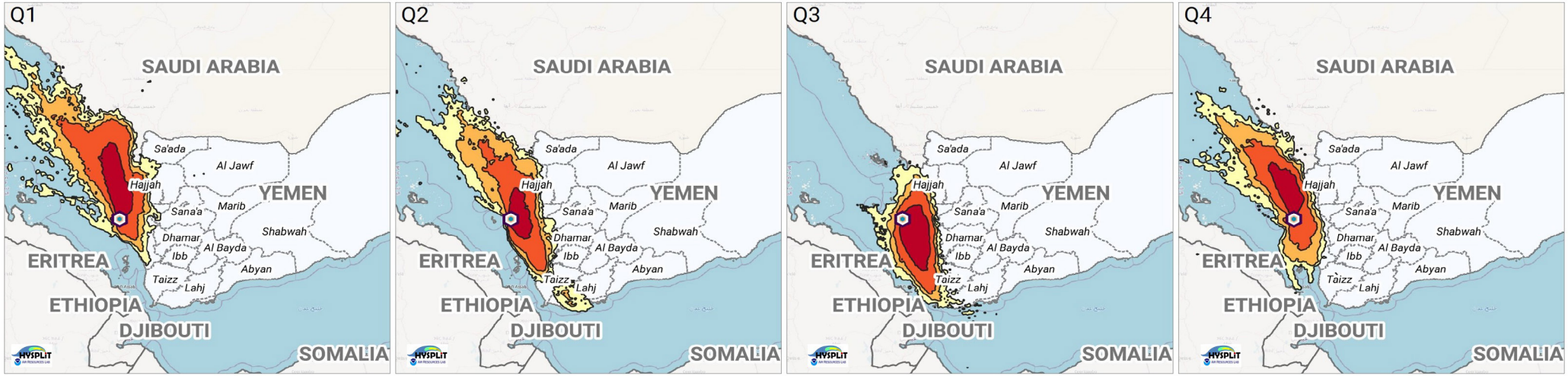
Affected population

- A fire could expose up to 6.2 million people in Yemen and one million in Saudi Arabia to very high air pollution levels, with harmful effects seen 24–48 hours after its onset.
- Affected Yemeni governorates would likely include Al Hodeidah, Al Mahwit, Dhamar, Hajjah, Raymah, Sadah, and Sana'a. In Saudi Arabia, a fire on the vessel would likely affect Jizan.
- Around one million IDPs live in areas in Yemen that could be covered by smoke plumes.

Health impacts

- A fire on the FSO Safer would likely aggravate heart and lung problems, posing a significant health risk to the elderly and those suffering from related conditions. The pollution would also create an additional hazard for COVID-19 patients with breathing problems. Affected populations would probably face difficulties getting adequate treatment given the limited availability of facilities as well as increasing and often unaffordable transportation costs because of fuel shortages.

Figure 2. Very high air pollution (PM2.5 above 71ug/m3) modelling results for each quarter.



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Sources: ACAPS using data from Catapult and Riskaware 07/2021; OCHA 21/02/2021; Meta 2018, OpenStreetMap accessed 18/02/2022.

Ground soot deposition

These models use three years of historical meteorological and marine current data. Actual events could unfold very differently depending on actual conditions.

Table 3. Impact assessment of ground soot deposition per quarter following a fire on FSO Safer.

	QUARTER 1 (JAN–MAR)	QUARTER 2 (APR–JUN)	QUARTER 3 (JUL–SEP)	QUARTER 4 (OCT–DEC)
Districts exposed to hazardous air pollution (250ug and soot)	18	28	28	9
People exposed to hazardous air pollution (250ug and soot)	900,000	1.8 million	1.9 million	90,000

Affected population

- A fire on the vessel could expose up to 1.9 million people in Yemen to hazardous air pollution levels and soot, with harmful effects seen 24–48 hours after its onset.

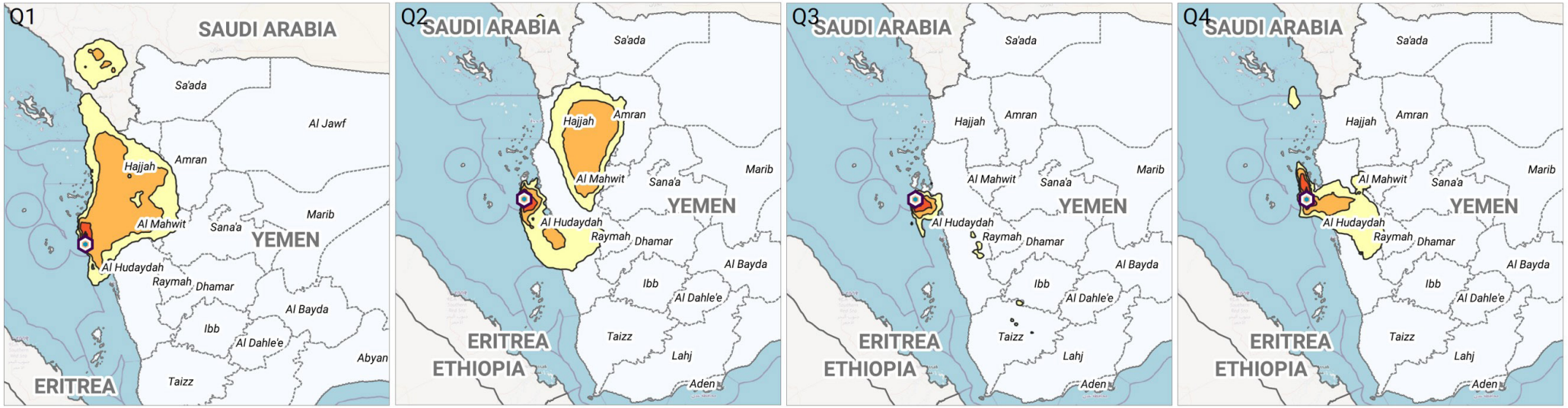
Economic impacts

- Soot deposition could lead to crop losses and related consequences, such as limited supplies to markets and price increases.
- Around 500km2 of agricultural land in Yemen could receive pollutant depositions, which would impair crop growth for both subsistence and profit. During this period, soot would cover papaya, citrus, and mango fruits and diminish the quality of still growing corn, tomatoes, sesame, watermelons, and sweet potatoes. The estimated loss in agricultural production could amount to USD 70 million.

Environmental impacts

- A fire on FSO Safer could potentially contaminate numerous wadis (river valleys) and 8,523 water well points. The computation for this number involved multiplying the estimated proportion of each governorate affected by atmospheric dispersion, by the total number of wells per governorate (Ministry of Agriculture 2002; Fanack Water 12/02/2020; KII 02/2020).

Figure 3. Ground soot deposition (PM2.5 above 20mg/m3) modelling results per quarter.



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SEASONAL VARIATIONS OF IMPACTS

The expected impacts assessed here would result from seasonal prevailing weather and marine current conditions influencing the extent and direction of an oil spill and smoke plume dispersion.

Compared with the assessments that covered prevailing current and weather patterns in October–December 2020 and January–March 2021, the April–June 2022 analysis predicts more severe impacts on agricultural production, livelihoods, and port operations, worsening the fuel shortage, its consequences on service delivery, and food and fuel prices in the country.

The following analysis details the projected impacts of an oil spill and explosion for each quarter.

THE DEVELOPMENT OF ACAPS' IMPACT ASSESSMENT

ACAPS conducted this impact assessment as part of a partnership project (funded by the Foreign, Commonwealth & Development Office of the UK Government) with the companies Catapult and Riskaware based on atmospheric dispersion modelling. For this update, ACAPS used the oil spill modelling of the IMO Oil Spill Response.

Both the Catapult/Riskaware and IMO models used global datasets of current and historical meteorological data to obtain prevailing weather and marine current conditions for the four quarters of the year. The Catapult/Riskaware model assessed the worst-case smoke plume scenarios for each period. The IMO oil spill model assessed coastal areas where the probability of an oil spill having sufficient concentrations to trigger shoreline oiling was greater than 25%. It assumes the entire inventory of FSO Safer (around 186,000m3 of oil) will be released over a few days.

To estimate economic and humanitarian impacts, ACAPS applied indicators specifically developed for the task to each of the four scenarios obtained from the modelling (see Appendix 1). These indicators were based on:

- humanitarian data available from the ACAPS Yemen CrisisInSight Core Dataset
- geographic information system analysis using Humanitarian Needs Overview (HNO) population figures and Meta population density data
- information and analysis of past ecological disasters and conflict events in Yemen
- consultation with humanitarian experts (health, agriculture, water, and economy experts) in Yemen to test and refine assumptions.

ACAPS estimated the populations affected by and vulnerable to an oil spill by calculating the population living within 10km of the coast. We also assessed fisheries to estimate the impact on the fishing industry.

We estimated the populations affected by and vulnerable to an explosion by calculating the population living under the smoke plume.

Further details on the methodology can be found in Appendix 1.

The project benefited from support by the IMEDA programme, which is supported by UK aid from the UK government.

Appendix 1: Methodology reference list

IMPACT CATEGORY	IMPACT	SOURCES
Oil spill people affected	Governorates affected (oil spill)	IMO modelling, HNO 2021, Meta population density
	No. of districts exposed to the risk of an oil spill (per governorate)	
	No. of people affected per governorate	
	Total population affected	
	PIN affected	IMO modelling, HNO 2021, Meta population density, ACAPS Yemen Core Dataset
	IDPs affected	IMO modelling, HNO 2021, Meta population density
	Impact on global shipping	
Oil spill economic costs	No. of Red Sea fisheries affected	IMO modelling, S Ballard & JFA (2021)
	Cost to the fishing industry	LSE 2018 and https://www.dw.com/en/exxon-valdez-oil-spill-a-long-painful-recovery/a-17515818-0
	People affected in the fishing industry	IMO modelling, LSE 2018, S Ballard & JFA (2021)
	Cost of clean-up	ThinkProgress 15/07/2013, CPI inflation calculator, Catapult/Riskaware 20/08/2019
	Cost of Al Hodeidah port closure	WFP VAM 2020
Atmospheric dispersion people affected	No. of governorates exposed to air concentration exceeding 250ug and soot (hazardous air pollution)	Catapult modelling, HNO 2020, Meta population density
	No. of districts exposed to air concentration exceeding 250 ug and soot (hazardous air pollution)	
	No. of people exposed to air concentration exceeding 250 ug and soot (hazardous air pollution)	
	No. of PIN exposed to air concentration exceeding 250ug and soot (hazardous air pollution)	Catapult modelling, HNO 2020, Meta population density, ACAPS Yemen Core Dataset
	No. of IDPs exposed to air concentration exceeding 250ug and soot (hazardous air pollution)	
	No. of governorates exposed to air concentration exceeding 71ug (very high air pollution)	Catapult modelling, HNO 2020, Meta population density
	No. of districts exposed to air concentration exceeding 71ug (very high air pollution)	
	No. of people exposed to air concentration exceeding 71ug (very high air pollution)	
	No. of PIN exposed to air concentration exceeding 71ug (very high air pollution)	Catapult modelling, HNO 2020, Meta population density, ACAPS Yemen Core Dataset
	No. of IDPs exposed to air concentration exceeding 71ug (very high air pollution)	
Atmospheric dispersion (soot deposition) economic effects	Water wells affected	Ministry of Agriculture database 2002
	Size of agricultural land affected	Yemen Ministry of Agriculture 2015
	No. of farmers affected	MOA 2015
	Loss of agricultural production in USD	Case study from China by Bergen, Greenwalk, Berten, Chameides 2001, quoted in Riskaware 2020
	No. of governorates exposed to soot deposition	Catapult modelling, HNO 2020, Meta population density, ACAPS Yemen Core Dataset
	No. of districts exposed to soot deposition	
	No. of people exposed to soot deposition	
	No. of PIN exposed to soot deposition	
	No. of IDPs exposed to soot deposition	