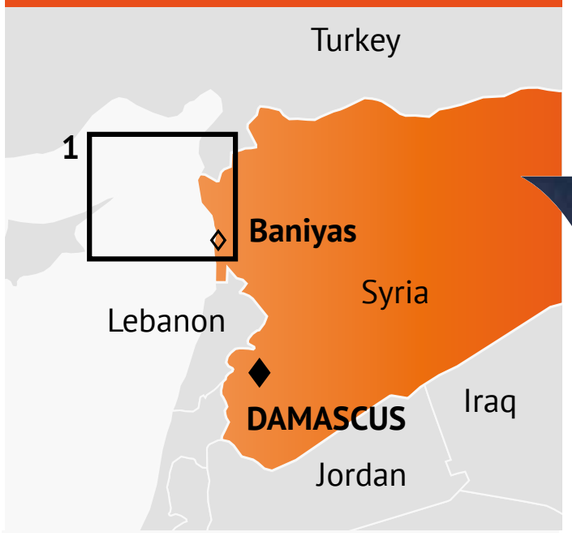
Environment and Conflict Alert 4

Baniyas: An Environmental Disaster in the Making

Peace. Are you in?

Middle East



Oil on surface leaking out of the Iranian oil tanker ROMINA, Baniyas, Syria

Planet Skysat, 17 April 2020

Introduction

The port of Baniyas is Syria's crucial economic lifeline as the area is home to Syria's 'Company for Oil Transport', hosting over 100 larger and smaller oil storage tankers with crude and refined oil product. Before the conflict in Syria escalated into a full out war, oil was transported to Baniyas from the oil fields in Deir ez Zor and Hasakeh. At its peak, the refinery had the capacity to process 125,000 barrels of oil a day, with ships coming in to pick up crude oil, refined petroleum products and LPG at eight Single Buoy Mooring Stations (SBMS) off the coast, where underwater pipelines connect to the visiting oil tankers. The Baniyas Thermal Power Plant (TPP), a 48 MWe capacity that was built in 1988 and operates using heavy fuel oil to generate electricity, is located on the shores southwest of the refinery.

The conflict in Syria has halted the flow of oil from the eastern oil fields, and Iran has stepped in since 2012 to provide Syria with crude oil and refined oil products, delivering them at Baniyas. At the same time, the Syrian government's diminished capacities from the conflict, has caused a lack in provision of sufficient maintenance and equipment to properly monitor its energy infrastructure and enforce relevant regulations, including environmental checks. Since then, the Baniyas area has faced toxic cocktail of covert attacks on oil infrastructure, gross mismanagement and degrading oil facilities resulting in structural environmental pollution at Syria's coastal areas. Ongoing spills and the dumping of wastewater full of pollutants into the sea pose serious risks to public health, the marine and coastal environment and livelihoods depending on it. Over the course of the last three years, ongoing larger and smaller incidents were reported in the media or witnessed using earth observation with satellite imagery, showing a looming disaster in the making. A catastrophic event occurred late August 2021, when an oil storage tank with a capacity of 12,000 m^3 leaked most of its content of heavy fuel oil into the sea, and within days spreading over hundreds of kilometers. Thick oil washed across the Syrian shores, affecting aquatic life in the coastal environment as local authorities struggled to contain and clean-up the spill with limited means. The current and wind took the oil north and west bound, and soon oil tar-balls washed up on the beaches of Turkey and Cyprus. PAX has actively monitored this area of the last years using commercial and public satellite imagery and open-source information to identify the scale, severity and linked public and environmental hazards at this conflict-linked pollution flashpoint.

Environment and Conflict Alert 4

Baniyas: An Environmental Disaster in the Making

Peace. Are you in?

Baniyas: 'A most Critical Pollution Hotspot'

Prior to the outbreak of the conflict, environmental pollution at Baniyas was high on the Syrian government's priority list of issues to be addressed with new investments and international support as the small city struggled with a range of concerns from the refinery, powerplant and general issues with the absence of proper wastewater treatment facilities. Numerous studies demonstrated the severity of the pollution in the coastal areas, including from UNEP's water quality sampling at the powerplant in 2002 and other sewage outlets at Baniyas. Another assessment made by the Syrian government in 2005 for protection of the Mediterranean marine environment further noted the major problems around Baniyas caused by the refinery and thermal power plant. A European Union assessment from 2007 notes that Baniyas is Syria's top priority, calling it 'a most critical pollution hotspot', and designed a 35 million Euro project to address the health and environmental concerns linked with wastewater discharges and water infrastructure. Additionally, a European Investment Bank analysis from 2008 also refers to the many concerns linked with pollutants from both the refinery and the thermal power plant. Ongoing concerns from the refinery's polluting practices led to protests in 2010 from citizens living nearby over the air pollution, fearing the health impacts. Despite the improvements made in 2011 seeking to achieve EU environmental standards, the worst was yet to come.

After the violent repression of peaceful protests in 2011 escalated into a full military conflict, weak governance worsened the conditions around the energy infrastructure, with less expertise and money available for maintenance and repairs. The refinery itself has witnessed various industrial incidents, ranging from explosions to fire outbreaks, while structural pollution problems continue to fester the refinery grounds with spills and leaks from the oil storage tanks and pipelines.

There are three main pollution vectors that can be identified in and around Baniyas, namely: (1) the thermal power plant; (2) the oil refinery and associated infrastructure, including the single buoy mooring stations off the coast; and (3) lastly, the public water infrastructure. All three are linked with pollution from massive leaks caused by explosions, discharge of fuel oil, the uncontrolled dumping of wastewater containing a range of heavy metals or other contaminants, posing health risks, and affecting ecosystems.

The power plant uses heavy fuel oil (HFO), a petroleum distillate rich in tar. Its combustion results in significant emissions of air pollutants such as Sulphur dioxide (SO^2), Sulphur trioxide (SO^3), Nitrogen dioxide (NO^2) and soot. The TPP itself also produces substantial amounts of wastewater that is discharged into the sea. Research on these types of powerplants shows that these discharges often contain a range of heavy metals and other pollutants, including arsenic, cadmium, chromium, lead, mercury, selenium, and combustion residual leachates, which all pose serious ecological threats to human health and aquatic ecosystems. The TPP has two main discharge outlets, one directly west on the facility, discharging water into a bay, and a wastewater discharge outlet 400 meters north of there, west of the heavy fuel oil storage tankers. The latter location is of special interest as we witnessed ongoing discharges of possible pollutants over the course of three years.

The Baniyas refinery is also a known pollution hotspot from its history of various leaks, spills and flaring practices that continue to pose persistent health and environmental risks. According to a study done by the Syrian Company of Oil Transportation, the main cause

Baniyas Thermal Powerplant discharge outlets

© MAXAR, October 25, 2019

Environment and Conflict Alert 4

***Baniyas**: An Environmental Disaster in the Making*

Peace. Are you in?

of pollution comes from spills as pipelines and storage tanks rust and erode, resulting in crude oil, refined oil products, radioactive materials causing soil, ground and surface water contamination. A quick remote sensing analysis using September 2021 satellite imagery observed 10 of the 36 large oil tankers with oil leaks and spills. Tainted discharges and spills into the sea were coming from three outlets, two of natural origin and one constructed to discharge water from an on-site water treatment plant. There are also concerns around the wider problems with untreated discharges of sewage and wastewater from public and industrial water infrastructure ending up in the sea at various locations. Dump plumes and oil spills into the marine environment can be observed with satellite imagery, and in this Environment and Conflict Alert, we will demonstrate how the increase of noted spills and other substances visible on the water surface around Baniyas heralded an environmental disaster.

Methodology

Detecting & identifying potential pollution sources such as oil can be conducted through both optical and radar remote sensing. To map the foreign substance on the water surface, visual interpretation was applied with optical sensors. The main identification criteria were reflectance, pattern or shape and location. The reflectance values contained in each band are also useful in these exercises. For example, some infrared bands showed high sensitivity to the presence of oil, additionally (clean) water absorbs almost all incoming radiation in these wavelengths. This creates a very dark background and highlights reflecting substances floating on the seawater surface. In order to obtain a footprint and some components of an event, different digital image processing methods were applied. This included image classification to determine classes, using a threshold to slice selected bands, and using the relation between bands - indexes and ratios. They gave some results but did not hold for all scenes and/or conditions.

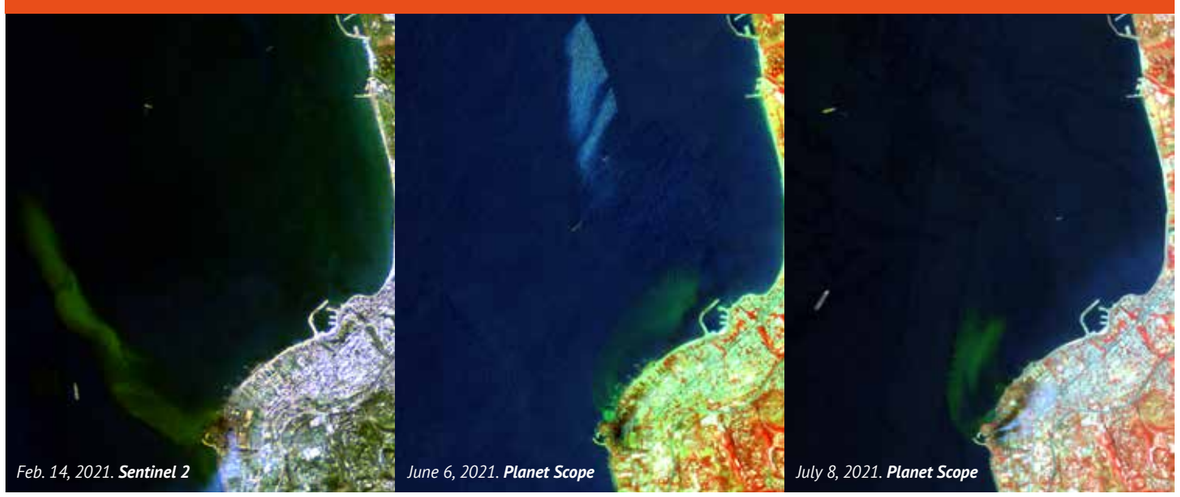
We used NOAA Guidelines on Open Water Oil Identification, Rajendran et all (2021) Oil Spill Identification methods in optical imagery for identification, and where possible collaborated with open-source imagery from Baniyas on the reported dates. Synthetic Aperture RADAR (SAR) imagery is often used to identify oil spills and was also used in our analysis. When present, oil reduces the water surface roughness, which can be detected with SAR sensors and used indication for an oil spill. Here we used two Sentinel-1 scripts to help with identification, including a Water Surface Roughness Visualization code by Anna Maria Luongo and the Oil Slick and Red Tide Monitoring code by TIZNEGAR.

To study and map the floating substances and water patterns several sensors were used. This included Planet Scope, MAXAR's World View, ESA's Sentinel 1 & 2, and

Oil leaking from Single Buoy Mooring Station at Baniyas coast, July 27 2019

August 27, 2021 Source: Facebook

Observed waste water discharges, **Baniyas, Syria**



Feb. 14, 2021. ***Sentinel 2*** *June 6, 2021.* ***Planet Scope*** *July 8, 2021.* ***Planet Scope***

Environment and Conflict Alert 4

***Baniyas**: An Environmental Disaster in the Making*

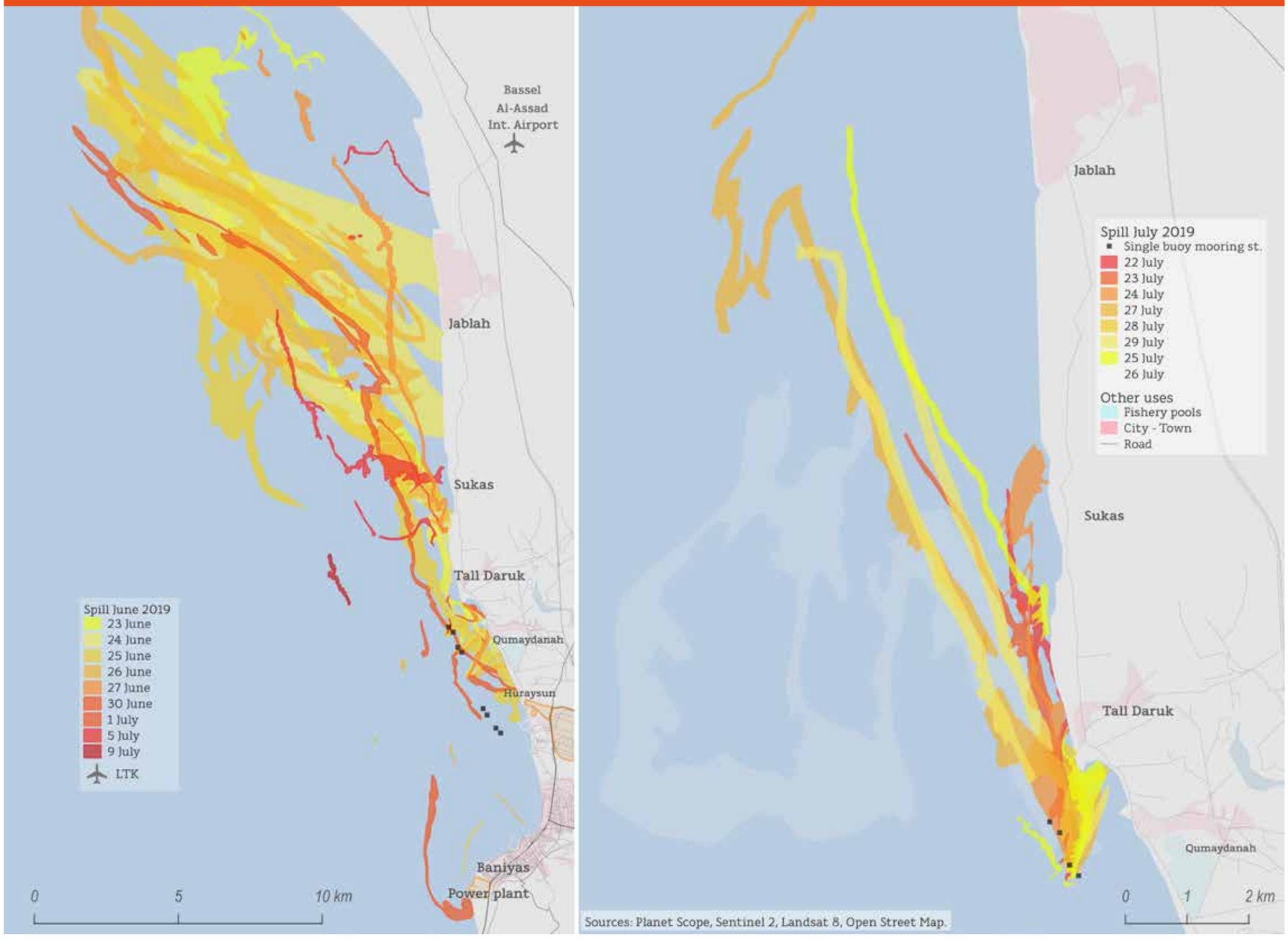
Peace. Are you in?

NASA's Landsat and MODIS. The temporal window was defined between 2019 and 2021. Imagery was selected from known spill dates reported on social media and regular news. Other cases were not reported, but through image inspection (mainly Planet & Sentinel catalogue) there was evidence of an unidentified substance in the bay of Baniyas. In some observations there was not clear evidence of oil or other pollutants, but still a suspicion of foreign substances in the water; these cases were cataloged as lower certainty.

Because remote sensing responds to the physical characteristics of the earth's surface – including water -- different water densities can cause differences in the water patterns in some cases very similar to drifting spills and plumes caused by pollutants. Different concentrations of dissolved and/or suspended materials and varying temperatures determine water density. Discharges from warm water – causing thermal pollution – can change water reflectance. At the same time cooler water from rainfall and sediment plumes from rivers and streams also cause differences detectable with remote sensing. Mining along a stream or river inputs more sediment into the run-off creating larger plumes. These can be detected with both optical and radar imagery.

A geodatabase was compiled with the 'water anomaly events', containing the observed extent, date, sensor and certainty of the interpretation. Drift distances of the observed spills were measured to quantify the spill sizes. Additionally, apart from the discharge plumes and evident oil spills, other layers were constructed for the study area. For example, a land-water layer was created, as well as differentiations for urban & populated areas, other uses like fishery and mining, the refinery and thermal plant perimeters, storage oil tanks, discharge outlets, water treatment plant tanks & pools, streams, rivers, single buoy mooring stations, and some tankers.

Observed oil on surface near **Baniyas, Syria,** june / juli 2019

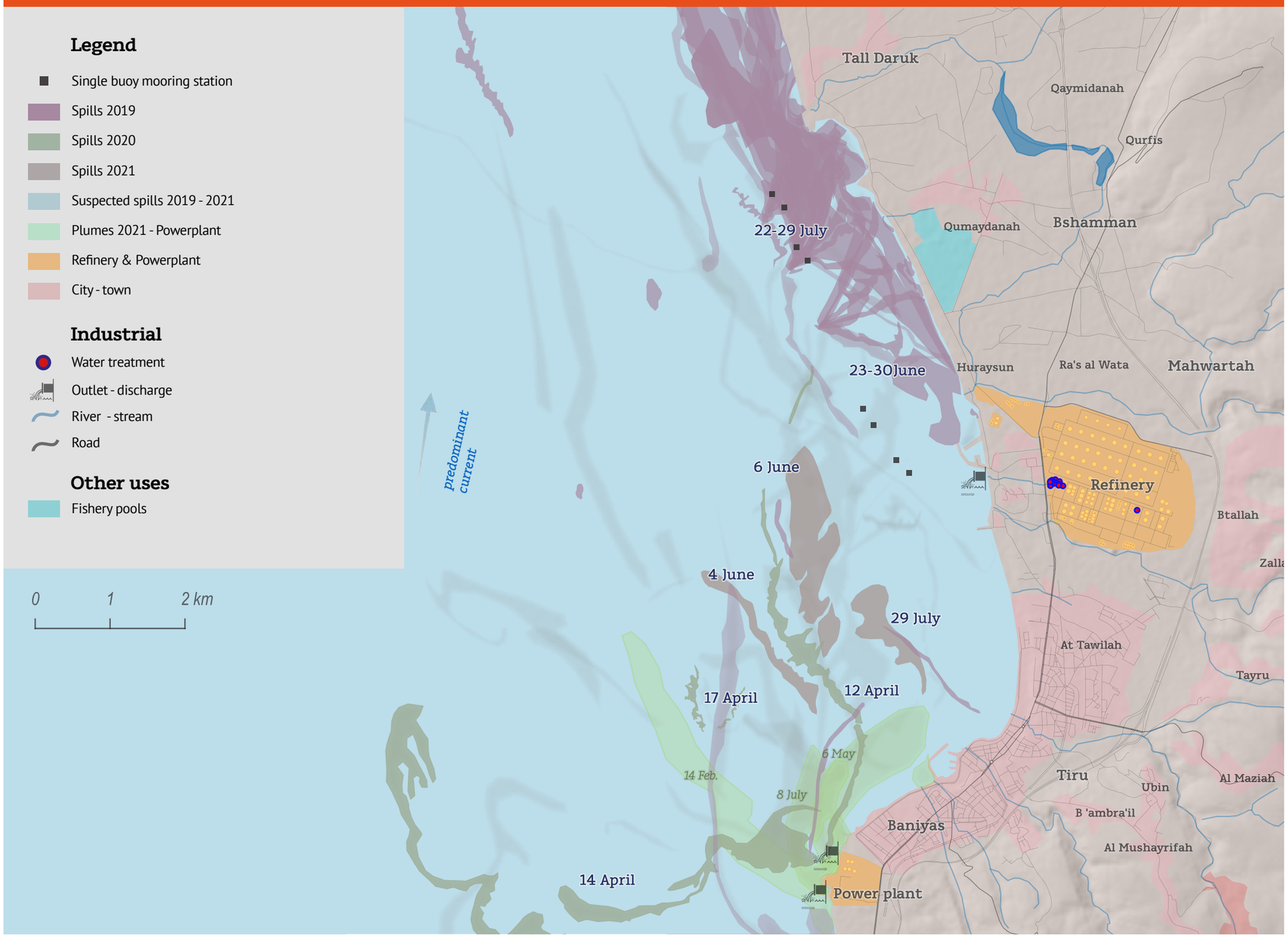


Environment and Conflict Alert 4

***Baniyas**: An Environmental Disaster in the Making* 5 of 6

Peace. Are you in?

Oil and waste water activities, **Baniyas, Syria,** 2019 / 2021



Main Findings

Over the course of the period between June 2019 and September 2021, our remote sensing analysis noted an increase of oil and wastewater spills in the Baniyas bay, causing marine and coastal environment pollution and posing risks to public health and livelihoods.

There are various pollution sources and dynamics evident in the study area, including on land from the TPP and the refinery and on water from the SBMS and tankers.

From the TPP, we observed 2 outlets that indicate oil and wastewater discharge prior to the August 2021 major oil spill. Particularly noticeable was an increase of discharges in the period of February to July 2021, possibly indicating a structural problem with wastewater treatment considering the visual clues of oil contaminants. Various discharges with unknown substances are evidenced which create a deeper mix in the water. The image in the middle shows oil and the other substance in one scene and how different their reflectance is. There are other dates when plumes are evident (such as May 14th, July 12th and 14th, and August 18th and 19th) and where blobs of the same apparent substance are visible in small pockets on the coast and between breakwaters.

The largest oil spills linked with the oil infrastructure followed the 2019 explosions at the SBMS underwater pipelines off the coast, with observed spills in the period June 23rd-July 9th, 2019 spreading oil over 30 kilometers. The same location witnessed another spill from the pipelines on July 22nd-July 29th, 2019, again reaching over 20 kilometers. Fall out of this leak is seen on the left side.

Environment and Conflict Alert 4

Baniyas: An Environmental Disaster in the Making

Peace. Are you in?

Other spills were also observed from various Iranian oil tankers, which was likely to be discharged fuel oil, contaminated ballast water, or residue spills from off-loading at the oil terminal SBMS.

The August 23rd Oil Leak at the Baniyas Thermal Power Plant

The massive heavy fuel oil spilling out of the TPP oil storage tanker was tracked for weeks with various remote sensors. A thick oil stream stretched out from Baniyas was taken by the current all the way northwest to Cyprus and Turkey. Heavy oil washed up on the shores north of Baniyas all the way up to Latakia, while other streams dispersed, diluted or formed tar balls that were spotted on the shores of Cyprus and Turkey. Considering the general current circulation of the Mediterranean, the pollution from the study area will likely predominantly drift northwards in the direction of several important ecosystems. The beaches, barrier reefs and dunes of Latakia have been already affected, while the pollution could reach the many coastal lagoons, reefs, dunes and wetlands of the Seyhan and Gosku deltas at the northeast of the Mediterranean Sea in Turkey. Oil has also reached the coasts of northeast Cyprus, where the Karpaz Peninsula, a unique nature reserve, was at particular risk from the oil spill.

Public Health and Environmental Impacts

Syria's coastal ecosystems are host to hundreds of fish species, sea turtles and sea mammals, according to country's report to the Convention on Biodiversity.

For the normal and present biodiversity in the study area pollution is likely to affect benthic and shore organisms. Even the fisheries at the artificial fish farms of Masab Al Sin north of the refinery could be exposed to pollution at drift and accumulating on the beach. Further inquiry would be required to understand the risks to the aquifer and groundwater resources, as well as for other activities like fishing along the shoreline and in the ocean. The sustained spills and wastewater releases pose a direct risk for aquatic life and impact livelihoods from degrading fish populations and a general loss of biodiversity from dying mammals and other wildlife, including the possibility of the disappearance of entire species.

The Mediterranean coastline is world-famous and popular for its tourism, attracting large crowds to swim in the sea and enjoy its long beaches. Exposure to seawater contaminated by ongoing oil spills and untreated wastewater dumping can pose acute human health risks, while accumulation of heavy metals in the marine environment can enter the food web through consumption of fish and seafood. These concerns are also reflected by international environmental organizations such as the World Wildlife Foundation and the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) and local environmental organisations in Cyprus. Despite efforts to contain oil spills by local authorities in affected States, with the rapid degradation of oil infrastructure combined with the ongoing risk of kinetic attacks against ships and pipelines, the next environmental catastrophe is likely lurking around the corner. Moreover, it would likely pose serious long-term public health and environmental risks that could affect the coastal areas and the lives and livelihoods of those living there for decades to come.

1 Development of August 23 spill drift

Workers clean up oil south on Baniyas, source: Facebook