A "vessel of opportunity" skims oil spilled after the Deepwater Horizon well blowout in the Gulf of Mexico in April 2010 (NOAA Office of Response and Restoration 2010).

Global Offshore Monitoring Progress Report

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SKYTRUTH

About SkyTruth

SkyTruth is a technology-driven nonprofit with a mission to protect the environment by making more of it visible. We do this by using satellite imagery and remote sensing data to identify and monitor threats to the planet's natural resources such as offshore drilling and oil spills, urban sprawl, fracking, mountaintop removal mining, and overfishing of the oceans.

We are driven by the belief that better transparency leads to better management and better outcomes. By sharing our findings—stunning imagery and robust science-based data—with the public for free, we move policy makers, governments and corporations towards more responsible behavior in the environment. We arm citizen activists with the tools they need to be more effective advocates. We also provide researchers and scientists with critical data that can inform groundbreaking work – and, notably, aid in the effort to begin asking a new set of questions.

SkyTruth's Ocean Monitoring Program

SkyTruth traces the start of its Ocean Monitoring Program to BP's Deepwater Horizon oil spill. In April 2010, the Deepwater Horizon exploded in the Gulf of Mexico, killing 11 men and setting in motion the largest accidental oil spill in history. Using imagery provided by NASA's MODIS satellites, SkyTruth was the first to publicly challenge BP's inaccurate reports of the rate of oil spilling into the Gulf. Based only on the oil that appeared on the surface, we calculated the rate of flow from the gushing well was between five and twenty-five times more than BP was reporting. As the disaster unfolded, we continued to document the spill on satellite imagery, and our images and calculations thrust SkyTruth into the spotlight.

Challenging BP's estimates brought major media attention to our mission and demonstrated the role that remote sensing has to play in understanding environmental issues. We demonstrated that imagery is a valid and valuable tool for detecting and analyzing oil spills/slicks in the ocean. So, in the summer of 2017, SkyTruth embarked on an ambitious new project: to systematically identify and monitor 'hot spots' of oil pollution in the world's oceans. Using freely available satellite imagery resources, we have been able to identify and map 'hot spots' of three major sources of oil pollution threatening the health of the world's oceans and coasts: the illegal dumping of oil at sea (also know as *bilge dumping*), persistent leaks from aging or damaged infrastructure, and extended vessel anchorages where dozens of small spills and leaks on a nearly daily basis create chronic pollution conditions.

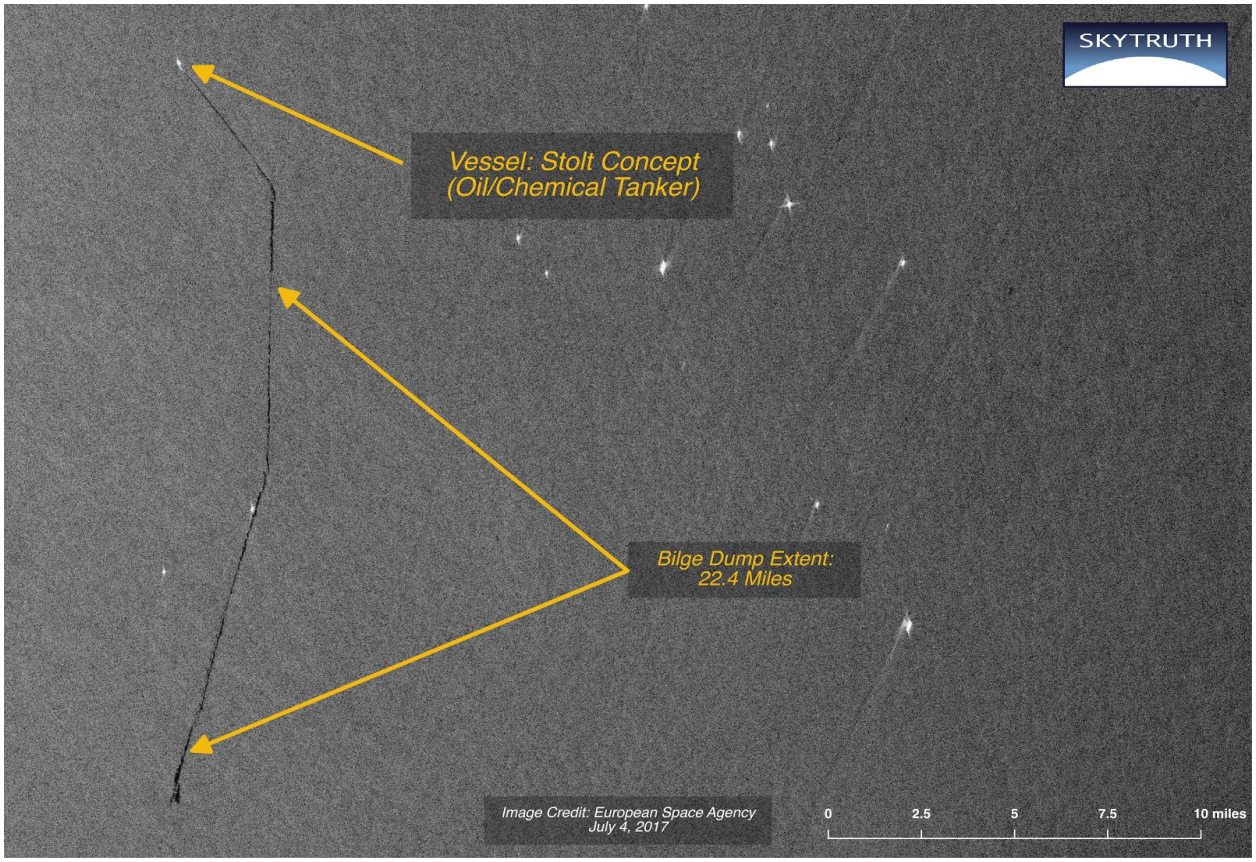
In this brief progress report, we highlight the unique challenges for addressing each of these sources of marine oil pollution. First, we investigate bilge dumping off the coast of Malaysia and Angola. Next, we examine the impact of aging and leaky oil infrastructure in the Gulf of Mexico and the Caspian Sea. Finally, we explore the chronic pollution conditions created by vessel anchorages off the coasts of the United Arab Emirates (UAE) and Singapore.

Case Studies | Bilge dumping in Malaysia and Angola

Bilge dumping is the practice of illegally dumping oily "bilge water" at sea. Most modern cargo and container vessels use heavy bunker oil for fuel, and it produces a thick, oily sludge when burned. The majority of this sludge—along with most of the waste from the ship—drains into the bottom of the vessel, into an area known as the *bilge tanks*. The bilge tanks need to be emptied regularly. International law specifies the proper handling of bilge water, but the unfortunate reality is that it is usually cheaper and easier to bypass costly pollution prevention equipment by simply flushing the bilge tanks directly into the sea.

Bilge dump from the *Stolt Concept*, coast of Malaysia:

Malaysian waters are some of the busiest in the world: the Strait of Malacca lies off the western coast of the Malay peninsula, the Port of Singapore sits at the southern tip of the peninsula, and the South China Sea sits between the Malay peninsula and the island of Borneo. Roughly



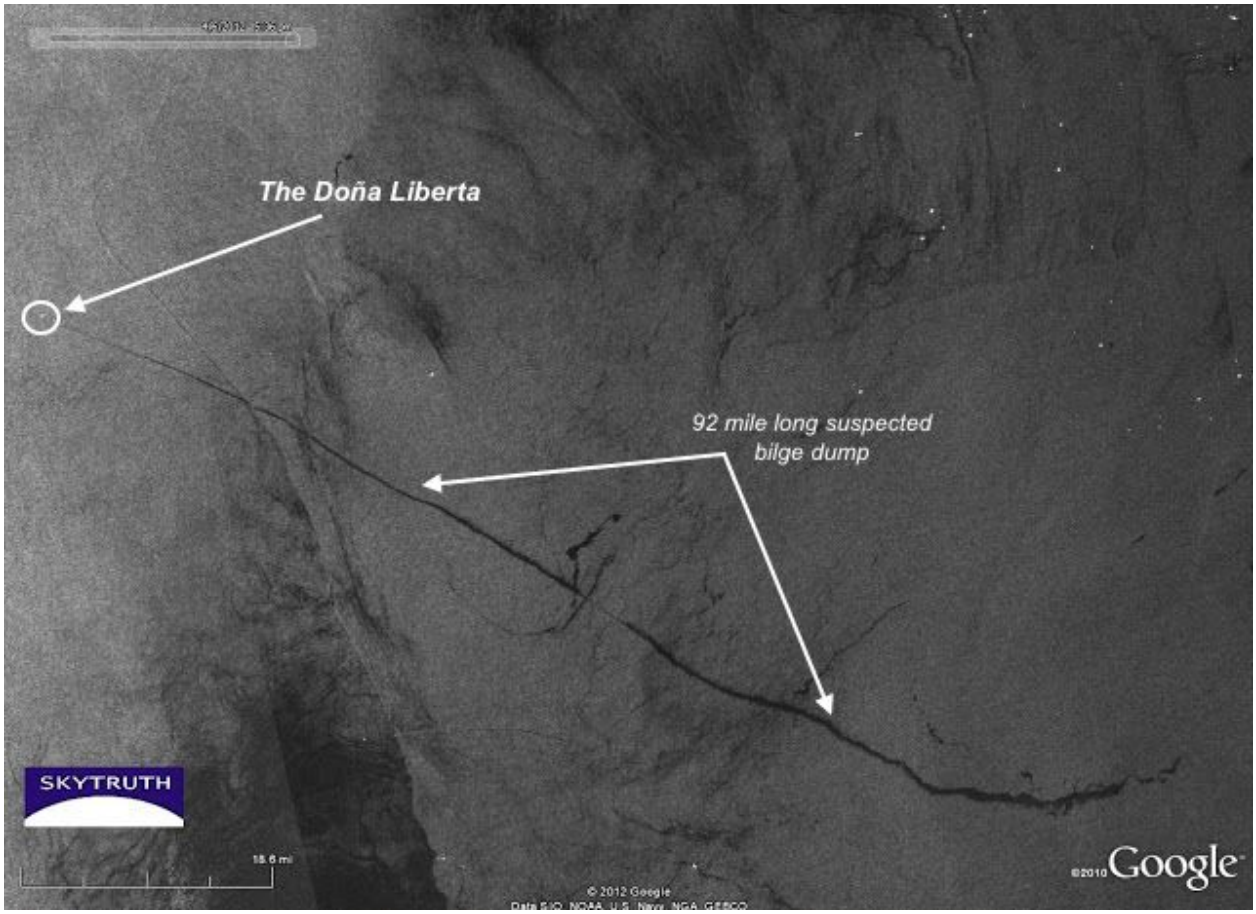
A 22.4 mile long suspected bilge dump by the Stolt Concept off the eastern coast of Malaysia. July 4, 2017.

one-third of global marine traffic passes through this part of the ocean (Khasawneh 2016). We've detected a number of pollution events off the coasts of Vietnam and Malaysia, where our analysis indicates bilge dumping is a long-standing issue. The image above was collected by

the European Space Agency's Sentinel-1 satellite on July 4, 2017. It shows the *Stolt Concept*—an oil/chemical tanker—at the end of a 22.4 mile long slick located roughly 50 miles off the eastern coast of Malaysia. The linear character of the slick, coinciding with the vessel's line of travel, strongly suggests this is the result of intentional bilge discharge directly into the ocean while the vessel was underway.

Bilge dump from the *Doña Liberta*, coast of Angola:

Angola has experienced rapid offshore oil development over the last two decades. Much of this development has taken place in offshore Block 17, described as Angola's 'Golden Block' (Total 2015). The radar image below was collected by the European Space Agency's Sentinel-1 satellite on April 6, 2012. The bright spot at the left end of the oily slick is the *Doña Liberta*, a refrigerated cargo ship owned (at that time) by NaviFruit LTD.



A 92 mile long bilge dump by the Doña Liberta off the coast of Angola. April 6,2012.

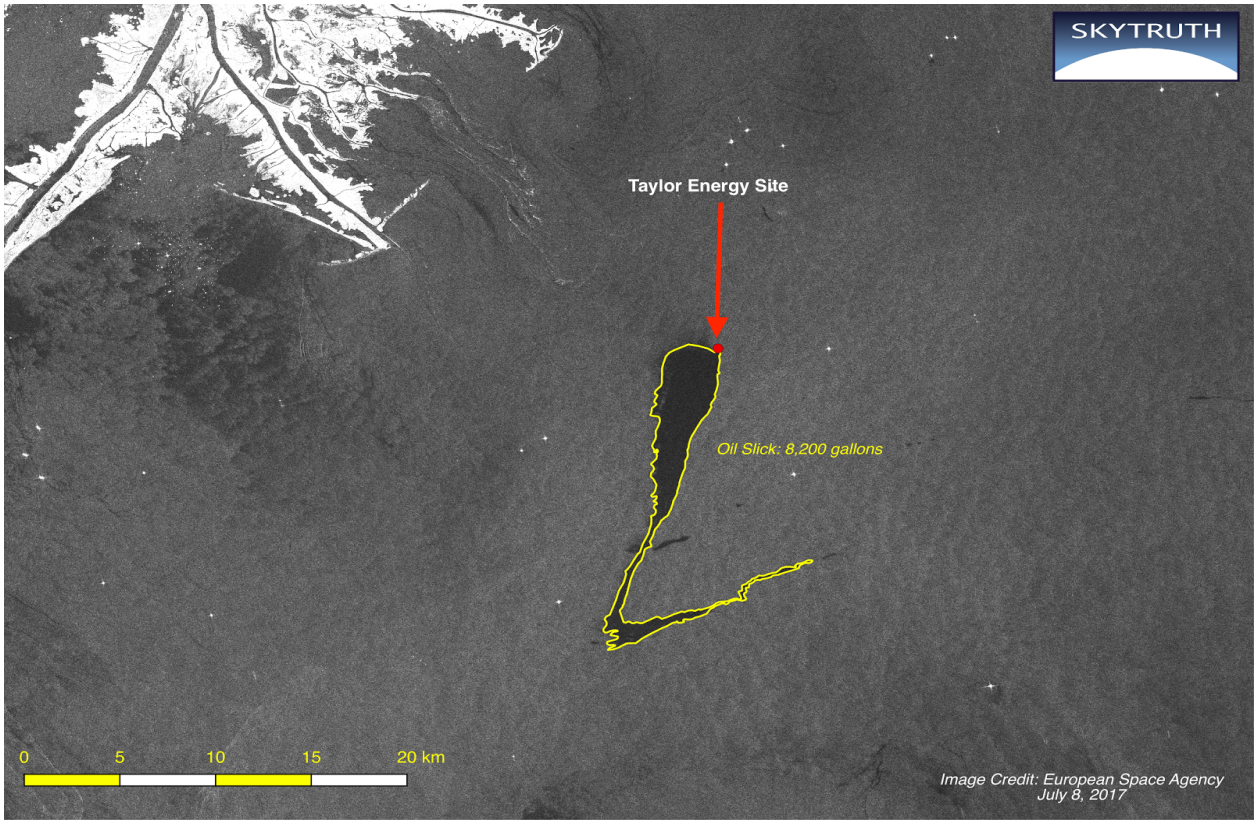
This vessel has made unfortunate news in the past. On July 4, 2011, the ship's captain dumped two Tanzanian stowaways in Liberia's territorial waters, strapped to empty barrels. One of the stowaways died while receiving medical treatment after washing up on shore. In February 2012, the *Doña Liberta* spilled oil in England's River Fal, prompting a cleanup response from local authorities (Barnett 2012).

Case Studies | Aging and leaky infrastructure in the Gulf of Mexico and the Caspian Sea

Offshore oil production requires massive infrastructure. There are numerous points throughout the production cycle where spills or leaks can happen: a subsea network of pipelines and flowlines carry oil to risers, which then carry it up from the seafloor to a production platform or a floating production, storage, and offloading facility (FPSO) at the surface. From there, large pipelines or shuttle tankers move the oil to refineries and markets onshore. Spills and leaks due to human error and mechanical failure are possible at every step of this process. Age, severe weather conditions, and insufficient maintenance magnify the risk.

Taylor Energy Site, Gulf of Mexico:

In 2004 Hurricane Ivan destroyed an oil platform operated by Taylor Energy, located 19 km off the tip of the Mississippi Delta. After the storm, the platform ended up on the bottom of the ocean, 900 feet from its original location.



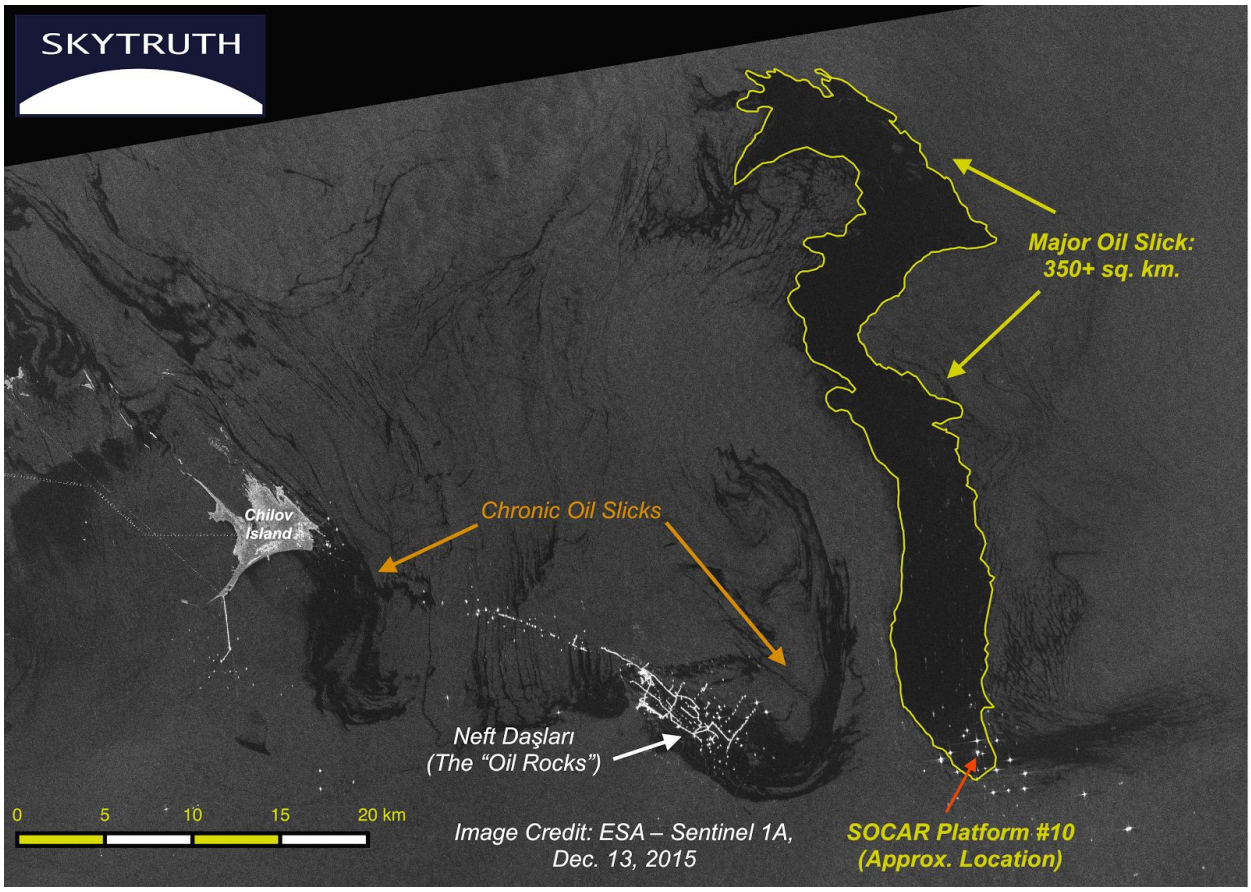
Chronic leaks from the downed Taylor Energy platform in the Gulf of Mexico. July 8, 2017.

More than 20 wells had been connected to the platform, and some immediately began leaking oil into the Gulf (Donaghy 2016). SkyTruth discovered the chronic slick coming from this site after BP's Deepwater Horizon disaster brought added scrutiny to the region in 2010, six years after the leaks began. The radar image above was collected by the European Space Agency's

Sentinel-1 satellite on July 8, 2017, demonstrating that the leaks continue unabated to this day. Assuming the average thickness of the oil is at least 1 micron, this image captures a slick that contains at least 8,200 gallons of crude oil.

Neft Daşları (The "Oil Rocks"), Caspian Sea:

Neft Daşları is a massive offshore industrial oil production settlement in the Caspian Sea. First constructed in 1949 and comprised of hundreds of interconnected drilling platforms, the "Oil Rocks" is the world's first—and now oldest—operating offshore oil field. The facility is owned and operated by the State Oil Company of Azerbaijan Republic (SOCAR). In December 2015,



Chronic leaks from Oil Rocks and a major oil slick detected from SOCAR Platform #10. Bright spots are platforms and vessels. December 13, 2015.

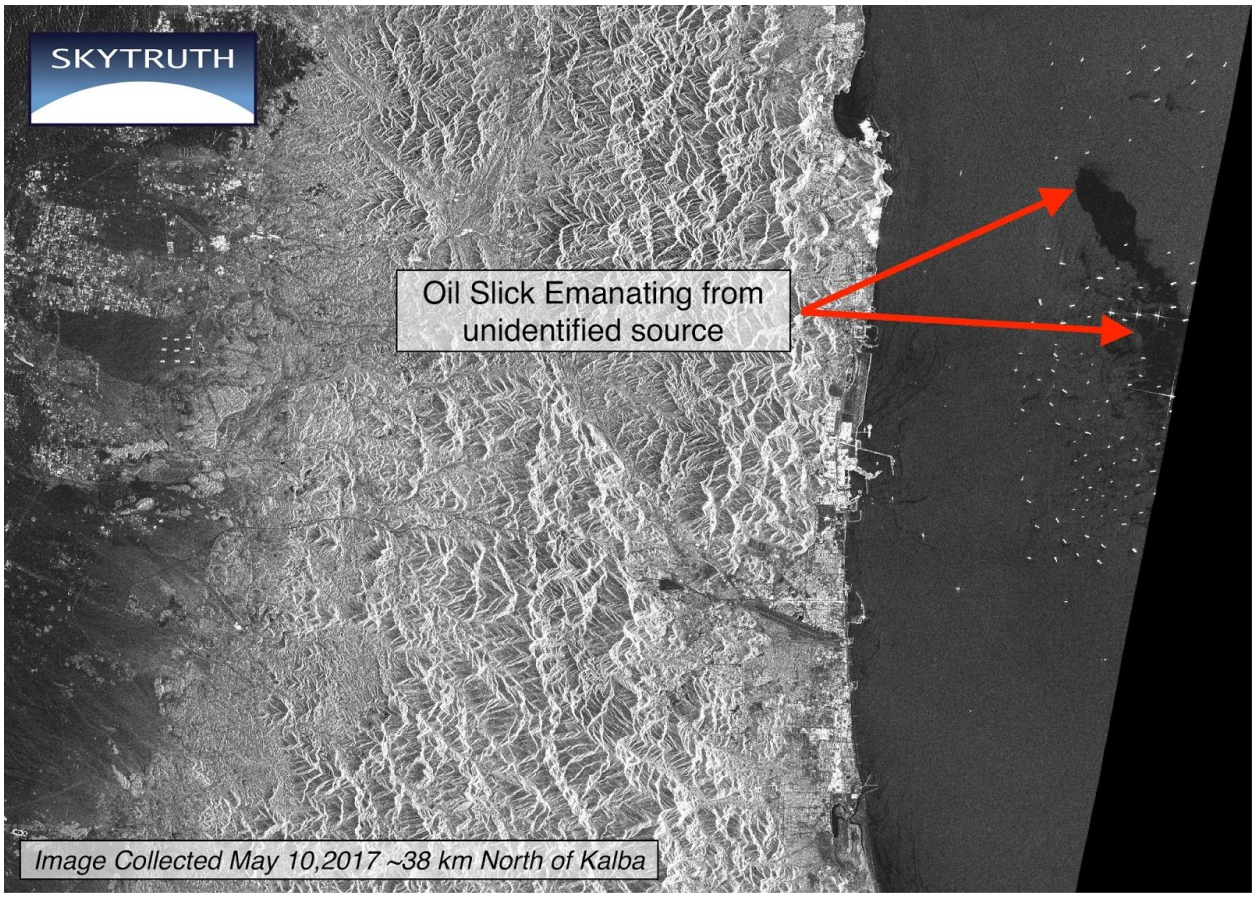
Oil Rocks made international headlines when three workers were reported missing after part of the living quarters fell into the sea due to a heavy storm. That same day, seven workers were killed, 23 reported missing, and 33 were rescued and evacuated when a fire broke out on Platform No. 10 at the western section of the Gunashli oilfield (Bagirova 2015). The radar image above was collected on December 13, 2015. It shows chronic oil leaks from the Oil Rocks along with an estimated 350+ square kilometer slick in the Caspian Sea.

Case Studies | Chronic pollution from vessel anchorages in the UAE and Singapore

Communities near major ports always face increased risk from marine pollution. But ports with large petrochemical refineries and storage facilities pose a unique risk, with tankers regularly anchoring offshore for long periods of time in hopes of a spike in prices (Wallis and Khasawneh 2016). It is unclear how long these vessels remain at anchor, but bunkering and routine maintenance probably occur regularly, and it is not entirely uncommon for us to observe tankers apparently flushing their bilge tanks or cargo holds—sending oily sludge, solvents, or other cleaners into the sea.

Chronic pollution associated with anchored vessels, east coast of the United Arab Emirates:

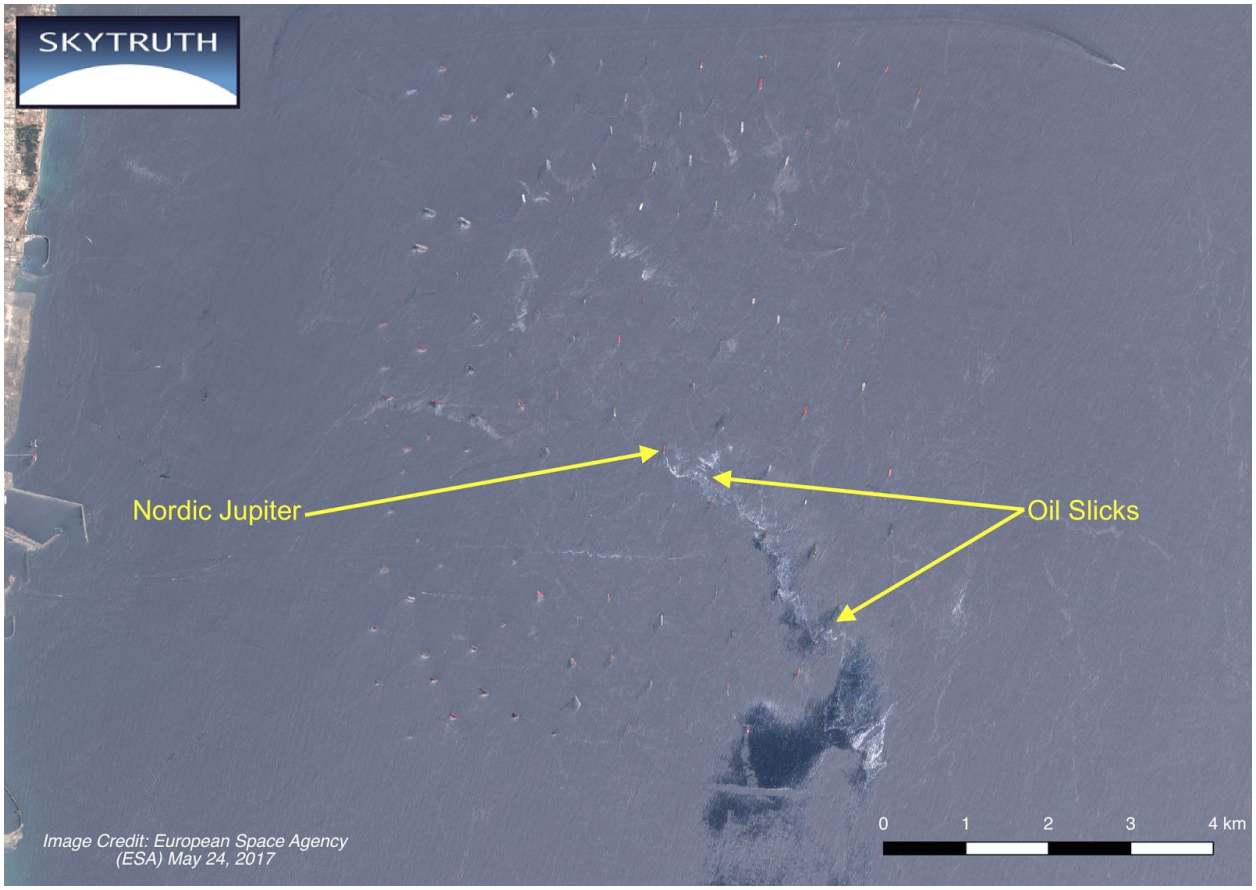
By June 2017, the east coast of the United Arab Emirates (UAE) had already seen four oil spills in three months. According to media reports, two of the spills led to a swimming ban in Al Aqah hotels that lasted for days (Haza 2017a). Just north of the coastal city of Fujairah is a vast



Oil spill from unidentified source in Fujairah anchorage. Bright spots are dozens of large vessels, mostly oil and chemical tankers, lying at anchor. May 10, 2017.

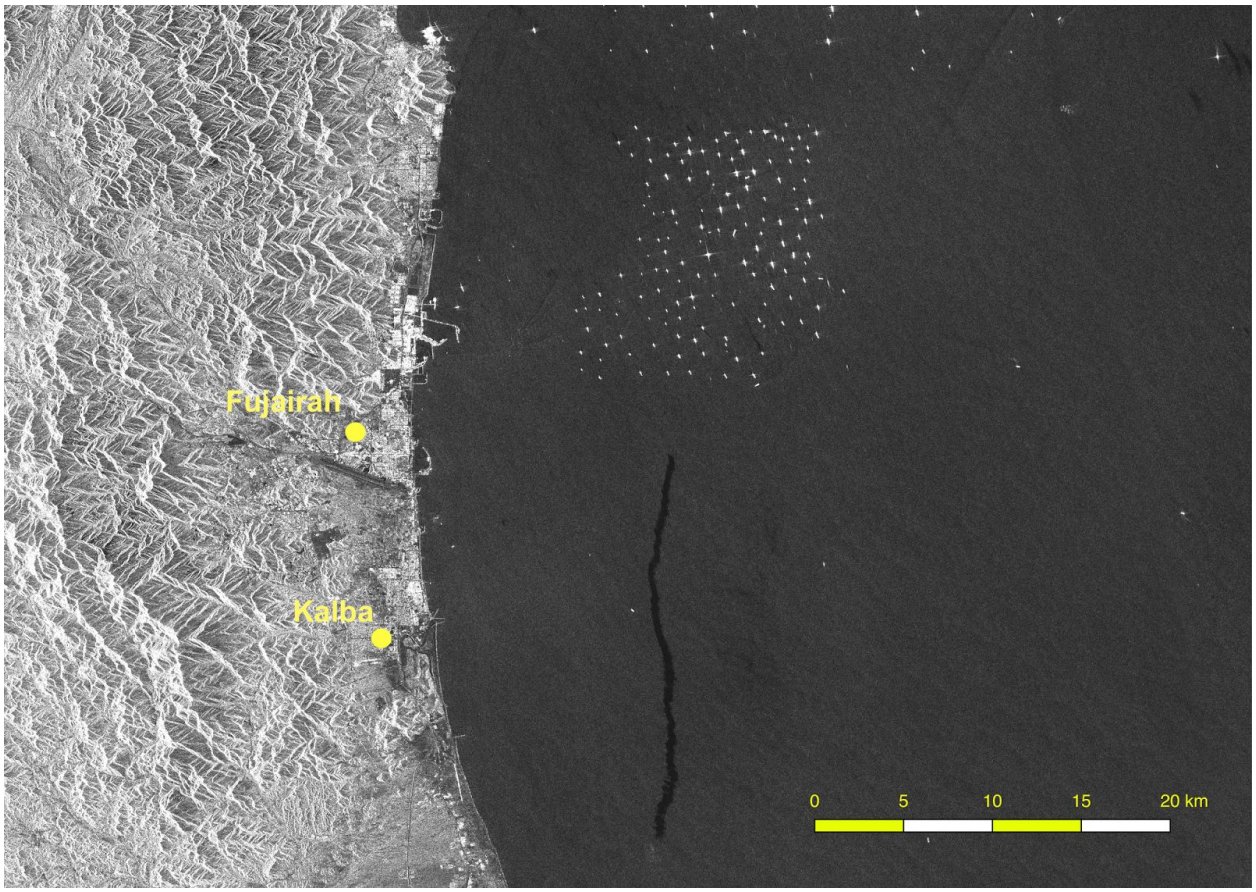
petrochemical complex that includes Fujairah Oil Terminal FZC, IL&FS Prime Terminals FZC (IPTF), and Gulf Petrochem Oil Terminal among numerous others. The radar image above was collected by the European Space Agency's Sentinel-1 satellite on May 10, 2015. It shows a large oil slick from an unidentified source in the tanker anchorage just beyond the 12 nautical mile monitoring responsibility of the coastguards and the port authority (Haza 2017b).

The image below, collected on May 24, 2017 by the European Space Agency's Sentinel-2 satellite, shows the Nordic Jupiter, one vessel which was anchored offshore during the weeks of chronic spills. Oil slicks are also visible on the surface of the water. Although we don't know if the Nordic Jupiter is the source, it seems likely based on this image.



The Nordic Jupiter and oil slicks off the east coast of the UAE. May 24, 2017.

Of particular concern is the Alqurm Protected Area, a globally significant biodiversity area in the coastal areas of Kalba city. The area is characterized by sea water mangroves (*Avicennia marina)*, swamps and salt marshes (sabkhas) and mudflats. The area is recognized by The Convention on Wetlands of International Importance as an important habitat area for rare and endangered species like the local Arabian Collared Kingfisher (*Todiramphus chloris kalbaensis*) (Environment and Protected Areas Authority 2017).

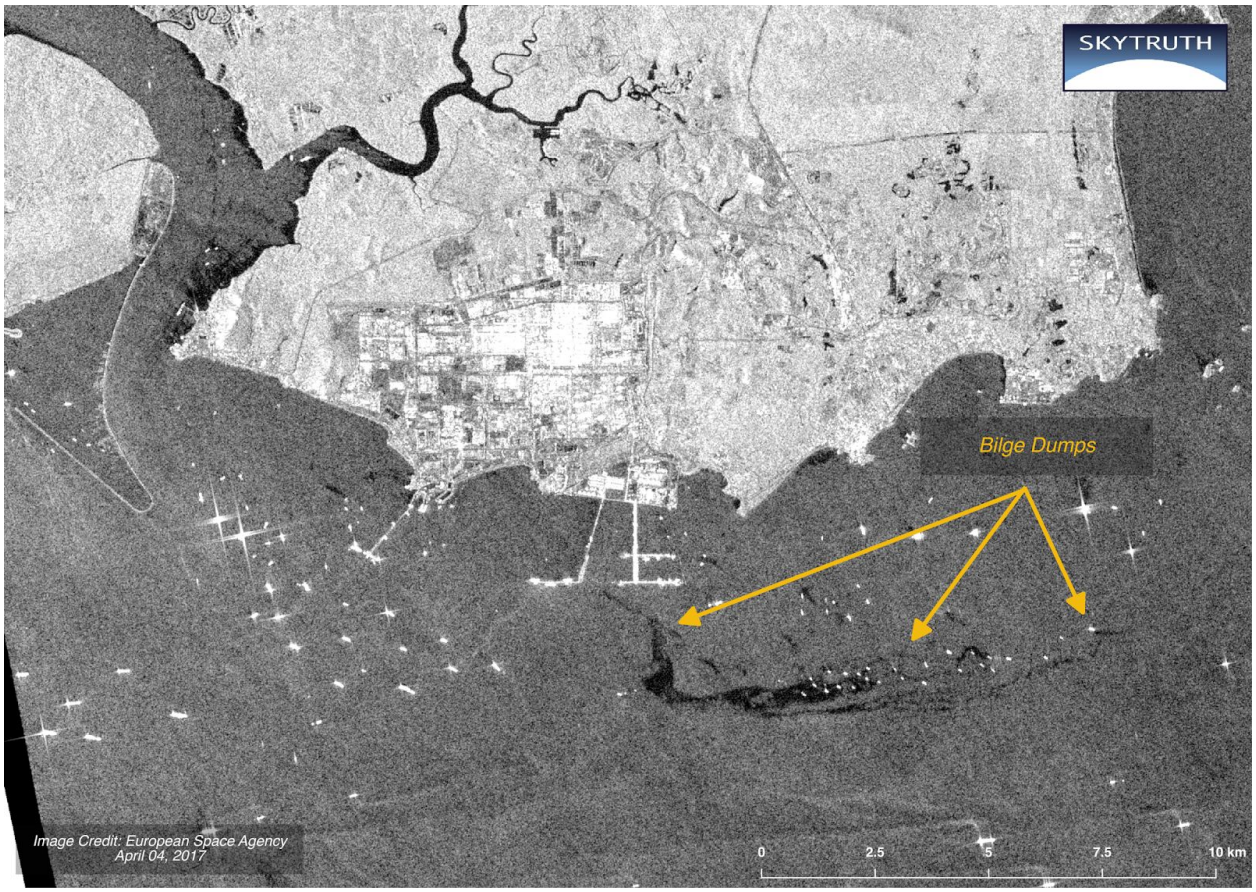


Likely bilge dump from unidentified vessel east of the Alqurm Protected Area . July 18, 2017.

The protected area is threatened by both intentional bilge dumping and the chronic low-level oil pollution that is the result of dozens of small spills associated with bunkering and vessels at anchor. The image above was collected by the European Space Agency's Sentinel-1 satellite on July 18, 2017. The image depicts a probable bilge dump from an unidentified vessel, likely anchored among dozens of other tankers by the time that this image was captured. Bilge dumps like this can be pushed ashore by wind and current, presenting a tremendous risk to the Alqurm Protected Area as well as to local businesses that rely on coastal tourism.

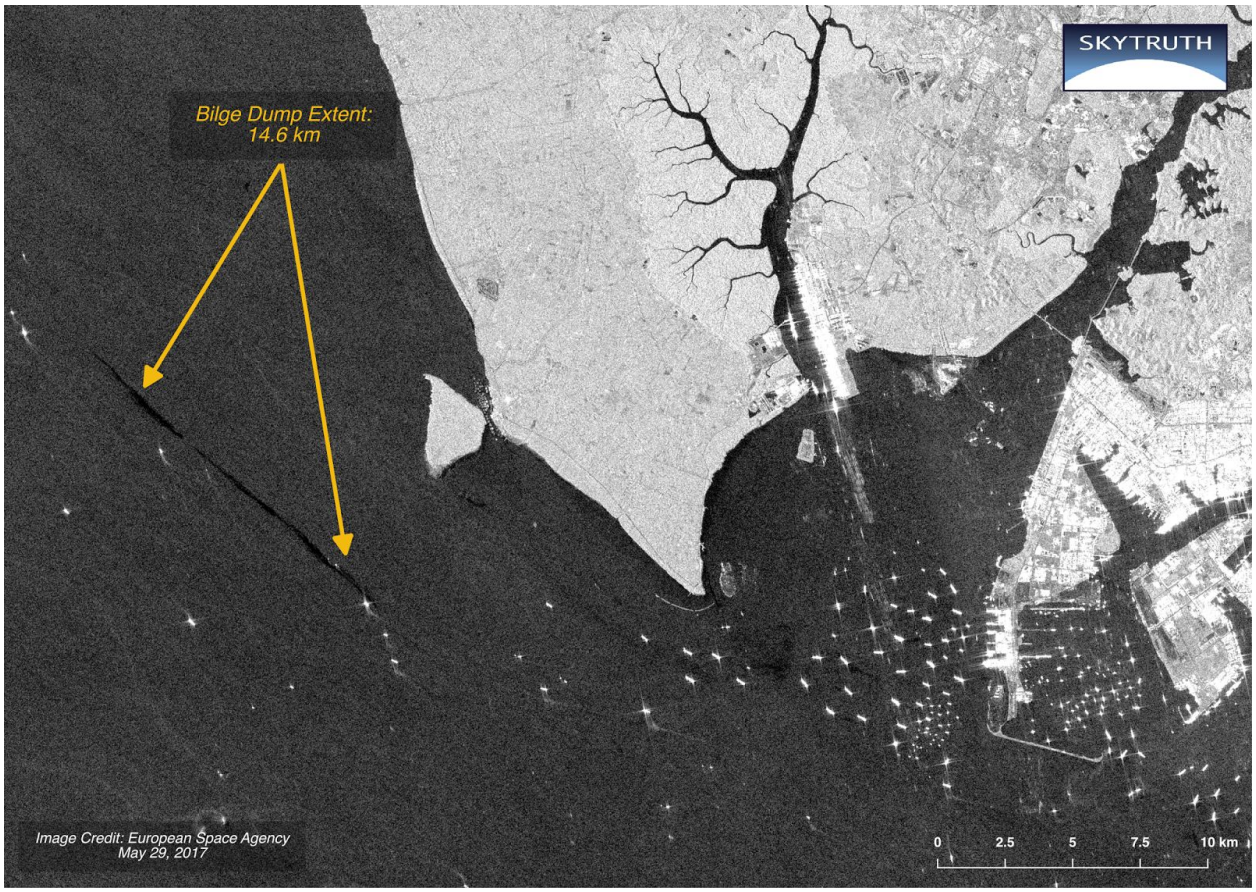
Chronic pollution associated with anchored vessels, Singapore:

The Port of Singapore is the world's second-busiest in terms of total shipping tonnage. More importantly, Singapore is Asia's largest oil-trading hub, with $600 billion in annual oil trade - a third of global oil demand (Khasawneh 2016). The port is also remarkably congested. The image below was collected by the European Space Agency's Sentinel-1 satellite on August 4, 2017. The image depicts slicks from bilge dumps or other leaks among unidentified vessels anchored just outside the port.



Oily slicks associated with unidentified vessels in the Singapore Strait. April 4, 2017.

Additionally, the rapid expansion of Asia's oil market has generated significant new investments in petrochemical industries and infrastructure here. Immediately west of Singapore is Malaysia's massive 'Pengerang Integrated Petroleum Complex' (PIPC). Scheduled for completion in 2020, the PIPC spans 20,000 strategic acres along major international shipping lanes. It will house oil refineries, petrochemical plants as well as a liquefied natural gas (LNG) import terminals and a regasification plant upon completion (Malaysia Petroleum Resources Commission 2017). A principal goal of PIPC is to complement Singapore's oil and gas storage capabilities to create a regional centre for oil and gas services. The image below was collected by the European Space Agency's Sentinel-1 satellite on May 29, 2017. It shows a nearly 15 km long slick trailing an unidentified vessel just west of the port.



Likely bilge dump from unidentified vessel west of Singapore. May 29, 2017.

Next Steps

SkyTruth's global monitoring program demonstrates that freely available satellite imagery resources are an invaluable tool for systematically detecting and monitoring oil pollution in the world's oceans. We have identified and mapped 'hot spots' of three major sources of oil pollution threatening the health of the world's oceans and coasts: bilge dumping, persistent leaks from aging or damaged infrastructure, and extended vessel anchorages which display chronic pollution conditions.

Building from the methods and case studies outlined herein, our goal is to develop a comprehensive daily ocean monitoring platform. Freely available satellite imagery will remain a core resource for this work. However, we also seek to leverage high temporal and spatial resolution commercial imagery resources in order to create a clearer picture of the sources of oil pollution at sea, and to empower and engage environmental advocates to protect their oceans and coasts.

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