

# Environmental cost of rare earth based-technologies

Sentinel-2 MSI acquired on **25 September 2015** at 03:46:36 UTC  
Sentinel-1 CSAR IW acquired on **28 February 2017** from 10:38:20 to 10:38:45 UTC  
Sentinel-3 OLCI FR acquired on **02 March 2017** at 02:20:49 UTC  
Sentinel-2 MSI acquired on **05 December 2017** at 03:31:09 UTC

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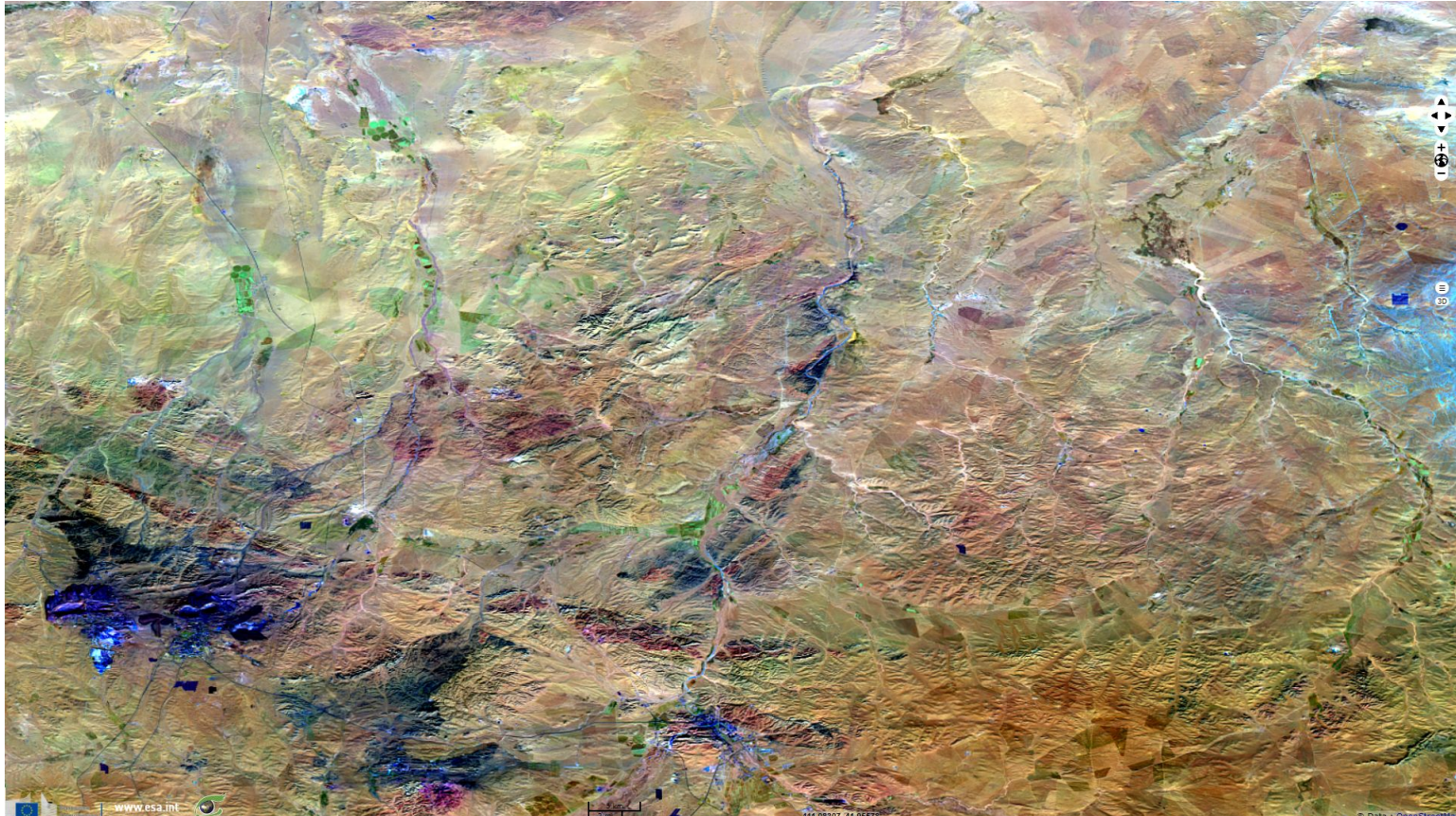
Keyword(s): Land, climate change, urban, environment monitoring, mining, geology, renewable energy, solar, eolian, wind, China



[2D Layerstack](#)

Fig. 1 - S2 (05.12.2017) - 11,8,2 colour composite - South-west of this image, Bayan Obo rare earth mine in Inner Mongolia, China.

[2D view](#)

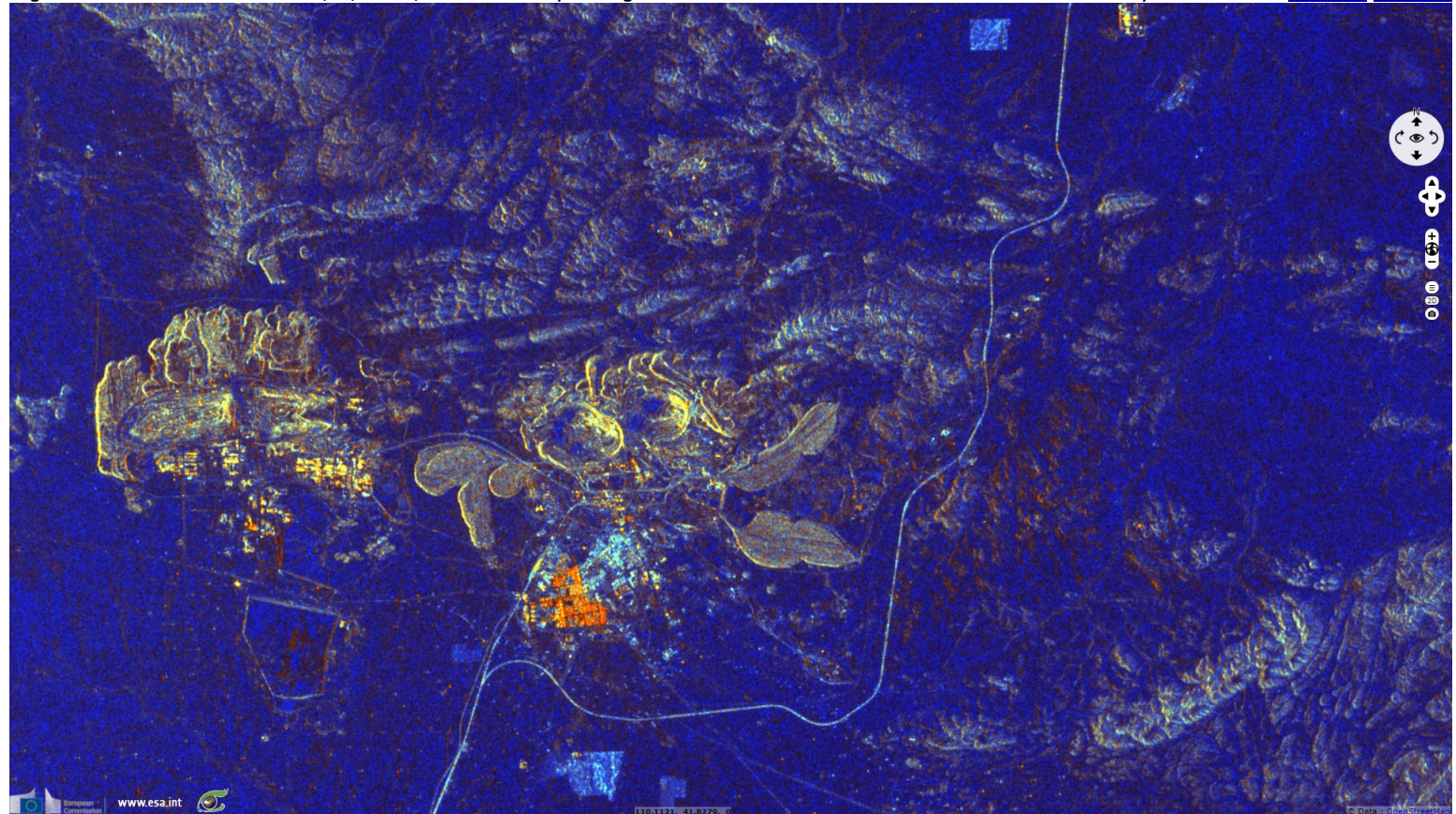


Rare earth is a series of 17 elements classified among metal. Their properties make them desirable for numerous technologies such as catalyst (used in cars), magnets (used in wind farms), alloys (used in batteries), optical lenses, light bulbs, flat screens, laser, superconductors, nuclear reactors, sonar systems... China is supposed to hold around 80% of the World's reserves and produces the overwhelming majority 90% of the rare earth ore worldwide.

In her 2010 article published by [The Cutting Edge](#), Cindy Hurst wrote "*China currently has an iron grip on the REE industry, supplying over 95 percent of the world's needs. This is significant because REEs are used in hundreds of high tech applications, including cellular telephones, laptop computers, iPods, critical military applications, and green technologies. In an effort to reduce dependence on foreign imported oil and natural gas, many countries are turning more and more to green technologies, such as wind powered generators, plug-in hybrid vehicles, and energy saving compact fluorescent lamps, all of which require an abundance of REEs.*"



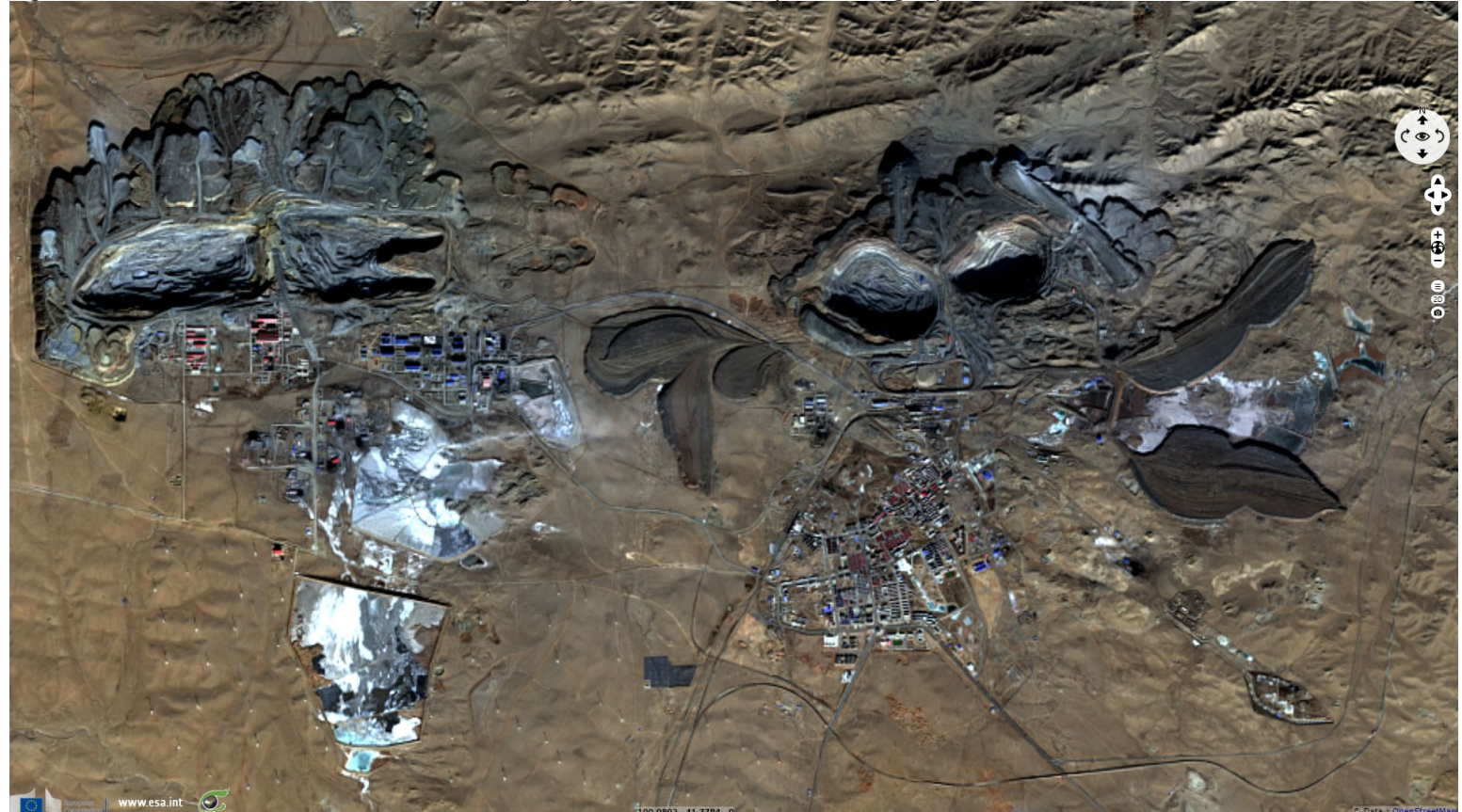
Fig. 2 - S1 IW (28.02.2017) - vv,vh,ndi(vh,vv) colour composite gamma correction - Solar farms north and south of Bayan Obo mine. [3D view](#) [2D view](#)



70% of the World's reserves would be located in Bayan Obo deposit alone, its characteristics are given by [mindat.org](http://mindat.org): "The deposit occurs in an east-west trending Mesoproterozoic rift zone along the northern margin of the Sino-Korean Craton. Host strata are quartzite, slate, limestone, and dolomite. The latter is also the main host rock. The orebodies are stratiform and lenticular, with masses, bands, layers, veins, and disseminations. Besides clear features of hot water sedimentation, the deposit also exhibits Mg, Fe, Na and F metasomatism. Sm-Nd monazite isochron age for bastnaesite and riebeckite is 1200 to 1300 Ma, whereas Th-Pb and Sm-Nd age of Ba-REE-F carbonates and aeschynite is 474 to 402 Ma."

Fig. 3 - S2 (05.12.2017) - 4,3,2 natural colour - The open pits are surrounded by mine tailing & ponds.

[3D view](#) [2D view](#)

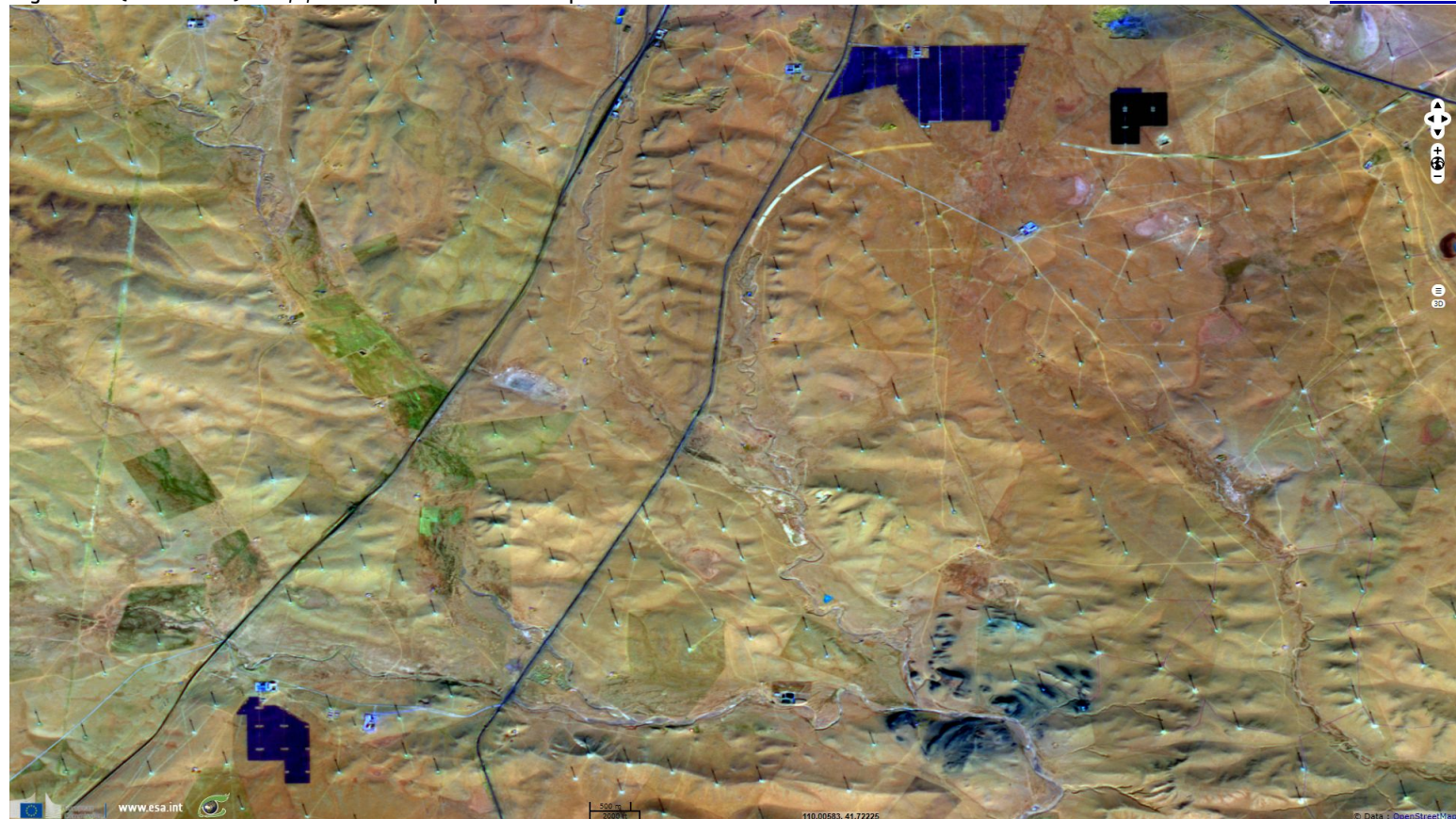


Cindy Hurst [continues](#): "The fact that REEs are needed for green technologies is shrouded in irony because of the potential environmental implications of mining and processing them. Mining and processing REEs presents environmental risks. Whereas the U.S. observes strict environmental policies on mining and other activities, a major concern surrounding China's practice of mining REEs is the negative impact it has had to the environment due to lax mining practices. Unfortunately, because of the revenue potential, many rare earth mines have been operating illegally, or with little supervision and little to no regulation, causing severe environmental hazards."



Fig. 4 - S2 (05.12.2017) - 11,8,2 colour composite - Solar panels & wind turbines south of the mine.

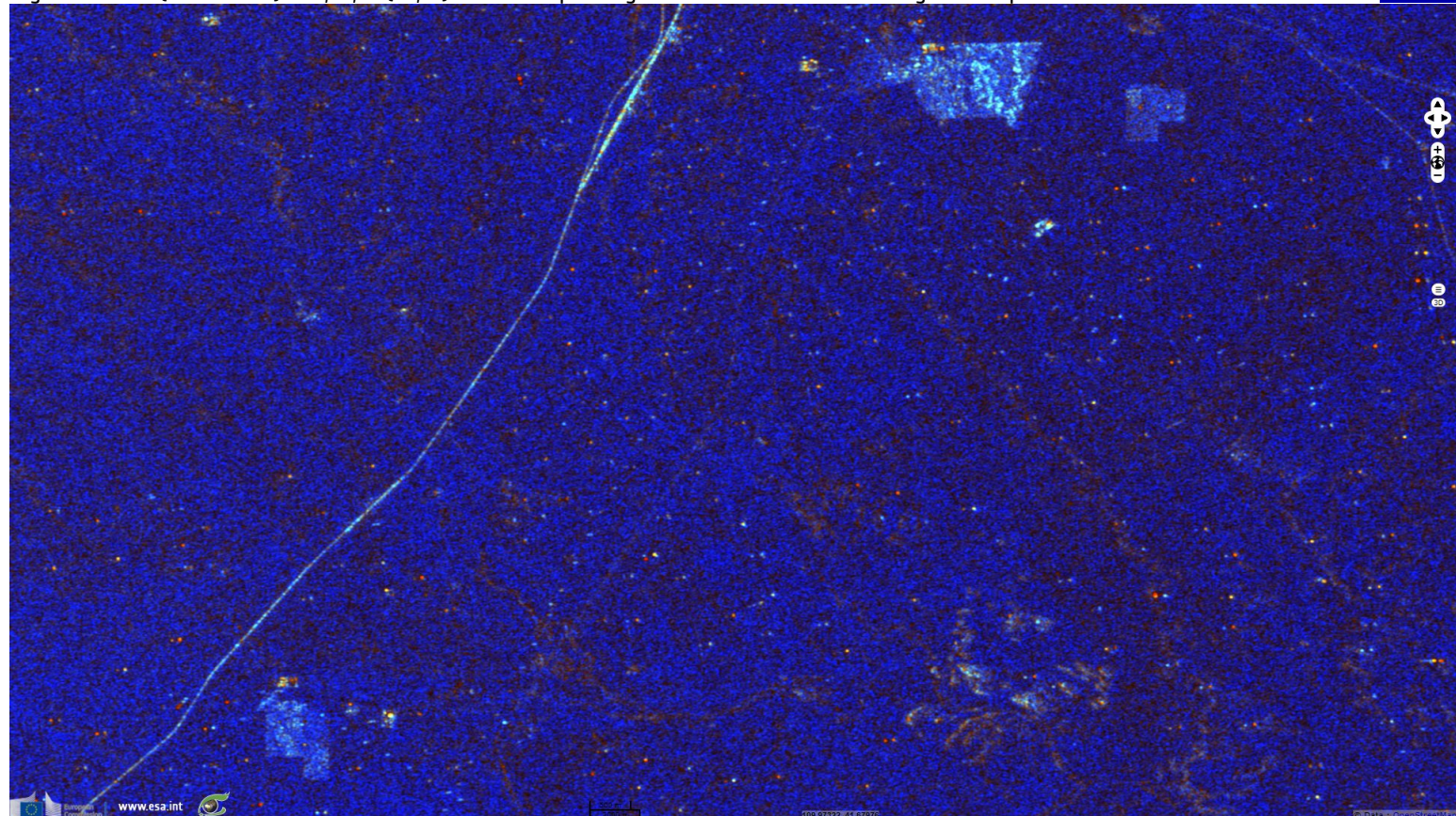
[2D animation](#)



In an article published in 2015 by the BBC, Tim Maughan [wrote](#): "It could be argued that China's dominance of the rare earth market is less about geology and far more about the country's willingness to take an environmental hit that other nations shy away from." Cindy Hurst [backs](#) this with numbers: "According to an article published by the Chinese Society of Rare Earths, 'Every ton of rare earth produced generates approximately 8.5 kg of fluorine and 13 kg of dust; and using concentrated sulfuric acid high temperature calcination techniques to produce approximately one ton of calcined rare earth ore generates 9600 to 12000 m3 of waste gas containing dust concentrate, hydrofluoric acid, sulfur dioxide, and sulfuric acid, approximately 75 m3 of acidic wastewater plus about one ton of radioactive waste residue (containing water).'"

Fig. 5 - S1 IW (28.02.2017) - vv,vh,ndi(vh,vv) colour composite gamma correction - Radar image of the previous view.

[2D view](#)

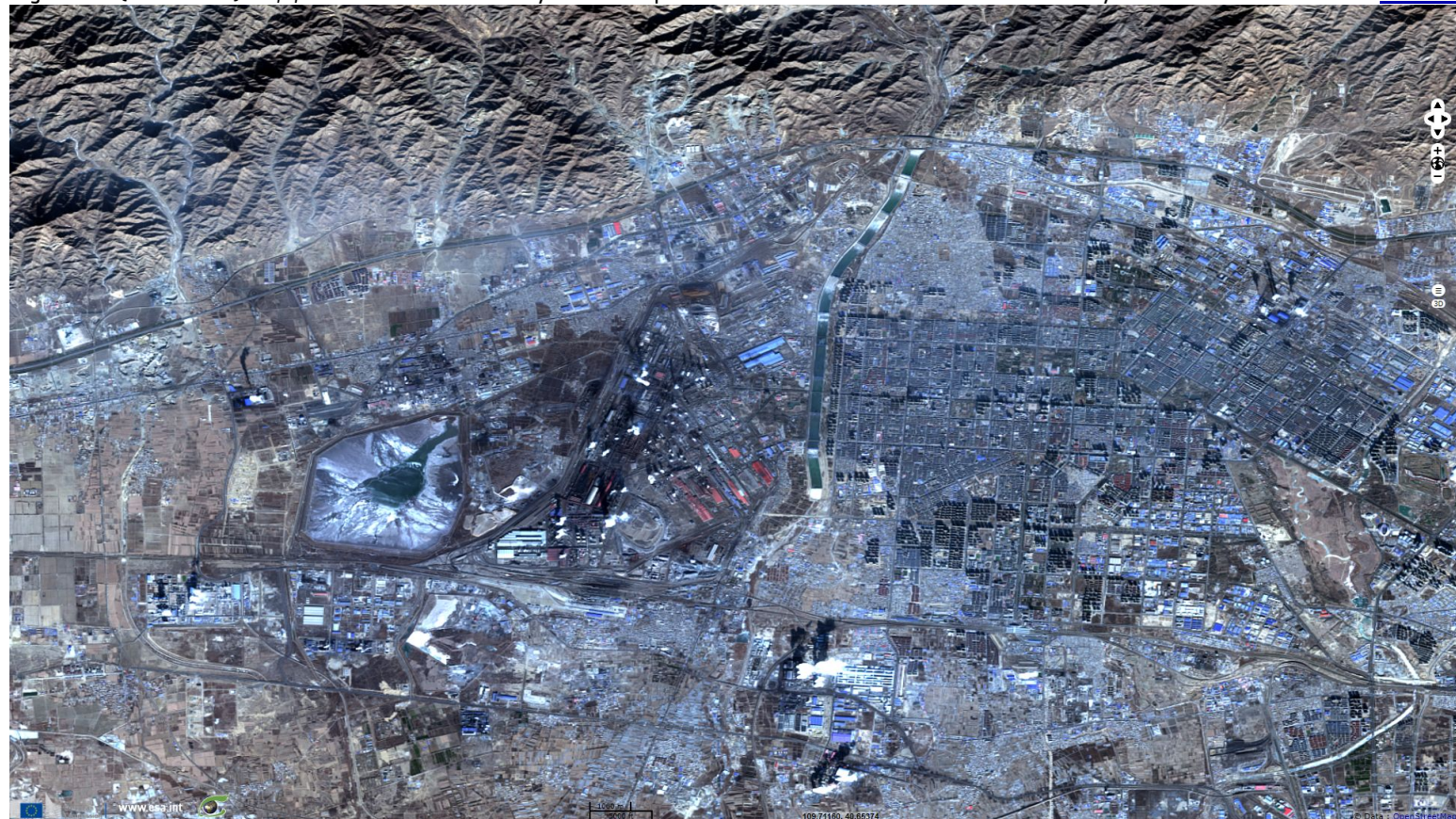


Tim Maughan [added](#): "The disposal of tailings also contributes to the problem. Tailings are the ground up materials left behind once the rare earth has been extracted from the ore. Often, these tailings contain thorium, which is radioactive. Generally, tailings are placed into a large land impoundment and stored. In the United States strict controls are put into place and permits are required to store tailings. According to Wang Caifeng, China's Deputy Director-General of the Materials Department of the Ministry of Industry and Information Technology, producing one ton of REEs creates 2,000 tons of mine tailings. Wang said that China has sacrificed greatly in its extraction of rare earths."



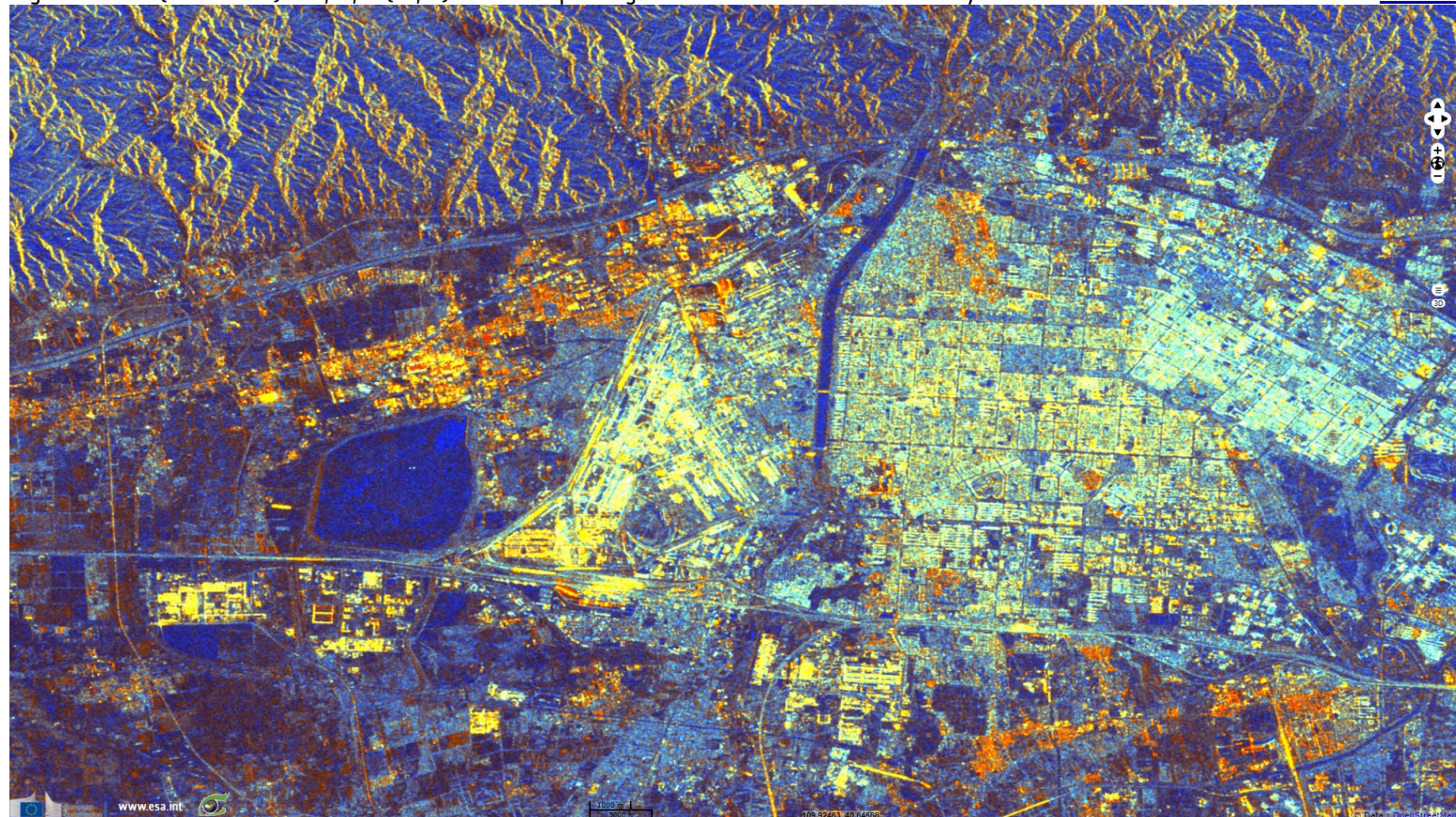
Fig. 6 - S2 (05.12.2017) - 4,3,2 natural colour - The city of Baotou processes the rare earth ore extracted from Bayan Obo.

[2D view](#)



The BBC article then [introduces](#) the city of Baotou where the rare earth material is processed: "In 1950, before rare earth mining started in earnest, the city had a population of 97,000. Today, the population is more than two-and-a-half million. There is only one reason for this huge influx of people - minerals. As a result Baotou often feels stuck somewhere between a brave new world of opportunity presented by the global capitalism that depends on it, and the fading memories of Communism".

Fig. 7 - S1 IW (28.02.2017) - vv,vh,ndi(vh,vv) colour composite gamma correction - Baotou economy is focused on rare earth transformation. [2D view](#)

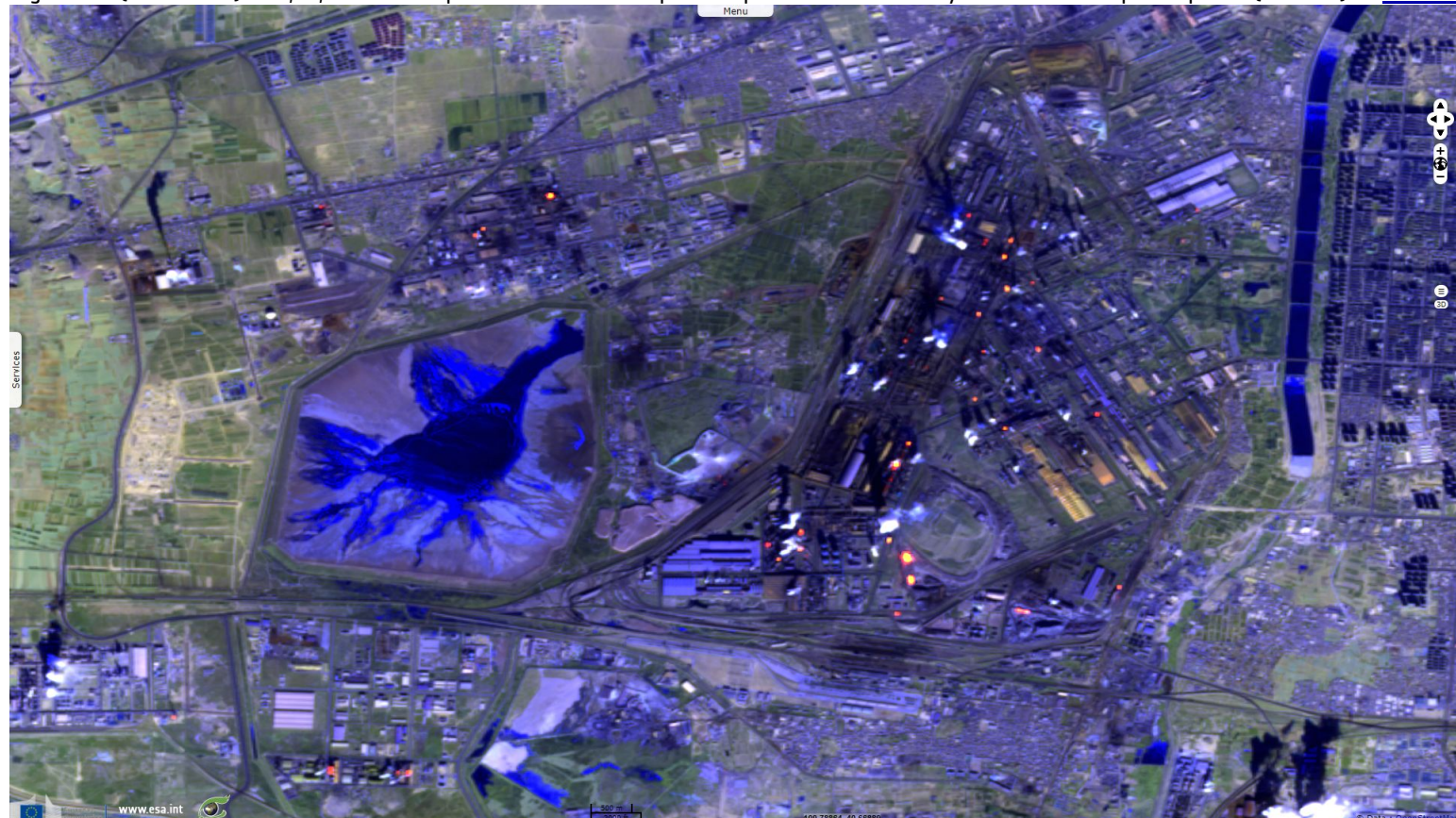


The Cutting Edge [specifies](#): "according to statistics conducted within Baotou, where China's primary rare earth production occurs, 'all the rare earth enterprises in the Baotou region produce approximately ten million tons of all varieties of wastewater every year' and most of that waste water is 'discharged without being effectively treated, which not only contaminates potable water for daily living, but also contaminates the surrounding water environment and irrigated farmlands.'"

[mindat.org confirms](#): "The ore is transported to the industrial city of Baotou for processing (hydrometallurgical leaching). There, liquid waste fills a 10 km<sup>2</sup> surface pool."



Fig. 8 - S2 (05.12.2017) - 12,11,2 colour composite - West Baotou polluted pond is surrounded by factories & coal power plants (red dots). [2D view](#)



Tim Maughan [reminds](#) another outlet for the induced pollution: "In Bayan Obo, the ore is mined and then transported back to Baotou via open railway cars, where it is then processed. Unfortunately, with old, outdated technology, equipment, and little oversight, the waste finds its way into the Yellow River, which passes by the south side of Baotou and travels another 1,300 miles, through mountainous terrain as well as through heavily populated areas before finally dumping into the Yellow Sea."

Fig. 9 - S2 (25.09.2015) - 12,11,2 colour composite - East of the pond, a part of the power plants ignited in 2015 were switched off in 2017. [2D view](#)

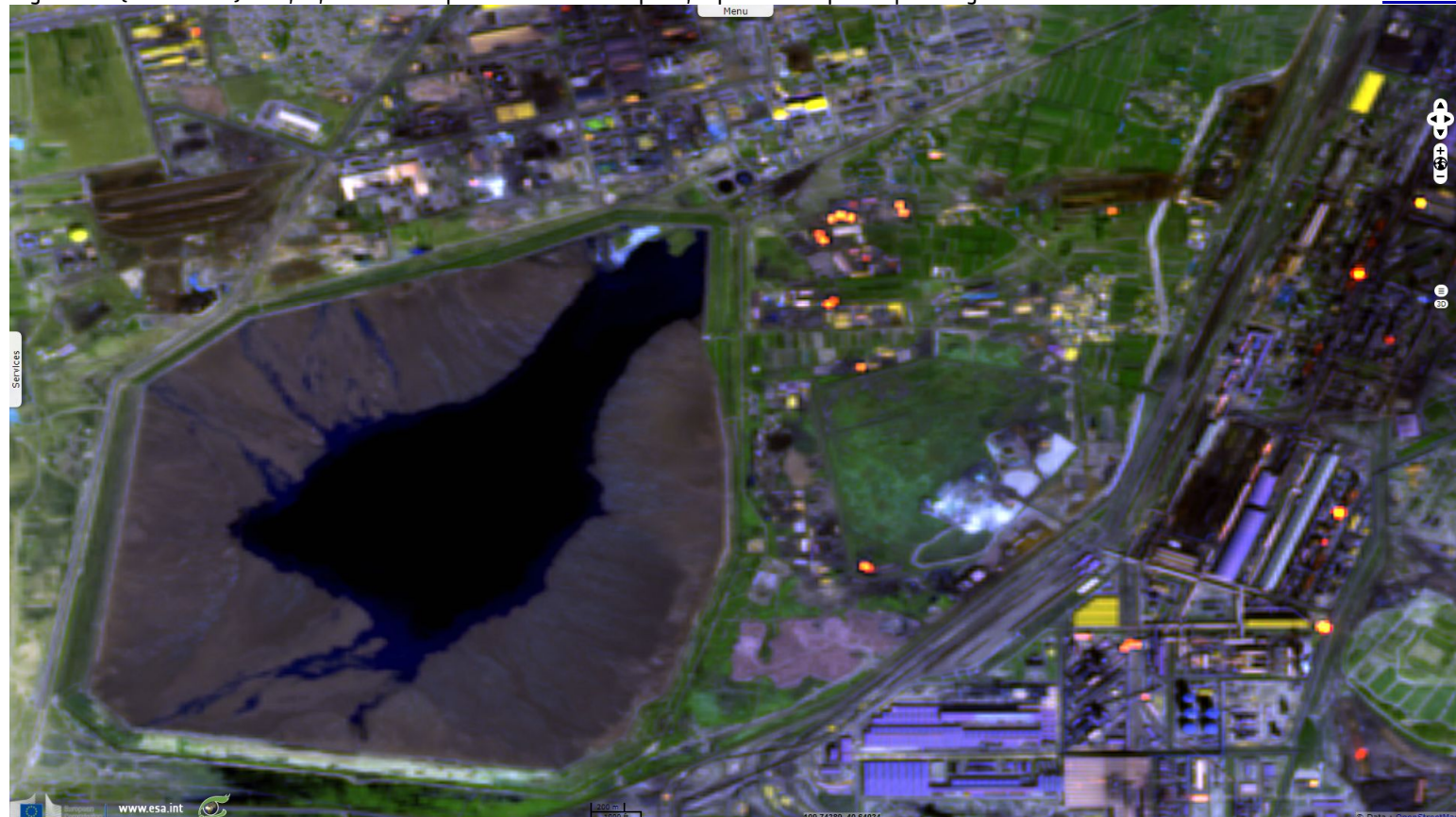
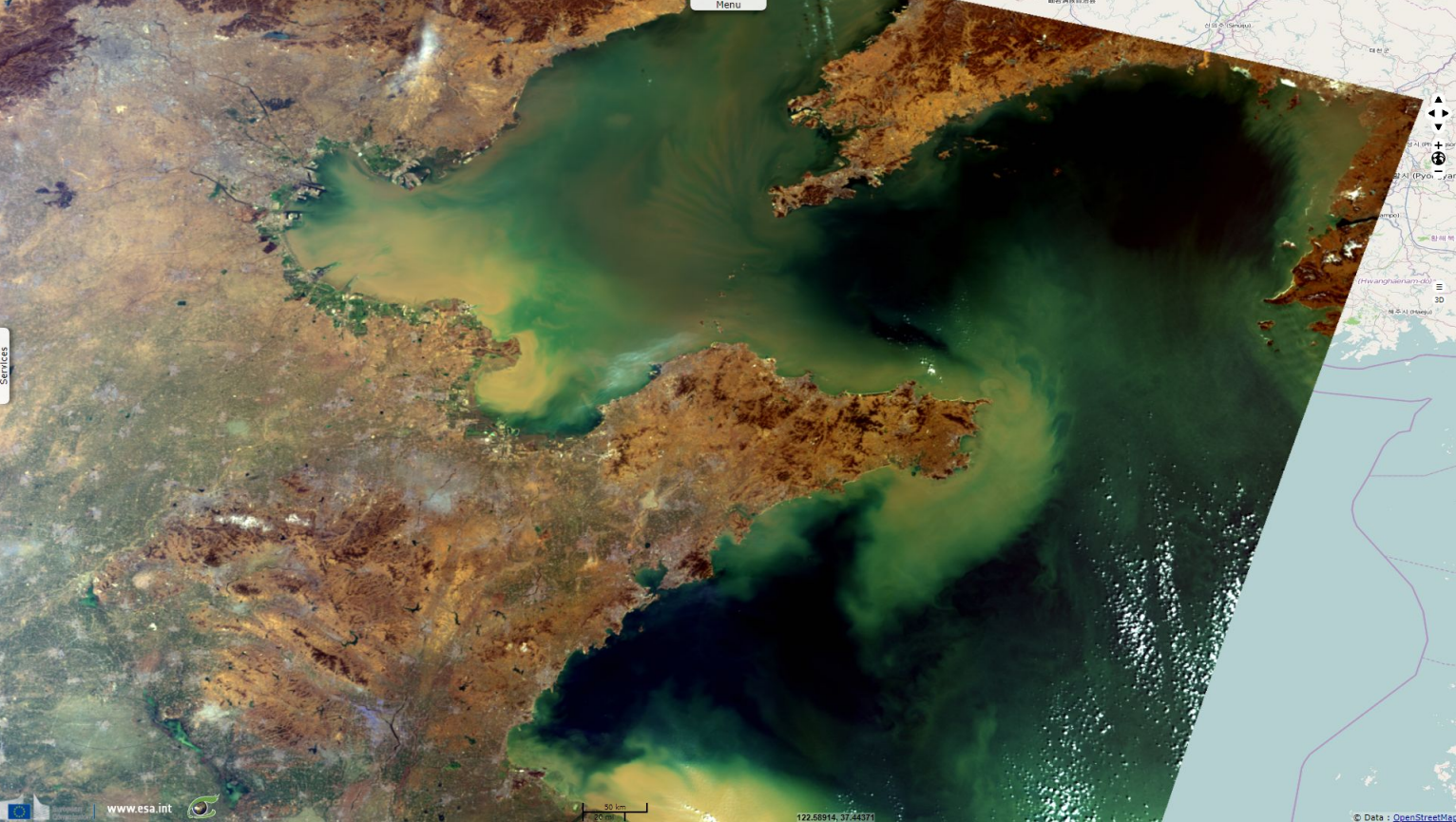


Fig.9 shows several fossil fuel based power plants that were ignited in 2015 while they were switched off in 2017 on fig.8. Tim Maughan [attempts an explanation](#): "Could local industry be artificially controlling market scarcity of products like cerium oxide, in order to keep rare earth prices high? We can't know for sure that this was the case the day we visited. Yet it would not be unprecedented: in 2012, for example, the news agency Xinhua reported that China's largest rare earth producer was suspending operations to prevent price drops."















Fig. 10 - S3 OLCI (02.03.2017) - 10,6,3 colour composite - Most of these pollutants flow in the Yellow River & end up in the Yellow Sea. [2D view](#)



Tim Maughan [concluded](#) about the final destination of the pollutants: "In 2005, Xu Guangxian, who is considered the father of China's rare earth industry, wrote that thorium was a source of radioactive contamination in the Baotou area and the Yellow River. This seems to also be born out by local observers, such as one local man who stated, 'In the Yellow River, in Baotou, the fish all died ... They dump the waste— the chemicals into the river. You cannot eat the fish because they are polluted.' Some 150 million people depend on the river as their primary source of water."

*The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.*

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