Sentinel Vision
EVT-671
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2D Layerstack

Booming development in the "floatovoltaic" industry

Sentinel-1 CSAR IW acquired on **08 January 2018** at 20:43:09 UTC
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Sentinel-2 MSI acquired on **03 November 2019** at 02:48:49 UTC
Sentinel-1 CSAR IW acquired on **06 November 2019** from 10:11:44 to 10:12:34 UTC
Sentinel-2 MSI acquired on **11 November 2019** at 02:59:41 UTC

Author(s): Sentinel Vision team, VisioTerra, France - svp@visioterra.fr

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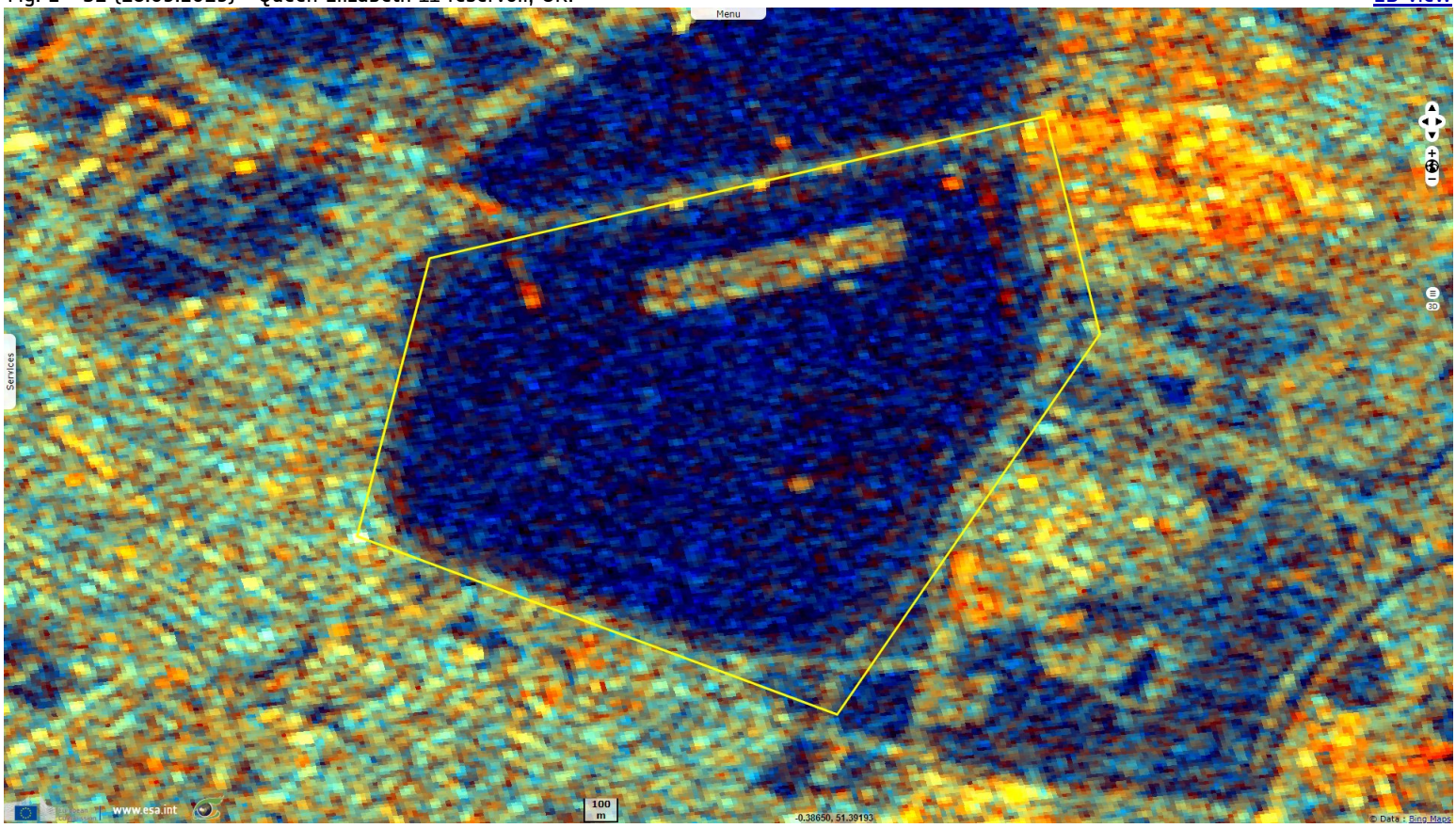
Fig. 1 - S2 (18.11.2019) - Godley reservoir in Hyde, Greater Manchester, UK. 2D view

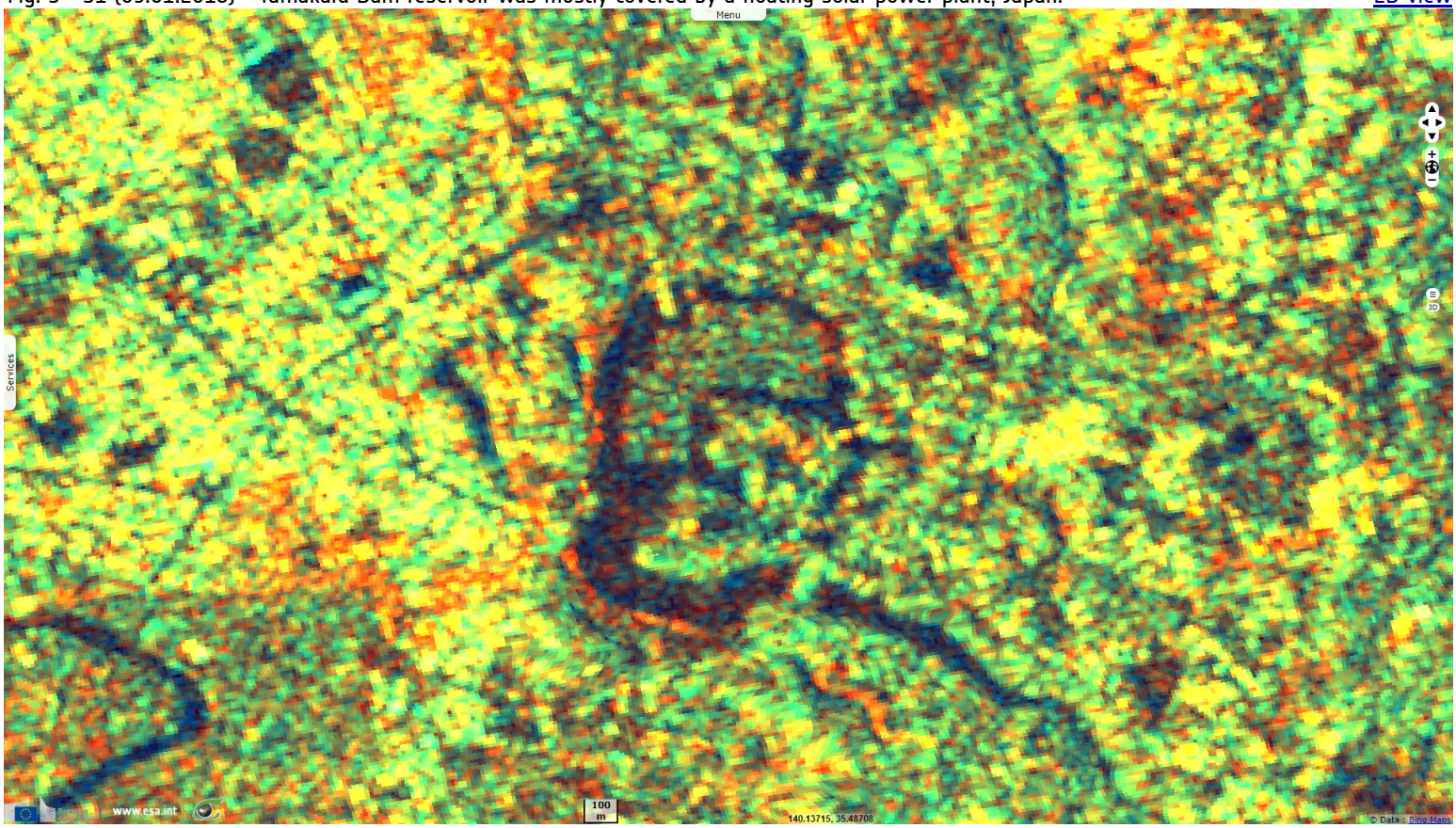
Fig. 2 - S1 (18.09.2019) - Queen Elizabeth II reservoir, UK. 2D view



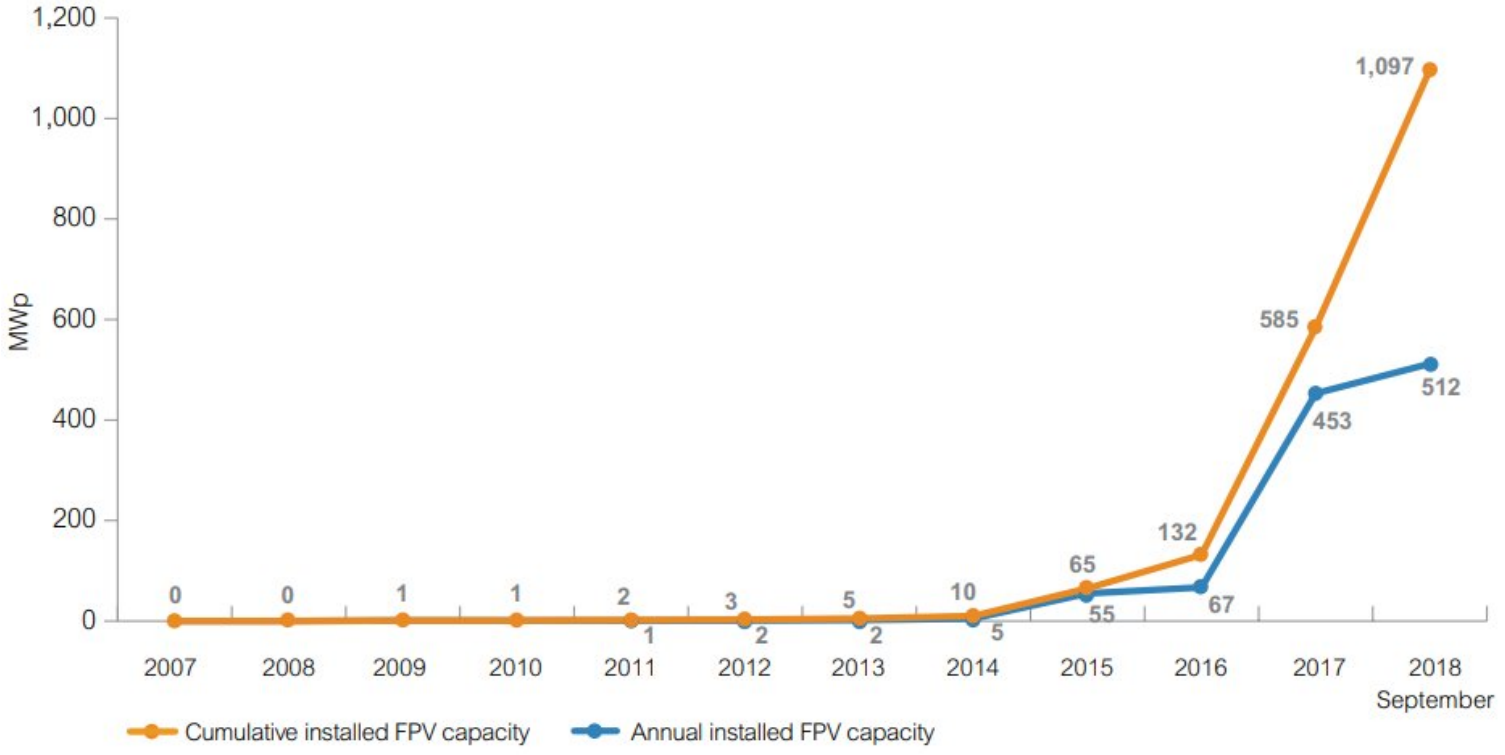
The BBC announced on 26 October 2015: "*About 12 000 panels will be placed on a reservoir in Hyde, Greater Manchester as part of efforts to reduce energy costs, water firm United Utilities said. The 45 500 m² array will be the second biggest floating solar farm in the world, after a scheme in Japan, a company spokesman said.*"

A few months later, in March 2016, the British company Lightsource Renewable Energy revealed it had "*successfully completed and connected Europe's largest floating solar farm.*" "*The farm, which will be the size of eight football pitches, is expected to generate 5.8 million kilowatt hours of electricity in a year.*" While this solution may compete for surface with natural wetlands, this is not a problem for artificial lakes. Fiona Harvey added for the Guardian: "*Though waterbirds, including moorhens and gulls, live on the margins, and a thin scum of litter is visible at the shore, the reservoir is not intended as a home to wildlife, and any fish living here are accidental visitors.*"

Fig. 3 - S1 (09.01.2018) - Yamakura Dam reservoir was mostly covered by a floating solar power plant, Japan. 2D view



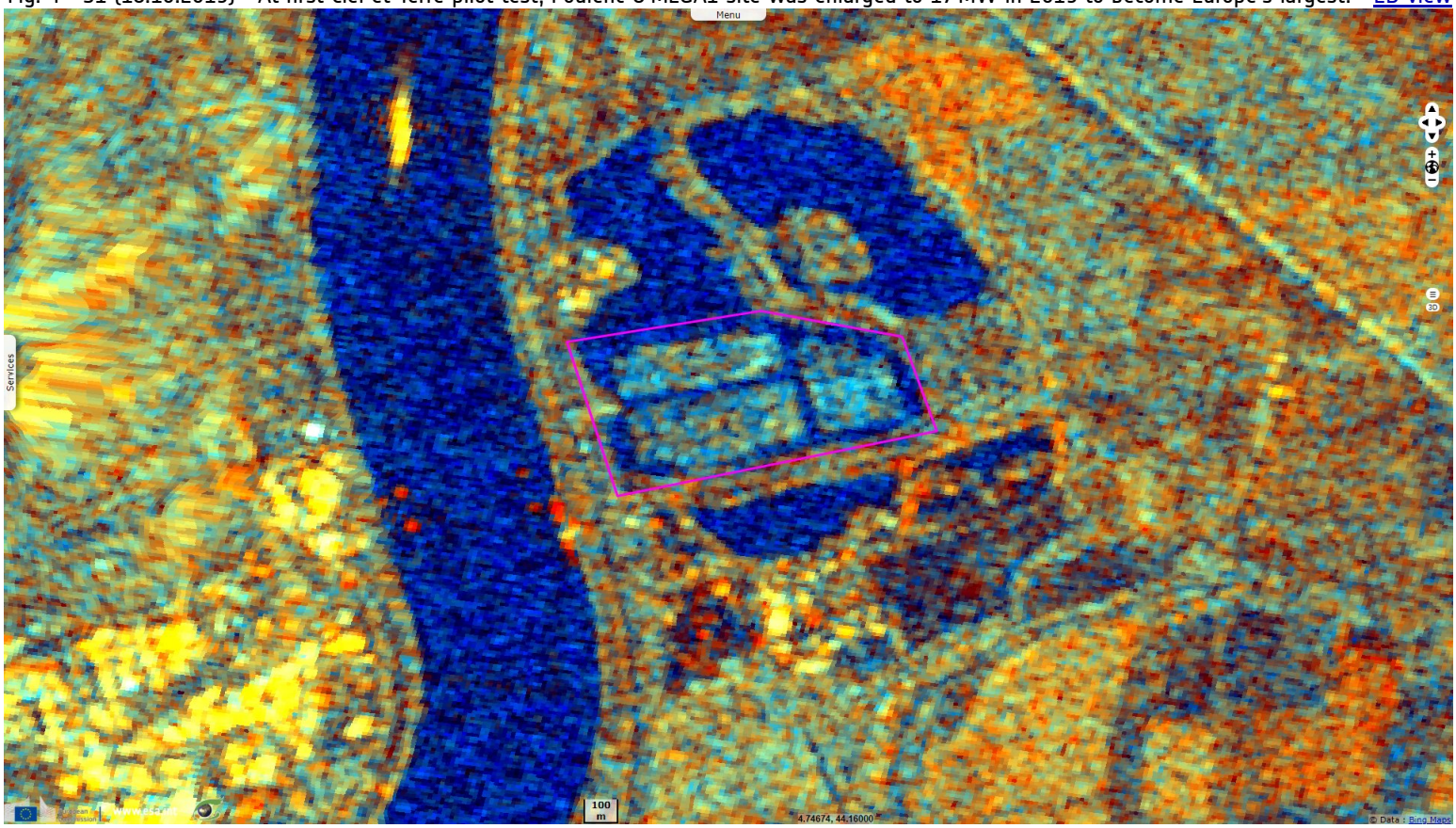
As of March 27, 2018 the Japanese company Kyocera TCL Solar LLC and Ciel et Terre declared: "*With 180 000 m² of surface area, 50 904 Kyocera solar modules were installed to generate an estimated 16 170 megawatt hours (MWh) per year - enough electricity to power approximately 4970 typical households.*" The 13.7 MW Floating Solar Power Plant was then the largest built in Japan. Unfortunately, it was heavily damaged after [190 kph] winds Typhoon Faxai brought to the coastal city of Chiba."



Source: Authors' compilation based on media releases and industry information.

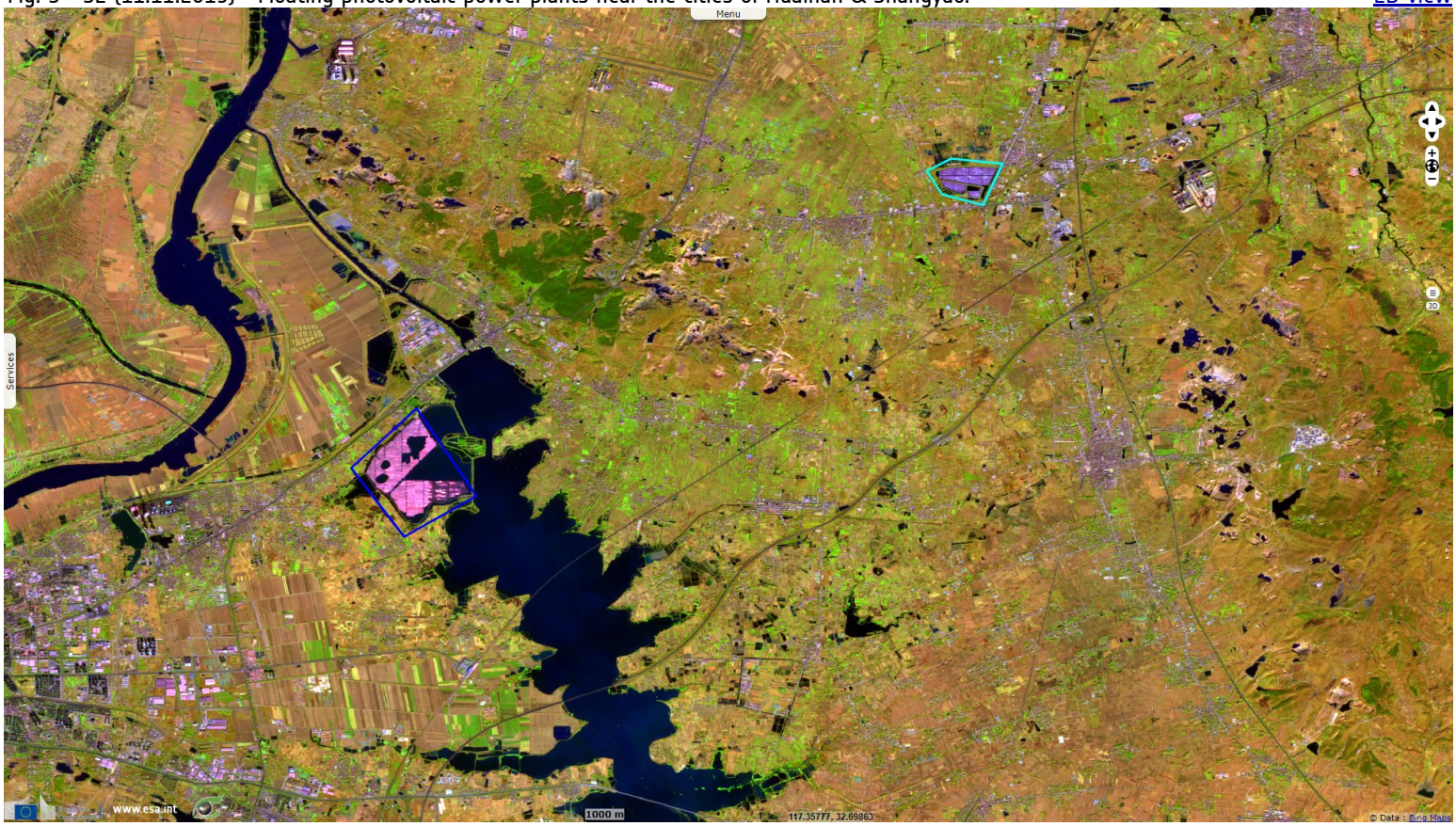
"*Global installed floating PV capacity*" - Source: World Bank.

Fig. 4 - S1 (18.10.2019) - At first Ciel et Terre pilot test, Poulenc O'MEGA1 site was enlarged to 17 MW in 2019 to become Europe's largest. 2D view



According to the World Bank: "*Internationally, floating solar initially tool off mostly in Japan, as the aforementioned National Renewable Energy Laboratories report stated that of the 200 MW installed globally by 2017, 80% of that capacity came from Japan. However, it is no longer 2017 and, as it is known to do, capacity has increased worldwide to 1.1 GW, a fact reported by the World Bank.*"

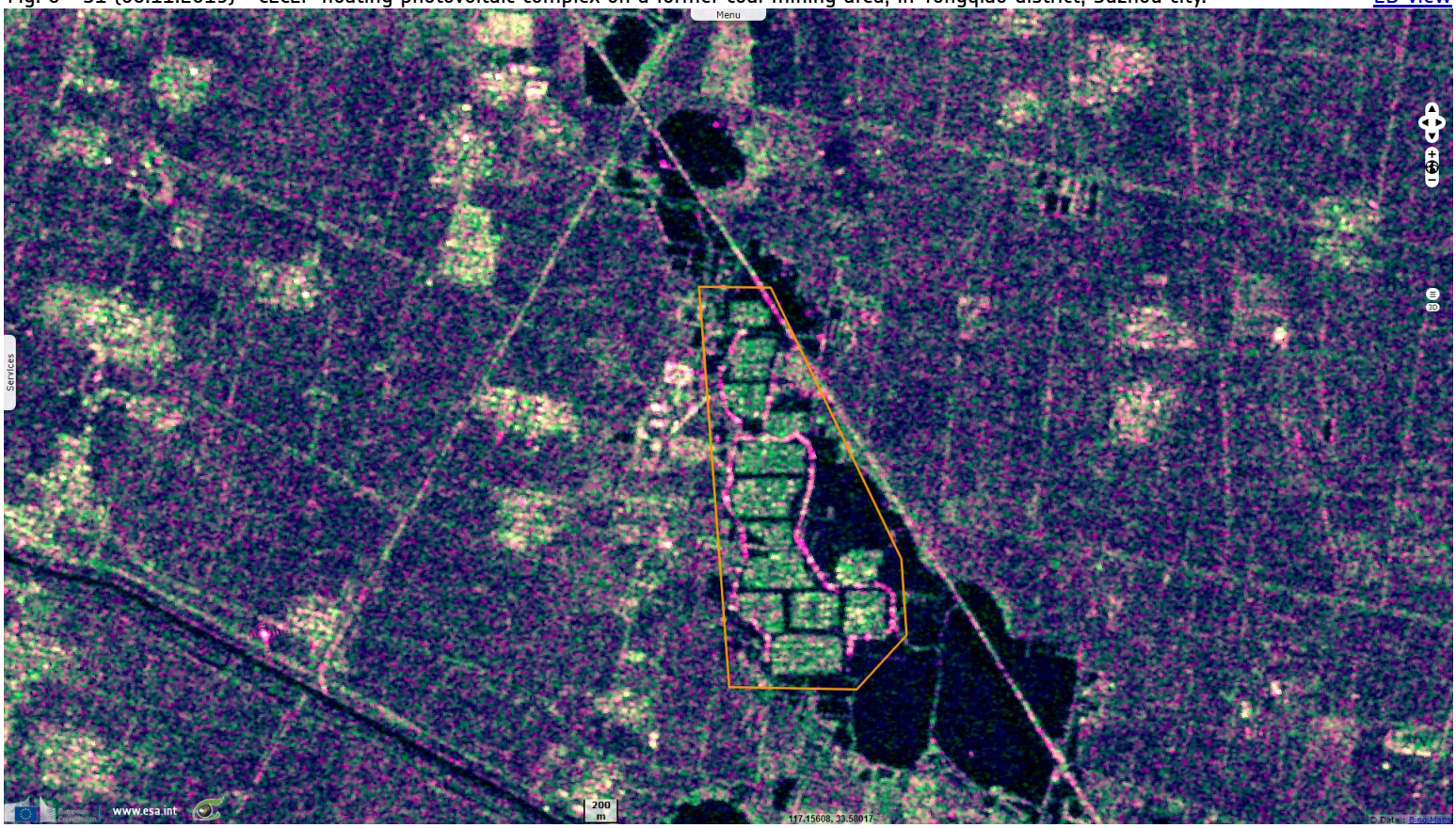
Fig. 5 - S2 (11.11.2019) - Floating photovoltaic power plants near the cities of Huainan & Shangyao. 2D view



However, European investments are dwarfed by the development of floating photovoltaic in Asia. On 12 April 2016, the Chinese company Xin Yi Solar published a news item as the 40-megawatt facility took the title of the world's largest floating solar plant and started producing power in Huainan, China: "*The Group's 20 MW floating solar power farm in Huainan City, Anhui Province was built on the water surface of a coal mining subsidence area where solar modules were installed on floating bases. After the on-grid connection is completed, this solar farm can annually generate 23 million kWh of electricity on average.*"

"*Compared with a conventional solar farm, a floating solar farm does not occupy scarce land resources, can reduce water evaporation and restrain the growth of algae. At the same time, water can be used to cool down solar modules and power cables, and subsequently improve the efficiency of power generation.*"

Fig. 6 - S1 (06.11.2019) - CECEP floating photovoltaic complex on a former coal-mining area, in Yongqiao district, Suzhou city. 2D view



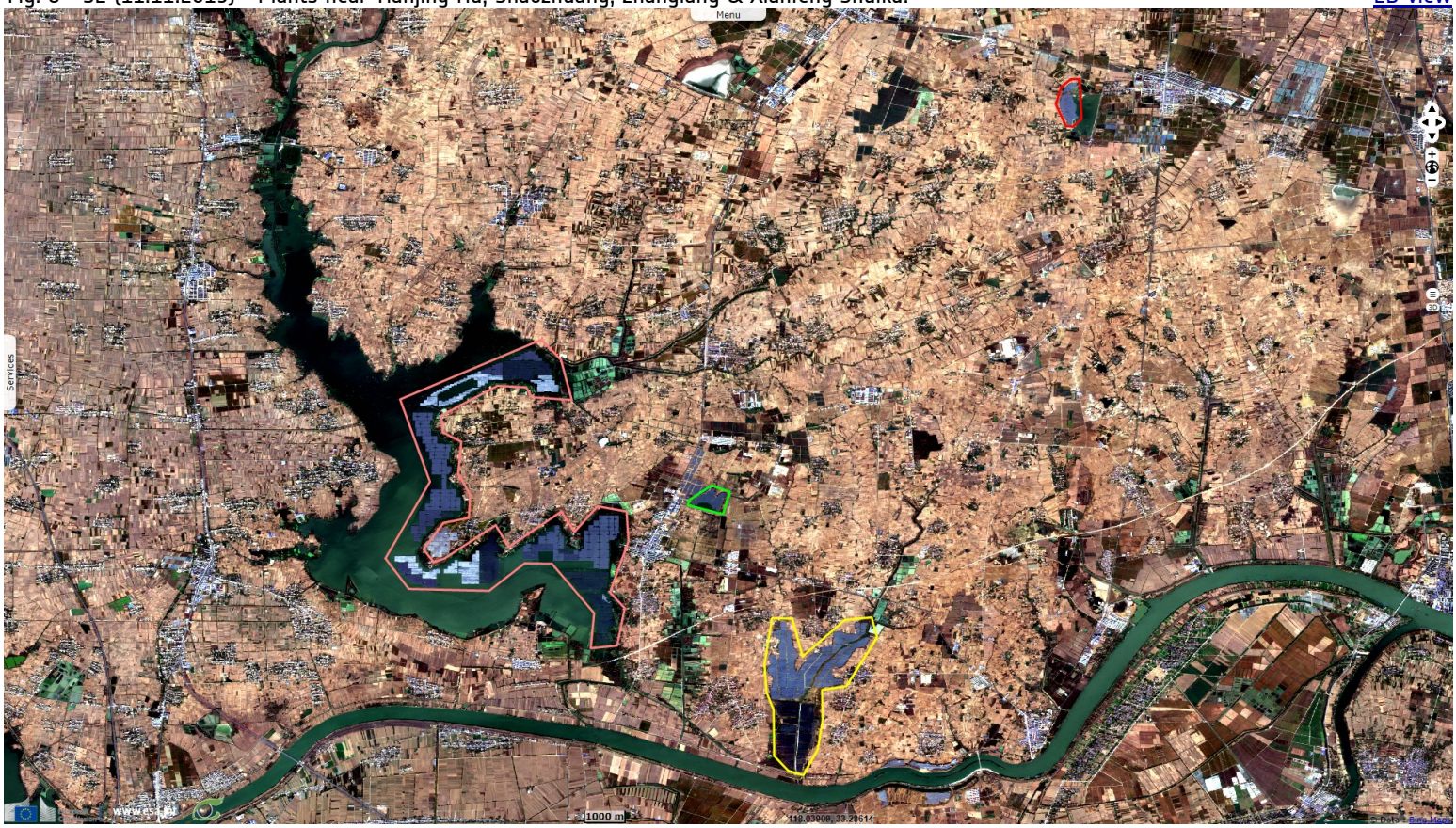
China then consolidated its record when it asked the French company Ciel et Terre to install the CECEP floating photovoltaic complex on a former coal-mining area, in Yongqiao district, Suzhou city: "*the system covers an area of 1.4 km². The whole facility in Anhui is currently the largest floating photovoltaic power station in the world. The plant is expected to generate up to 77 693 MWh in its first year, which represents the electricity consumption of some 20 910 households. Within 25 years, the solar farm should generate around 1.94 million of MWh. This project completes another project supplied by Ciel & Terre in Anhui province, the 32 MWp GCL floating PV plant.*"

Fig. 7 - S2 (11.11.2019) - Panji, Jiagouxiang & Huainan plants. Among other major infrastructures, a 150 MW floating photovoltaic power plant being constructed by the Chinese company Sungrow in Anhui province of China.

2D view

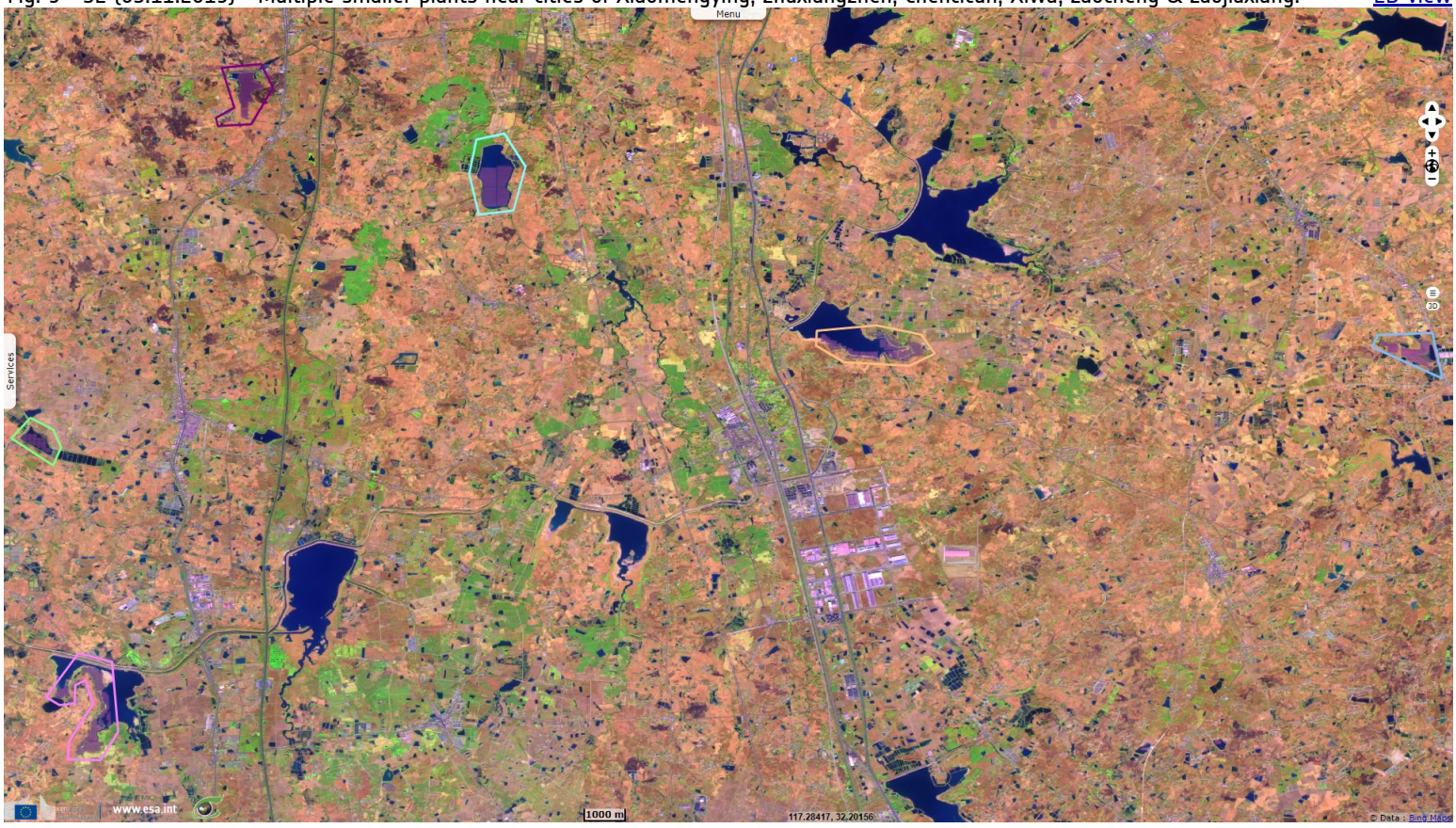
Compared to conventional land-based photovoltaic panels, the main advantage of floating photovoltaic plants is that they do not take up any land, except the limited surfaces necessary for electric cabinet and grid connections.

Fig. 8 - S2 (11.11.2019) - Plants near Tianjing Hu, Shaozhuang, Zhanglang & Xianfeng Shuiku. 2D view



Floating photovoltaic plants are more compact than land-based plants, its promoters add that their management is simpler and their construction and decommissioning straightforward. The main reason is that no fixed structures exist like the foundations used for a land-based plant so their installation can be totally reversible. Regarding maintenance, it does not require as much cleaning as panels are not located in dusty deserts. When it requires cleaning, water is easily accessible and not lost to evaporation.

Fig. 9 - S2 (03.11.2019) - Multiple smaller plants near cities of Xiaomengying, Zhuxiangzhen, Chencicun, Xiwa, Zaocheng & Zaojiaxiang. 2D view

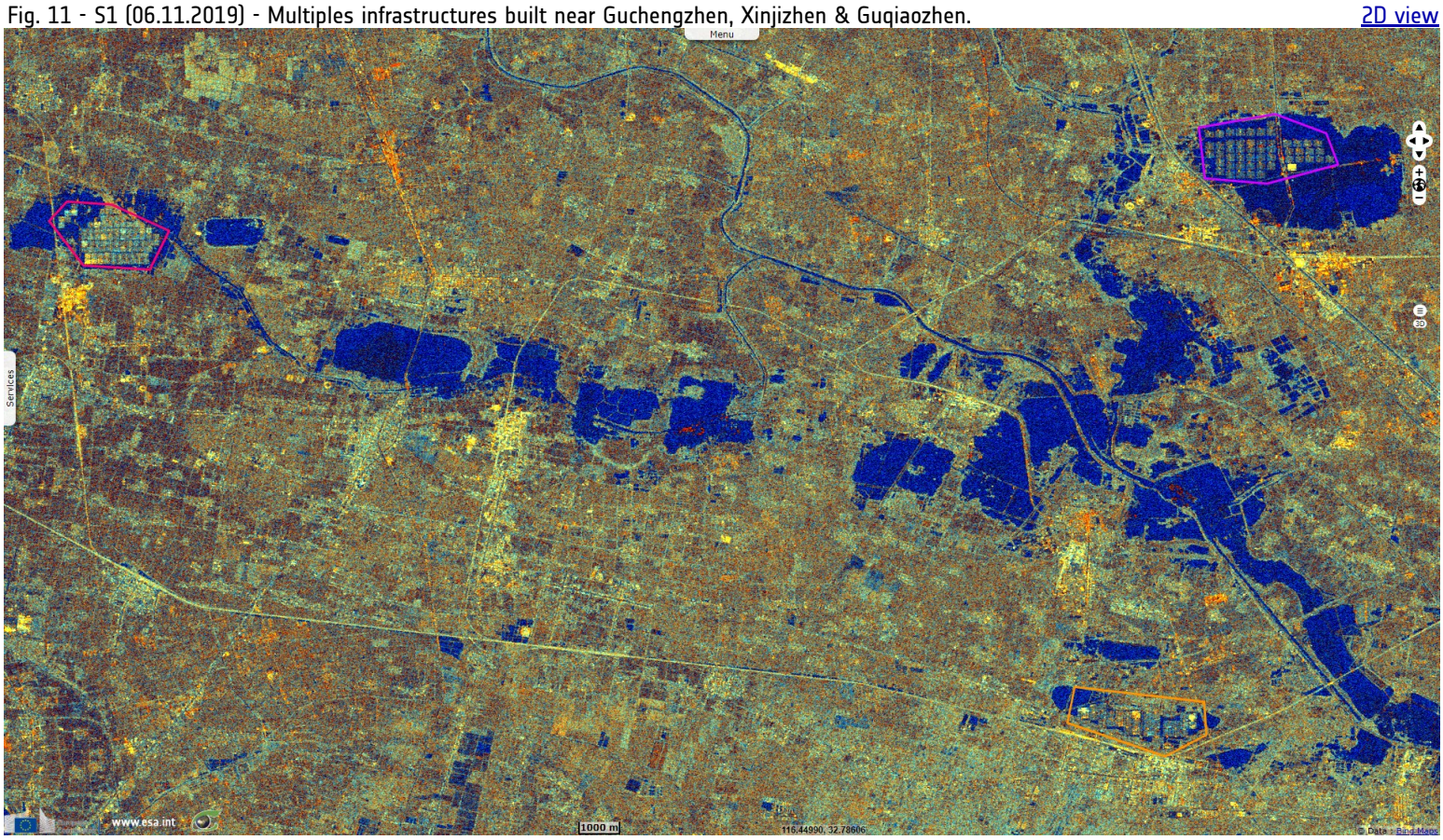


The partial coverage of basins can reduce the water evaporation. This result depends on climate conditions and on the percentage of the covered surface. In arid climates such as Australia this is an important advantage since about 80% of the evaporation of the covered surface is saved and this means more than 2 m^3/m^2 yearly. This is a very useful feature if the basin is used for irrigation purposes.

Fig. 10 - S2 (03.11.2019) - Flooded mines converted to FPV plants near Xiaomengying, Zhuxiangzhen, Donggegang & Hexiang. 2D view

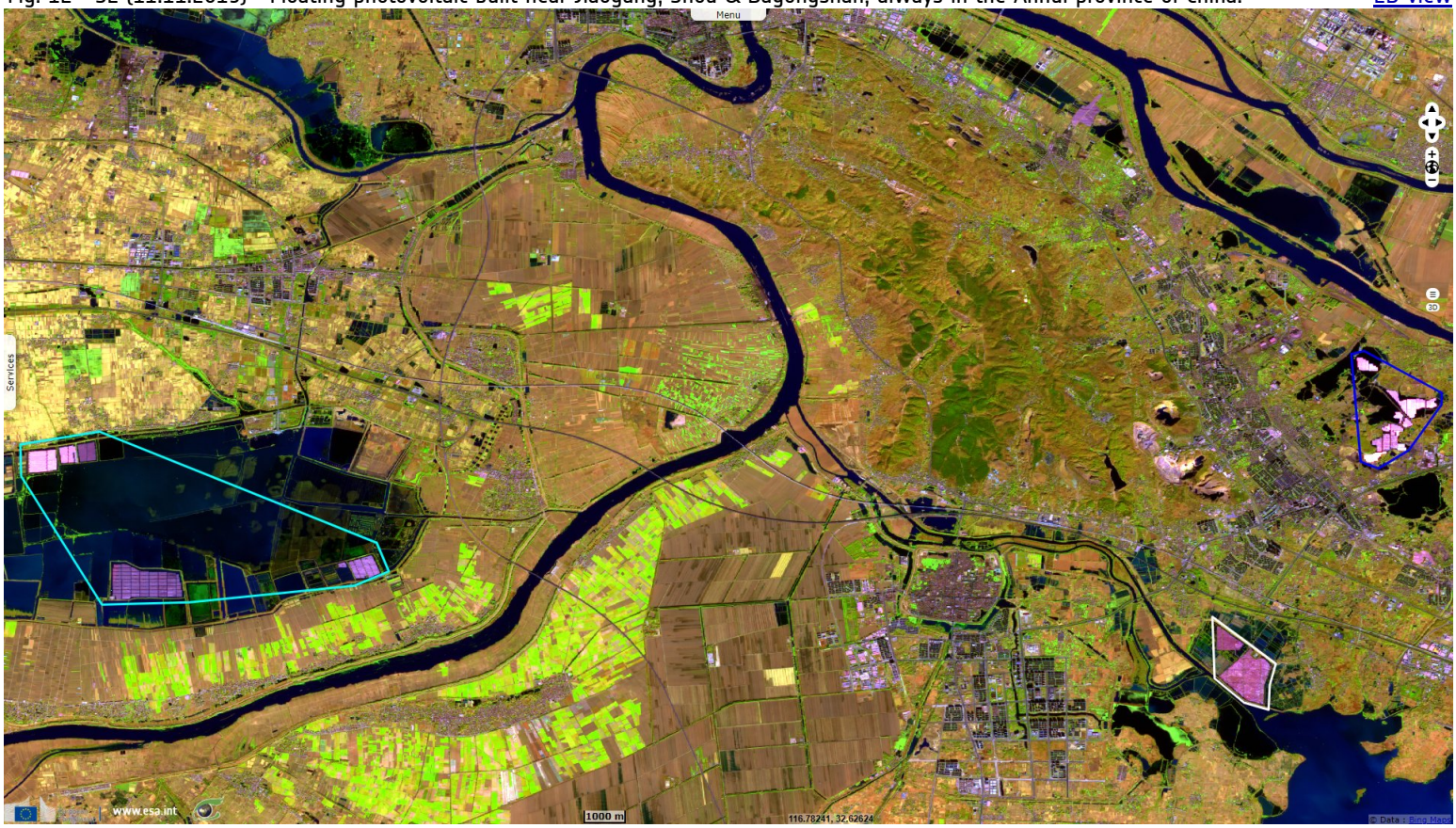
A parallel advantage is the containment of the algae bloom, a serious problem in industrialized countries. The partial coverage of the basins and the reduction of light on biological fouling just below the surface, together with active systems can solve this problem.

Fig. 11 - S1 (06.11.2019) - Multiples infrastructures built near Guchengzhen, Xinjizhen & Guqiaozhen. 2D view



A large floating platform can be easily turned and can perform a vertical axis tracking. A floating photovoltaic plant equipped with a tracking system has a limited additional cost while the energy gain can range from 15 to 25%.

Fig. 12 - S2 (11.11.2019) - Floating photovoltaic built near Jiaogang, Shou & Bagongshan, always in the Anhui province of China. 2D view



On September 29, 2016, Tibi Puiu already wrote: "*The scale of renewable energy adoption in China has been huge, but the grid infrastructure hasn't kept up and many panels and wind turbines have to sit idle. This is called "curtailment," which means power grids do not use renewable power even when wind and solar power plants are capable of producing it. Close to 10 percent of solar capacity remained untapped during the first half of 2015, while around 15 percent of wind power was wasted throughout the year. In Ningxia things are even worse as about 20 percent of solar power sat unused. Hopefully, as China adds solar panels by the millions, it will also upgrade its grid to stay in tune.*"

Fig. 13 - S2 (12.09.2019) - Prototype on Alto Rabagão Dam lake, Portugal. 2D view

Ciel et Terre developed an innovation allowing to anchor floating solar panels even if the level of the lake is subject to large variations: "*Located in Montalegre, Portugal, this 218 kWp floating solar plant is the first project installed on a hydroelectric dam with an area of 22 km². Anchored at the bottom of the pond, the very specific anchoring solution here has been designed to meet a maximum 60 m depth while dealing with a 30 m water level variation (currently the most challenging anchoring system ever build for a floating photovoltaic project).*"

"*The presence of water suggests using gravity energy storage mainly in the coupling with hydroelectric basins. However other possibilities has been*

explored and in particular CAES systems have been suggested." Installed over an hydroelectric dam lake, this prototype benefits from the existing local grid equipment which allows gravitational storage of excess solar energy by pumping the water back to the top of the reservoir lake.

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