Artificial intelligence and satellite imagery in the service of solving waste problems

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Problemme of waste

Some consequences of waste for the living world, nature and economy:

- Harmful substances from waste, especially heavy metals, destroy plants and animals in rivers, and find their way to drinking water;
- Leads to increased coastal erosion;
- Waste also endangers the operation of hydropower plants and water intakes of drinking water factories;
- Polluted rivers are not attractive for recreation, and negatively affect the development of tourism.

- In 2019, some 2212 illegal landfills were registered. One third has been cleaned several times, but persistently reappears (SEPA).

Partnership

We explored the possibility of using satellite imagery and remote sensing to detect illegal dumps, with the support of UNDP's strategic partner - the European Space Agency (ESA).

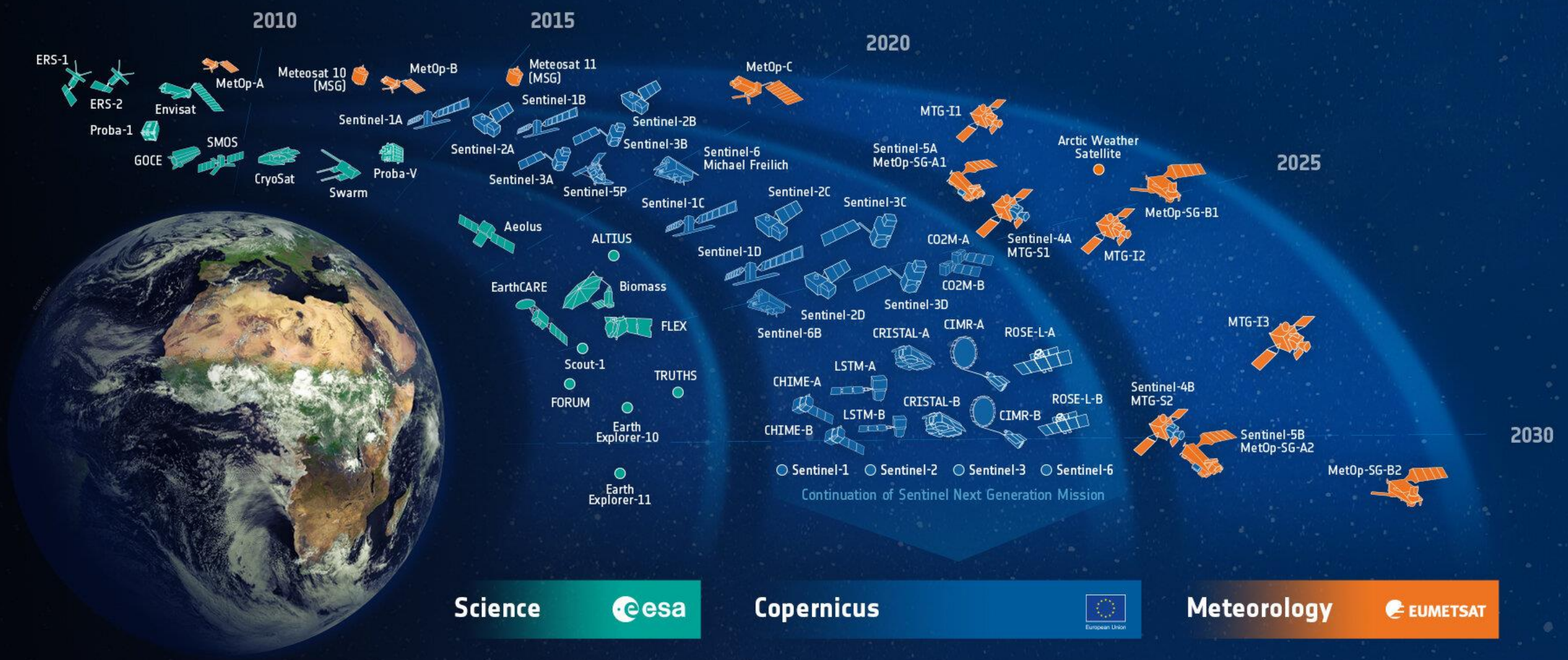
By using artificial intelligence (AI) or, in this case, the neural network algorithm for deep learning ResNet, it is possible to have an AI-based classification that continues learning and improves over time.

With the help of ESA, we obtained satellite images of the flow of Lima through Serbia.

ESA also hired an international consortium: Everis, Effigis, i-Sea, which provided computer resources for data processing, provided expert assistance in developing the artificial intelligence model and in interpreting the results of the experiment.

Subject of mapping: the course of the river Lim through Serbia, in the length of about 100 km.

ESA-DEVELOPED EARTH OBSERVATION MISSIONS



Use of artificial intelligence

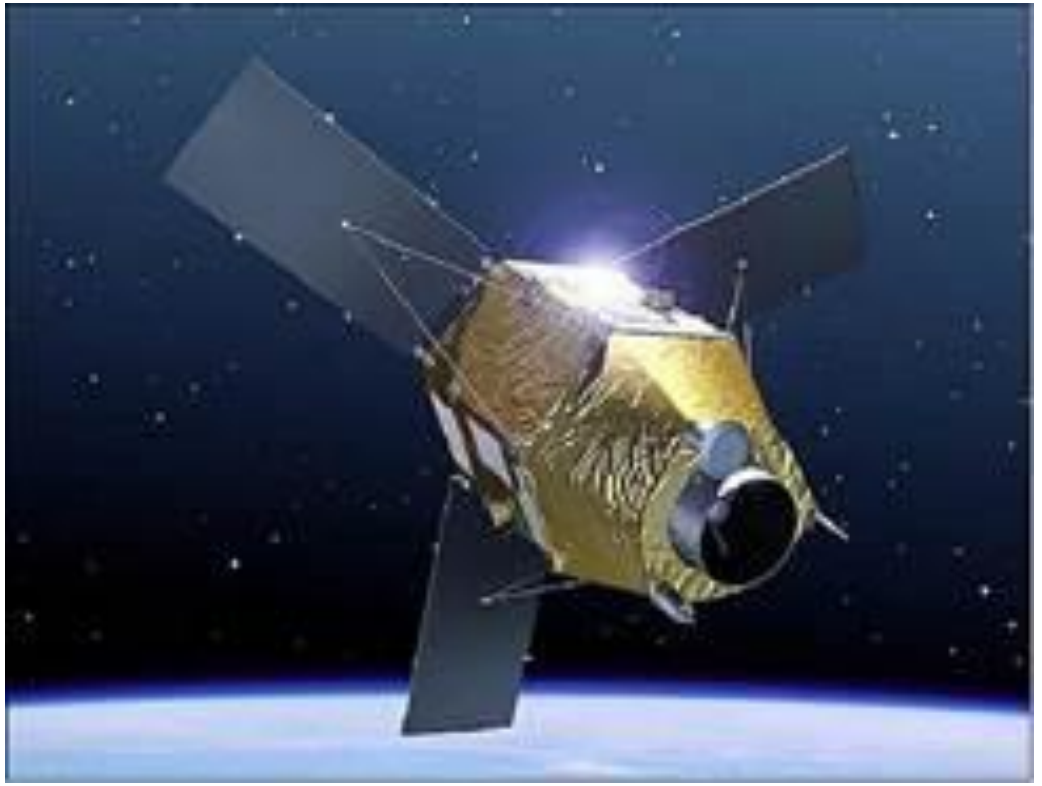
An important step was to "learn" a computer program to recognize similar formations on other recordings - the so-called "Supervised machine learning".

We first obtained data on the geographical locations of known landfills and recordings of these locations from the SEPA database (data on 150 legal and 3350 illegal landfills in Serbia were taken over and converted into a cartographic data layer).

Thanks to the Ministry of Environmental Protection, we received recordings from the Republic Geodetic Authority for the period from 2007 to 2013, when most data on landfills was collected. From that, we selected close to 500 high-quality images of confirmed landfills, which were used to "learn" the model of artificial intelligence. This data set was used to train a system (using machine learning) to identify landfills on the latest satellite imagery.

Waste disposal site detection

- When the model was ready, it was applied to identify landfills on appropriate satellite images of the flow of the Lima through Serbia.
- At the time of the experiment, the most recent cloudless images were from the Pléiades satellite, taken during the second half of 2019 at a resolution of 50cm.
- The model detected 1443 areas that could be landfills on these images.



The identified waste sites identified in this process are attributed to one of the following four classes:

1. exposed waste

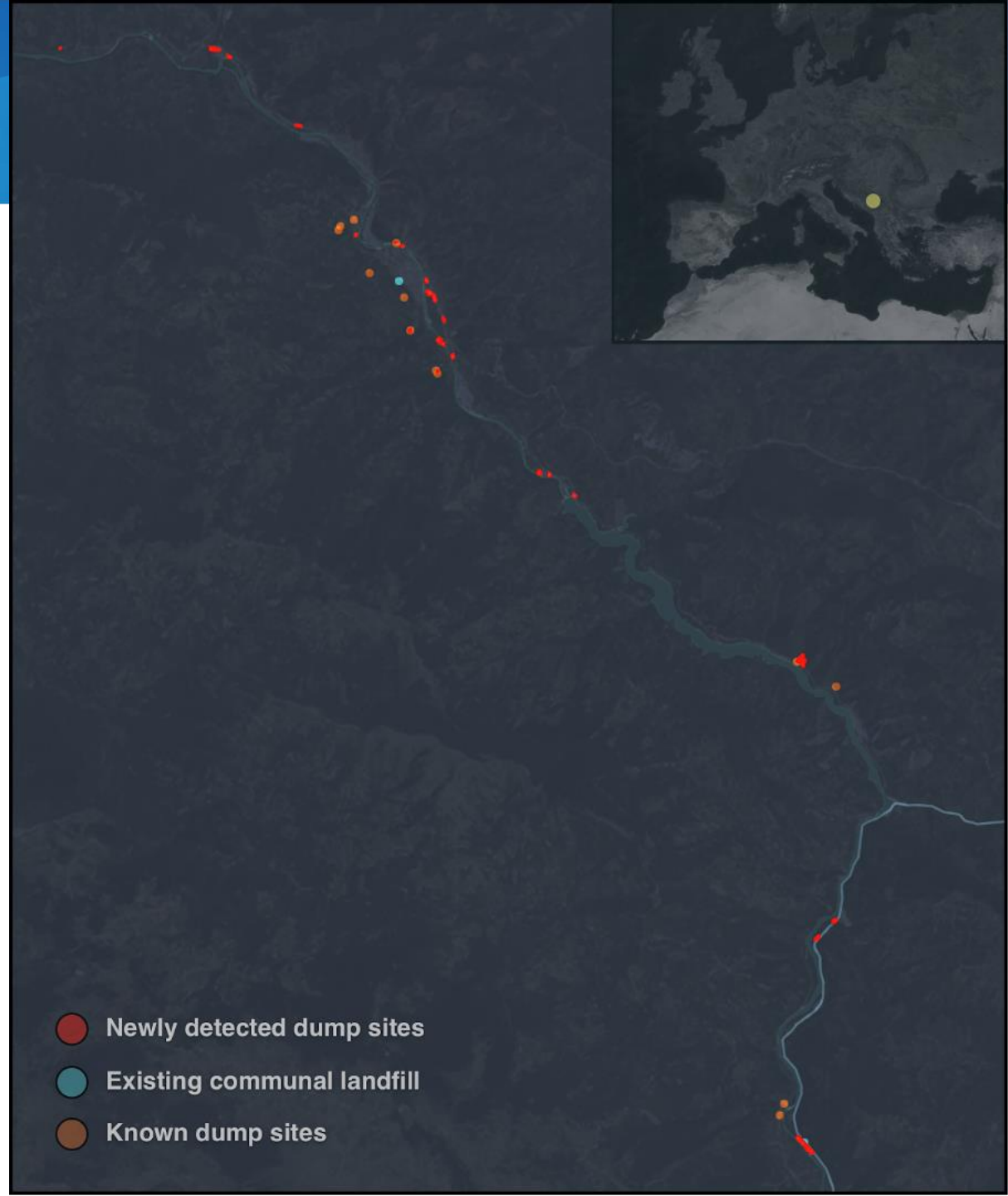
2. buried waste

3. leveled waste

4. industrial waste

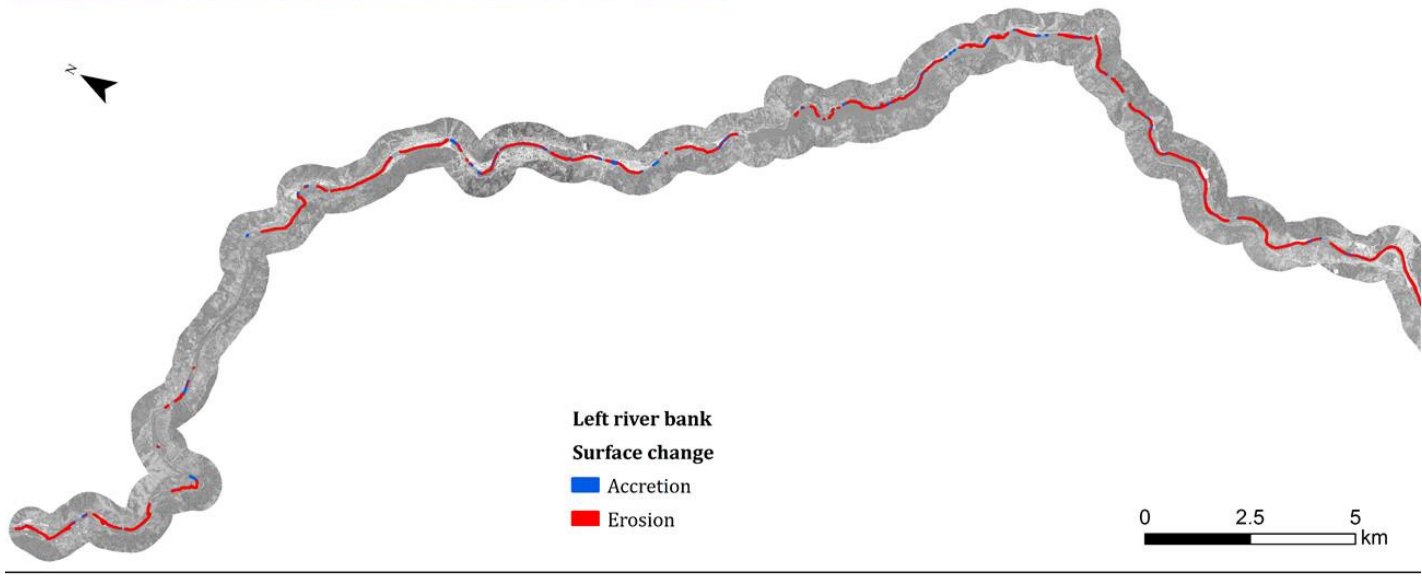
Results

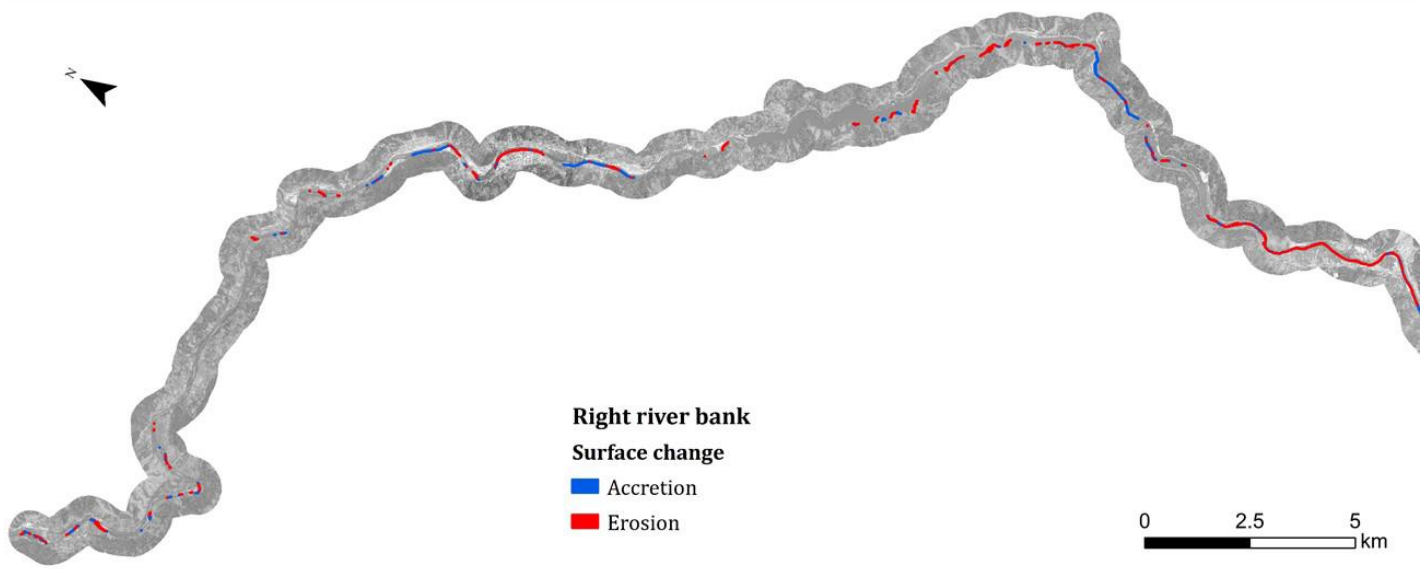
- Experts hired by ESA visually inspected these areas and narrowed the selection to 61 potential landfill sites.
- This is a significant increase compared to 23 that SEPA recorded 7-8 years earlier.
- We shared these results with the officials of the Ministry of Environmental Protection and the Municipality of Priboj.



Coastal vulnerability to erosion in waste disposal areas

- The analysis covered the period 2012-2019. years in high resolution images.
- 59.02% of the left bank and 35.56% of the right bank show signs of statistically significant erosion.
- 18.48% of the profiles on the left bank and 34.07% on the right show significant formation of deposits.





Coastal vulnerability to erosion in waste disposal areas

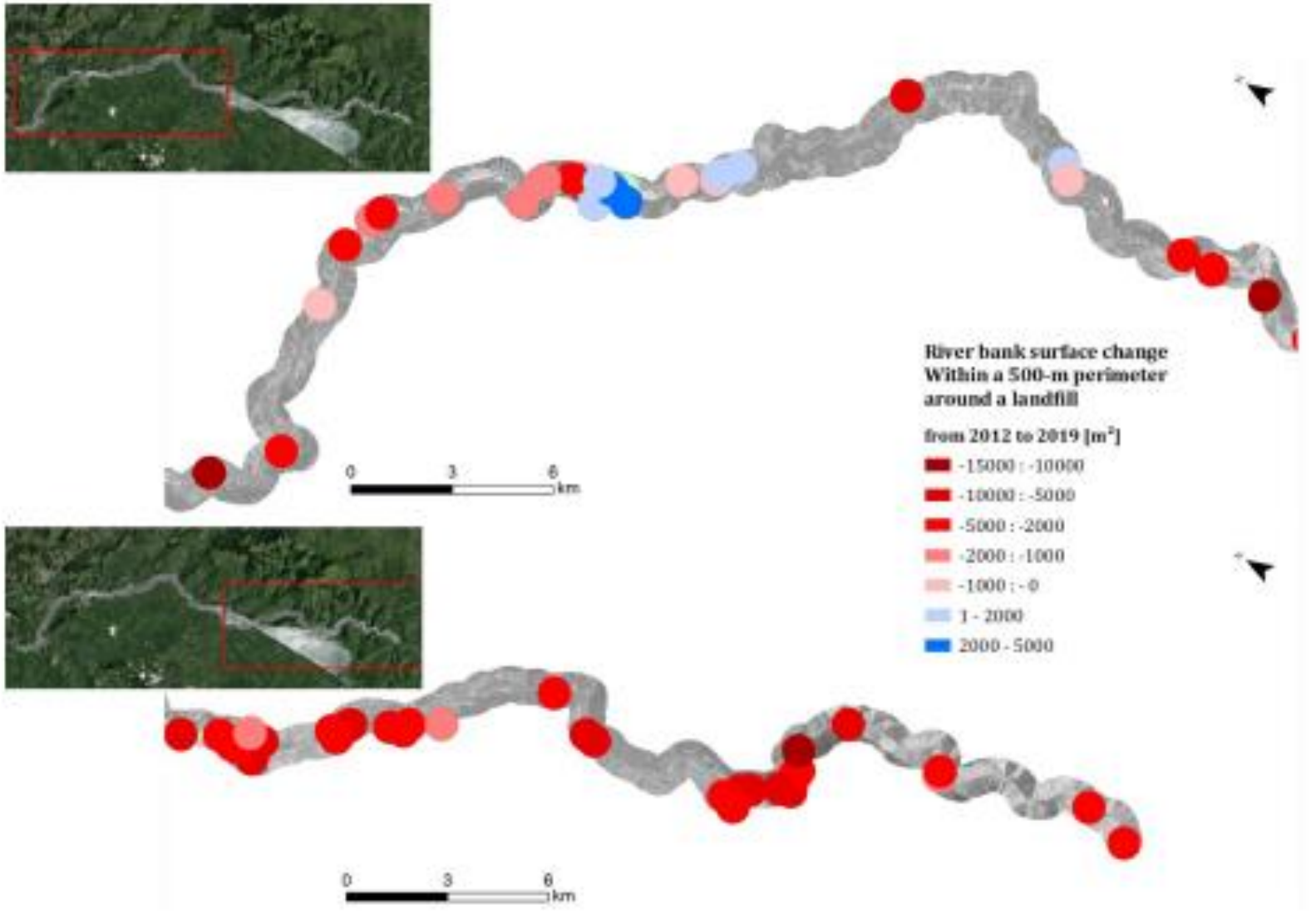


Figure 23 *Map showing riverbank changes over a 500-m perimeter around each landfill*

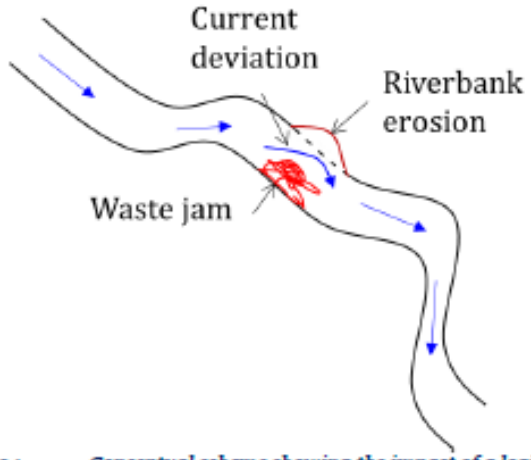


Figure 24 *Conceptual scheme showing the impact of a logjam caused by waste jams*

Pioneering enterprise

- In order to increase the accuracy of the model, it is necessary to train with a larger number of images of confirmed landfills, as well as to use images of much higher resolution - at least 30 cm, and preferably 20 cm or better.
- In recent years, we have witnessed the very rapid development of space and cloud technologies, the launch of satellites and the use of increasingly powerful computer resources as well as artificial intelligence.
- We can expect significant improvements in this field in the future.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