



2020

Emergency Management

White Paper - Flood Mapping

 **OPT/NET**



Partners and Contributors

IBM Watson AI **XPRIZE**

 **Copernicus**
Europe's eyes on Earth

AIRBUS

510  AN INITIATIVE OF
THE NETHERLANDS
RED CROSS

 **esa**

 **ASTROSAT**



OPT/NET

An Introduction

The printing revolution was catalyzed by the invention of the printing press in 1440. **Before, expertise in any domain was developed through direct observation** (apprenticeship). Books existed, but writing was a practice reserved for monks, historians, and nobility. The invention of the printing press meant that **knowledge could be documented, rapidly reproduced & shared in the form of books**. This made existing expertise widely accessible & distributable, revolutionizing the medium of knowledge exchange forever.

We have now entered the digital age. **The next step in scaling human capability will involve Artificial Intelligence**. AI technology has the potential to empower humans, but challenges still plague its adoption. The majority of AI solutions rely on Deep Learning. **Deep Learning approaches require massive labeled training data sets, are tailored to one specific use-case & are unsuited to deal with new or unpredictable environments**. Similarly, before the invention of the printing press, books for a new subject took years to write, months to produce a single copy, & writers had to devote themselves to one specific subject.

At OPT/NET, we deliver the next generation of AI: a hybrid platform which combines the processing & automation capabilities of AI with the natural problem-solving abilities of humans. Just like the printing press changed the way humans acquire and distribute knowledge, **OPT/NET has laid the groundwork for the mass proliferation of Artificial Intelligence**.

We flip Deep Learning on its head. Our patented generic AI approach autonomously detects patterns of significance in any time-series data without the prerequisite of model training. Forget about labeling massive training data-sets to feed your model. The OPT/NET AI Engine turns the complex process of moving from raw data to insights into an intuitive pattern interpretation exercise. Domain experts interpret the presented clusters by defining the pattern's significance & can even create reaction protocols. This process allows any domain expert to interpret any time-series data, without being a data scientist. Experts can effectively "distill" their domain specific expertise using our platform into what we call a **"Knowledge Pack"**. **Knowledge Packs make access to AI-assisted domain expertise as easy as purchasing a book on Amazon**.

At OPT/NET we are AI experts. Since our incorporation in 2018 we have developed several Knowledge Packs for a variety of domains: Smart Agriculture, Network Management, Critical Infrastructure Monitoring, Rapid Terrain Monitoring + Change Detection & more. **Companies across all industry verticals can leverage our patented AI engine** to rapidly interpret the patterns in their data to develop their own Knowledge Packs.

In this white paper we explore **TSAR AI** - a domain-specific application of the OPT/NET AI platform that processes Earth Observation Imagery to rapidly classify & monitor terrain for changes. This white-paper details its validation and usage in the Emergency Management domain & includes a flood mapping exercise covering the 2019 spring Ottawa floods.



Problem Overview

Since the beginning of the 21st century, the number of reported natural disasters has sharply increased. **Floods and extreme weather continue to be major causes of death and economic damage worldwide.** With climate change on the rise, this threat is becoming increasingly important, and necessitates the development of innovative tools that can assist emergency responders. We can't stop natural disasters, but we can react as effectively as possible to minimise the negative impact.

Earth Observation Data ("EOD" e.g. satellite imagery) can provide a solution for the effective coordination of relief efforts. It provides organisations with a bird's eye view on areas of interest. With EOD, analysts can establish which areas are affected, which key infrastructures demand attention & how many people are at risk. Unfortunately, these processes currently rely heavily on manual effort. **Manual analysis takes time and is prone to human error.** This means the initial emergency responders have to make critical decisions with a limited view of the disaster as it unfolds. In situations where lives are literally at stake, every second counts.

Less than 10% of disasters are mapped and overall less than 5% of Earth Observation Data (EOD) from satellites is ever processed by human analysts. In the coming years, the growing number of satellites and IoT in-situ data sources will only increase the quantity of raw observation data. **As such, the portion of data which is never analysed is expected to keep rising exponentially.**

Systems supplemented by Artificial Intelligence can scale with the increase of data, enabling users to leverage the full potential of Earth Observation Data.

Key Challenges



Satellite's view obstructed
by weather conditions



Constant stream of
relevant complex data



Absence of detailed
historical reference data

During the development of PoC demonstrations and after joining forces with 510 - the data & digital team of the Netherlands Red Cross - we discovered a number of underlying challenges (above) that needed to be solved prior to tackling the central problem itself.

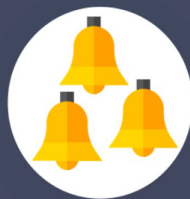
Sources: OPT/NET B.V. team interviews of Red Cross NL (2019) and Airbus DS representatives (2019)



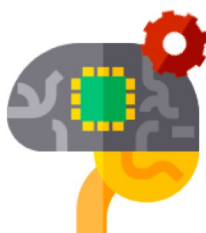
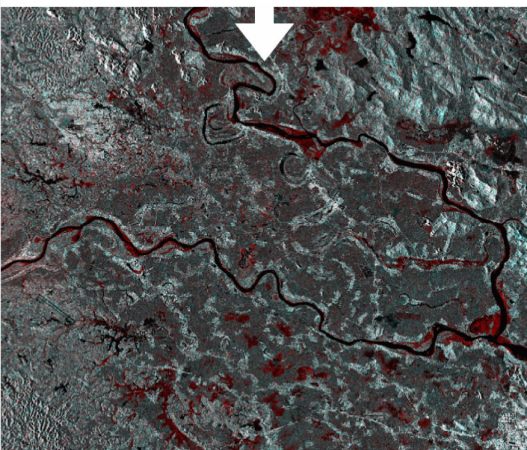
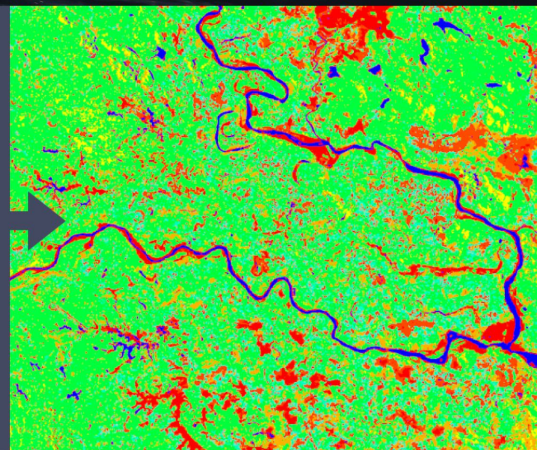
Solution Overview



Satellite collects imagery
(SAR, SLSTR, etc.)



AI Engine autonomously clusters
terrain & detects changes



AI Engine analyses
SAR data rapidly



Operators have results
presented through Web GUI

Inspired by the emergence of many new EOD systems that provide access to valuable datasets, we applied our AI approach to this domain & developed TSAR AI. This product aims to **address the full scope of the aforementioned challenges**, thereby saving lives and minimising the economic losses incurred by natural and human made disasters.

TSAR AI solves the challenges by processing **Synthetic Aperture Radar (SAR) Data** using artificial intelligence. SAR is an imaging radar mounted on a moving platform (satellite) which transmits Electromagnetic waves sequentially & subsequently collects + digitizes the reflections to monitor surfaces. The data is extremely complex and is **impossible for humans to effectively analyse without pre-processing techniques**. Crucially, SAR can provide **insights regardless of weather and lighting conditions** (e.g. night/day/cloudy/clear), & contains a wealth of meaningful data vs. optical data.

The TSAR AI product leverages our patented AI engine & combines a unique variety of unsupervised clusterers and supervised classifiers to rapidly classify terrain & detect changes. The developed solution enables effective detection of emergency situations under **reduced budgets, on a larger scale, and with faster and more precise results than existing solutions**.

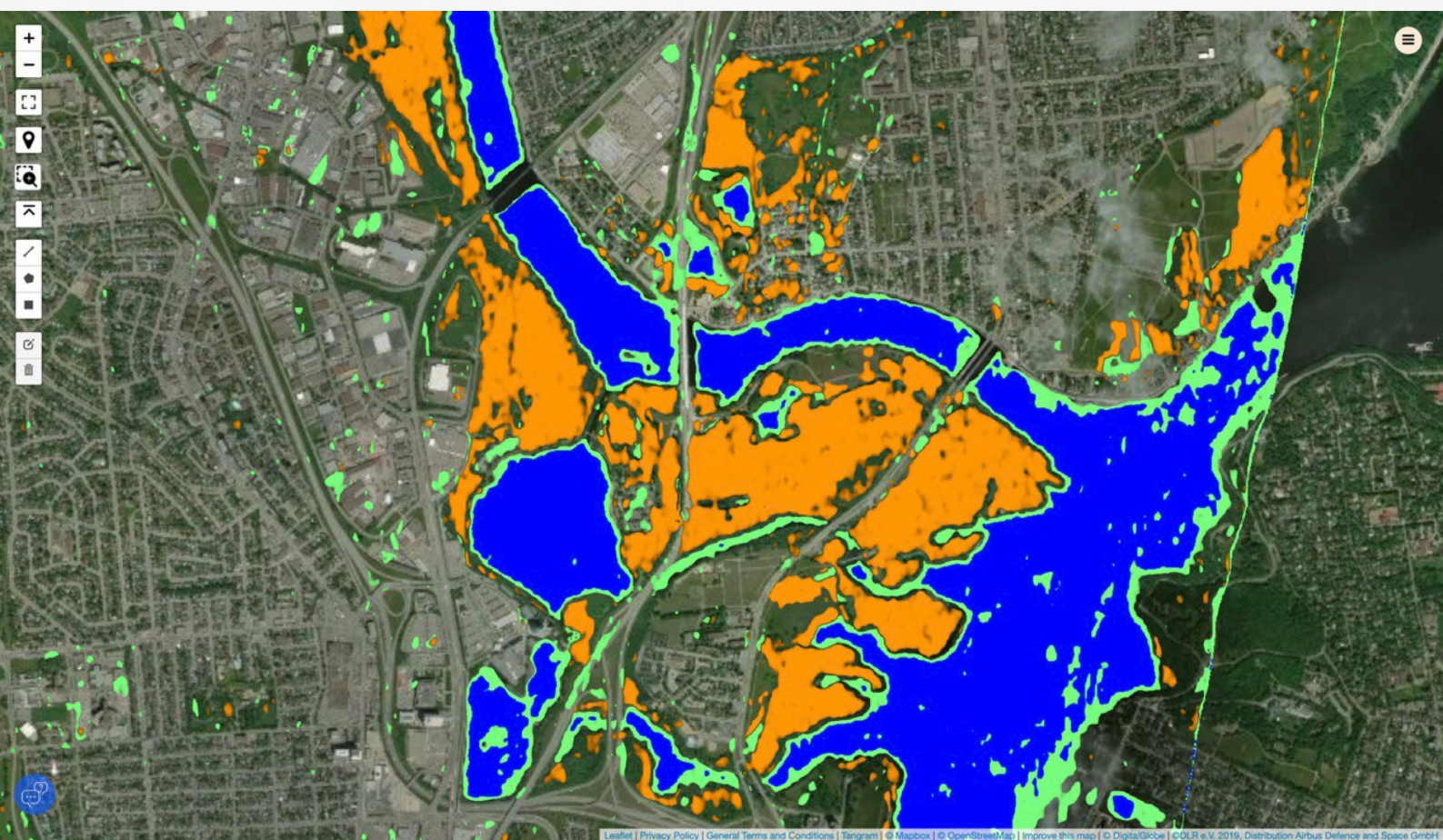


Technical Results

In Q3 2019, we performed a study to measure the accuracy & speed of the OPT/NET AI engine. TSAR AI was used to map the May 2019 floods in Ottawa, Canada, and was compared to existing practices enacted by the “Canada Centre for Mapping and Earth Observation” (CCMEO).

Our AI produced flood maps using two TerraSAR-X StripMap SAR (SCC) Image Products, provided by our partner Airbus Defence & Space : © DLR e.V. 2019, Distribution Airbus Defence and Space GmbH.

At first glance, it is clear how much richer the TSAR AI maps are.



TSAR AI-generated flood map differentiates: *Flooded vegetation*, *Raised water*, *Pre-flood body of water*



Technical Results

Based on the flood map produced by TSAR AI, we were able to assess the impact of the floods on local populations and infrastructure. **Insights that were extracted include number of flooded objects, length of flooded roads, damaged buildings, etc.**

From a qualitative perspective, the TSAR AI maps are richer and more precise than those created by the CCME0, which distinguish between “flooded” or “not flooded”. Our AI first categorizes various types of surfaces, e.g. buildings, roads, industrial structures, low vegetation, trees. Then, it clarifies if these surfaces are flooded. **This provides far more context to the emergency responders interpreting the maps.**

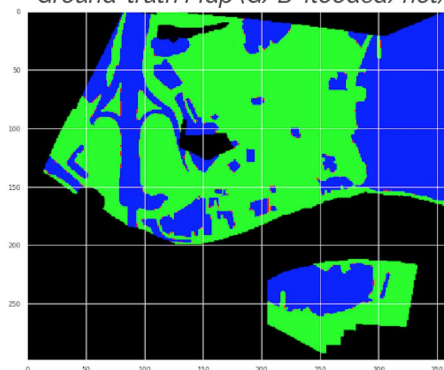
It took our AI **just 53 minutes** to classify the terrain, detect which areas are flooded & cross correlate it with a database of infrastructure from Open street maps to produce a damage report for an area of **2134,65 km2**.

We do not have concrete information on how long it took the CCME0 to produce their flood map, but we interviewed 510 - the data and digital team of the Netherlands Red Cross - about their experience in a similar case. In 2018, Sint Maarten was hit by hurricane Irma. The Dutch division of the Red Cross was tasked with conducting a full damage assessment of the storm to help emergency responders coordinate their efforts. In total, 100+ people worked tirelessly for 5 days to produce a damage report on the affected area of 36 km2.

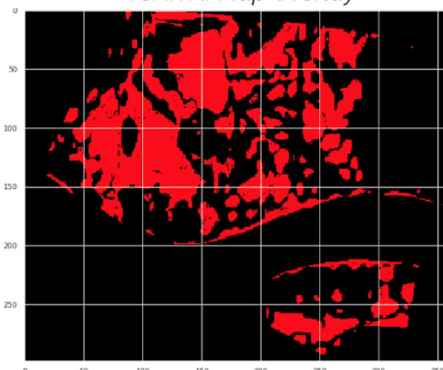
The accuracy of the TSAR AI-generated map was also evaluated and confirmed quantitatively through ground-truthing. We were able to establish that the AI demonstrates results **with an accuracy that is comparable to human analysts, in less time, and boasted a false positive rate that was 3x lower.**

When combined with the ability of the AI to work on a large scale and with higher specificity for mapping large areas, the solution **can easily be deployed for constant monitoring of various flood prone regions on a continuous basis.** This is simply impossible for a team of human analysts.

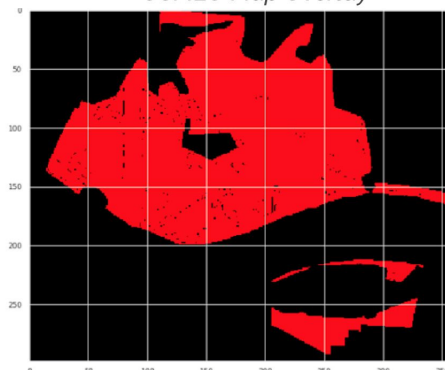
Ground-truth Map (G/B=flooded/not)



TSAR AI Map Overlay



CCME0 Map Overlay





Going Forward

TSAR AI has gained traction with a number of key stakeholders in the Emergency Management domain. In late 2018, TSAR AI received praise from the **European Commission** & was awarded the **Copernicus Masters Emergency Management Prize**

"TSAR AI was selected on the basis of its high potential to contribute concretely to the development of the Copernicus emergency service, showing a high maturity both as a technical project and a business structure." — Françoise Villette, Policy Officer, European Commission



In Q2 2019 funding was secured from the European Commission via the Copernicus Incubation program. **Currently, TSAR AI is top 32 in the ongoing prestigious IBM Watson AI XPRIZE competition.** OPT/NET has made key partnerships with industry veterans such as Airbus Defence & Space who has been a sponsor of the project so far & with whom various adjacent domains are being explored.

By early 2020 we aim to automate the recognition of known patterns in newly acquired EOD and therefore increase the share of analysed data by one order of magnitude (currently 5%). This will help support Earth sustainability studies & will increase our understanding of climate change, ultimately contributing to the fulfilment of the UN's Sustainable Development Goals.

The technology used to classify terrain & detect changes therein has far-reaching applications in a wide variety of industries. Some immediate application areas being discussed with several scientific and industrial teams include: crop monitoring; commodity supply monitoring; maritime activity + ship monitoring in coastal waters; oil spill detection; energy corridor and pipeline security monitoring; unauthorized construction detection; forestry and illegal logging monitoring; urban growth monitoring and far more.

Domain Experts & Distribution partners are critical for our strategy to target each potential use-case effectively. OPT/NET welcomes strategic partners to contribute in delivering new AI powered solutions to their respective domains. Leave the AI tech to us, & focus on generating the best insights possible for your clients!

If you have a data-driven use-case which requires the capabilities of the OPT/NET AI engine, please don't hesitate to reach out to our Business Development team for an introductory call.

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