

Space for Smarter Government Programme



Project 61933-454216 Optical and Microwave Extension for Floodwater Mapping (OMEF) in Rural and Urban Environments

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Led by the UK Space Agency

Delivered in collaboration with the Satellite Applications Catapult

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Project Overview



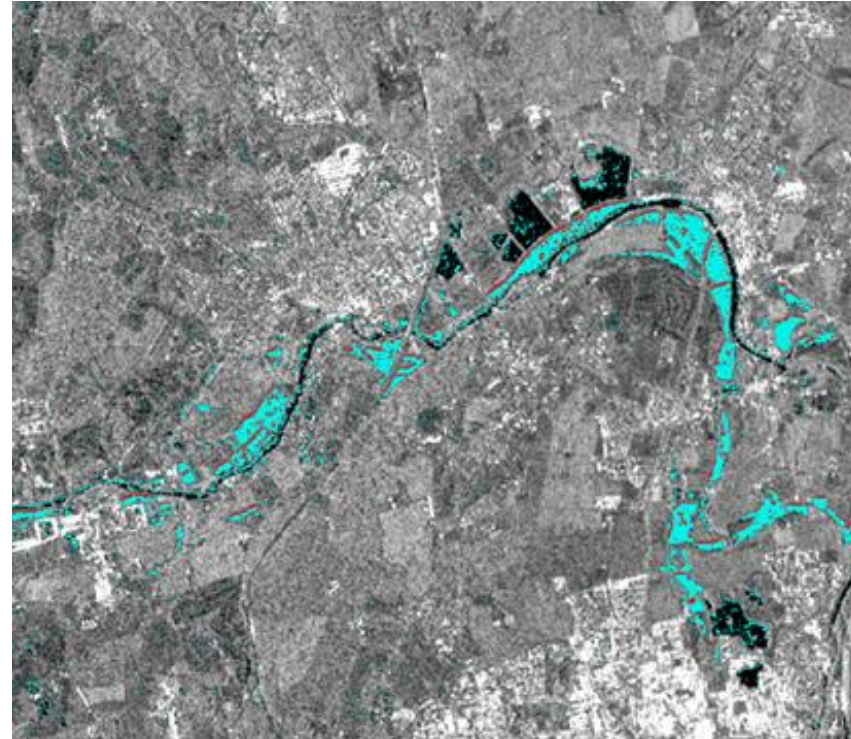
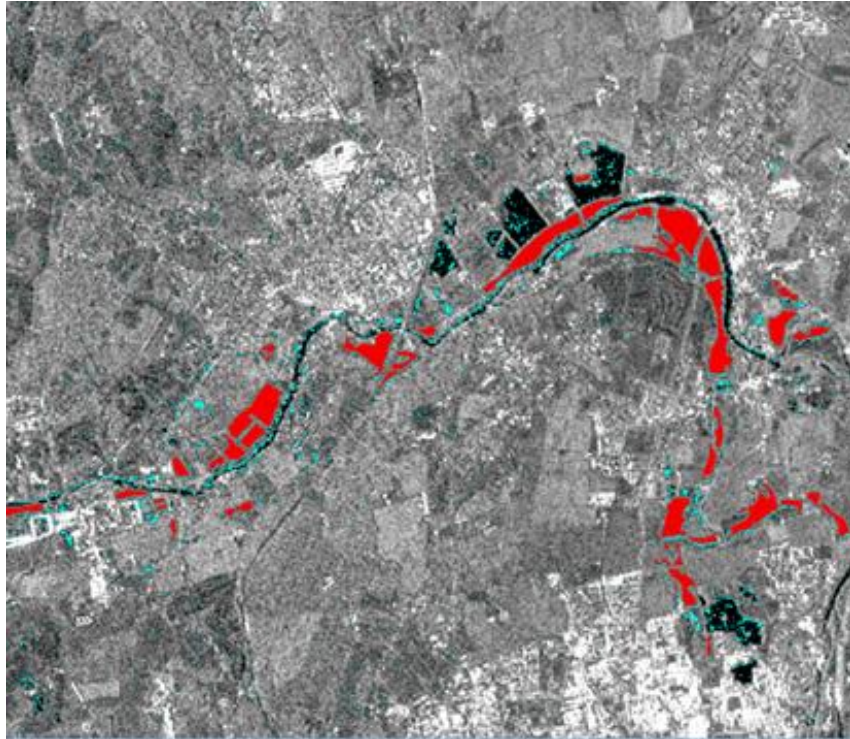
- Environment Agency wanted to improve operational flood water extent and depth mapping during flooding incidents, specifically:
 - Delineation of flood waters in urban areas.
 - Improving flood mapping over a large geographical area.
 - Automatic dissemination of information to staff during a flooding incident .
- Proof of concept project, which successfully demonstrated the potential for an operational system by implementing satellite remote sensing algorithms from recent scientific research to improve the accuracy of floodwater delineation, and provided a simple interface to produce the results.

Satellite enabled solution



- The project implemented four approaches, and developed an ENVI extension to allow them to be run without specialist expertise:
 - **Estimation of floodwater extent** based on the scientific research of Matgen et al. (2011), Giustarini et al. (2013) and Greifeneder et al. (2014).
 - **Application of algorithms to a variety of Synthetic Aperture Radar (SAR) satellite data** in areas such as lower Severn (2007), upper Thames (2014), York (2015) and Spain (2015).
 - **Evaluation of the results**, compared with the EA and Copernicus Emergency Management Service remotely sensed flood extents, to determine accuracy.
 - **Demonstrator extension to the ENVI software package**, which allows the algorithms to be run on pre-processed imagery.

TerraSAR-X results (upper Thames 2014 flooding)



Environment Agency remotely sensed derived flood mapped layer in red overlaid with OMEF derived layer based on TerraSAR-X in pale blue (left), and (right) OMEF overlaid with EMS flood mapped layer. *TerraSAR-X: © DLR e.V. 2014, Distribution Airbus DS Geo GmbH, and Environment Agency flood outlines ©Environment Agency (2016)*

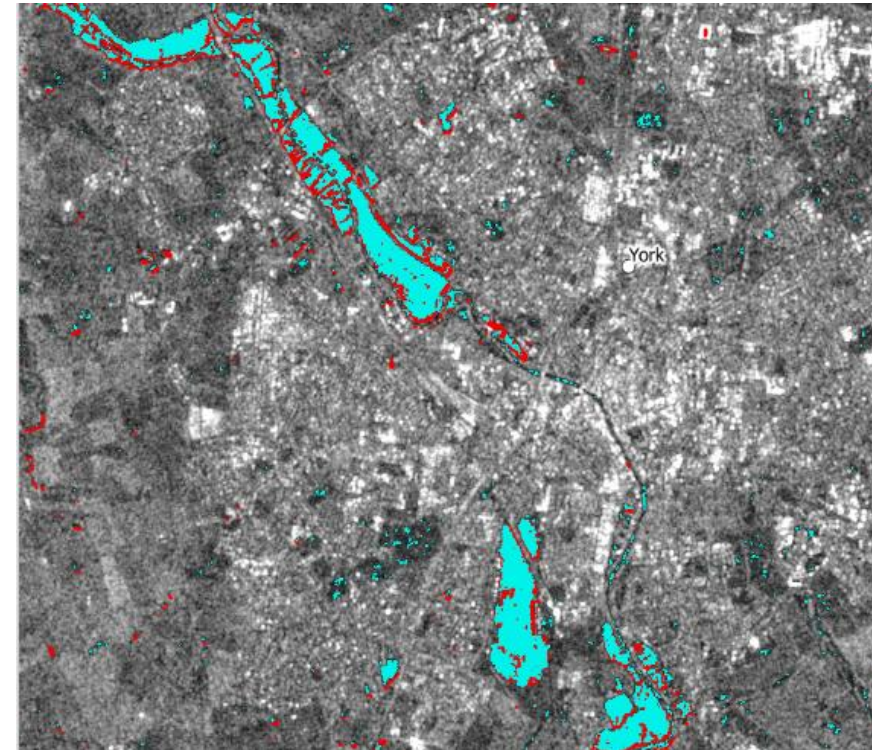
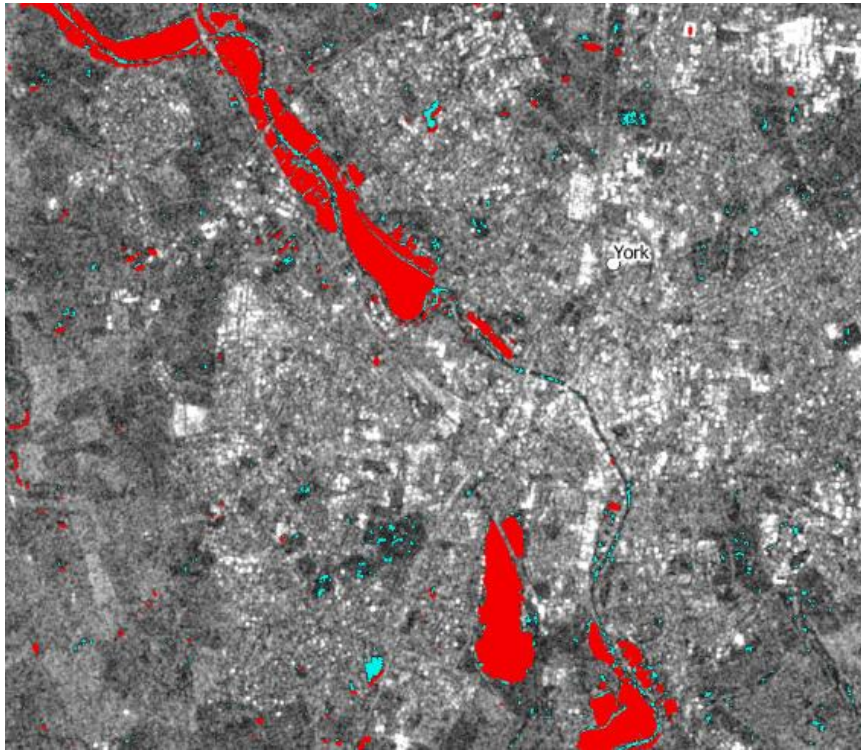
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Sentinel-1 results (York 2015 flooding)



Copernicus Emergency Management Service (EMS) derived flood layer based on RADARSAT 2 in red overlaid with OMEF derived layer based on Sentinel-1 in pale blue (left), and (right) OMEF overlaid with EMS flood mapped layer. *Sentinel-1 data courtesy of Copernicus / ESA and Copernicus Emergency Management Service (© 2015 European Union), [EMSR150] York: Delineation Map, Monitoring 1.*

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Engagement with end users

- Environment Agency helped shape the project with: an initial meeting; datasets to help with the evaluation; reviewed the evaluation report; provided feedback and ideas for further development at a second meeting.
- Overall we received positive feedback, with a key point for future work being that satellite SAR data cannot be used alone if all flooded areas must be detected as it will always underestimate the extent. However, it does provide a large area assessment tool that can provide an overarching assessment to enable the best use of ground / airborne mapping.

Benefits for end user - economic social or financial

- The key user capability is ability to access the system and limited training.
- Specific benefits include:
 - **Faster initial flood maps**, which provide improved knowledge of flood events.
 - **Improve decision making** on the deployment of resources in response to flood events.
 - **Sentinel-1 as the primary data source** offers savings compared to commercial imagery.
 - A **web-based interface** reduces the need for specialist knowledge.
 - **ENVI extension: more knowledgeable users** can produce their own flood extents.
- Wider applications could include offering:
 - Secondary users a **fast flood mapping solution** which could for example, enable insurance companies to support claimants more effectively.
 - Planning officers, and potential homeowners, the opportunity to **review historic flooding incidents** before building/buying houses.

Business models considered

- Two business models have been considered:
 - **Licensed solution:** ENVI module which the user runs on their own infrastructure with no restriction on usage. Will have an initial licence fee, coupled with an annual maintenance fee. Through this solution more knowledgeable end users would have the potential to produce customised flood extents for specific needs. Anticipated this solution would be for primary users, such as Environment Agency.
 - **Monthly subscription or cost per image solution:** This would be a web-based system managed by Pixalytics, where users would request the required flood images. Anticipated this will be for the secondary, or casual user, such as insurance companies or home owners.

Next Steps



- We've learnt the information needed to implement scientific **research doesn't reside only in the scientific paper.**
- The key gains for Pixalytics, through our SSGP involvement, are:
 - Development of potential flood mapping product for end-users, but also secondary stakeholders such as the insurance industry.
 - Strengthening our radar processing knowledge and capabilities.
 - **Positive publicity**, including an increased profile from the work.
- This was a proof of concept project that can become a commercial product by:
 - Developing **Sentinel-1 non-flood archive**, which is ready to be used
 - Combining SAR data with optical and altimetry data, plus new algorithms, **to enhance the estimation coverage and accuracy in urban areas.**
 - **Optimising the flood map production.**
 - Turn the ENVI demonstrator into a **saleable software solution.**

Conclusions

- Overall, our involvement in the SSGP programme has been beneficial.
- The proof of concept Phase 1 project included the application of different approaches to a range of SAR data (both Copernicus Sentinel-1 and higher spatial resolution commercial missions).
- The results were encouraging with the accuracy being comparable to existing data sources, but additional testing is needed to come to definitive conclusions on the accuracy as the comparison datasets were not available during the projects' timeframe.
- We have a clear plan for what was developed, which includes two business models:
 - Licensed solution, and
 - Monthly subscription or cost per image solution.
- Will allow both experienced and inexperienced users to be catered for.