

# Capturing flood events with SAR satellites is all about being lucky... or is it?

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Some disasters are more suited to spaceborne monitoring than others as for some post-event rather than event monitoring is actually a welcomed option (e.g. earthquakes, volcanoes). Flooding, however, requires satellites to capture the event while it is taking place, as in many cases especially over smaller basins in Europe floods recede relatively quickly and post-event

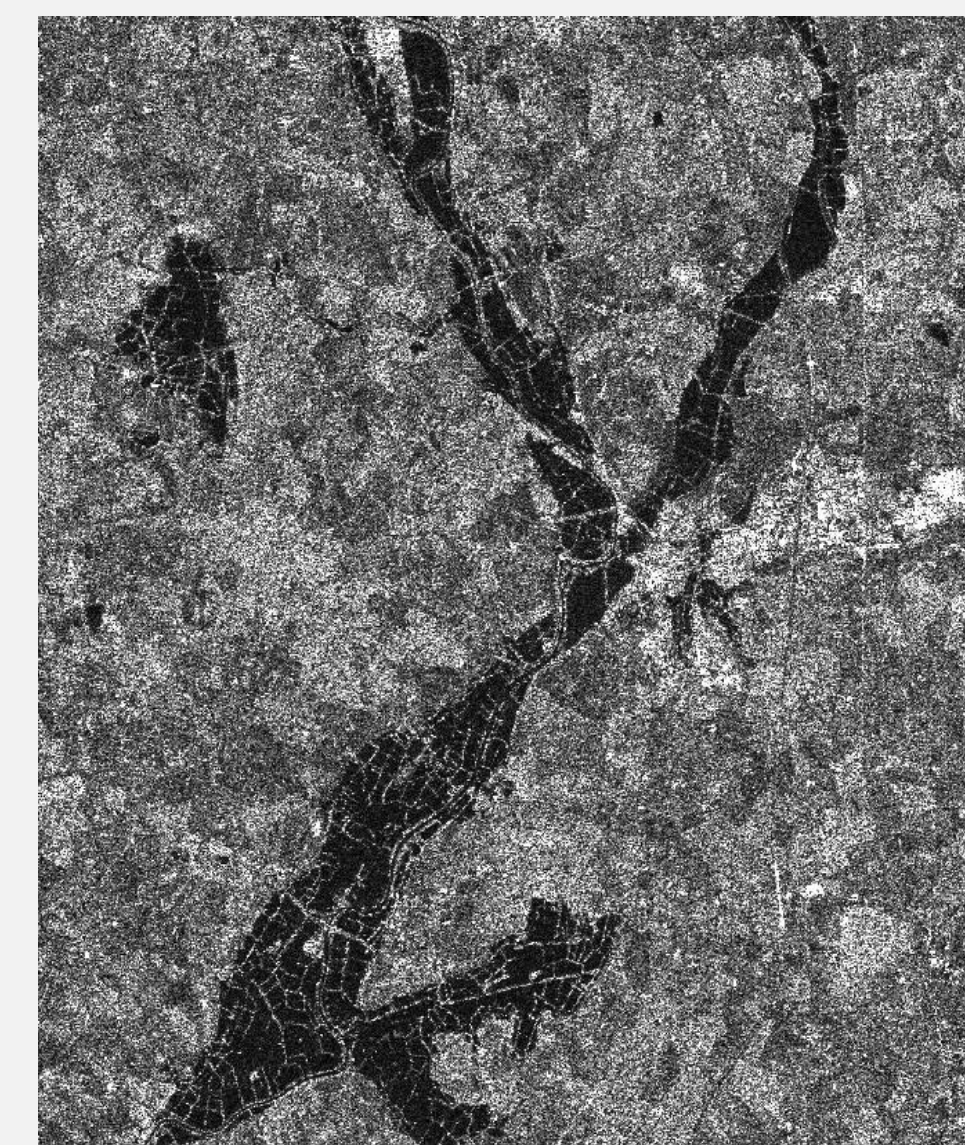
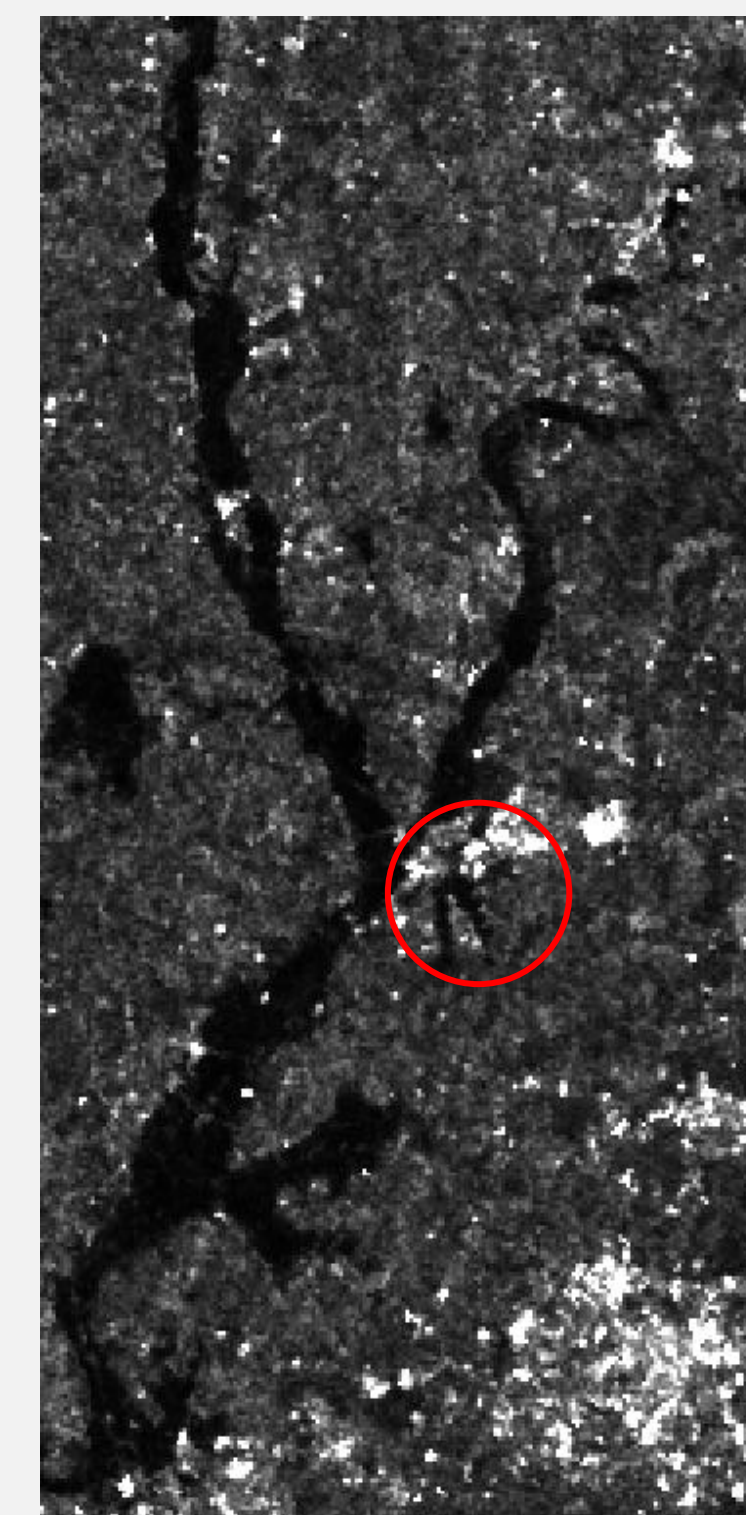
monitoring from space becomes very difficult. Efforts are currently undertaken by major space agencies to reduce the number of days in orbital revisits for future radar image acquisitions. This will without doubt increase the potential of radar satellites for event-based flood monitoring.

## Test case for all SAR image modes

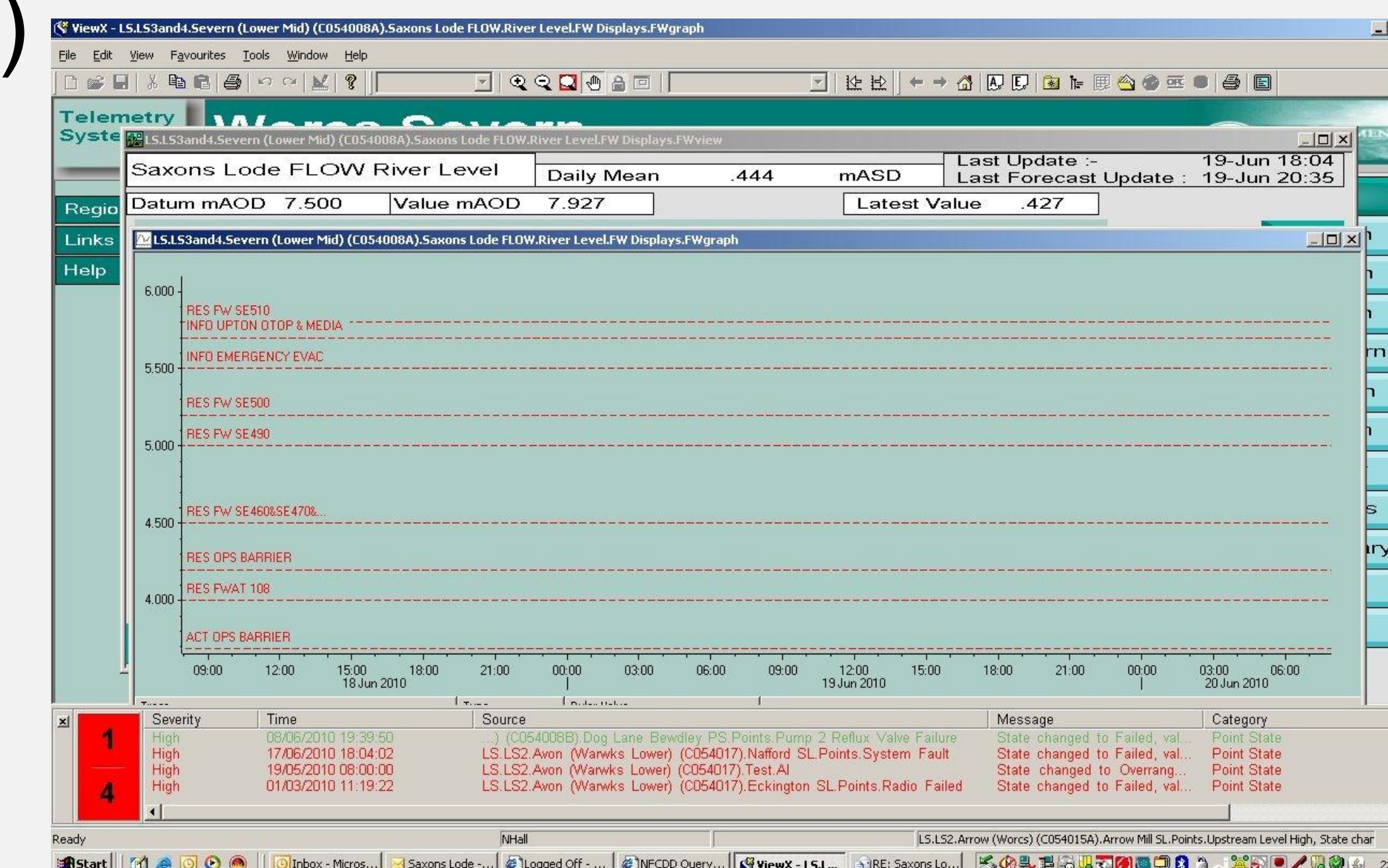
Using the River Severn catchment in the UK and the town of Tewkesbury as a test site (**Figure 1a**), we analysed 8 years of ENVISAT SAR archived image acquisitions and assessed the probability of capturing actual flood events on the River Severn. Even though revisit times for the Tewkesbury area of all SAR modes combined is around 2.5 days (40% of the total number of days in 8 years) only on 4% (97 days) of the total number of days the river levels actually exceeded overtopping thresholds (>4.5 m, **Figure 1b**). As a result, of these 97 days ENVISAT

captured an image of a 'dangerous' water level on only 17 days. If however we are interested in whether the satellite acquires an image of the actual event, which may last up to >6 days, then we capture 12 out of 14 flood events (where an event is classified as lasting three or more days). Of these, 5 events have been recorded on two images, however the second image always being in wide swath mode and thus of only limited use for our test site.

(a)



(b)

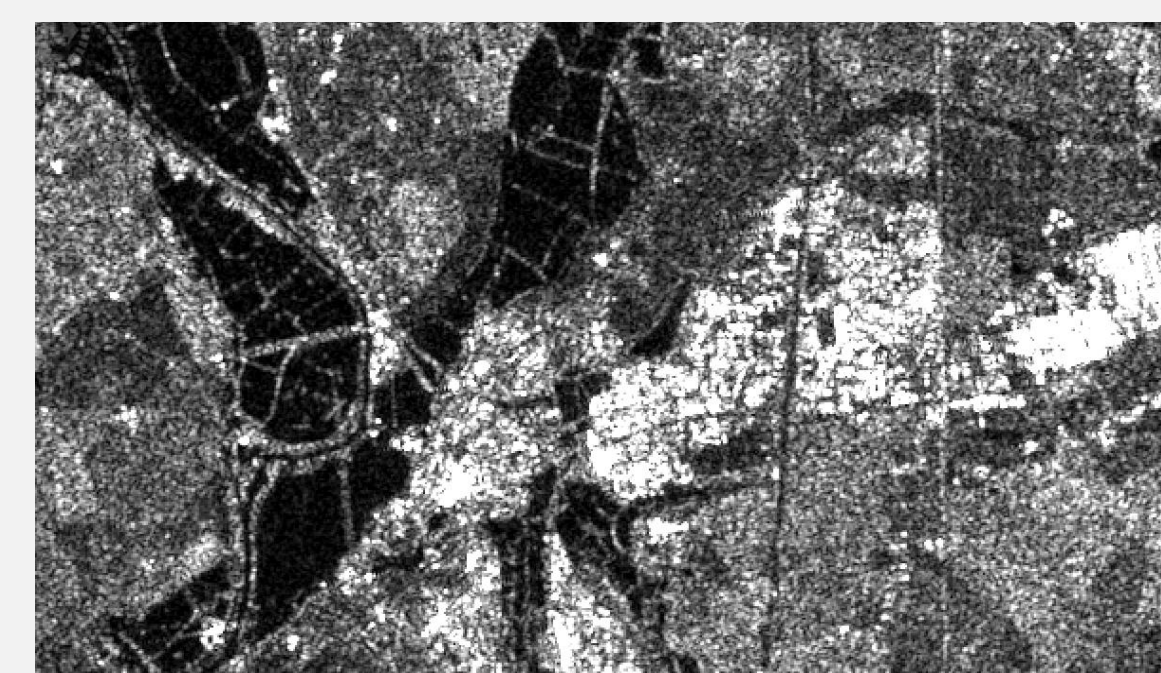


**Figure 1:** (a) Subset of a wide swath mode (WSM) SAR image (75 m pixels) acquired of the devastating flood on July 23 2007 (left) and of a SAR image mode (12.5 m pixels) acquisition (right) of the event on July 26 showing the rivers Severn and Avon (UK) at the Tewkesbury (red circle) confluence (© ESA). (b) Screen shot of the Environment Agency's data base showing danger thresholds for water levels at Saxons Lode station just upstream of the town of Tewkesbury (© EA).

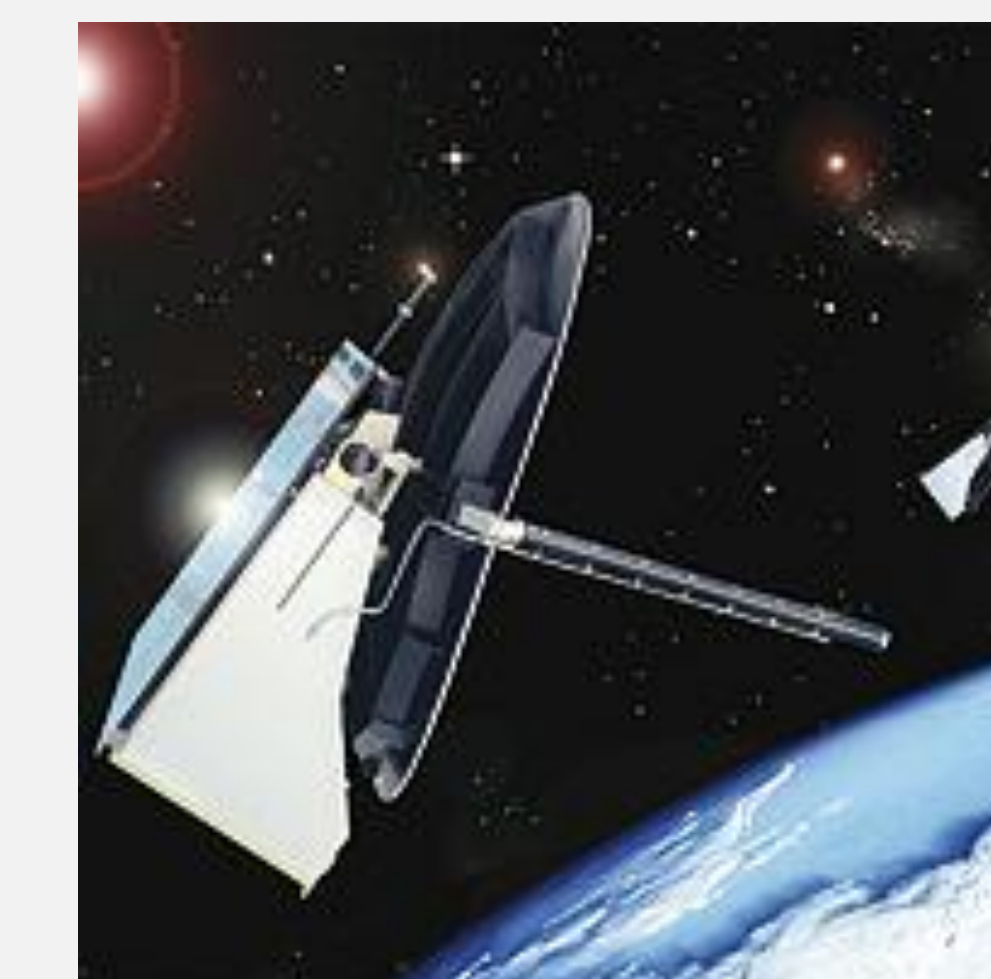
## Situation for adequate geometric resolution

The situations worsens dramatically when looking only at higher resolution imagery (e.g. 12.5 m), which for our test site is the only useful geometric resolution in case of ENVISAT (**Figure 2**). In this case capturing inundation on the same day decreases to 8 out of 97 days and only 7 out of

14 events; although this statistic looks disappointing, it is slightly higher than the revisit time of all SAR modes on ENVISAT combined (40%).



**Figure 2:** Subset showing flooding of the urban area of the town of Tewkesbury. An ENVISAT SAR image mode (12.5 m pixels) acquisition on July 26 (left) and a TerraSAR-X strip map (3 m) acquisition on 25 July (right) (© ESA, DLR).



**Figure 3:** Artist impression of the COSMO-SkyMed satellite constellation (left). Currently there are four SAR satellites in this constellation (© ESA). Artistic view of the SAR Lupe constellation which currently includes five high resolution SAR satellites (© DLR).

It is worth noting that in our analysis we did not assess whether flooding was actually visible on the images, which is of course the crucial factor. With this in mind it can be concluded that without leaving it to chance, the only guarantee to capture a flood when it actually happens and for which meaningful information can be obtained is with SAR satellite constellations such as

COSMO-SkyMed or SAR Lupe (**Figure 3**). Nonetheless, in the case of the Severn where certain events can last up to 6 days or more, recent satellites such as TerraSAR-X (11 days cycle) or future missions such as SENTINEL-1 (every 6 days) can prove promising.