Open Water Flood Extent Maps – Product Guide

Background:

Flooding can have devastating impacts on human life, infrastructure, wildlife, agriculture, and economy. Flooding can result from a variety of factors including spring snowmelt, ice jams, extreme rainfall, hurricanes, tsunamis, and coastal flooding. Canada typically experiences spring flooding on a yearly basis, for example the Red River in Manitoba. It is expected with changes in climate that there will be an increase in flood events frequency and intensity.

Access to near-real time flood maps and information detailing the extent, severity and progression of a flood event greatly improves on the ground situational awareness and facilitates decision making and flood forecasting. Other methods of collecting flood extent information include aerial survey, field surveys and UAV's (Unmanned Aerial Vehicule). While these methods have many advantages including excellent flexibility in terms of observation timing and frequency, some of the disadvantages are they can be expensive and provide limited spatial coverage. Satellite remote sensing systems provide a very good alt alternative due to their routine, systematic, synoptic and repetitive imaging capability. While optical satellite imagery is subject to weather conditions, Synthetic Aperture Radar (SAR) satellites such as Canada's RADARSAT-2 are particularly well suited to the task because they can image independent of daylight and weather conditions. However, SAR satellites operate in certain orbits that limit their imaging capabilities in terms of time and frequency of acquisition. As such, SAR satellite and traditional observation must be considered as complementary rather than conflicting sources of information.

The success of SAR satellites in support of flood mapping is well-documented. On SAR imagery, the contrast between water (specular scattering) and land (diffuse scattering) is usually easily detected. These differences in scattering allow easy interpretation of the flood extent and can produce quick flood maps for disaster response.

Description of Open Water Flood Extent Product:

This open water flood extent map was derived from an image acquired by Canada's RADARSAT-2 Synthetic Aperture Radar (SAR) satellite. The SAR image processing method used to produce this flood extent product was developed by an in-house research team at the Canada Center for Remote Sensing, Natural Resources Canada (NRCAN).

This open water flood extent map discriminates 'open water' from all other land cover classes (Figure 1). Calm water results in specular reflection, therefore very little backscatter is returned to the satellite (Figure 2). The severity of the flood is best interpreted as a time series and/or in conjunction with ground validation. The flood status can be very dynamic throughout the spring melt season and products reflect the conditions at the date/time of satellite image acquisition (information available in distributed flood product metadata).

Figure 1: Flooding on the Red River, Canada: derived from a RADARSAT-2 image from April 28, 2011, 12:40 UTC. The open water flood extent from April 28, 2011 is represented by the dark blue polygons.

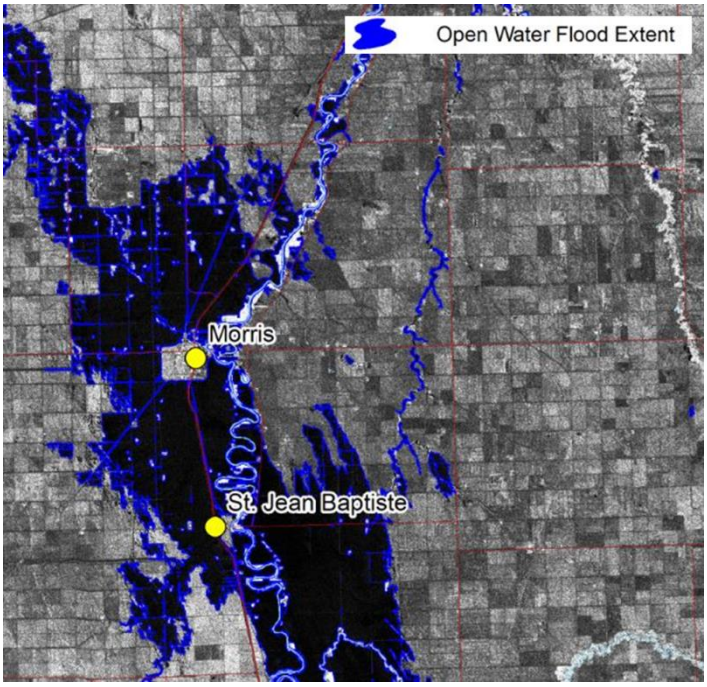


Figure 2: a) An example of flooding in Red River, Manitoba. The water is calm and therefore has specular reflection. b) specular reflection: A smooth surface acts like a mirror for the incident radar pulse. Most of the incident radar energy is reflected away, and very little energy is scattered back to the radar sensor.

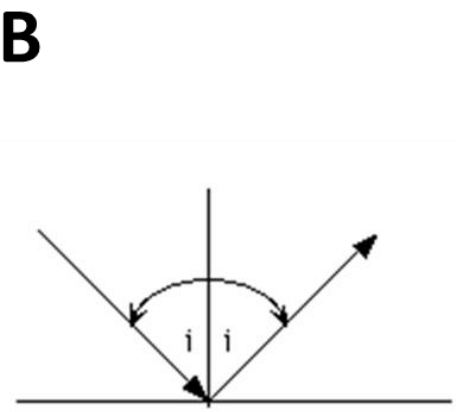
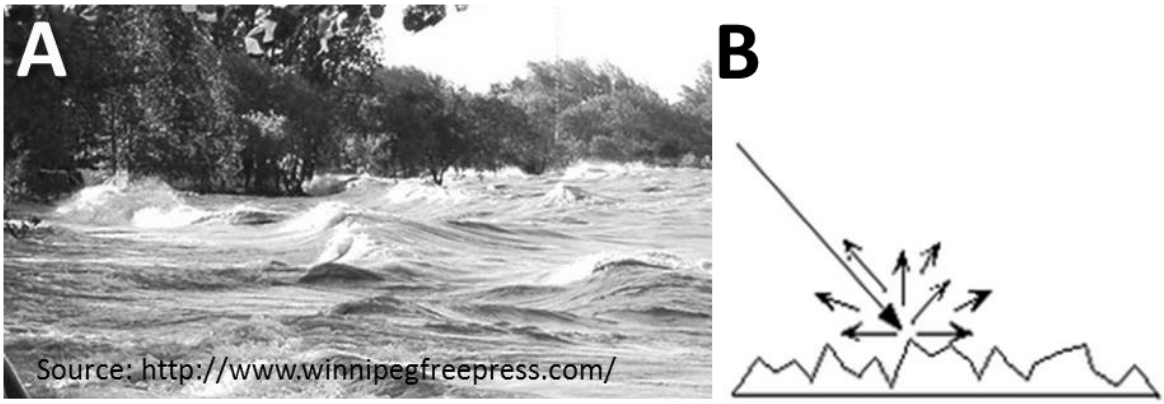


Figure 3: a) An example of waves on Lake Winnipeg, Manitoba. The water is rough and therefore has diffused reflection. b) Diffuse Reflection: A rough surface reflects the incident radar pulse in all directions. Part of the radar energy is scattered back to the radar sensor. The amount of energy backscattered depends on the properties of the target on the ground.



Product Use Limitations:

Emergency response authorities are the primary users of these satellite-derived open water flood extent map products. These product are are generated to provide analysis and emergency response situational awareness and to facilitate decision making during major flood events. The open water flood extent products are generated rapidly and limited time is available for editing and validation. The flood products reflect the open water flood conditions at the date/time of acquisition. While every effort is made to produce high quality products, near-real time products may contain errors due to the limited time available for vector editing and validation. Please note that current algorithms do not map flooded areas under forest canopy and are not optimized for urban flood mapping. NRCan does not assume any liability deemed to have been caused directly or indirectly by any content or the use of the products. User Agreement for Digital Data https://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/free-data-geogratis/licence/17285

Information products derived from SAR images, in general, have limitations imposed by sensor parameters and environmental conditions at the time of acquisition. For example:

- SAR images are sensitive to surface roughness. The presence of high winds that generate waves, current/rapids, and the presence of ice on water increases the roughness of the water surface and complicate the discrimination of open water.
- SAR images are sensitive to moisture; large amounts of wet snow can be expected to be misclassified as water.
- Other natural or manmade targets which exhibit a specular reflection can be misclassified as water. Examples: Smooth wet ice, asphalt highway/parking lot, desert sand, airport landing strips. SAR images acquired in mountainous areas can have

significant relief displacement (foreshortening, layover and radar shadow) due to SAR side looking geometry. Thus in presence of steep terrain can render the extraction of flood extend difficult.

Additional considerations:

- To minimize editing, a fixed spatial extent processing mask is often used to delimit the extraction of open water polygons to areas of interest. Areas outside of this mask are not processed. The footprint of the area processed is available for download on our FTP site with open flood extent products.
- A minimum polygon size is set in hectares and varies by regions, end user needs and ground conditions.

Credit:

Use of this data for publications, posters, or presentations is encouraged. All use must include the following standard acknowledgement paragraph: "The open water flood extent products are derived from RADARSAT-2 images with a system developed and operated by the Strategic Policy and Results Sector of Natural Resources Canada © Department of Natural Resources Canada. All rights reserved".

Contact us:

For questions and feedback please contact the Emergency Geomatics Service (nrcan.egs-sgu.rncan@canada.ca). Users are also encouraged to send ground reference (e.g. georeferenced photographs), this information will be used for to validate/refine the algorithms and improve the map products.

Data Products/Data Sources:

The open water flood extent products are available for download in KML formats from the EGS anonymous FTP server at: ftp.neodf.nrcan.gc.ca/EGS . For information on the RADARSAT-2 image specifications (i.e. time, beam mode) used to generate flood extent map products, please see the individual metadata file associated with the individual products.

For additional information on RADARSAT-2 please refer to http://www.asc-csa.gc.ca/eng/satellites/default-eo.asp