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A Review of Identification of Flood Location from Remotely Sensed SAR Images of Floods

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ABSTRACT

Probabilistic hail mapping offers weather managers, decision makers, protection agencies, and magnanimous relief organizations a complacent characterization of shot in the dark in flood mapping delineation. This study introduces a review of probabilistic hail mapping matter of form based on atrocious aperture radar (SAR) data.

I. INTRODUCTION

FLOOD events pose a major threat to human life and property. Worldwide, almost one billion people are estimated to be exposed to flooding with an annual probability above 0.01[1].Global financial losses due to flooding are expected to increase fromUS$6billion per annum in 2005toUS$52billion per annum by 2050, due to socioeconomic change alone[2]. As space assets are continuously improving there is a growing pressure on the scientific community to find new ways to use the increased volume and accuracy of remote sensing data for disaster risk reduction. The introduction of products and services based on Earth observation (EO) into the working practices of flood managers represents an opportunity to improve our society's capacity to respond to threats posed by large flood events. Insurance companies and flood managers require disaster impact databases, to better identify areas vulnerable to flood losses. Understanding the uncertainties in the flood maps can help identify locations where the provided classification might be highly uncertain. These locations are often critical from an infrastructure and human life perspective. Flood extent observations are also used by emergency response services to target their limited resources on the most risk-prone areas. However, risk assessment and optimal decision making in emergency situations would benefit for man appropriate communication of areas whose classification is uncertain. The most efficient way of mapping flood extents in near real time and over large areas is to exploit EO satellite images. These images represent a globally coherent and consistent source of flooding-related information, both spatially and temporally. In the growing collections of available EO data, data sets derived from synthetic aperture radar (SAR) are often considered as the most promising resource due to their almost all-weather day/night image acquisition capabilities [3]. Flat surfaces such as calm water appear as dark areas in a radar image, since most of the incident radar pulses are specularly reflected away from the antenna [4].As a result the mapping of water bodies in SAR images is often relatively straightforward, with notable exceptions being built environments, vegetated canopies, deep valley bottoms, and various surface water like response areas. As a consequence of the side-looking nature of SAR sensors, areas of a ground surface may not be visible to the satellite due to radar shadowing and layover caused by buildings or taller vegetation.

Non-flooded areas, such as tarmac, paved roads, and parking lots which appear smooth and water surface like at radar wavelengths, produce very low signal returns and are not easily distinguishable from flooded areas

Detection of flooded urban areas in high resolution Synthetic Aperture Radar images using double scattering BY D.C. Mason, L. Giustarini

A difficulty with using SAR for urban flood detection is that, due to its side-looking nature, substantial areas of urban ground surface may not be visible to the SAR due to radar layover and shadow caused by buildings and taller vegetation. This paper investigates whether urban flooding can be detected in layover regions (where flooding may not normally be apparent) using double scattering between the (possibly flooded) ground surface and the walls of adjacent buildings. The method estimates double scattering strengths using a SAR image in conjunction with a high resolution LiDAR (Light Detection and Ranging) height map of the urban area. A SAR simulator is applied to the LiDAR data to generate maps of layover and shadow, and estimate the positions of double scattering curves in the SAR image.

Water Level Estimation and Reduction of Hydraulic Model Calibration Uncertainties Using Satellite SAR Images of Floods BY Renaud Hostache, Patrick Matgen

Exploitation of river inundation satellite images, particularly for operational applications, is mostly restricted to flood extent mapping. However, there lies significant potential for improvement in a 3-D characterization of floods (i.e., flood depth maps) and an integration of the remote-sensing-derived (RSD) characteristics in hydraulic models. This paper aims at developing synthetic aperture radar (SAR) image analysis methods that go beyond flood extent mapping to assess the potential of these images in the spatiotemporal characterization of flood events. To meet this aim, two research issues were addressed. The first issue relates to water level estimation. The proposed method, which is an adaptation to SAR images of the method developed by [1] and [2] for water level estimation using flood aerial photographs, is composed of three steps: 1) extraction of flood extent limits that are relevant for water level estimation; 2) water level estimation by merging relevant limits with a Digital Elevation Model; and 3) constraining of the water level estimates using hydraulic coherence concepts. Applied to an ENVISAT image of an Alzette River flood (2003, Grand Duchy of Luxembourg), this provides ±54-cm average vertical uncertainty water levels that were validatedusing a sample of ground surveyed high water marks. The second issue aims at better constraining hydraulic models using these RSD water levels. To meet this aim, a “traditional” calibration using recorded hydrographs is completed via comparison between simulated and RSD water levels. This integration of the RSD characteristics proves to better constrain the model (i.e., the number of parameter sets providing acceptable results with respect to observations has been reduced).

Monitoring Flood Evolution in Vegetated Areas Using COSMO-SkyMed Data: The Tuscany 2009 Case Study BY Luca Pulvirenti

Synthetic Aperture Radar (SAR) systems represent a powerful tool to monitor floods because of their all-weather capability, the very high spatial resolution of the new generation of instruments and the short revisit time of the present and future satellite constellations. To exploit these technological advances, an accurate interpretation of the multitemporal radar signature of the flooded areas is required. Mapping flooded vegetation is a task in which the interpretation of SAR data is not straightforward and should rely on the knowledge about the radar scattering phenomena in the volume between canopy, trunks and floodwater. This paper presents a methodology aiming at mapping flooded areas with a focus on flooded vegetation; the algorithm is based on an image segmentation technique and a fuzzy logic classifier. The tuning of the parameters of the fuzzy algorithm, based on the outputs of a theoretical backscattering model, is described in detail. Ancillary data giving accurate information on land cover are also used to set the input parameters of the model. The methodology is tested on a case study regarding a flood occurred in Tuscany (Central Italy) on December 2009 monitored using COSMO-SkyMed data. The multitemporal radar signatures observed during the event are discussed;

Discrimination of Water Surfaces, Heavy Rainfall, and Wet Snow Using COSMO-SkyMed Observations of Severe Weather Events BY Luca Pulvirenti

An automatic method to distinguish water surfaces (either flooded or permanent water bodies) from artifacts caused by heavy precipitation and wet snow is designed to improve flood detection accuracy in X-band synthetic aperture radar (SAR) images. The algorithm implementing the proposed method, mainly based on image segmentation techniques and on the fuzzy logic, consists of two principal steps: 1) detection of regions (or segments) of low-radar backscatter that appear dark in a SAR image, and 2) classification of each detected segment. Ancillary data, such as a local incidence angle map, a land cover map, and an optical image (helpful to detect wet snow), are also used. Through the fuzzy logic, the algorithm integrates different rules for the detection of dark areas, as well as for their classification based on radiometric, geometrical and shape features extracted from the segmented SAR image and on the ancillary data.

Conditioning Water Stages From Satellite Imagery on Uncertain Data Points BY Guy Schumann

Observed spatially distributed water stages with uncertainty are of considerable importance for flood modeling and management purposes but are difficult to collect in the field during a flood event. Synthetic aperture radar (SAR) remote sensing offers an inviting alternative to provide this kind of data. A straightforward technique to derive water stages from a single SAR flood image is to extract heights from a digital elevation model at the flood boundaries. Schumann et al. have presented a regression modeling approach as an improvement to this simple technique. However, regression modeling associated with their model may restrict output to mapping purposes rather than extend it to integration with other data or models. This letter introduces an inviting alternative that conducts statistical analysis on river cross-sectional data points, thereby allowing uncertainty assessment of remote-sensing-derived water stages without any regression modeling constraint.

Worldwide, almost one billion people are estimated to be exposed to flooding with an annual probability above, due to socioeconomic change alone. Insurance companies and flood managers require disaster impact databases, to better identify areas vulnerable to flood losses. Understanding the uncertainties in the flood maps can help identify locations where the provided classification might be highly uncertain.

These locations are often critical from an infrastructure and human life perspective. Flood extent observations are also used by emergency response services to target their limited resources on the most risk-prone areas. However, risk assessment and optimal decision making in emergency situations would benefit from an appropriate communication of areas whose classification is uncertain.

SYNTHETIC aperture radar (SAR) sensors are particularly useful for data acquisition during flood events due to their all-weather as well as day and night capabilities, and given the rapid recession of floods in smaller catchments, SAR is currently the most promising possibility to monitor floods from space. Despite the fact that many authors have shown since the mid-1980s that remote-sensing images of water bodies can be merged with topographical data to derive water stage, volume, and depth (e.g., [1]–[6]), a SAR flood image is, most of the time, limited to a simple wet–dry thresholding [6]. Schumann et al. [1] presented a (steady-state) SAR-based model that uses regression analysis to account for most of the “noise” in water heights extracted from a LiDAR digital elevation model (DEM) at the SAR-derived flood boundaries. They developed the Regression- and Elevation-based Flood Information eXtraction (REFIX) model on a reach of the River Alzette north of Luxembourg City (G.D. of Luxembourg) for which they proposed a linear regression model to estimate spatially distributed water stages for the 2003 flood event. The methodology allows for rapid mapping and prepares the observed data in a consistent way with the SAR extractions. It is worth noting that the regression coefficients are not set by any field data butare conditioned on the SAR waters tag extracted at the flood boundaries of river cross sections drawn perpendicular to the direction of flow. In the presence of a hydraulic structure influencing the water surface gradient and therefore extent, piecewise or nonlinear regression can be applied to the SAR data to adapt the regression to localized flow behavior. The water stages estimated with the REFIX regression model can be used in a Geographic Information System to create a Triangular Irregular Network (TIN) mesh of the water surface, from which the actual flood plain DEM is subtracted to generate a 3-D flood depth and area map [1].

Block Diagram of Proposed Approach

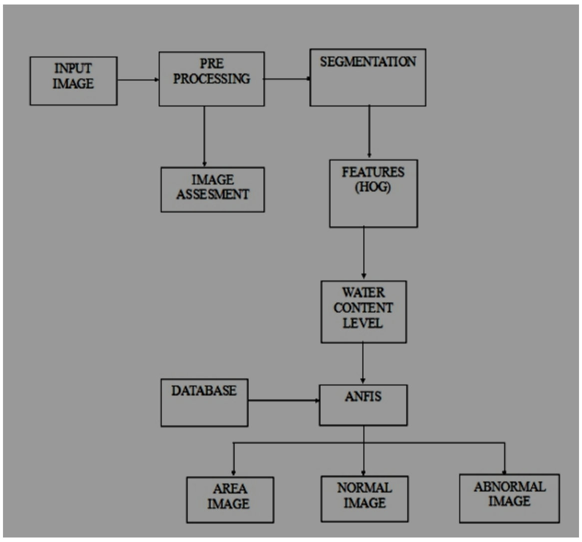

Figure 1

II. CONCLUSION

We have proposed a Bayesian approach for generating probabilistic flood maps from remotely sensed SAR images of floods. The probability of a particular pixel being flooded is derived from the histogram of back scatter values, the latter being modelled as a mixture of two populations of back scatter values, corresponding to flooded and non-flooded pixels, respectively. In addition to the SAR maps, the probabilistic flood mapping approach only requires the specification of the prior probability of a given pixel being flooded. With the help of K means segmentation we can identify the histogram of gradient. With ANFIS classifiers the output image are building, normal image and abnormal image can be determined. Based on the flood levels the voice board gives announcements.

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