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Flooded area cartography with kernel-based classifiers and Landsat TM imagery

M. Volpi (1), G. P. Petropoulos (2), and M. Kanevski (1)

(1) Institute of Geomatics and Analysis of Risk, University of Lausanne, Switzerland, (2) Institute of Geography and Earth Sciences, University of Aberystwyth, Wales, UK

Timely and accurate flooding extent maps for both emergency and recovery phases are required by scientists, local authorities and decision makers. In particular, the issue of reducing exposure by quantifying vulnerability to inundation has recently began to be considered by European policies.
Remote sensing can provide valuable information to this task, particularly over inaccessible regions. Provided that cloud-free conditions exist, multi-temporal optical images can be exploited for automatic cartography of the inundation. Image processing techniques based on kernels are promising tools in many remote sensing problems, ranging from biophysical parameter estimation to multi-temporal classification and change detection. The success of such methods is largely due to the explicit non-linear nature of the discriminant function and to their robustness to high-dimensional input spaces, such as those generated from remote sensing spectral bands.
In our study, we examined the application of two supervised kernel-based classifiers for flooded area extraction from Landsat TM imagery. As a case study, we analyzed a region of the Missouri River in South Dakota, United States, in which images before and after a flood that took place in 2011 were available. In our approach, the mapping issue is recast as a change detection problem, whereby only the amount of water in excess to the permanent standing one was considered. Support Vector Machine (SVM) and Fisher's Linear Discriminant Analysis (LDA) classifications were applied successfully. Both classifiers were utilized in their linear and non-linear (kernel) versions. Evaluation of the ability of the two methods in delineating the flooding extent was conducted on the basis of classification accuracy assessment metrics as well as the McNemar statistical significance testing.
Our findings showed the suitability of the non-linear kernel extensions to accurately map the flood extent. Possible future developments of the methodology presented herein are discussed in relation to flooded area mapping, such as the inclusion of spatial regularizers or of physically inspired features in the change detection system.

Keywords: natural hazards, floods, remote sensing, change detection, kernel methods, classification

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