Reducing False Alarms in Urban Flood Detection: An Enhanced NDWI (ENDWI) with Hybrid Max Fusion on Sentinel-2 Data.

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Authors' Response to Referee Comments

(Note): Reviewer comments are in black, Author response in blue.

RC1: Comment on egusphere-2026-672, Anonymous Referee #1, 19 Apr 2026

General Comment RC1:

Thank you for submitting this well-prepared and valuable manuscript. The manuscript presents a meaningful contribution by proposing an enhanced water index (ENDWI) and demonstrating its effectiveness in reducing false alarms in urban flood detection. The methodology is sound, and the results are convincing.

Thank you very much for your time and kind words.

Specific Comment 1:

The abstract could more clearly state whether ENDWI is a novel index or a modification of existing indices (e.g., NDWI), and briefly indicate its key characteristics.

Thank you for this valuable suggestion. The abstract has been revised to clarify that ENDWI is a novel enhancement of NDWI, formulated as NDWI divided by the green band, designed to suppress urban noise. **(Lines 08–10).**

Specific Comment 2:

A short explanation of the spectral rationale behind the reduction in false alarms would improve the interpretability of the results.

The spectral rationale has been elaborated in the Methodology section, explaining that dividing NDWI by the Green band causes non-water urban surfaces to attenuate more strongly than water pixels, thereby reducing false alarms. A full explanation is provided in the manuscript. **(Lines 218–238).**

RC2: Comment on egusphere-2026-672, Guy J.-P. Schumann, 19 Apr 2026

General Comment:

This paper presents a method to process S2 flood images using an enhanced NDWI method. The paper is well written and I have only a few comments but some of those deserve moderate to major attention.

Thank you very much for your time and valuable feedback.

Specific Comment 1:

It is appreciated that the authors demonstrated the innovation presented relative to other published methods, but I feel they need to better justify why their method is preferred. Is it better accuracy, more robustness/consistency, better scaling. I feel the accuracy gained does not necessarily justify the implementation.

Thank you for this valuable comment,

Three justifications have been provided in the revised manuscript:

- ENDWI relies exclusively on Green and NIR bands, making it simple, low-cost, and applicable to a wide range of sensors and platforms including UAVs. **(Lines 105-112, 434–442).**
- ENDWI achieved a FAR of 10.95% among the top three performers out of eight evaluated indices, and the hybrid fusion further reduced FAR to 2.99%. **(Lines 366–372, Eq. 12, Eq. 13, Fig. 4 and 5, and Tables 3 and 4).**
- A novel Z-Split normalization technique was developed to address the near-zero clustering of ENDWI values, enabling reliable Otsu thresholding. This step represents a methodological contribution to spectral index post-processing, enhancing the robustness and consistency of the thresholding stage and further justifying the implementation of the proposed method. **(Lines 250–296, 477-478, 485-489, Eq. 9, and Fig. 3).**

Specific Comment 2:

The authors should also perform a simple cost-benefit analysis against other methods using some of the performance measures, but also computational efficiency and robustness, obtained by computing a series of different flood events.

Thank you for this valuable suggestion.

- Regarding cost-benefit, ENDWI relies exclusively on Green and NIR bands, which are also used in NDWI **(Eq.1 and Eq.2),** requiring no additional spectral bands or computational overhead beyond a single division operation executable by only one band within seconds using any standard raster analysis tools.
- Despite this minimal added complexity, ENDWI reduced the false alarm rate from 37.84% (NDWI) to 10.95%, while the hybrid fusion further reduced it to 2.99%,

representing a significant improvement at negligible computational cost. These updates are at **(Lines 450–459, 480-484).**

- Regarding robustness across multiple events, due to the lack of reliable high-quality validation data, this study focused on a single well-documented flood case. However, the ENDWI was informally tested on an independent flood event reported in Ahmadi et al. (2026), where ENDWI clearly outperformed NDWI in false alarm reduction **(Lines 464, and 497-499).** This limitation is explicitly acknowledged in the Discussion section **(Lines 462–466).** Furthermore, the Conclusion section highlights the need for future validation across multiple flood events and recommends extending such analyses in future research to further assess the robustness and generalizability of the proposed approach **(Lines 497–503).**