

Soil erosion has become a critical global phenomenon with profound implications for essential ecological cycles, food security, and the sustainable development of nations. Globally, numerous attempts have been made to precisely estimate soil erosion; however, achieving flawless accuracy remains challenging due to the sheer complexity and multi-dimensional nature of the driving environmental factors.

Recognizing the urgent need to mitigate this issue, Germany enacted the German Soil Protection Law and its accompanying decree to safeguard the nation's environmental livelihood. In the current version of the manuscript, the authors argue that this legislation was established with limited or insufficient knowledge of key driving forces, specifically the recurrence intervals or return periods (RP) of erosive rainfall events. Consequently, the authors aim to investigate this issue at a fundamental level to ensure that future policy and environmental legislation are guided by rigorous scientific evaluation rather than ad-hoc assumptions. Based on the current draft of the manuscript, the following points are brought forward for detailed discussion:

1. LINE 50-52: The central problem statement of the manuscript focuses on the German Soil Protection Law and its respective ordinance, arguing that the framework fails to adequately include the return period (RP) of erosive events. While the manuscript correctly identifies the timeline of the legislation, the current version lacks substantial evidence or background to fully justify this claim. To strengthen the introduction, it would be highly beneficial if the authors provided deeper context in lines 50–52 regarding how the legislators originally formulated these guidelines. Clarifying what foundational assumptions or baseline historical data the legislators relied upon when the framework was established would significantly anchor the study's rationale. Currently, the text adopts an overly critical stance toward the 2021 legislative updates, which risks coming across to readers as an unfair dismissal of the regulatory body's efforts rather than an objective scientific critique. Reframing this section to focus on the technical opportunities for optimizing the law—backed by historical context—will make the research objectives much more compelling and well-received by the audience.

2. LINE 80-213: The methodology employed to resolve the problem statement (line 50-52) is highly debatable. In hydrology, it is well-established—though under-documented—that soil erosion or the erosion damages [line 50–52] is not a phenomenon dictated solely by rainfall magnitude and duration. The authors' current approach might be preferred by administrative engineers for bureaucratic simplicity, from a scientific standpoint, this is a major oversimplification. The underlying soil type plays a critical role in governing actual erosion damages. To make this research robust, the authors must incorporate specific soil types, map their spatial distribution across Germany, and demonstrate how these spatial variations alter the outcomes and conclusions of their research.

In addition to soil type, localized soil management practices (e.g., tillage, cover cropping, crop rotation) represent a critical variable that significantly alters soil vulnerability to erosive forces. This influence is particularly pronounced when dealing precisely with the low-magnitude, high-frequency rainfall events that the German decree legally regulates. Ignoring management practices overlooks a primary operational variable of how the law functions in practice. The manuscript needs to account for or explicitly discuss this human-induced variable.

3. LINES 109–114: The authors claim that there are 357,779 pixels covering the country at a 1 km spatial resolution, which then changes to 3,884 pixels when the resolution is resampled to 10 km. Considering the initial value of 357,779 pixels as the benchmark, a 10-fold spatial aggregation should theoretically yield approximately 3,577 pixels ($357,779 / 100$). This leaves an unaccounted discrepancy of 307 pixels, which depends heavily on the specific masking method used during coarsening. The manuscript does not explicitly explain the cause of this pixel count inflation. Are pixels outside the defined domain of interest inadvertently being incorporated into the coarser resolution dataset?

4. LINES 115–118: The manuscript states that the R-factor ranges between 46 and 454 units, with approximately 90% of these values falling between 62 and 163, and values exceeding 250 localized within the Alps. The authors also note that the average R-factor for the "mean year" 2007 was 96. It remains unclear what is meant by the phrase "mean year 2007." Furthermore, the authors should provide a standard mean value to allow for a direct comparison with previously published 2007 literature. As currently written, the broader motivation behind listing all of these specific, uncontextualized numerical values is outside the necessary scope of this section.

Moreover, the concentration of the highest R-factor values within the Alps—a region predominantly characterized by non-arable land—suggests a fundamental mismatch in the study's framework. Since the core policy issue raised by the authors focuses on managing erosion risks under the Federal Soil Protection Act (which primarily impacts agricultural landscapes), highlighting extreme values in non-agricultural, alpine zones does not help resolve the specific problem statement posed in this manuscript. The authors need to better align their spatial analysis with the actual domain of application, rather than using these uncontextualized outliers to justify generic, open-ended future research directions.

5. LINE 50-52: Considering the core objectives outlined in LINES 50–52, it is questionable whether calculating the Return Period (RP) in isolation provides a hydro-geomorphologically sound solution. Soil erosion damage is not driven exclusively by isolated factors like R, EI, and RP. Following the authors' grid-based evaluation, a rainfall event occurring in a specific cell would realistically be influenced by antecedent or simultaneous conditions in adjacent cells. In grid-based surface modeling, this is standardly addressed using an 8-point routing scheme, where the eight surrounding cells dictate directional flow and runoff accumulation. Consequently, even a minimal local rainfall event can cause severe erosion if the accumulated runoff from surrounding cells is accounted for. Therefore, evaluating the RP of erosive rains in spatial isolation may not accurately address the problem statement posed by the authors.

6. The authors must clarify Equation 1 in light of the statement made in LINE 86. According to the text, the R-factor represents the long-term mean annual sum of event erosivities. However, Equation 1 mathematically defines a summation of all erosive rainfall events occurring *within a single year* at a specific cell. The authors must explicitly clarify whether this single-year summation is indeed what they are defining as a "long-term mean annual sum," or correct the formula/text accordingly.

7. Line 106: The authors state that radar rainfall (RR) technology is evaluated for the exact radar pixel in which the rain gauge (RG) data was obtained. It is unclear what is mechanically meant by this statement. To the best of our knowledge, rain gauges provide

localized point measurements, whereas radar data represents spatial grid cells (pixels). Attempting to pair a pixel directly to a point measurement implies an implicit assumption regarding the spatial representativeness or areal coverage of a single gauge. Is this the intended meaning of the authors? Furthermore, how does this specific approach align with or depart from established prior work in radar-gauge merging/validation? While providing citations is necessary, the text must explicitly articulate the underlying spatial concept to the reader rather than relying on references to do the explanation.

8. LINE 85-90. The description of the rainfall erosivity parameter (EI) requires critical clarification. The manuscript states that EI is the product of the total kinetic energy of a storm multiplied by the "maximum intensity within 30 minutes". However, the technical definition of rainfall intensity intrinsically includes a time duration in its denominator (i.e., rainfall depth divided by duration). As currently written, the phrase "*maximum intensity within 30 minutes*" is mathematically and conceptually ambiguous. It is unclear whether the authors mean the maximum localized intensity recorded *during* any 30-minute window within a specific storm event, or if this value is evaluated across an entire annual dataset. Because this parameter serves as a foundational component of your erosivity calculations, the exact mathematical formulation and temporal window used to isolate this maximum value must be made explicitly clear to the reader rather than assuming its definition.

9. Lines 101–106: The manuscript indicates that the analysis is based on rain gauge data spanning only from 2001 to 2016. Given that the current year is 2026, this dataset is significantly outdated relative to contemporary climatological standards. Over the past decade, many regions have experienced pronounced natural and anthropogenic shifts in climate and weather patterns. Restricting the analysis to data prior to 2017 is difficult to justify—particularly for Germany, a highly developed nation with substantial public and institutional investments in atmospheric and scientific research. The authors must explicitly state the rationale for omitting the last decade of records. Did the national meteorological service fail to document these years, or was there a deliberate transition to satellite- or radar-based monitoring post-2016 that led to the exclusion of newer ground station data?

10. LINE 90-95: In scientific writing, it is standard practice to define variables alongside their respective units upon first introduction. Because this standard applies universally across disciplines, the detailed discussion regarding unit conversions in lines 90–95 feels somewhat redundant and dilutes the core focus of the manuscript. As long as each dimensional variable is clearly annotated with its chosen unit, the presented data will be easily understood by the reader without requiring an extensive list of alternative regional unit systems. I suggest streamlining this section to keep the text concise and impactful. Additionally, there appears to be a confusion in lines 92–93. The unit $\text{MJ} \cdot \text{mm} \cdot \text{ha}^{-1} \cdot \text{h}^{-1}$ is presented as equivalent to $\text{MJ} \cdot \text{mm} \cdot \text{ha}^{-1} \cdot \text{h}^{-1} \cdot \text{a}^{-1}$. The inclusion of the "a" term changes the dimensional meaning and implies a completely different variable altogether.

11. LINE 80-213: In the current version of the manuscript, Section 2 (Materials and Methods) is divided into only two subsections: Section 2.1 (Rainfall Erosivity Data) and Section 2.2 (Data Evaluation). There appears to be no dedicated subsection outlining the core methodology, or computational workflow. Without a distinct Section 2.3 (Methodology), the current structure gives the impression that the section covers only the dataset description and its basic evaluation, leaving the actual experimental design unclear. The authors should introduce a dedicated methodology subsection to provide a crystal-clear, step-by-step explanation of the analytical framework used in this study.

12. Lines 450–455: Since multiple authors are involved, the current version of the manuscript utilizes abbreviated initials (e.g., "TW") to outline individual contributions. The authors should verify whether this specific formatting aligns with the journal's standard guidelines, as high-impact journals typically require a systematic, standardized framework. Moreover, since one of the authors has claimed authorship for calculating the rain radar(RR) data, the methodology used to assign credentials among the co-authors must be clearly explained. This is necessary to delineate the scope of each author's intellectual contribution, ensuring transparency and scientific integrity.

SIVARAJAH MYLEVAGANAM, M.S., M.Eng.

Computational Hydrologist | Systems Architect | Environmental Modeler

Email: mylevaganamsivarajah@gmail.com

PROFESSIONAL SUMMARY

Computational Hydrologist, Systems Architect, and Environmental Modeler with a proven track record of engineering high-velocity software and mathematical solutions to complex catchment anomalies. Expert in continental-scale hydrological datasets, Physics-Informed Machine Learning, and high-resolution gridded watershed frameworks. Core contributions include solo-engineering the foundational spatial integration of the multi-million-element USGS NHDPlus dataset into the United States national grid using Soil and Water Assessment Tool (SWAT), and serving as the principal technical architect behind the 3D mathematical physics modeling for Singapore's sovereign urban stormwater initiatives.

CORE TECHNICAL COMPETENCIES

Hydroinformatics Frameworks: Expert in orchestrating multi-scale water frameworks and hydroinformatics pipelines using engines like SWAT.

Geospatial Engineering: Full-stack development across ESRI enterprise ecosystems and advanced open-source spatial stacks.

Intelligent Modeling: Design and deployment of Physics-Informed Machine Learning models.

Advanced Analytics: Production-grade integration of spatio-temporal statistical pipelines, custom APIs, and advanced clustering matrices.

CONCISE CAREER TRAJECTORY & IMPACT

- **One Tool Any Country (OTAC) Global Framework (Ongoing):** Conceptualized and independently developing a multi-year global Python framework fusing surface/groundwater, water quality, and climate science with GCMs, satellite imagery, and advanced ML pipelines.
- **Continental-Scale Big Data Integration:** Executed the integration of the multi-million-element **USGS NHDPlus** watershed dataset into the United States national grid using the **SWAT**.
- **Enterprise Software Engineering Support:** Engineered custom codebase workarounds for enterprise clients directly at **ESRI Headquarters (Redlands, CA)**.
- **Sovereign Infrastructure Modeling:** Modeled 3D rain garden physics at the **National University of Singapore (NUS)**, directly defining Singapore's National Bioretention Guidelines.
- **Academic Instruction:** Delivered advanced undergraduate engineering curriculum covering core disciplines in hydrology, hydraulics, and fluid mechanics.

SCIENTIFIC SERVICE & GOVERNANCE

- **Interactive Scientific Peer Review:** Contribute analytical commentaries within the interactive open-access review platforms of **Hydrology and Earth System Sciences (HESS / European Geosciences Union)**, driving technical accountability in climate and hydrological literature (e.g., *hess-2023-275*).
- **Selected Peer-Reviewed Publication:** Mylevaganam, S., Srinivasan, R., & Singh, V. (2015). Ecohydrologically Driven Catchment Evaluation and Prioritization. *Open Journal of Applied Sciences*, 5, 325-334.

EDUCATION & CREDENTIALS

M.S. in Spatial Science (Hydrology) | Texas A&M University, USA

- MS GPA: 4.0/4.0 | Doctoral Coursework GPA: 3.78/4.0

M.Eng. in Water Engineering and Management | Asian Institute of Technology, Thailand

- Coursework GPA: 3.83/4.0 | Research GPA: 4.0/4.0

B.Sc. Eng. in Civil Engineering | University of Moratuwa, Sri Lanka

- GPA: 3.86/4.0 | First Class Honors