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XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Programma della Giornata

08:15 Registrazione
09:00 Saluti istituzionali. Intervengono: *Mauro Soldati*, Presidente AIGeo; *Emanuele Tondi*, Prorettore Vicario Università di Camerino; Coordinatori Giovani Geomorfologi AIGeo
09:20 Keynote: *Piero Farabollini* – Grandi frane indotte da terremoto sui fronti di sovrascorrimento: Esempi dal fronte montuoso dei Monti Sibillini (Umbria Marche)
09:50 Presentazione della rivista Geografia Fisica e Dinamica Quaternaria – *Andrea Ferrando*

Session 1 - Geomorphological analysis of river systems: Methods, indicators and application

Conveners: Filippo Russo, Vittoria Vandelli

10:00 *Mercurio C., Bellomo V., Azzara G., Conoscenti C., Rotigliano E.* - A multi-scale method for objective river segmentation using geomorphological indicators: application to Sicilian rivers

10:15 *Bellomo V., Azzara G., Mercurio C., Martinello C., Rotigliano E.* - Morphological quality index of surface water bodies in western Sicily

10:30 *Pezzotta A., Zucali M., Al Kindi M., Zerboni A.* - Reconstructing riverscape evolution of the Sultanate of Oman through integrated geomorphological analysis

11:00 *Angelone F., Martucci F., d'Onofrio E.G., Russo F., Magliulo P.* - Assessing the hydromorphological quality of the Sabato River (southern Italy)

11:15 *Sabato G., Luppichini M., Bini M., Scicchitano G.* - AI-assisted optical flow system for real-time river surface velocity monitoring

11:30 *Coffee break*

Session 2 - Hillslope geomorphology of landslides, deep-seated gravitational deformations and sinkholes: From field survey to modelling

Conveners: Paola Coratza, Francesco Seitone

12:00 *Poggi F., Caleca F., Nardini O., Barbadori F., Del Soldato M., De Luca C., Bonano M., Lanari R., Tofani V.* - Innovative approach for landslide vulnerability assessment using InSAR data at the regional scale

12:15 *Barbera L., Maltese A., Conoscenti C.* - Extending multi-sensor remote sensing approaches for landslide timing analysis in Google Earth Engine

12:30 *Valiante M., Guida D., Ferlisi S.* - Hillslope evolution model as a tool for hazard scenarios: the Ligea landslide system case study

12:45 *Bonasera M.* - From sinkhole inventory to hazard assessment: a multiscale geomorphological and GIS-based approach in Messina province (NE Sicily, Italy)

13:00 *Licata M., Seitone F., Fubelli G.* - GOGIRA: a low-cost system for remote spatial data acquisition for geomorphological field mapping

13:30 *Pausa pranzo*

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Session 3 - Slope and landscape dynamics: Erosion, tectonic–climatic controls and coastal processes

Conveners: Ciro Cerrone, Marta Della Seta

14:30 *Luppichini M., Bini M.* - Physical geography as a key framework to investigate Earth surface processes under climate change

14:45 *Ruscitto V., Delchiaro M., Richard M., Iacobucci G., Piacentini D., Troiani F., Della Seta M.* - Quaternary landscape evolution of the Apennines peri-Adriatic belt: insights into climate and tectonics from the fluvial record

15:00 *Contillo L., Corrado G., Gioia D., Minervino Amodio A., Schiattarella M.* - Decadal erosion rates from semi-arid areas of southern Italy: a comparison between direct and indirect measurement data

15:15 *Costanzo S., Di Nocera G. M.* - Ultra-high resolution RUSLE erosion modelling at the UNESCO archaeological site of Arslantepe (Malatya, Republic of Türkiye)

15:30 *Fasciglione G., Anzidei M., Benassai G., Mattei G., Trippanera D., Aucelli P.P.C.* - A multidisciplinary framework for coastal flood monitoring: remote sensing, sedimentology, and numerical modelling applications

15:45 *Sozio A., Marsico A., Colacicco R., La Salandra M., Muscillo S., Scicchitano G., Capologono D., Refice A*. Multi-source approach via Random Forest for badlands mapping

16:00 *YGs Meeting & coffee break*

16:30 Sessione poster

1. *Ronchi M., Bosino A.* - Geomorphological characterisation of Val Toggia (VB) through field surveys and GIS analysis
2. *Franceschi L., Bossi A., Szatten D., De Amicis M., Brzezińska M., Ferrari E., Garzonio R., Ferigato L., Bosino A.* - Geomorphological assessment of the Rio dell'Inferno catchment (Omegna) thirty years after the flood
3. *Ferigato L., De Amicis M., Bosino A., Franceschi L.* - Methodological proposal for identification of a multi-risk analysis technique to support strategic decisions for civil protection planning: preliminary results from Lombardy region datasets
4. *Malocco S., Licata M., Seitone F.* - From field measurements to regional models: linking soil properties and rainfall thresholds for shallow landslides investigations
5. *Pietrogrande S., Mandarino A., Faccini F., Azzoni R.S., Brandolini P.* - Mapping Anthropocene impact on natural processes and landforms within a small Mediterranean catchment
6. *Possenelli M., Devoto S., Parolai S.* - Integrated predictive models for the assessment of earthquake-induced landslide hazard: a geostatistical and AI approach
7. *Ferrando A., Carton A., Coratza P., Soldati M., Vandelli V.* - Geomorphological mapping supporting geoconservation at the Dolomites UNESCO World Heritage Site (NE Italy)
8. *Lampa F., Bendia F., Bufalini M., Gentilucci M., Aringoli D., Dramis F., Farabollini P., Gentili B., Materazzi M, Pambianchi G.* - Deep-seated gravitational slope deformations in active tectonics areas of central Italy
9. *Bernardi A., Licata M., Seitone F.* - Reconstructing fluvial and anthropogenic interactions with multidisciplinary approach: Insights from Turin, NW-Italy.

18:00 Fine dei lavori e proclamazione dei vincitori per il **Miglior Poster** e la **Migliore Presentazione**

19:30 Apericena sociale YGs presso il locale "Bar Civico 28" di Camerino

Session 1: Geomorphological analysis of river systems: methods, indicators and application

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A Multi-Scale Method for Objective River Segmentation Using Geomorphological Indicators: Application to Sicilian Rivers

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Abstract

European countries have transposed the Water Framework Directive (2000/60/EC), adapting it to their ecosystems and river morphologies. Although the Directive allows methodological flexibility, it requires watercourses to be subdivided into homogeneous reaches for proper characterization and management. However, river segmentation is strongly influenced by the spatial scale of analysis, often introducing subjectivity into the process. This study presents a semi-automated approach for river segmentation based on the combined use of the Sinuosity Index (SI) and the Confinement Index (CI), aiming to improve objectivity and consistency in morphological classification. The proposed framework is designed as a rapid and transferable tool that can support river analyses across different European contexts, complementing existing national methodologies. Sinuosity is calculated every 50 m along the channel using multiple moving windows ranging from 100 to 2000 m. Each SI value represents the sinuosity computed within a moving window, covering a distance equal to its size. This multi-scale analysis helps understanding sinuosity variations across different spatial scales and identifying the most representative scale by comparing and analysing SI distributions along the river profile. Graphical analysis of SI variability highlights morphological transitions and meander spacing along the analysed reaches. After selecting the most representative SI scale, sinuosity is combined with the Confinement Index, also computed every 50 m, based on the ratio between channel width and floodplain width. A Python-based workflow integrates both indices to automatically delineate morphologically homogeneous reaches. The resulting segments are classified into Rectilinear, Sinuous or Meandering categories (SI-based) and Confined, Semi-confined or Unconfined settings (CI-based). The method was tested on several Sicilian rivers with contrasting geomorphological characteristics, demonstrating its adaptability and interpretative value. Results confirm that segmentation outcomes are highly scale-dependent, emphasizing the need for careful selection of analysis parameters. By integrating only parameters related to floodplain extent and fluvial morphology, the approach provides an efficient and reproducible tool for fluvial geomorphology and river management, reducing subjectivity in river classification.

Keywords: river segmentation, sinuosity, phyton, rivers, sicilian rivers

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Morphological quality index of surface water bodies in Western Sicily

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Abstract

The assessment of the "morphological quality" of surface water bodies represents a fundamental element for expressing their ecological status under the European Water Framework Directive (WFD). Italian legislation has adopted the IDRAIM methodology, including evaluation criteria based on the Morphological Quality Index (MQI), which is derived from the expert evaluation of indicators of geomorphological functionality (F), artificiality (A) and morphological variations (CA).This contribution presents the results of the application of the IDRAIM methodology to 40 water bodies in western Sicily, segmented into 335 reaches, developing analyses at multiple spatial scales. At the reach scale (the fundamental unit of the methodology), a sensitivity analysis of the MQI was carried out, aimed at evaluating the index response to variations in the assigned indicator classes. For each reach, the range of values, the frequency of morphological class changes and the thresholds for morphological class modifications were then calculated. The analysis was then extended at the whole surface water body scale through the study of the longitudinal continuity of the MQI, by evaluating morphological class changes from upstream to downstream and introducing a morphological quality fragmentation index (MQFI), calculated as the normalized frequency of class changes between consecutive sections. The results highlight 61 cases of morphological improvement, 80 cases of worsening and 193 cases with unchanged class. The fragmentation index distinguishes water bodies characterized by poor longitudinal continuity, often associated with localized pressures, from water bodies with good longitudinal continuity often associated with pressures extending throughout the water body (poor or very poor MQI). The results suggest that the integration of reach-scale sensitivity analyses and water body-scale longitudinal continuity analyses could represent a useful contribution to a detailed interpretation of IDRAIM results and good support for the definition of monitoring and planning plans for river restoration measures.

Keywords: Morphological Quality Index, IDRAIM, sensitivity analysis, river assessment, water bodies, Western Sicily

XI Giornata dei Giovani Geomorfologi AIGeo
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Camerino, 26 febbraio 2026
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Reconstructing riverscape evolution of the Sultanate of Oman through integrated geomorphological analysis

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Abstract

Rivers are primary agents of landscape evolution, responding dynamically to tectonic forcing, litho-structural framework, and climate. Their erosional and depositional activities imprint distinct signatures on the surrounding topography, producing a mosaic of landforms that records interactions among these drivers across multiple timescales. This work investigates the riverscapes of the northern Sultanate of Oman. This region is characterised by a complex tectonic history, beginning with the Late Cretaceous obduction, followed by the Cenozoic uplift and doming. This distinctive geodynamic setting offers a unique natural laboratory for probing the interplay between river networks and tectonics in shaping the landscape. Several complementary methods were applied in the study area. First, geomorphological mapping - integrating remote-sensing data with detailed field surveys - was used to delineate both active and fossil surface processes. The mapping was then refined with deep learning algorithms to analyse the Pliocene-Pleistocene evolution of local alluvial fans, alongside geomorphometric analysis to quantify the resulting landscape modifications. The geomorphological mapping reveals that Miocene-Quaternary erosion, karstification, and fluvial and gravitational processes are tightly coupled to tectonics and litho-structural frameworks, as well as Quaternary climatic oscillations. Deep learning algorithms enhance detection accuracy of fluvial landforms on satellite images, allowing reconstruction of palaeo-hydrological regimes and highlighting the imprint of tectonic uplift on development of alluvial fans. Concurrently, geomorphometry quantifies landscape variations using topographic and river network indices, highlighting zones still in disequilibrium with ancient stable surfaces. The integrated workflow provides a comprehensive understanding of the complex interactions within the river network, allowing for the quantification of the role of both regional tectonic processes and local structural settings in shaping the landscapes of the Sultanate of Oman, revealing that the current landscape is still in a state of evolution, indicative of ongoing geodynamic processes.

Keywords: landscape evolution, Oman, geomorphological mapping, geomorphometry, deep learning

XI Giornata dei Giovani Geomorfologi AIGeo
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Assessing the hydromorphological quality of the Sabato River (Southern Italy)

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[2]Department of Pure and Applied Sciences, University of Urbino "Carlo Bo", (PU), Italy.

Abstract

Hydromorphological assessment is a key component of river management frameworks developed under the European Water Framework Directive (WFD), in which river morphology supports the assessment of ecological status. In river systems, hydromorphological alterations constrain the achievement of good ecological status, making standardized assessment methods essential for river management and restoration planning. Despite their regulatory relevance, applications of standardized hydromorphological assessment methods remain limited in Southern Italy. In Italy, hydromorphological assessment is commonly carried out using the IDRAIM method, which provides a standardized procedure for evaluating river morphological quality through the Morphological Quality Index (MQI). This study focuses on the assessment of the MQI in an anthropized river system, the Sabato River (Southern Italy). The spatial distribution of the MQI along the river course was assessed through functionality, artificiality, and channel adjustment indicators, as suggested by the IDRAIM method. Based on confinement, channel pattern, and hydrological discontinuities, the Sabato River was subdivided into 15 reaches. Indicators and MQI were calculated for each reach using an integrated approach based on GIS analyses of topographic and remotely sensed data, as well as field-surveyed data, in accordance with IDRAIM guidelines. Results indicate that eight reaches show "moderate/sufficient" morphological quality, five reaches show "good" morphological quality, and two reaches show "poor" morphological quality. MQI values vary along the river course, indicating inhomogeneous hydromorphological conditions. Although the IDRAIM framework integrates artificiality, functionality, and morphological variations, results show that the MQI of the Sabato River is mainly controlled by artificiality rather than by functionality and channel adjustments. The data obtained provide a basis for identifying problematic reaches, according to the WFD, where river restoration measures are needed to improve ecological status. This study contributes to filling the gap in assessing the morphological quality of rivers in Southern Italy.

Keywords: hydromorphology; IDRAIM; morphological quality index (MQI); anthropogenic alterations; fluvial geomorphology.

XI Giornata dei Giovani Geomorfologi AIGeo
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AI-Assisted Optical Flow System for Real-Time River Surface Velocity Monitoring

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Abstract

Recent advancements in Artificial Intelligence (AI) and computer vision are reshaping environmental monitoring, offering novel opportunities for automated analysis in geomorphology. This work presents the development and application of a cost-effective optical flow system designed to estimate river surface velocity fields from fixed video monitoring stations, providing a scalable solution for hydrological analysis and flood-risk management. The proposed methodology relies on an AI-assisted optical flow algorithm capable of tracking the displacement of water surface patterns—such as ripples, foam, and floating debris—within standard RGB video sequences. By leveraging dense flow estimation techniques combined with adaptive filtering and metric perspective transformation, the tool generates high-resolution velocity maps continuously updated in near real-time. Experimental validation across diverse riverine environments demonstrates the system's robustness under varying lighting conditions and flow regimes, successfully capturing both steady and transient hydrodynamic dynamics. A primary strength of this approach is its operational flexibility and low barrier to entry. Implementing conventional cameras and open-source software eliminates the reliance on expensive proprietary instrumentation, making the system particularly suitable for establishing permanent observation networks in data-scarce or flood-prone regions. Continuous surface velocity monitoring provides essential data for calibrating hydrodynamic models, identifying morphological changes, and supporting decision-making processes. Beyond technical implementation, this research emphasizes the critical integration of AI-based tools into broader territorial management frameworks. Strengthening collaborations with stakeholders—including Basin Authorities and civil protection agencies—through shared data analytics significantly enhances the efficacy of early-warning systems. Ultimately, this study highlights how intelligent, low-cost monitoring solutions can drive more proactive responses to extreme events, fostering greater resilience in vulnerable communities.

Keywords: optical flow, surface velocity measurement, AI-based river monitoring, flood risk management

Session 2: Hillslope geomorphology of landslides, deep-seated gravitational deformations and sinkholes: from field survey to modelling

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Innovative approach for landslide vulnerability assessment using InSAR data at the regional scale

F. Poggi [1,2], F. Caleca[1], O. Nardini[1], F. Barbadori[1], M. Del Soldato[1], C. De Luca[2], M. Bonano, R. Lanari[2], N. Casagli[1,3], V. Tofani[1], F. Raspini [1]

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Abstract

Landslides can cause significant economic impact worldwide by damaging exposed structures, including buildings. In order to identify effective mitigation strategies, scientific community focuses on estimating the consequences of landslide activity. Vulnerability assessment is a key component of risk analysis and is addressed from both social and natural science perspectives. In social sciences, vulnerability refers to socioeconomic factors influencing the ability of individuals or communities to cope with stress, whereas in natural sciences it represents the degree of potential loss of elements exposed to a landslide of a given intensity. Most existing methods are site-specific and applied at local scales, as they require detailed knowledge of landslide processes and exposed structures. However, data collection is often challenging and affected by uncertainty. To overcome data limitations, alternative approaches based on aggregated indicators, such as the percentage of landslide-affected area, or precautionary assumptions setting vulnerability equal to total loss, have been adopted. This study proposes a quantitative procedure for assessing the vulnerability of buildings exposed to slow-moving landslides using empirical fragility and vulnerability curves. These curves describe the probabilistic relationship between landslide intensity and building damage severity, providing vulnerability values ranging from 0 (no loss) to 1 (total loss). The methodology is based on a catalogue of landslide-induced damage to more than 4,000 buildings in the Northern Apennines (central Italy), developed within the ASI-funded "DInSAR-3M" project. Landslide intensity is derived from freely available Sentinel-1 SAR data processed using the Small Baseline Subset (SBAS) technique. The Northern Apennines were selected due to their high susceptibility to slow-moving landslides, as documented by the Italian landslide inventory, which includes approximately 190,000 mapped events. A quantitative risk assessment integrating hazard, vulnerability, and exposure was performed for over 700,000 buildings. The total landslide risk for buildings in the study area is estimated at approximately 1.8 billion euros.

Keywords: Landslide, Risk, Fragility curves, Vulnerability curve, Sentinel-1

XI Giornata dei Giovani Geomorfologi AIGeo
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Extending Multi-Sensor Remote Sensing Approaches for Landslide Timing Analysis in Google Earth Engine

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Abstract

The dating of landslides allows the reconstruction of slope dynamics and link landslide events to the geomorphological processes that triggered them. In many areas, the timing of landslide initiation is uncertain due to limited observational data. In the absence of such information, the analysis of satellite remote sensing time series provides an essential tool for landslide dating, thanks to the availability of multi-sensor observations. In this context, Google Earth Engine (GEE) provides a cloud-based environment capable of processing large volumes of satellite data, enabling the application of methodologies across different study areas. This study presents an integrated methodology for the objective dating of landslides through the combined use of optical and radar satellite data. To improve the temporal coverage of the analyses, Landsat 8 data are incorporated with Sentinel-2 data. The optical data are used to assess changes in vegetation indices associated with landslide triggers, allowing the identification of a preliminary time window. Simultaneously, ALOS PALSAR-2 radar data are complemented with Sentinel-1 data to fully exploit the radar datasets available in GEE and expand the information provided by backscattering analysis, which is sensitive to changes in the physical properties of the ground surface. The use of radar data improves the detection of surface changes even under cloudy conditions or in the absence of sunlight. To strengthen the analysis, the landslide area is compared with an adjacent undisturbed reference area, defined using a variable buffer around the landslide body. The integration of optical and radar data allows estimation of landslide initiation timing, reducing possible errors in analyses based on a single sensor. Furthermore, the implementation of the methodology in GEE ensures high reproducibility, allowing scripts to be easily shared and the analysis to be applied to different study areas.

Keywords: Landslides, landslide dating, Google Earth Engine, optical imagery, SAR imagery

XI Giornata dei Giovani Geomorfologi AIGeo
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Hillslope evolution model as a tool for hazard scenarios: the Ligea landslide system case study

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Abstract

The Ligea landslide system is located west of Salerno, along coastal hillsides, and covers an area of approximately 0.4 km². The site is considered critical for the presence of numerous structures and infrastructures developed in recent decades along the south-facing slope affected by slope movements. The unstable area interferes with a strategic infrastructural corridor that includes the A3 Naples–Salerno highway, the Naples–Battipaglia railway, the SS18 Tirrena Inferiore state road, the commercial port of Salerno, and several civil and industrial buildings. The phenomenon was previously classified as a DSGSD (UoM Desta Sele, 2011). However, recent geological and geomorphological surveys, supported by in situ investigations, allowed a more detailed reconstruction of slope dynamics. The hillslope is mainly composed of Mesozoic limestones and marls, with secondary dolostones in the upper sectors, frequently affected by tectonic lineaments contributing to mechanical degradation (Iannace et al., 2021). From a geomorphological perspective, the slope records a complex gravitational evolution. The earliest and basal movement can be interpreted as a rotational landslide (sensu Hungr et al., 2014), clearly identifiable at the detachment area but poorly constrained at the toe, due to intense anthropogenic modification of the slope foot and probable submarine extension. Subsequently, the displaced mass progressively disaggregated into multiple sectors, evolving at different rates through various rock and debris slide mechanisms. At present, the dominant processes include rockfalls from cliffs associated with the main escarpment of the initial movement and younger scarps, as well as debris flows along channels incised within and around the landslide body. Recognition of the spatial and temporal relationships among these processes enabled classification of the phenomenon as a landslide system (sensu Valiante et al., 2021). This approach improves understanding of interactions between past and active movements, supports scenario development, and enhances hillslope evolution models, contributing to more effective hazard assessment.

Keywords: Landslide system, Geomorphological model, Hillslope evolution model

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From sinkhole inventory to hazard assessment: a multiscale geomorphological and GIS-based approach in Messina Province (NE Sicily, Italy)

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Abstract

Sinkholes represent a significant geological hazard in both urban and mountainous environments, resulting from the interaction between natural processes - such as karst dissolution and collapse - and anthropogenic factors related to land use and subsurface infrastructure. This contribution presents an updated and expanded sinkhole inventory for the North-eastern Sicily, developed through a multidisciplinary approach integrating geomorphological field surveys, historical and bibliographic analysis, UAV-based photogrammetry, remote sensing data and a multiscale GIS framework. Natural sinkholes are mainly associated with karst-prone lithologies in the Peloritani and Nebrodi mountain ranges, while anthropogenic sinkholes are predominantly concentrated in the urban area of Messina, where they show strong spatial correlations with buried stream channels, ancient hydraulic works and deteriorated underground utilities. Semi-automatic extraction of topographic depressions from LiDAR-derived digital terrain models, combined with morphometric filtering and lithological constraints, proved effective in identifying clusters of potential sinkholes and guiding targeted field investigations. A detailed case study on the Mt. Scuderi plateau highlights the added value of high-resolution UAV surveys for geomorphological characterization, metric analysis and interpretation of both natural processes and anthropogenic modifications. The integration of geomorphological analysis and advanced geotechnologies within a GIS environment provides a robust basis for sinkhole hazard assessment and supports land-use planning, prevention and risk mitigation strategies in complex geological settings.

Keywords: Sinkhole hazard; geomorphological survey; GIS spatial analysis; UAV photogrammetry; geomorphometry

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GOGIRA: a low-cost system for remote spatial data acquisition for geomorphological field mapping

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Abstract

While Global Navigation Satellite Systems (GNSS) have revolutionized field mapping by accurately identifying a surveyor's location, a significant challenge remains in "remote mapping". This is the ability to capture coordinates of distant features from a single field position. Current solutions for Direct Numerical Cartography (DNC) are often polarized between low-cost tablet-based GIS software, and high-cost complex equipment such as terrestrial LiDAR or Total Stations. To fill this gap, we introduce the GOGIRA (Ground Operative-system for GIS Input Remote-data Acquisition) system, optimized for remote spatial data acquisition in the field. The system utilizes the "Range-R" targeting device paired with a central processing unit running the "CoordFinder" algorithm. Unlike traditional methods, this setup allows for real-time Line-of-Sight (LOS) visualization and profile analysis using Digital Terrain Models (DTMs), enabling the expert to validate and collect spatial data immediately in the field. This approach demonstrates how integrated hardware-software tools can provide a practical, and accessible solution for geomorphological data collection.

Keywords: Digital Mapping, GIS, Remote Sensing, Field Survey

Session 3: Slope and landscape dynamics: erosion, tectonic–climatic controls and coastal processes

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Physical geography as a key framework to investigate Earth surface processes under climate change

M. Luppichini[1] *, M. Bini[1]

[1] University of Pisa, Pisa, Italy

Abstract

Physical geography provides an integrative framework for understanding Earth surface processes, especially under current climate-change conditions. This contribution synthesizes research conducted in the Mediterranean region using long climatic time series, extreme-event analyses, and environmental response studies.

Climate is treated not as background information but as a key morphoclimatic variable influencing system equilibrium and evolution. Advanced statistical and data-driven approaches are presented as diagnostic tools to identify regime shifts, loss of stationarity, and emerging morphoclimatic configurations, complementing rather than replacing physical modelling.

Results show that global warming accelerates surface processes by reducing catchment response times, amplifying hydrological peaks, and altering sediment transport, with direct implications for fluvial and coastal plain evolution.

Keywords: physical geography; climate change; climate impacts; Earth surface processes

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Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Quaternary landscape evolution of the Apennines peri-Adriatic belt: insights into climate and tectonics from the fluvial record

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Abstract

Reconstructing the landscape evolution of the peri-Adriatic belt of the Apennines requires disentangling climatic and tectonic signals preserved in fluvial terraces. This study investigates Middle Pleistocene–present fluvial systems draining the Marche–Piedmont sector of the Central Apennines, an area uplifted since the Middle–Late Pliocene.

Terrace treads were mapped using semi-automatic extraction from LiDAR-derived DTMs, integrated with detailed mapping of basal straths and new luminescence ages. Results indicate that many aggradation phases correspond to late interglacial cooling and glacial periods, when increased sediment flux dominated fluvial dynamics.

Age–elevation relationships reveal spatially variable uplift histories, suggesting differential crustal uplift and fold growth along strike. The study highlights the value of fluvial archives for resolving coupled climate–tectonic controls on landscape evolution.

Keywords: fluvial terraces; tectonic uplift; climate; Apennines; luminescence dating

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Decadal erosion rates from semi-arid areas of southern Italy: a comparison between direct and indirect measurement data

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Abstract

Quantifying soil erosion at very short temporal scales remains a major challenge in geomorphology due to strong variability in controlling factors and methodological limitations of individual approaches. This work presents an experimental framework that couples direct and indirect measurements of erosion rates at event-to-seasonal scales, tested in the clay-rich, semi-arid Bradano foredeep (southern Italy).

Direct measurements were obtained using sediment traps installed along hillslopes and ephemeral channels to capture mobilized material during rainfall-runoff events. These data were combined with rainfall characteristics from nearby meteorological stations. Indirect measurements relied on remote sensing and geomorphometric techniques, including vegetation and moisture indices, high-resolution photogrammetric DEMs, DEMs of Difference, and sediment connectivity indices.

Results highlight strengths and limitations of both approaches and demonstrate that their integration improves the reliability of short-term erosion rate estimates in rapidly evolving landscapes.

Keywords: soil erosion; multi-proxy approach; short-term monitoring; semi-arid areas; southern Italy

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Ultra-high resolution RUSLE erosion modelling at the UNESCO archaeological site of Arslantepe (Malatya, Republic of Türkiye)

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Abstract

Assessing the physical integrity of archaeological sites is crucial for heritage conservation. This study applies ultra-high resolution RUSLE (Revised Universal Soil Loss Equation) modelling to evaluate surface erosion vulnerability at the UNESCO site of Arslantepe (Malatya, Türkiye).

Drone-based photogrammetry and a field-based geoarchaeological framework were used to derive detailed topographic inputs. Results show overall limited erosion, with localized degradation restricted to steep trench walls and spoil heaps, indicating a generally good conservation status.

The study demonstrates that high-resolution RUSLE modelling is an effective and scalable tool for evaluating surface process impacts on archaeological heritage and for supporting evidence-based conservation strategies.

Keywords: RUSLE modelling; geoarchaeology; surface processes; Arslantepe; UNESCO

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

A multidisciplinary framework for coastal flood monitoring: remote sensing, sedimentology, and numerical modelling applications

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Abstract

This study presents an integrated framework for analysing coastal flooding and morphodynamic processes in low-lying Mediterranean environments, applied to the Volturno and Fondi coastal plains. The approach combines high-resolution topographic and bathymetric data, GNSS surveys, drone photogrammetry, sedimentological analyses, wave-climate statistics, and numerical modelling.

Storm scenarios were simulated using Delft3D and XBeach under high-emission climate scenarios (SSP5-8.5), accounting for sea-level rise, subsidence, and extreme surge conditions. Results show strong contrasts between the two plains, with high inland flood penetration in the Volturno Plain and reduced vulnerability in the Fondi Plain due to nearshore bar systems and coastal defences.

The framework is transferable and supports coastal vulnerability assessment and adaptation planning under climate change.

Keywords: flood mapping; remote sensing; numerical modelling; sea-level rise; coastal vulnerability

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Multi-source approach via Random Forest for badlands mapping

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Badland landscapes represent a critical geomorphological response to the interplay between climatic forcing and soft, erodible lithologies. This study proposes a multi-source Machine Learning workflow to assess erosion susceptibility in a representative badland site in the Basilicata Region (Southern Italy). Geologically, the study area (0.025 km²) is located within the Sant'Arcangelo Basin and is constituted by Lower Pleistocene marine deposits. These poorly cemented silty clays exhibit low shear strength and high erodibility, driving the development of calanchi-type deep incisions. To capture these dynamics, a UAV survey was conducted in May 2025, generating high-resolution products (3 cm/px). A Random Forest (RF) classifier was employed to process these data through two distinct experimental setups using open-source GIS tools (GDAL/GRASS). The first experiment utilised ten geomorphometric and hydrological predictors derived exclusively from the Digital Elevation Model (e.g., Stream Power Index, curvature, TPI). The second experiment integrated these topographic drivers with RGB spectral bands from optical orthomosaics. Spatial cross-validation on 12,900 points demonstrated the superior performance of the integrated approach. Global Accuracy rose from 82.49% (morphometry only) to 97.43% (morphometry + RGB). The resulting classification, segmenting 'Badland', 'Vegetation', and 'Pediment' classes, was used to derive a pixel-based land cover map and a Gully Erosion Susceptibility Map (GESM). The results suggest that while the high albedo contrast of the bare clays is a powerful discriminator, it must be coupled with hydrological parameters to mitigate shadow-related misclassifications. This scalable approach provides a robust basis for quantitative monitoring of badlands landscapes in other environmental and geological settings.

Keyword: Badlands; Machine Learning; Geomorphometry; UAS Photogrammetry; Land-cover mapping

Session 4: Poster session

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Geomorphological characterization of Val Toggia (VB) through field surveys and GIS analysis.

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The Toggia Valley, a tributary of the Formazza Valley, is located in the of Verbano-Cusio-Ossola province (N-W Italy). Despite the presence of geomorphological hazards, the area is a natural laboratory for observing landforms with significant geotourism potential. This study aims to produce a 1:10,000 scale geomorphological map of the valley by integrating fieldwork, use of remote sensing techniques and GIS analysis. Field mapping was carried out during an extensive field campaign to map and digitalize the landforms in accordance with the National Guidelines for Geomorphological Mapping (Campobasso et al., 2021- Q13). This map provides the first detailed geomorphological assessment of the area and was implemented through the MorphDB (Bosino et al., 2024). In addition, remotely sensed data includes the analysis of aerial and satellite imagery, a 5 m DTM and topographic maps. All data were processed within a GIS environment. The mapping results reveal a geomorphological setting that is dominated by gravitational and glacial landforms. The first includes both erosional and depositional landforms, among which gravitational saddles shaped by gravity-induced erosion are particularly significant. The latest novel landforms are not represented in Q13 symbology, even if they can be considered significative in terms of geomorphological risk. Additional geomorphological units include karst landforms that crop out in the Toggia Valley sectors due to gypsum substrates. Polygenic landforms are also relevant in this area and should be noted, even though they are not properly classified in Q13. The most distinctive of these is the glacio-karstic pond: a collapse doline formed in a karstic substrate whose basin was later sealed by silty glacial deposits. From an applied perspective, the study also highlights slope instability along the carriage road and the potential for sediment input into artificial reservoirs (Lake Toggia and Castel), representing significant factors for landscape management and hazard assessment. Dedicated to my dear friend Giacomo Armellini, may you still be smiling upon these mountains.

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Keywords: Val Toggia; geomorphological mapping; MorphDB

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Geomorphological assessment of the Rio dell'Inferno catchment (Omegna) thirty years after the flood

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This study analyzes the geomorphological features of the Rio dell'Inferno catchment, located in the municipality of Omegna (VB), thirty years after the flood event of July 8th, 1996. The event was triggered by a high-intensity debris flow, which included deposits from the Rio dell'Inferno stream and an abandoned quarry. This caused significant damage to several infrastructures. The main objective of this work is to provide a geomorphological assessment of the basin, aimed at understanding the still-active morphogenetic processes and evaluating the effectiveness of the mitigation works implemented after the catastrophic event. The research is based on the integration of historical data, field surveys, petrographic analyses, and remote sensing through GIS techniques and drone photogrammetry. This multidisciplinary approach enabled the creation of a geomorphological map at a 1:10,000 scale, useful for identifying both active and relict processes and for defining the main hydrogeological criticalities of the basin. The map was created by integrating the morphotypes proposed by the National Guidelines for Geomorphological Mapping (Campobasso et al., 2021-stated Quaderno 13 (Q13)), into the geomorphological database MorphDB (Bosino et al., 2024. The results highlight the persistence of widespread instability along the slopes and within areas characterized by morainic and semi-consolidated deposits, where erosion and sediment remobilization processes remain active. The hydraulic defence structures (selective check dams and retention basins), built downstream after the 1996 flood, proved to be still functional and effective, as confirmed by recent field inspections. However, the accumulated material needs to be periodically removed. This work therefore provides a valuable basis for hydrogeological risk management and prevention in the area, emphasizing the importance of continuous monitoring and the integrated use of GIS technologies and high-resolution surveys for the evolutionary assessment of small alpine catchments.

References

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Campobasso C., Carton A., Chelli A., D'Orefice M., Dramis F., Graciotti R., Guida D., Pambianchi G., Peduto F., Pellegrini L., 2021. Aggiornamento ed integrazioni delle linee guida della Carta Geomorfologica D'Italia alla scala 1:50000 e banca dati geomorfologica. Quaderni del Servizio Geologico Nazionale, III, 13 (1), Versione 2.0, 153 pp."

Keywords: Geomorphological mapping; MorphDB; Mottarone-Baveno granite quarry; Drone Survey

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Methodological proposal for identification of a multi-risk analysis technique to support strategic decisions for civil protection planning: preliminary results from Lombardy region datasets

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The proposed methodology aims to develop a multi-risk index at the municipal level for the whole territory of Lombardy region, which considers its physiographical complexity, differential vulnerability and exposure to different kinds of risk. In order to evaluate fairly the impact of each risk in the diverse territory of Lombardy (that stretches from the Alpine Chain to the Po plain, from inhabited areas to densely populated metropolis), it was divided into geomorphologically and demographically coherent areas. The collected risk data for each municipality (Lombardy's Geoportal, ISTAT) is firstly standardized and, if necessary, translated into numerical classes. The approach of Analytical Hierarchical Process (Saaty & Vargas, 2012) is then applied in each coherent area to guide risks' comparison, i.e. assign each of them a relative weight in accordance with risk's importance. This decision is taken with the support of experts' opinion and the regional registry of damage (RaSDa) occurred to public property since 2003. RaSDa represents a precise proxy of the type, frequency and magnitude of hazardous events in the last two decades. At last, normalized data for each municipality are gathered in a matrix, applying the Multiple Criteria Decision Analysis (Kirker et al., 2005), summarising one comprehensive index of risk. Final adjustments concerning the number of inhabitants and the proportion of urbanized areas are implemented. The final output is a multi-risk map that will highlight simply yet thoroughly the different multi-risk probability of each municipality. This map will call the attention to the most sensible areas to the manifold of considered risks and guide both local and regional stakeholders in the design of ad hoc civil protection plans. This work synthesises the joint efforts of researchers and decision makers, aiming to develop a reproducible, adjustable and transparent decision support tool also beyond Lombardy

Keywords: Civil Protection, Multi-risk Analysis, Multiple Criteria Decision Analysis, Lombardy, decision support tool

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

From field measurements to regional models: linking soil properties and rainfall thresholds for shallow landslides investigations

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Upscaling from local physically based models to regional landslide susceptibility assessments remains challenging, primarily due to the difficulty of spatially representing key physical parameters such as soil thickness, infiltration and runoff rates, cohesion, and friction angle. While morphometric parameters can be readily derived and spatially distributed using Digital Terrain Models (DTMs), categorical variables (e.g. lithology, land cover, and soil type) generally require extensive field surveys and large-scale digital mapping efforts. In addition, soil physical properties may vary substantially at the site scale as a function of lithology, local morphometric settings, and climatic conditions, further complicating their regional characterization. We adopted an integrated empirical–statistical framework to investigate the relationships between commonly used spatial predictors in physically based shallow landslide susceptibility modelling and site-specific soil physical parameters. A rainfall-triggered shallow landslide inventory in north-western Italy was used to reconstruct the spatial and temporal distribution of landslide occurrences and to identify associated rainfall triggering thresholds. In situ measurements of soil physical and mechanical properties were then collected at a representative set of landslide sites, capturing local variability in soil conditions. Multivariate statistical analyses were applied to quantify the relationships between measured soil properties and spatial variables, including continuous morphometric parameters and categorical environmental factors. This integrated empirical–statistical approach supports the spatialization of key site-specific soil parameters that are critical for physically based shallow landslide modelling. By linking field measurements with spatial predictors, the proposed framework contributes to improving regional-scale physically based susceptibility assessments and provides a basis for more effective shallow landslide risk management.

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Mapping Anthropocene impact on natural processes and landforms within a small mediterranean catchment

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Earth surface processes are indeed influenced by human activities, although climate change intensifies of extreme meteorological events, geomorphological hazards and risks are often amplified by human modifications to natural processes and morphologies. In this context, the identification and mapping of anthropogenic landforms and human-modified natural landforms represent an effective tool for analysing the interaction between natural processes and anthropogenic constraints. This study presents a prototype geomorphological map oriented to the Anthropocene, aimed at identifying and classifying anthropogenic landforms and modified natural features. The San Francesco stream catchment (approximately 6 km²), draining into the Ligurian Sea at Rapallo (Eastern Liguria, Italy), was selected as a case study. Despite its limited extent, the basin is representative of Mediterranean coastal environments characterised by steep topography, short hydrological response times, and a long history of human pressure. The catchment experienced intense and often unregulated urban expansion during the second half of the 20th century, a process locally referred to as "rapallisation", which altered slope and fluvial systems. The most evident modification concerns traditional agricultural terraces supported by dry-stone walls, historically stabilising hillslopes and regulating sediment transfer, have been largely abandoned, while urbanisation has expanded across the alluvial plain and lower slopes. Geomorphological and anthropogenic landforms were identified through the integration of high-resolution remote sensing data, field surveys, and regional datasets. Mapped features include excavations, landfills, quarry areas, culverted stream sections, channel embankments, and terraced slopes in different states of conservation. The results highlight the spatial overlap between anthropogenic modifications and areas prone to hydro-geomorphological hazards, with significant implications for slope stability and hydrogeological dynamics. The proposed mapping approach provides a spatially framework for assessing the role of human activities in shaping geomorphological processes and risk scenarios, offering practical support for land-use planning and hazard management in densely anthropised coastal catchments.

Keywords: Anthropocene geomorphology; Land use changes; Hydro-geomorphological hazards; Coastal catchments

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Integrated predictive models for the assessment of earthquake-induced landslide hazard: a geostatistical and AI approach

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In an era marked by climate crisis and increasing urbanization in vulnerable areas, the management of geohazard requires advanced analytical tools to ensure territorial resilience. Several authors have focused their research on Central Asia, a region severely affected by large landslides, which are favoured by the complex interaction between geomorphological processes, active tectonics, and geology. The study carried out by Saponaro et al. (2014) in Kyrgyzstan provided a harmonized model employing the Bayesian Weights-of-Evidence (WoE) statistical method for landslide susceptibility. However, the efficacy of this traditional static model is limited by the requirement for conditional independence among factors and the inability to provide dynamic temporal predictions. Conversely, in this project we propose an innovative approach for assessing the susceptibility and hazard of earthquake-induced landslides by integrating the traditional geostatistical Weight of Evidence (WoE) method with Machine Learning (ML) techniques and Explainable Artificial Intelligence (XAI). The combination of these methods would enable the identification of the relative importance of static predisposing factors (morphology, geology, etc.) and dynamic factors (seismic signals, climatic factors, etc.). The study has two main objectives: first, to verify the accuracy of the susceptibility model developed by Saponaro et al. (2014). By updating the landslide inventory in Kyrgyzstan to include events that occurred over the last decade (2015–2025), it becomes possible to assess whether areas originally identified as high-risk have indeed been affected by new events. Second, to provide tools capable of supporting local and regional authorities in geohazard assessment and management.

Keywords: Hazard, Susceptibility, Central Asia, Earthquake-induced landslides, Artificial Intelligence (AI)

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Geomorphological mapping supporting geoconservation at the Dolomites UNESCO World Heritage Site (NE Italy)

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The identification of threats to geoheritage, whether natural or anthropogenic in origin, and the consequent assessment of degradation risk, is a fundamental aspect in a well-structured geoconservation strategy. This requires recognising the processes that drive the evolution of geosites, and which may ultimately lead to their degradation. Geomorphological survey and mapping are essential for identifying active processes, understanding their spatial and temporal patterns, and defining how they interact with geological and geomorphological features with heritage interest. This is particularly relevant in highly dynamic environments such as high mountain areas, which are also highly sensitive to climate change. This research presents the geomorphological maps of three study areas within the Dolomites UNESCO World Heritage Site (NE Italy): 1) the Antermoia valley, on the NE side of the Catinaccio massif; 2) the Rudo valley, in the Fanes-Sennes-Braies Natural Park; 3) the Bletterbach gorge. All three areas are characterised by high geomorphodiversity and by a number of geological and geomorphological features with heritage interest. However, they are also affected by active geomorphological processes, that have lead to rapid geosite evolution, and by significant anthropogenic pressure, mainly related to tourism. The three maps focus on the representation of the active landforms and deposits, showing the interaction between active geomorphological processes and geosites. The data collected in the field provided the basis to assess the degradation risk of the geosites included within these areas and to define baseline conditions for geoconservation. The results also highlight the importance of geomorphological survey and mapping in the context of geoconservation, to support evidence-based geoheritage management strategies.

Keywords: Geoheritage, geomorphological mapping, geoconservation, degradation risk

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Deep-seated gravitational slope deformations in active tectonics areas of Central Italy

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This study presents several case histories of deep-seated gravitational slope deformations (DSGSDs) occurring in active tectonics areas of Central Italy. The investigated area has been affected by multiple and intense seismic sequences. Research on these phenomena began in the 1970s following the 1979 Norcia earthquake and was subsequently expanded after the 1997 seismic sequence and the most recent 2016 seismic crisis. A correct genetic interpretation of the studied phenomena was achieved through detailed geological and geomorphological investigations, hydrogeological analyses, and the interpretation of a large amount of geotechnical and geophysical data. Some of these DSGSDs have also been monitored in situ using satellite-based techniques. These are large-scale phenomena, reaching several square kilometers in extent and depths of several hundreds of meters, affecting the calcareous–marly and marly lithotypes of the Umbria–Marche–Abruzzo–Lazio sedimentary succession. The analyzed case studies are mainly located along slopes affected by major tectonic discontinuities, such as thrusts and normal and reverse faults, which also control the alignment of the epicenters of major earthquakes (capable faults). In particular, DSGSDs developed along fault slopes bordering Quaternary tectonic basins are highlighted. These structures have shown recent reactivations, including during the latest seismic sequence, as documented by interferometric measurements. Other phenomena occur along Apennine valleys whose higher sectors were deeply shaped by glacial processes. In these settings, the lithostructural conditions of the sedimentary succession—characterized by the alternation of more competent and more ductile materials—play a key role. Finally, the long-term investigations carried out over several decades have significant applied value. Major infrastructures (e.g. viaducts, gas pipelines, tunnels, ski resorts) have been constructed in these areas, and the research activities have provided an important contribution not only to hazard assessment but also to advances in geomorphological mapping and its methodological innovation."

Keywords: Deep-seated Gravitational Slope deformations; Geomorphology; Monitoring; Active Tectonics; Central Apennines.

XI Giornata dei Giovani Geomorfologi AIGeo
"The role of early-career geomorphologists in natural hazard assessment and risk reduction"
Camerino, 26 febbraio 2026
Polo di Geologia, Via Gentile III Da Varano 7, 62032, Camerino

Reconstructing fluvial and anthropogenic interactions with multidisciplinary approach: Insights from Turin, NW-Italy.

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In the context of accelerating environmental and societal change, territorial planning increasingly requires a critical understanding of long-term landscape trajectories. Landscapes can be interpreted as the cumulative outcome of interactions between geomorphological processes and human activities, reflecting the evolving relationship between society and its physical environment. Within this perspective, geomorphological analysis offers an essential interpretative framework for informed decision-making, by clarifying inherited forms, active processes, and constraints embedded in contemporary urban landscapes. The Mario Carrara Park (Pellerina), located along the Dora Riparia River in northwestern Turin, represents a significant case study for investigating the evolution of urban fluvial geomorphological systems. The area has undergone a complex morphological transformation resulting from the long-term interaction between fluvial dynamics and progressive anthropogenic modification. This study adopts the urban geomorphology approach, based on the integration of geophysical surveys (geoelectrical investigations), morphometric analyses, and detailed field-based geomorphological mapping with a systematic examination of historical cartography, technical reports, and archival sources spanning the 15th to the 20th century. The combined datasets are cross-referenced to support a diachronic reconstruction of the site's morphological and cultural palimpsest. The results highlight the significant impact of 20th-century hydraulic works and urban expansion on channel morphology, floodplain configuration, and subsurface structures, while also revealing the persistence of residual processes within the urbanised riverine morphological zone. This integrated approach provides a detailed local-scale framework for interpreting urban geomorphology interpreting urban fluvial dynamics and for supporting hydrogeological risk assessment and river corridor revitalization strategies. Beyond its scientific relevance, the study demonstrates the potential of urban geomorphological analysis as a geoeducational tool and as a basis for applying geomorphological quality indices in urban environments, contributing to informed territorial planning and sustainable urban development.

Keywords: Urban geomorphology, Urban fluvial dynamics, Historical geomorphology, Anthropogenic landforms, Sustainable urban development