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BOOK OF ABSTRACTS

List of abstracts

GEOCHEMICAL AND MINERALOGICAL STUDIES OF CLAY DEPOSITS IN MAKHANDA AND ITS ENVIRONS, EASTERN CAPE, SOUTH AFRICA

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This current project aims to study the geochemical and mineralogical properties as well as the distribution of the clays presented in the Makhanda Formation. This work is based on data collection from all cardinal sections of Makhanda (Beaconsfield, Collingham, Cradock and Strowan deposits). The chemical and mineralogical compositions of the clays were investigated using X-Ray Diffraction analysis (XRD), X-Ray Fluorescence (XRF) and Inductively Coupled Plasma-Mass Spectrophotometer (ICP-MS) coupled by Rare Earth Elemental analysis (REE), to determine their provenance, weathering history and most appropriate use for industry. Previous studies carried out on the clays were solely localized to the Beaconsfield field farm deposits, which is a minute section of the area detailing properties using lithological logs on a micro-scale on only the northern part of the regional peneplain.

This study is focused on the internal variability within the deposits and the diversity among different deposits. XRD analysis shows kaolinite as the main clay mineral (11.4 to 60.4 wt. %), indicating an extreme weathering of aluminum-rich source rocks. The non-clay minerals in the assemblages are quartz, rutile, pyrophyllite, muscovite, smectite and calcite. Results of the geochemical analysis show a predominance of SiO_2 (58.76 wt% to 85.42 wt%) and Al_2O_3 (9.29 wt% to 20.05 wt%), which affects the morphology and nature of the clay deposits. The high average values of the Chemical Index of Alteration (CIA) at a weight percentage of 90.45 wt% and the Chemical Index of Weathering (CIW) of 99.19 wt% indicate an extremely intense chemical weathering in the study area. Geochemical indices plot of TiO_2 versus Al_2O_3 ratios gives an insight into a felsic source and provenance. The clays are characterized by fineness, low-moderate Loss on Ignition (LOI), mineral assemblage and chemical composition, making them useable in the ceramics and refractory bricks industry. In addition, paleoenvironment reconstruction indicates that the investigated clays were deposited in a continental setting.

DISPERSION OF SEDIMENT CAUSED BY LAND USE CHANGE

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Mining regions in case of exploration of mineral resources could be exposed to extensive land-use and land cover changes. Land-use and land-cover change coupled with climate changes have environmental and social impacts and require better understanding of processes occurring in the field that would lead to better prediction of future land-use changes and innovations in land management approaches.

Neogene lacustrine basins in the Balkans have recently attracted a lot of attention and are extensively investigated for the purpose of finding mineral deposits, namely boron and lithium minerals. In the case of open-pit exploration, once they are exposed to the surface conditions dispersion properties of soft-sediments will become an important factor in future surface processes. Consequently, depending on their sensitivity, the appropriate land management practices will be necessary.

Due to that, forty-seven sediment samples from four lacustrine basins were analyzed in order to determine and compare the dispersity of sediments. Twelve were sampled from the Valjevo-mionica basin were more than a half are carbonate sediments, while the rest are marls; thirteen carbonate and marl sediment samples were taken from the Lopare basin; eight samples from Aleksinac basin are marls and oil shales, while fourteen samples from Toplica basin are mainly sandstone, clay and tuffs and marls in smaller portions. Electrical conductivity (EC), pH and elemental composition were measured, while dispersivity index sodium-adsorption ratio (SAR) was calculated from the concentration of cations.

The obtained results show that the pH values of all analyzed samples vary from neutral to base (pH 6.96 – 11.65). EC, organic matter content (C_{org}) and SAR cover a wide range of values (EC 93.6–2840 μScm^{-1}; C_{org} 0.15–32.85%; SAR 0.03-17.80), in which in Aleksinac basin were measured the lowest EC and SAR values and the highest C_{org} values.

According to the carbonate and organic matter content, samples were organized into three groups: carbonates (Lopare and Valjevo-mionica basin), marls (Lopare, Valjevo-mionica and Toplica basin) and marls rich in organic matter (Aleksinac basin).

Statistical analysis of measured parameters implies that pH and EC values have positive correlation in marls rich in organic matter, while according to Pearsons correlation coefficient, C_{org} and SAR are negatively dependent. SAR-EC dependence (Rengasamy classification) showed that marls rich in organic matter are potentially dispersive, while carbonates and marls are on the border between potentially dispersive and dispersive. Analyses of variance showed that marls rich in organic matter have statistically significant SAR, EC and C_{org} values, compared to carbonates and marls, while pH values differ in case of carbonate samples.

Results show that marls rich in organic matter (Aleksinac basin) are the least subjected to dispersion compared to marls and carbonates from other basins (Lopare, Valjevo-mionica and Toplica basin) implying the importance of C_{org}.

These kinds of finding are giving C_{org} the important role in understanding sediments stability, enables its dispersion predictions, raising new questions of caution measurements during exploration and give ideas of new land management approaches according to sediment's composition.

VEGETATION RENEWAL IN AREAS RECURRENTLY AFFECTED BY LARGE WILDFIRES

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Wildfires are a key variable in the global earth system and are an integral part of some biomes, being an essential factor for the functioning of many ecosystems. With climate change, associated with global change, extreme events (Mega fires) are expected to gradually become the new "normality", generally worsening their frequency, intensity and destructive capacity. Areas that are frequently affected by wildfires, especially large wildfires (LWF), with high severity, change significantly the behaviour of the different factors and processes, as well as the conditions related with erodibility, contributing for an increasing erosion risk.

In fact, LWF promotes the removal of vegetation and produce a major impact on soil, being considered a major cause of soil degradation. It also promotes significant changes on the hydrologic and geomorphic response of a catchment to rainfall events, increasing subsequent soil erosion.

Therefore, the main objective of this presentation is to discuss the role of the recurrence and severity of fire on vegetation regeneration in areas affected by LWF, and its importance in the development of a natural protective cover against soil erosion processes. This study is based on the 2019 LWF occurred in the municipality of Baião (Portugal).
We were able to determine the frequency (incidence) and recurrence of wildfires in the study area. For the same area, there were a maximum of 12 fires between the years of 1975 and 2019 and a maximum of 11 recurrences as a result.

The analysis of the wildfire recurrence data revealed that between 1975 and 2019, LWF (larger than 100 ha) affected 84.3% of the burnt area twice or more. The scrub type vegetation is present where the LWF showed the highest recurrence.

Based on the application of the dNBR spectral index to the Sentinel-2A images, we could distinguish the different degrees of severity experienced by the action of the fire. For the area affected by the LWF, 40% corresponded to a high severity class, 25.25% to a moderately high severity class, 16.6% to a moderately low severity class, 12.95% to a low severity class, and 5.13% of the area was not burnt.

In the evaluation of vegetation regeneration after 6 months of the wildfire, we identified that 40.7% of the area showed high vegetation growth, 20.8% low vegetation growth, 22.4% had a response comparable to a nonburned area, and 17.8% of the area still has the characteristics of a burnt area.

One year later, we identified that 60.83% of the area showed high vegetation growth, 20.61% low vegetation growth, 14.97% had a response equivalent to an unburnt area and, 3, 59% of the area still has the characteristics of a burnt area. However, two years after the wildfire, 76.27% of the area registered high vegetation growth, 12.15% low vegetation growth, 8.97% continued with the spectral behaviour of an unburnt area and 2.61% with burnt area characteristics.

We verified that two years after the fire, the area occupied by the forest and the scrub class, which were affected by high severity, already showed significant levels of vegetation regrowth corresponding to approximately 100% of the area occupied by this class. An increase was registered in the upper-class regrowth, going from 15% to 42% in forest areas, from 6 months to 1 year, and from 58% to 80% in scrub areas, also from 6 months to 1 year, and in the second year of analysis 98% of the forest area and 99% of the scrubland area showed photosynthetic activity, with vegetation returning to the area burnt by the LWF in 2019.

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SEDIMENT SOURCES, SEDIMENT (DIS)CONNECTIVITY, SPATIOTEMPORAL VARIABILITY AND FUTURE TRENDS OF LAND-TO-SEA SOLUTE AND SEDIMENTARY FLUXES IN MEDITERRANEAN CATCHMENT SYSTEMS IN EASTERN SPAIN

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The Pou Roig-Quisi and Mascarat catchments in eastern Spain (Calpe region) are located as neighbouring catchment systems in a Mediterranean, mostly mountainous and anthropogenically modified environment. The catchments drain directly into the Mediterranean sea. The selected study areas are characterized by a mild Mediterranean climate with a mean annual air temperature of ca. 18°C and a mean annual precipitation sum around 400 mm (measured slightly above sea level). During the coldest months (January, February) frost and snow can occur in the highest elevations although the mountain ranges are situated close to the coast. In contrast, maximum summer temperatures (July, August) can easily exceed 30°C and south-facing hillslopes and rockwalls are exposed to high solar radiation. The lithology in the area is clearly dominated by marine limestones. Elevation ranges from sea level up to 1126 m a.s.l. Relevant geomorphological processes include chemical weathering and denudation, mechanical weathering, rock falls, debris flows, slides, splash and slope wash, fluvial erosion, and fluvial solute, suspended sediment and bedload transport.

This ongoing GFL research is focussed on sediment sources, sediment (dis)connectivity, spatiotemporal variability and rates of contemporary denudational processes and land-to-sea solute and sedimentary fluxes. Our work includes detailed field and remotely sensed geomorphological mapping and computing of morphometric catchment parameters combined with extended statistical analyses of high-resolution meteorological and rock temperature data and the observation and monitoring of sediment-transfer, runoff and fluvial transport events. In the field, we are using a combination of different observation, monitoring and sampling techniques, including different tracer techniques and sediment traps in stream channels, remote time-laps cameras, and event-based high-resolution field monitoring combined with frequent water and sediment samplings.

Sediment connectivity is significantly reduced by extended terraced surface areas within the catchment systems. Sediment transfers, the intermittent runoff, and fluvial transport

and land-to-ocean fluxes are almost entirely controlled by pluvial events. High runoff during extreme rainfall events forms a relevant hazard particularly in the urbanized and lowest parts of the catchment systems. Mechanical fluvial denudation shows a higher spatiotemporal variability than chemical denudation. Altogether, drainage-basin wide chemical denudation dominates over drainage-basin wide mechanical fluvial denudation which is explained by partly limited sediment availability, long-term sediment storage at defined locations, and by the predominant marine limestones found in the catchment areas.

It is expected that climate change with increasing air temperatures and a larger frequency of extreme rainfall events will lead to higher chemical and mechanical denudation rates in the selected catchment systems. In addition, continuing urbanization creates a growing potential for extreme and hazardous runoff events and connected fluvial erosion and transport.

BOULDER TRANSPORT MONITORING USING ACOUSTIC IMPACT PLATES IN A HEAVILY ARMORED BASALT STREAM, NAHAL MESHUSHIM, CENTRAL GOLAN HEIGHTS AND NE SEA OF GALILEE, ISRAEL

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Boulders in gravel-bed streams are stabilizing elements of the bed, they support sedimentary structures such as reach-scale steps, bars and microform pebble-clusters, they protrude above finer grain fractions and create important pocket water habitat for a variety of aquatic organisms. Therefore, boulders transport is crucial to the entire morphology and sedimentology of the alluvial reach.

While direct measurement of boulders movement during floods proved difficult, indirect monitoring methods such as seismic and acoustic sensors can overcome these limitations and demonstrate boulder transport at all the sedimentary spectrum of transport from incipient motion to full mobility. Using three acoustic Japanese impact plates embedded in the concrete weir of the official Israel Hydrological Service hydrometric station in Nahal Meshushim, Golan Heights near the Sea of Galilee, Israel, we present a vast boulder movement dataset. During base flows and sub-bankfull discharges, the boulders remained stationary as shear stress is insufficient to transport them. As shear stress increases towards bankfull discharge, incipient motion of sporadic boulders was recorded and the channel bed gradually destabilized - releasing the finer sediment fractions underneath them but also exposing the neighboring clasts that were previously protected to substantial hydraulic influence. During above-bankfull discharges, flows were capable of transporting most of the bed boulders causing armor layer break up and motion of all sedimentary fractions. Rare equal mobility conditions may occur during extreme large floods where the largest boulders (d_{max}) movement signify the upper bound of channel sediment transport. We therefore suggest a subdivision of boulder sizes that is more detailed than the typical four-sized 256-2048 mm (-8-11Phi) division into eight-sized division using half Phi increments to better describe the bed condition during high discharges and detect the narrow shear stress value needed for full boulder and bed transport.

GEOMORPHIC MONITORING OF EXPERIMENTAL FLOW RELEASES FROM THE NEW NATIONAL REVERSE WATER CARRIER, LOWER NAHAL TSALMON, LOWER GALILEE, ISRAEL

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Background

The Reversed National Water Carrier, an engineering project that links the Mediterranean Sea desalination plants along the coast with the Sea of Galilee in the Rift Valley, was recently completed. The last 5 km of the project flows through the open ephemeral channel of Lower Nahal Tsalmon. The goal of the project is to use excess desalinated water to stabilize the Sea of Galilee level during droughts, decrease the sainity, restore Nahal Tsalmon's ecological functions and allow larger quantities of water transfers to the state of Jordan.

Research Objectives

- Study the geomorphic effects of desalinated "hungry water" on the natural channel
- Study the extent of erosion following each released discharge

Methods

The first release plan included three discharge phases in two days: 0.83 m^3/s, 1.25 m^3/s with 1 hour break in the first experimental day, and 1.67 m^3/s in the second day. These discharges correspond to 12, 18 and 24% of the 2-year flood (7 m^3/s), respectively. The duration of each discharge release was 3 hours. Discharge was measured at the nearby Israel Hydrological Service (IHS) gauging station. Suspended sediments were continuously monitored using an optical turbidity sensor with a 1-minute interval readings. Hand-held sampling was applied for turbidity calibration into SSC (Suspended Sediment Concentration) units. Bedload was measured using 5 net samplers across the channel bed. Eight 1m*1m spray-painted patches of bed surface were planned to identify movement of different grain size fractions. Channel cross-sections were measured at 3 sites before and after the experiment to detect morphologic change.

Results

The first release produced a triangular hydrograph while the second and third releases had a trapezoidal shape reflecting steady flow. However, the sedigraph (SSC) in all three flows had a concurrent triangular shape, indicating limited amounts of fine sediment availability. The sediment peaks preceded the peak flows indicating clockwise hysteresis. During the first flow release, SSCs range was 25-486 mg/l (average of 178 mg/l), 21-1016 mg/l (average of 167 mg/l) during the second release and 34-1423 mg/l (average of 151 mg/l) during the third release. The peak SSCs increased with discharge; average SSCs decreased with time. Bedload captured by the sediment traps was meager. Only in one painted patch, sediment transport was documented. Transport distance was up to 7.1 m and the clast sizes were 11-99 mm. The bedload was finer than the texture of the bed surface, but coarser than the subsurface layer. The repeating cross-sections at all 3 locations showed no geomorphic change.

Conclusions

A 3-staged flow experiment released from the new Reverse National Water Carrier was monitored in the Lower Nahal Tsalmon. Despite the entrance of hungry water into an ephemeral channel, the amounts of sediment transported were low in both SSC and bedload movement. Cross-sections before and after the experiment indicate no morphologic change. We attribute the small geomorphic impact of the flows to their low discharge. However, future operation of the Reverse National Water Carrier at higher discharges should include further geomorphic monitoring in order to preserve Nahal Tsalmon's properties and morphology.

DENUDATION VS SOIL FORMATION: LANDSCAPE DYNAMICS IN THE MOUNTAINOUS TROPICAL SOUTHERN MEXICO

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The soil formation under tropical conditions is intensive as well as denudation in mountainous areas. The convergence of both processes maintains active landscape dynamics and confers a high level of heterogeneity to these systems. Certainly, geomorphic stability strongly affects the rates of soil formation and its spatial arrangement. To study the dynamics in a mountainous tropical landscape we chose the Copalita basin in southern Mexico under two main research objectives. First, understand the soil forming processes in dynamic denudation conditions. Second, investigate the spatial distribution of soil properties and how they drive main land uses. According to WRB (2022), we described and classified a catena with 12 soil profiles. We determined that denudation and accumulation of colluviums are the main forces that re-activate the soil formation clock. Furthermore, organic matter accumulation in forested surfaces helps to incorporate the colluviums into the soil body avoiding soil loss. Thus, a large differentiation in soil variability throughout selected catena was found. From young soils due to erosion (Leptosols) or accumulation (Phaeozems) on higher convex surfaces to relatively mature leaching soils (Luvisols) and some remanent of preserved old soils (Acrisols) on concave surfaces. This knowledge is applied for land use. Forests and coffee agroforestry systems are located on those higher convex surfaces meanwhile maize is cultivated on lower concave surfaces. In other words, convex forested areas protect the soil body and maintain active soil formation in denuded conditions allowing stability in lower concave non-forested areas. A conclusion about the need to analyze mountainous tropical regions as complex denudation-soil formation systems is made.

BADLANDS EVOLUTION IN A PILOT AREA OF THE EMILIA APENNINES (NORTHERN ITALY)

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Badlands are erosional landforms widely occurring along the Apennine mountain chain (Italy) where Plio-Pleistocene clayey and marly terrains outcrop. Widespread, and locally spectacular, badlands features characterize the middle and lower reaches of the Northern Apennines. Their evolution has been investigated only marginally so far, despite its significance and interest in geomorphological terms.

This study aimed at the identification and assessment of areal and temporal changes of badlands within a pilot area of the Modena Province (Emilia Apennines). A multitemporal investigation was carried out in order to detect changes in the drainage networks during the last 40 years, and to assess changes in badlands areal extension and morphometry, especially with reference to land use and pluviometry.

Aerial photo and satellite image interpretation, accompanied by field surveys, allowed the first badlands inventory map in the study area and insights into badlands evolution. A general stabilisation trend of badlands was detected. A significant reduction in the bare surface area between 1973 and 2014 was recorded, due to natural revegetation. This trend, in agreement with evidence from other sectors of the Northern Apennines, can be ascribable to remarkable land use changes — mostly the increase in forest cover and reduction of agricultural land — occurred in the study area from the 1970s onwards.

ENVIRONMENTAL CHANGE AND CHANGING RATES OF ESCARPMENT RETREAT IN A SEDIMENTARY TABLELAND, SW POLAND

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Attempts to identify climatic controls on rates of geomorphic processes typically focus on analysis of datasets collected in different morphoclimatic zones. The problem can be also addressed in another way, by recognizing changing patterns and rates of processes at one place, but through a time span, within which significant environmental changes occurred. Sedimentary tablelands are modelled by diverse suites of processes, but an overarching pathway of landscape development is escarpment retreat. In many escarpments rock cliffs occur in the upper slope sections and their degradation is accomplished by the release of blocks, which then make the boulder cover mantling the sub-caprock slopes. If these boulders could be dated, rates of escarpment retreat can be constrained and related to environmental changes known to have occurred.

The sedimentary tableland in south-west Poland (Stołowe Mountains) is supported by alternating strong sandstone units and much weaker mudstone/marl complexes. The former build cliffs up to 40 m high. Our previous research, based on landform mapping, failed to identify unequivocal geomorphic signatures of changing environmental conditions, which included the cold periglacial Pleistocene and humid temperate Holocene. On the other hand, studies of boulder weathering provided strong evidence that boulder covers are diachronic and the most distant boulders on slopes are the oldest. They also demonstrated that block release was largely via in situ disintegration or fall to the cliff base, whereas catastrophic long run-out rockfalls were of minor significance. However, these studies alone did not allow us to constrain the process of escarpment retreat in terms of timing and rates.

To fill the gap, cosmogenic dating of boulders using ^{10}Be was applied on a representative slope of the mesa of Mt. Szczeliniec Wielki, along a 400-m-long transect from the rock cliffs to the footslope. Seventeen boulders were sampled and three samples were

collected from the contemporary cliff lines. The dates obtained cover the time span of the last 100 ka, hence nearly the entire last glacial period and the Holocene. In general, the dates show systematic increase downslope, with the most distant boulder yielding the age of 99 ka. This translates into an average retreat rate of 4.18 m/10^3 yrs, approximately one order of magnitude higher than most (although infrequent) data reported so far, mostly from arid environments. Plotting cosmogenic ages versus distance from the cliffs allowed us to identify clear acceleration of escarpment retreat in the latest Pleistocene and early Holocene, suggesting the role of environmental transition from cold and dry to humid temperate climate. It seems that the rate of retreat was slow during glacial periods, up to two orders of magnitude less than in the last 15 ka or so. Unblocking of groundwater circulation concurrent with the decay of permafrost and increasing efficacy of mechanical weathering were likely the key driving factors. However, the overall pathway of escarpment evolution seems to have remained the same.

QUANTITATIVE ASSESSMENT OF DENUDATION PROCESSES ON THE SLOPES OF THE AIGBA RIDGE UNDER INCREASED ANTHROPOGENIC IMPACT

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The construction of mountain sports resorts contributes to the activation of denudation processes due to the elimination of vegetation cover, cutting slopes and the movement of significant volumes of soil and bedrock on the slopes. The construction of a mountain cluster of infrastructure facilities for the 2014 Winter Olympics on the slopes of the Aigba Ridge began in the second half of the 2000s. This led to the intensification of various erosion and slope processes both directly on the construction sites and on the slopes of the catchments and in the watercourses within which the construction work was carried out. The task of the study was to assess changes in the areas of activation of slope processes within the 25 km^2 polygon, within which the mountain cluster was created, their subsequent development after the completion of construction in 2014 and until 2022, as well as detailed monitoring of the relief transformation due to the active development of erosion-accumulative processes in two key areas.

BOULDERS TRANSPORT AND SUSPENDED SEDIMENT AMOUNTS DURING LARGE FLOODS IN NAHAL HATZERA STREAM, NEGEV DESERT, ISRAEL

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Measurements of sediment transport in desert streams are rare, especially for boulders entrainment. The present study documented boulders that were transported during large documented flood in 2004 and together with a 30-years record of suspended sediment accumulated in a small reservoir at a small dammed tributary (7.3 km^2), analyzes total sediment transport in the hyperarid, ungauged Nahal Hatzera ephemeral stream (45 km^2), which drains the Makhtesh Hatzera Erosion Cirque (MHEC).

The MHEC is a deep, oval shaped depression 5 × 7 km in size, surrounded by 300–400 m high cliffs. It is situated at the crest of a southwest – northeast, asymmetric anticline that forms a prominent topographic ridge which is composed of hard upper Cretaceous carbonate rocks exposed at the top of the cliffs overlying relatively soft lower Cretaceous sandstone. At the bottom, along the axis of the anticline, older Jurassic dolomite and marls are exposed. The MHEC has one outlet through a deep gorge incised in the steeply inclined southeastern flank, which is the only opening for the drainage system that drains the MHEC.

The 2004 flood (peak discharge 470 m^3 s^{-1}, recurrence interval 120 years) transported 0.85–2.1m concrete boulders and natural boulders. EDM and drone air-photographic surveys documented the geometry of the study reach and the location of boulders. Flood slackwater deposits established a 600-year paleoflood record of 23 floods with peak discharges range of 200–760 m^3 s^{-1}. Hydraulic analysis provided discharges and hydraulics along the study reach, and velocity, shear stress and stream power for each boulder. MAX program and Pearson-3 distribution were used for flood frequency analysis. Maximum velocities of the largest boulders, 8–9.2 m s^{-1}, shear stress - 437-507 N m^{-2}, and stream power - 4222-4972 N m^{-1} s^{-1}, characterize medium-large floods with return period of 20–120 years, indicating that these are the most

geomorphological effective floods rather than the largest floods. Boulders about 2.1 m and weighing about 15 t can be transported at least once in 120 years.

The suspended sediment measurements (1964-1994) are derived from a regulation dam and reservoir that was filled with sediments to almost 75% of its capacity (about 24,000 m^3), before it breached. The sediments were composed of sand and silt and some small pebbles and granules mainly sandstone, few carbonate rocks and chert. The sedimentological record included 19 flood deposits with a volume range of 50 - 7800 m^3 per event and about 580 m^3 yr^{-1} (880 ton yr^{-1}), in average. The average annual sediment yield of 120 ton $km^{-2}yr^{-1}$, falls within the documented range - 40-180 ton km^{-2} yr^{-1} of the arid Negev streams.

ROLE OF LITHOLOGICAL PROPERTIES ON DEVELOPMENT OF BADLANDS IN ARID REGIONS

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By definition, badlands are poor agricultural landscapes that can develop in a range of low-permeable but normally erodible materials and can occur in a variety of climatic conditions characterized by high erosion rates and sparse vegetation. The research questions concerning lithological controls on badland development has received attention; however no clear trends and especially the link between the properties and processes have still not been established. The effects of climate on material behavior cause variability of erosional responses in badland areas indicating that they cannot be treated as simple landscapes with immediate reactions to climate change. In badland areas where two or more different lithologies are present, erosion rates, slope properties and processes are often different on different lithologies. Some of the main features of the lithological characteristics leading to the development of badlands are soil dispersivity and the changes in dispersivity along hillslopes. Physical weathering as a necessary process for badland development on most rocks was studied both at the field and laboratory scales for wetting–drying cycles. In arid badlands, with annual precipitation below 200 mm, vegetation has no relevant role and the processes are governed by climate properties. Lithological properties that should be considered are particle size, sorting, clay mineralogy and porosity.

In this study we compared materials from less investigated badland sites in Turkey and China. Critical composition in badland material is the presence and ratio of the clay and silt size particles, clay mineralogy and presence of mobile ions, especially anions. In analyzed materials the presence of smectite governed the formation of surface crust. Surface cracks enabled ion leaching and became preferential paths from sediment movement. Critical composition in badland material is the presence and ratio of the clay and silt size particles and poor sorting. Sulphate and carbonate ions proved to be crucial for surface processes on these materials. Summarizing results it can be concluded that erodibility of badland lithologies is a combination of clay type, silt content and ion concentration.

LATE QUATERNARY PALEOENVIRONMENTAL EVOLUTION OF THE YESHA VALLEY, NAFTALI MOUNTAINS, ISRAEL

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The Yesha Valley is an elongated (1.8 km) and narrow (<0.1 km) N-S trending tectonic depression in the Naftali mountains. It follows a marginal fault of the Hula pull-apart basin and is incised into the Dir Hannah Formation. It is drained eastward by 3 slope-channels and the Nahal Kadesh stream to the south. The Yesha Valley serves as an active subsiding local base level and a disturbance for channel flow and sediment transport to the Hula Valley. Sediments that accumulate in the valley include mostly reddish clays of Terra Rossa origin and aeolian dust.

The aim of the study is to analyze the sedimentary sequence in order to reconstruct the regional paleoenvironment and the later tectonic phases along the Yesha marginal fault.

A 20 m long core of reddish clay sediments was extracted, down to the underlying limestone at the bottom of the valley. The analyses comprise magnetic susceptibility, sedimentological description, grain-size, mineralogy, and chemistry (XRF, XRD, FTIR and TOC). Chronology is based on luminescence dating.

Four different sedimentological segments were described (from the top): Segment A - 4.1 m thick, is composed of dark reddish clay, where the uppermost 3 m are significantly affected by agriculture. Segment B - 2.4 m thick, dated to about 85±4 ky, is composed of brownish clay, rich in organic material, implying on a moist environment. Segment C - 8.5 m thick, is composed of relatively uniform reddish brown quartz-rich sediments dated to between 271±18 and 767±65 ky. The high Si content suggests large aeolian dust contribution. Segment D - 4.5 m thick, comprises 5 well-cemented calcic horizons (calcrete) older than 767±65 ky. These calcic horizons indicate periods of tectonic quiescence, stability and pedogenesis in somewhat drier climate conditions.

The intervals of clay units between the calcic horizons possibly indicate on tectonic subsidence phases. The relatively constant rate of accumulation of segments A-C is 17.209 mm/ky average, suggesting similar rates of tectonic gradual subsidence (creep).

TRENDS OF CHANGES IN EROSION, TRANSPORTATION AND DEPOSITION OF SEDIMENTS IN FLUVIAL SYSTEM OF THE UPPER VISTULA RIVER (POLAND) CAUSED BY HUMAN IMPACT – SELECTED ASPECTS

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In the drainage basin of the Upper Vistula River some changes in intensity of fluvial erosion and sediment deposition have been recorded since the beginning of the 20th c. In the conditions of variable frequency of great flood occurrence in this area, and, what is more, radical changes in land use in the Carpathian part of the Vistula drainage basin since the mid-20th c., essential changes in intensity of slope and riverbed erosion as well as intensity of sediment deposition upstream the water dams and on the Vistula floodplain are anticipated. In such situation the following questions appear: (1) what are the present trends in fluvial transportation at the background of changes in water discharge, (2) what is the role of the increasing number of dam reservoirs in sediment retention in rivers, (3) what are hydrological and geomorphological results of river regulation considering the frequency of occurrence of overbankfull water stages.

The following multiannual measurements of the Hydrological Service have been quantitatively analysed: (1) levelling measurements repetitive since the beginning of the 20th c. in the succeeding gauging stations on the Vistula, (2) maximum water stages during great floods on the Vistula since the beginning of the 20th c., (3) measurement results of river turbidity in the drainage basin, which were used to count the size of suspended sediment loads in gauging stations in the drainage basin in the monthly and annual scales. This was the base to determine: (4) trend of changes of the size of suspended load transportation along the Upper Vistula and its tributaries in the second part of the 20th c. at the background of changes of water discharge, (5) changes of loss of dam reservoir capacity.

In longitudinal profile of the Upper Vistula, there are river bed sections which undergo deepening or shallowing. The floodplain zones adjacent to the riverbed are overbuilt by sediments during floods in varying degree: in the highest degree downstream of the Carpathian tributaries and also along the riverbed sections which are being permanently deepened. The deepened sections of the Vistula riverbed are therefore an important source of sediment deposited beyond the riverbed. In the Carpathian tributaries and also in the

Vistula, a decreasing trend of suspended load transport (as much as tenfold) in the second part of the 20th c. occurred. This process took place regardless of periodic (about 35 year-long) changes in water discharge. Extrapolation of changes of suspended load transportation in the Vistula back to the beginning of the 20th c. was carried out basing on analysis of overbank sediment increase, and also in present situation basing on data from scientific literature concerning investigations in special scientific stations. Crucial influence of positive changes in land use on still occurring reduction of suspended load transportation is visible. This results in containment of the rate of capacity loss of dam reservoirs in the Carpathians, especially in the case of objects which at the beginning underwent rapid silting. On the other hand, the increasing speed of flood wave concentration in the Carpathian tributaries and in the Vistula is recognised as a hazardous process, as it causes the increase of flood risk despite the presence of flood control embankments.

SEDIMENT SOURCES AND SPATIOTEMPORAL VARIABILITY OF FLUVIAL BEDLOAD TRANSPORT IN THE COLD-CLIMATE MOUNTAIN ENVIRONMENT OF THE UPPER DRIVA DRAINAGE BASIN IN CENTRAL NORWAY

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The absolute and relative importance of mechanical denudation and different sediment sources is controlled by a range of factors and can be affected by ongoing climate change. In cold-climate environments, climate change can cause changes in the precipitation, hydrological and ground frost regimes which affect the activation of sediment sources and sediment transfers.

The upper Driva drainage basin in central Norway (Oppdal-Hjerkinn) is situated in a cold-climate and mountainous environment and ranges with a total drainage basin area of 1630 km^2 from 220 to 2286 m a.s.l. The mean annual air temperature at Oppdal (545 m a.s.l.) is 4.3°C, and mean annual precipitation amounts to 532 mm. The lithology in the drainage basin is complex and varied, and is dominated by metamorphic rocks, mostly gneisses and schists. Vegetation cover varies between tundra vegetation in the high and rather flat areas of the uppermost drainage basin area, tree vegetation in the lower parts of the incised tributary valleys of the Driva main river and grasslands in the agriculturally used areas along the main river valley of the Driva. Relevant geomorphological processes include chemical and mechanical weathering, rockfalls, snow avalanches, debris flows, slides, wash processes, fluvial erosion, fluvial stream bank erosion and down-cutting, and fluvial solute, suspended sediment and bedload transport.

This ongoing GFL research on sediment sources, controls and spatiotemporal variability of fluvial bedload transport includes detailed field-based studies with extensive granulometric and shape analyses of bedload material, and high-resolution bedload transport measurements applying different tracer techniques, Helley-Smith samplings, and underwater video filming together with impact sensor measurements. Specific focus is on selected stream channel stretches in the six tributary systems Svone, Kaldvella, Stølåa, Tronda, Vinstra and Ålma, and on three selected stream channel stretches of the Driva main river in the upper Driva drainage basin system. Stationary hydrological stations are monitoring runoff continuously as discharge

occurs in all tributary systems year-round. The runoff regime is nival with mean annual runoff amounting to 576 mm for the entire upper Driva drainage basin.

The activation of sediment sources and the temporal variability of fluvial bedload transport are largely controlled by thermally and, to a lower degree, pluvially determined events. The selected tributary systems display varying intensities of bedload transport and varying particle-size compositions and shape characteristics of the bed-surface material. These detected spatial variations are explained by different lithologies, different levels of sediment connectivity and spatially varying sediment availabilities in the different tributary systems. The clearly highest share of annual bedload transport occurs during the snowmelt period in spring. Continuing climate change might lead to less distinct spring snowmelt generated peak discharge events associated with reduced fluvial bedload transport during these events. Altogether, fluvial bedload transport is of variable relevance for the total fluvial transport in different sub-catchments of the upper Driva drainage basin.

IMPACT OF RAINFALL INTENSITY ON SOIL EROSION BASED ON EXPERIMENTAL RESEARCH

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Slopes are considered to be the most common landform on all the continents and they may be modified by many processes. In the face of advancing climate changes, resulting i.a., in more and more frequent violent rainfalls, soil erosion and surface runoff are one of the most important processes. Favorable conditions for generating soil erosion and surface runoff occur in the situation of high intensity or long duration of rainfall. The aim of conducted research was to assess the rainfall impact to soil erosion and surface runoff processes. It was realised by conducting series of field experiments with simulated rainfall.

The experiment was conducted at the research station located in the Różany Strumień catchment in the northern part of Poznań, Poland. The station consists of 4 plots, 20 m long and 1 m wide, with different land cover: black fallow, sand, concrete paver blocks and an insulated testing plot. In this paper, only data from black fallow were considered. The slope at the station is located on a south-facing slope of 6 degrees. Its base consists of sandur sand with thin interbeds of clay sand.

The program of experiments included seven types of rainfall, corresponding to individual classes of rainfall according to the classification of Chomicz used in Poland: A0 (strong rain, intensity: 4 mm/h, duration: 360 min.), A1 (heavy rain, intensity: 8 mm/h, duration: 180 min.), A2 (heavy rain, intensity: 16 mm/h, duration: 90 min.), A3 (heavy rain, intensity: 30 mm/h, duration: 50 min.), A4 (heavy rain, intensity: 40 mm/h, duration: 45 min.), B1 (torrential rain, intensity: 50 mm/h, duration: 60 min.), B2 (torrential rain, intensity: 60 min. mm/h, duration: 70 min.). Each rainfall was simulated twice: in dry and wet ground conditions. The experiment was carried out in July 2022 during a period of constant sunny and rainless weather, so there was no disruption due to natural rainfall.

Depending on the experiment program, 2÷8 m^3 of water is necessary, which is stored in the tank. From the tank water flows through the suction pipeline to the pumping system and then through the pipeline it is distributed to the nozzles. In the bottom edge of each plot catchers with volume of 350 dm^3 were installed. The increase in the water level in the catchers was registered

with the use of levelloggers with a time step of 1 minute. Five automatic soil moisture sensors were also installed on the plot at the following depths: 5, 10, 20, and 50 cm below ground level.

During the least intense precipitation (A0 and A1), the surface runoff and soil erosion process did not occur. Small amounts of soil loss (~0.001 kg/m^2) and surface runoff (~0.75 dm^3/m^2) occurred during rainfall A2. During subsequent rainfalls, soil loss and surface runoff increased exponentially with increasing intensity and duration of rainfall. Comparing irrigation on dry and moist soil, each time larger soil loss occurred when irrigating a dry surface, while greater runoff was recorder after irrigating wet surface.

SPATIAL AND TEMPORAL DISTRIBUTION OF MOISTURE IN TAFONI: WAY TO REVEAL THE WEATHERING PROCESSES

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Cavernous weathering forms, tafoni and honeycombs, are typical examples of the degradation pattern and they belong to long-term investigated and discussed enigma in geomorphology. Tafoni are meter-sized hollows shielded by the vizors that protect them from rain. Smaller cavities in cm scale are called honeycombs. Cavernous weathering is most common in desert, semi-desert, and coastal regions but it has been described from all climatic zones on Earth. While most scientists agree that salt weathering is the main erosion mechanism, there are many theories explaining the process of origin and growth. The weathering of rock is clearly selective. In otherwise the same rock small hollows grow and deepen in one place while in another place the surface is stable. Thus, a mechanism exists that leads to preferential deepening of the voids. Relatively new is the hydraulic hypothesis with a preferential flow of pore water with dissolved salts into cavities because their surface dries out the latest (Huinink et al. 2004; Karatas et al. 2022). This theory reliably describes the formation of cavities, but the reason for the size difference between honeycombs and tafoni remains unresolved. Also, few is known about moisture patterns and fluxes in these forms.

In this study, the laboratory measurements (the hydraulic conductivity, the retention curve, the pore size distribution, the capillary water absorption, and the water vapour diffusion coefficient) and field observation (the evaporation front depth, the suction pressure, the capillary water absorption, and air humidity condensation) on the study site with tafoni was done. Tafoni occur in arkose sandstone outcrops in the Vltava River valley near Kralupy nad Vltavou (Czechia). From measured data, the evaporation rate, the rock moisture content, and the amount of precipitated salts were calculated. Evaporation front depth oscillation during the year was modelled. Oscillation of evaporation front in shallow depth indicated that tafoni are no longer active. Suction pressure distribution demonstrated prevailing moisture flux toward the surface, but its reversion after rain events. For the first time, moisture patterns and fluxes were characterised on the outcrop with tafoni during the seasons. Combination of methods newly developed (the uranine-probe method) and adopted from soil hydrology for quantitative description of the moisture transport in the rock demonstrated to be a powerful tool in

deciphering the exact location and frequency of weathering events connected to capillary water in landforms.

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EFFECTS OF GROUNDWATER SAPPING ON DRAINAGE NETWORK AND LANDSCAPE EVOLUTION IN POSTGLACIAL AREAS (THE DĘBNICA CATCHMENT, POMERANIAN LAKELAND, NW POLAND)

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In the drainage network of the postglacial areas in NW Poland, there is an increase in the number of 1st-order streams, whose valleys branch out and extend towards the drainage divide. In the upper reaches of the erosional-denudational valleys, formed in earlier periods of the Holocene, groundwater outflows, through the seepage erosion lead to the development of a spring-head alcove, which often becomes the channel head. The river initiated by groundwater outflows have various locations within the valley network of the Dębnica catchment, and some of them are cut into the bottom of the lower part of dry erosional-denudational valleys. The goal of the study is to determine the participation of groundwater outflows and seepage erosion in the development of the headwater sections of drainage system in Debnica catchment. The conducted morphological, hydrological and geomorphological studies prove the role of groundwater in the formation of the channel heads, and at the same time the fluvial system.

The erosional-denudational valleys occurring in the Dębnica catchment show a diversified volume, ranging from 212 to 16,834 m^3. They are generally short forms with a relatively narrow bottom. In the case of valleys where the elongation ratio value is above 0.5, it can be concluded that linear erosion, occurred with a similar intensity as transverse processes, such as mass movements and other sidewall slope erosion processes, coupled with the transport of the materials from valley. The deepening of in the lower part of a valley segment by linear erosion has led to the dissection of aquifers and the drainage of groundwater onto the surface. The effect of groundwater sapping is the development of erosional undercuttings, which undermines the stability of slopes and causes their destruction via mass movement. As a result of headward erosion, around a groundwater outflow there develops a channel head, with steep slopes separated from the slopes of the initial depression (colluvial valley) by a distinct knickpoint. Narrow headwater alcoves gradually kept widening, vertical erosion led to the levelling and deepening of the older landforms, the steepening of their slopes, and in effect, a modification of the inherited cross-profile.

Changes in outflow efficiency until their disappearance, may occure as a result of climate change and changes in land use, may cause cessation of erosion processes and filling the spring-head alcove with sediments. It will also contribute to excluding some of the 1st order valleys from the active drainage system.

The channel head is sensitive to the impact of actual external and internal drivers of denudational processes in differentiated landscape controls, and its condition can be considered as a geoindicator of changes not only in the fluvial system, but also in the surrounding natural environment.

The share of seepage erosion in the formation of river valleys is still a topical research problem. There has been too little field research into relief-forming effects of groundwater outflows and their interaction with other morphogenetic processes that would corroborate the computer simulations and laboratory experiments conducted.

ANTHROPOGENIC IMPACT ON SOLUTE FLUXES AND CHEMICAL DENUDATION IN A HEADWATER CATCHMENT – A CASE STUDY OF THE TERENO WÜSTEBACH EXPERIMENTAL CATCHMENT

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Headwaters are a source of fresh water and material transported to the downstream sections of river channels. In most regions of Europe, the natural environment of headwaters has been significantly transformed by human activities, which is reflected in the quality of surface waters and the rate of solute fluxes. In this study, we determined the anthropogenic impact on solute fluxes and chemical denudation in a headwater catchment in Germany. The study area (Wüstebach experimental catchment) is located in the Eifel Mountains and is part of the TERENO (Terrestrial Environmental Observatories) network. The catchment is currently subject to the following anthropogenic pressures: the use of de-icing salts on the motorway running through the catchment and the logging of 22% of the forest area in 2013 by the National Park to promote the regeneration of near-natural beech forest. We used data from 9-year (September 2011-August 2020) environmental monitoring in the Wüstebach catchment to calculate monthly and annual rates of chemical denudation. The concentrations of ions in stream water and precipitation were determined: Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Al^{3+}, Fe_{tot}, Mn^{2+}, NO_3^{-}, SO_4^{-}, and Cl^{-}. Data from the Wüstebach catchment were compared with data from the control (untreated) catchment, and data after deforestation were compared with data before deforestation. The average annual rate of chemical denudation in the Wüstebach catchment was 65 t/km^2/a. In the first two years after deforestation, there were no significant differences in the chemical denudation rates between the period after and before deforestation, which indicates a slight impact of logging on the chemical denudation. This resulted from the limited soil erosion that followed deforestation as the soil was well protected during logging works by covering harvester lanes with branches. Significant differences the chemical denudation rates that occurred in the following years resulted rather from climatic factors. However, there is a significant impact of road salting on the solute fluxes in the headwater catchment. Assuming that the control catchment is not affected by using de-icing salts, the road salting inputs in the

Wüstebach catchment calculated based on the precipitation share for Na^+, Ca^{2+}, Mg^{2+}, K^+, and Cl^- ions were, on average, 88%, 53%, 18%, 53%, and 90%, respectively, of the original ion loads. The input with road salting was so large that elevated concentrations of Na^+ and Cl^- were noted throughout the study period with slight seasonal fluctuations. This proves the subsurface build-up of salt due to the long-term application of de-icing salt. Without the input of de-icing salts, the average annual rate of chemical denudation in the catchment would be about 17 t/km^2/a. Thus, on average, this ion storage effect in the soil has increased the chemical denudation rate by 74%. In summary, it can be concluded that long-term intensive road salting in winter has a greater impact on the solute fluxes than the clear-cut of 22% of the catchment area.

DEBRIS-FLOW AND SNOW-AVALANCHE ACTIVITY IN FĂGĂRAŞ MOUNTAINS (SOUTHERN CARPATHIANS, ROMANIA) RECONSTRUCTED USING TREE-RINGS

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In Făgăraş Mountains (Southern Carpathians, Romania), debris flows (DFs) and snow avalanches (SAs) are the main geomorphic processes which contribute effectively to the transfer of sediments from the alpine slopes to the valley bottoms. DF tracks and SA paths may extend hundreds of meters downslope across the coniferous forests established on the debris cone surfaces. Trees located along the trajectories where DFs and SAs occcur may frequently be damaged, and register in their growth rings distinctive signs of the past geomorphic process activity. In areas where the monitoring of geomorphic process and/or the historical records of past geomorphic activity are lacking, tree-ring analyses may serve to reconstruct DF and SA event history with annual and even with seasonal accuracy. In this study we aim to reconstruct the DF and SA frequencies by using tree ring analyses. To this end, dendrogeomorphic methods have been applied on multiple debris cones investigated, in order to gain a better understanding of DF and SA activity in terms of past frequency and spatial extent. Samples (cores, wedges and discs) collected from Norway spruce (*Picea abies* (L.) Karst.) trees provided records of past events which extend bach in time to the beginning of the 20th century. Despite few inherent limitations of dendrogeomorphic methods, mainly related to the symultaneous occurrence of DFs and SAs on the same forested debris cone, tree-ring analyses proved to be a reliable method to document past geomorphic activity, contributing to a better knowledge of the frequency of geomorphic processess in the study area.

LATE QUATERNARY AEOLIAN-FLUVIAL PALAEOARCHIVES RECORD LANDSCAPE EVOLUTION ALONG DUNEFIELD MARGINS

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We studied aeolian-fluvial processes of two middle-sized basins (< 100 km^2) that were dammed by vegetated linear dunes (VLDs) during the late Pleistocene at the southern edge of the northwestern Negev desert dunefield. Easterly moving VLDs, encroaching parallel to the Negev highland sourced fluvial systems, formed seasonal dune-dammed water-bodies. A series of vertical and lateral wadi-bank sequences of fine-grained deposits of these water-bodies which overlapped and truncated VLDs were analyzed along transects of the dunefield margins.

At the Raviv-Ruth basin, in the southwestern dunefield margins, VLDs encroached during the Heinrich-1 and the Younger Dryas events. At the Atadim basin, at the southern fringe of the central sand incursion of the dunefield, VLDs encroachment began during the LGM, and continued until the Heinrich-1 event.

Thick, massive, silty-loam deposits at basal sections of dune-dammed water-bodies, infilled the fluvial accommodation space upstream the dune-dam. The loam resembles loess and probably reflect enhanced availability of eroding loess from the upstream Negev highlands. During the early Holocene reduction in the availability of this source material and in the accommodation space upstream the dune-dam, led to depositions of fine sand – loam couplets that appear to discretely record seasonal to single flood events. These finds may also demonstrate enhanced hydrological activity when stabilized VLDs were still maintained as dams. This last stage of early Holocene dune-dammed water-bodies extended further upstream over larger areas than earlier ones. Altogether, the environmental transitions of the LGM-early Holocene time span characterized by aeolian domination and dune-damming led to amplified aeolian-fluvial sediment archives recording the landscape evolution along the dunefield margins.

THE INFLUENCE OF CROP PATTERN ON THE LOESS GULLY EROSION RATE AT THE LUBLIN UPLAND (STOCKI CREEK, E POLAND)

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The study was carried out in a loess subcatchment of a branching gully, with an area of 1.23 km^2. Water and suspended solids outflow, as well as rainfall intensity and totals have been monitored here for over the past 20 years. Recording of active erosional landforms (e.g. piping, gully heads and gully edge cuts) are also carried out. The gully system occupies almost 30% of the subcatchment area. It is locally formed as badlands and covered with Tilio-carpinetum oak-hornbeam forest. Agricultural land covered about 2/3 of the catchment, half of that is occupied by perennial plantations of berry bushes, mainly: currant, raspberry and chokeberry. The other half of the arable land is occupied by annual crops: cereals (winter and spring), root crops (potato and sugar beet) and brassica vegetables (cauliflower and broccoli). The pattern of annual crops and their location changes from year to year, while sometimes there is a repeat crop. In perennial crops, on the other hand, rotation usually occurs every ten years or more. The agricultural land in the subcatchment area belongs to small individual farms, where the arrangement of fields is characterized by considerable fragmentation. The average area of parcels with individual crops is 0.4 hectares. The patchiness of the crop pattern somewhat limits runoff, which in turn is favored by the longitudinal arrangement of fields perpendicular to the gully. Concentration of runoff from such fields, especially under annual crops and berry shrub plantations in the growth stage, causes cutting of the gully edges. The cutting of its bottom is also influenced by runoff from fields far from the gully. An inventory of the types of crops in the catchment was carried out during periods of high propluvial runoff, in 2010-2014 and 2020-2021. An attempt was made to determine the influence of crop pattern on the dynamics of gully erosion. To assess this relationship, annual ratios were calculated, reflecting (a) the number of active cuts per 1 km of gully edge at the contact of fields with particular crop categories, (b) the ratio of the length of gully bottom cuts to the acreage of susceptible crops in the catchment, and (c) the ratio of the volume of water runoff and suspended solids to the acreage of susceptible crops in the subcatchment. The multi-year averages of the ratios determine the susceptibility of individual crops to washing and water runoff into the gully, resulting in the development of a gully system.

SOURCE TO SINK SEDIMENT FINGERPRINTING IN A MIXED LITHOLOGY CATCHMENT; THE CASE OF NAHAL SA'AR, GOLAN HEIGHTS, ISRAEL

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Nahal (*=river*) Sa'ar basin is located at the boundary between the basaltic plateau of the Golan Heights and the Mesozoic sedimentary rocks of Mt. Hermon anticline. The drainage evolution is controlled by the regional tectonics, alternating cycles of volcanic activity and mixed lithology. While the tectonic factor determined the high relief and slope angles, the highly erodible sedimentary rocks at Mt. Hermon's piedmont enhanced fast slope erosion and river incision, shaping a 650 m wide and 100 m deep canyon. Nahal Sa'ar terminates in a small alluvial fan, as a tributary of the Nahal Banias (a major tributary of the Jordan River).

We hypothesize that the main channel alluvium of Nahal Sa'ar will demonstrate sedimentary traits that reflect different degrees of resistance to erosion of each lithology. The study focuses on sediment sources, controls and variability of the alluvium in attempt to understand to what degree are the competing lithologies reflected in the sediments transported in the basin.

Six different sampling sites were chosen along Nahal Sa'ar's main channel, as representative of the catchment. At each site we surveyed (1) an extensive grain size distribution (GSD), (2) a visual differentiation between limestone and basalt clasts and (3) the roundness and sphericity of both fine and coarse sediments. The results were then plotted against the longitudinal profile, to determine the spatial sedimentary characteristics.

Preliminary results show significant downstream coarsening in the upper parts of the basin and typical downstream fining in the lower sections. However, at the alluvial fan, the grain size distribution resembles the upstream sampling sites. This can be explained by the large floods of Nahal Banias which removed the large boulders (> 0.5 m) at the confluence between the two. In several upstream locations, the alluvium is disrupted by abundant cuboid mega-boulders (up to 3 m) that fell or rolled into the channel from the adjacent rocky slopes; although they are part of the alluvium, they are not entrained at any flood flows.

Along the upper channel, the alluvium is composed of carbonate rocks (mostly Jurassic limestone), in accordance with the contributing area – the karstic slopes of the Hermon anticline. Further downstream, as the basaltic lithology is exposed in the basin, the basalt sediments predominate, both in presence (~80%) and size. The channel has sufficient transport capacity,

and the channel alluvium turns into predominantly basalt clasts. These results are explained by faster erosion of the carbonate sediments, compared to the more resistant basalt. At one of the study sites (Ha'Yedidut Bridge site), sandstone layers are exposed along the slopes. These sandstone outcrops contribute boulders into the channel as a result of landslides and rockfalls. At this sampling site, only 3% of the alluvium is composed of sandstone, but these clasts are quickly eroded and pulverized. At the immediate downstream site they comprise only 0.5% of the alluvium, and completely gone further downstream.

We conclude that despite the two differing lithologies, the alluvium characteristics of Nahal Sa'ar resemble the basaltic streams of the Golan Heights to the south and not the karstic streams of Mt. Hermon to the north.

SOIL EROSION IN POST-GLACIAL AREAS AND TEMPERATE CLIMATE ON THE EXAMPLE OF NORTH-EASTERN POLAND BASED ON 15-YEAR MONITORING

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The aim of the study was to recognize soil erosion in the last-glacial area on the example of NE Poland. Monitoring of soil erosion was conducted on selected slopes in the upper Szeszupa catchment in hydrological years: 1987-1989, 1998-1999 and 2007-2016, a total during 15 years. Erosion measurements were carried out using small collectors placed along the longitudinal profile. The collectors were emptied at least once a month and additionally after heavy rainfall. The rill erosion was estimated on the basis of the volume of the rills and footslope accumulation after heavy rainfalls. During rainfalls of moderate intensity sheet wash caused erosion of the upper and the middle segments of hillslopes and deposition of eroded material in their concave (lower) segments. Rills conditioned by the direction of cultivation formed locally due to rainfalls above 20 mm on sandy-loamy, sandy-silty and loamy-sandy slopes longer than 100 m. Only a limited amount of material was transported beyond slopes and accumulated at the footslopes. For the average intensity of rainfalls, annual soil interrill erosion ranged from 0,03 (ceraels) – 2 $t \cdot ha^{-1}$ (potatoes) and rill erosion to 7 $t \cdot ha^{-1}$. Erosion along the entire slope was recorded during rains with an erosivity of more than 300 $MJ \cdot mm \cdot ha^{-1} \cdot h^{-1}$. The greatest erosivity was recorded on May 17, 2010 (EI_{30} =608 $MJ \cdot mm \cdot ha^{-1} \cdot h^{-1}$) corresponding to the annual erosivity in the study area. The effectiveness of both processes: sheet and rill erosion were several times greater, up to 30-50 $t \cdot ha^{-1}$ and locally even 80-90 $t \cdot ha^{-1}$. Intensive erosion, accompanied by soil loss up to 170 $t \cdot ha^{-1}$, lead to the formation of a network of rills, and locally, to the development of single ephemeral gullies. Strong erosion occurred on hillslopes were several features facilitated the soil loss, most importantly: the type of crop and the early stage of its development, local lithology and morphology of the slope. The study area experiences heavy rainfalls (>30 mm and erosivity > 300 $MJ \cdot mm \cdot ha^{-1} \cdot h^{-1}$) in May or June with frequency once every 7-10 years on average.

DENUDATION AND SOLID TRANSPORT ASSESSMENT IN SMALL MOUNTAIN CATCHMENTS: THE ALPE VEGLIA TEST SITE (CENTRAL-WESTERN ITALIAN ALPS)

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Proglacial areas (i.e., the environments identified between the glacier snouts and the Little Ice Age moraines; Schiefer and Gilbert 2007) can be considered hot spots of geomorphological dynamism and sediment delivery (Bollati et al. 2022; Savi et al. 2023), features that reflect the nature of a transient environment, in a meta-stable state, between glacial and non-glacial conditions (Johnson 2002). Assessing the magnitude of these modifications requires a collection of quantitative data from different test sites under different morphoclimatic conditions. In 2021, we installed a multiparametric automatic station to collect data along the Aurona creek, draining the western portion of the Alpe Veglia hydrographic catchment, where the Aurona and Leone glaciers coverage represents less than 6% of the total surface. The proglacial areas are featured by the presence of a relevant quantity of unconsolidated glacial sediments, by the evident signs of permafrost degradation, and a high energy relief predisposing to slope instabilities (e.g. rock falls, debris flows and snow avalanches), and to water-related erosive processes (e.g. gullying and rilling). The multiparametric station is located at 1750 m a.s.l., in the Alpe Veglia alluvial plain, about 3 km downvalley from the Aurona proglacial plain (~2250 m a.s.l.). The probe records, at 5 min intervals, the hydrometric level, the electric conductivity, the temperature, and the turbidity, for estimating the Suspended solid load-SSL along the Aurona river (collecting waters from both proglacial plains). The flow rating curves of the station are retrieved through water discharge measurements by the salt dilution technique (Gees 1990). Water samples are taken to establish the relation between turbidity and SSL (Gippel 1995), and data from the automatic weather station in the area are also used to put in relation hydrometric and meteorological events. Through these measures, we aim to assess the evolution trend of the proglacial areas by monitoring the related sediments' paths downvalley. Moreover, geomorphological mapping, GPS monitoring, digital photogrammetry and Structure from Motion-Multi-View Stereo

techniques are also being applied to understand the sediment connectivity patterns in the proglacial areas. In this first phase, the spatial distribution of landforms is analyzed by building 3D models of the geomorphological environment of the Aurona proglacial plain. In this way, we aim to compare, from a multi-temporal perspective, the different surfaces (onsite data) and to assess the variation through different techniques (Digital cloud comparing, DEM of Difference), to put them in relation with sediment connectivity and SSL data (offsite data). Preliminary results of geomorphological reconstructions, through historical aerial photos analysis and recent UAV surveys, confirm conditions of highly dynamic proglacial areas, with ephemeral proglacial lakes and evident gullies affecting the LIA moraine inner flanks. Moreover, preliminary 3D models and DEM were built for the Aurona proglacial area. The first 2 years (2021-22) of data from the multiparametric station along Aurona creek show a well-delineated pattern in the turbidity-water level relation, with at least two main clusters of data. The first represents the snow melting period (from June to July), characterized by a clockwise cycle of the logged data, while the second represents the glacier melting period (from July to October), characterized by a counterclockwise cycle.

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SMALL ENDORHEIC BASINS AS PALEOENVIRONMENTAL ARCHIVES

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Israel's varied landscape along climatic gradients suggests varied responses to environmental perturbations of the late Quaternary. These may have been correspondingly distinctive, and not necessarily contemporaneous or unidirectional. Some of these environmental changes resulted from rapid and short-term climatic events, requiring the use of spatially spread and temporally continuous, high-resolution paleoenvironmental archives.

Endorheic (closed/terminal) basins record hydro-climatological conditions and long-distance aeolian fluxes, thereby offering a potential paleoenvironmental record. Sediments in small basins are expected to provide continuous and well-preserved records due to limited source-sediment variability and erosion. We are studying climatic-controlled geomorphic process between small basins along south-north transects from the Negev Desert through the East Mediterranean coast, while also identifying local site-specific events, to construct a regional paleoenvironmental framework for the late Quaternary.

Here we show preliminary results from the sedimentological infill of three endorheic basins across a ~150 km south-north transect (1) Givat Hayil (0.08 km^2, ~80 mm annual rainfall) (2) Agamim (0.87 km^2, ~390 mm annual rainfall) (3) Dora (0.14 km^2, ~450 mm annual rainfall). We performed continuous and high-resolution analyses of grain size distribution, magnetic susceptibility, luminescence, and elemental geochemistry. These proxies will be used to reconstruct depositional environments, track sediment sources, and determine burial ages and sedimentation rates. Results indicate several distinct depositional phases often with cyclic characters, that when dated, are hypothesized to often correspond to established climatic events.

IMPACT OF CLIMATE CHANGE ON POLLUTION TRANSPORT IN RIVER SEDIMENTS

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During last few decades it became evident that climate changes have adverse impacts on economy and population in many world's regions, including Southeastern Europe. Studies of present and potential future climate change in Southeastern Europe region show an increasing trend in air temperature and significant precipitation decrease, especially in the warm half of the year. That may cause long-lasting droughts, more intense wildfires, stronger storms.

More and more evidences indicate that fluvial sediments in many watersheds have been disturbed by environmental changes. Climate changes, such as more frequent and intense rain events, higher river water levels, and faster stream velocity can increase erosion and result in increased suspended sediment material in water bodies and affect normal distribution of sediment along river.

In this study the chemical composition of the Vrbas River sediments (Bosnia and Herzegovina) was investigated with the aim to understand how human activity is affecting pollution status of river sediments (and subsequently water quality) and to assess the geochemical distribution and potential mobility of some trace elements. The river is located in a typically temperate continental climate zone with an average annual precipitation of 1021 mm, with moderately cold winters and warm summers. The average annual temperature 11.2 °C has a positive linear trend with an increase of 0.46 °C per decade in the last 30 years (Fig. 1a).

Nineteen sediment samples were collected along entire course of the Vrbas River from the source to the confluence with the Sava River, a large tributary of the Danube River. Content of macro and micro elements were measured using X-Ray Fluorescence (XRF). Results showed some alterations in major element concentration, especially at the industrial points. Micro elements Cr, Ni, Cu, Pb and Zn have a similar behavior, especially in locations with higher population density, traffic, industrial and municipal wastewater discharge, which reflects anthropogenic contributions as responsible for increasing concentrations (Fig. 1b).

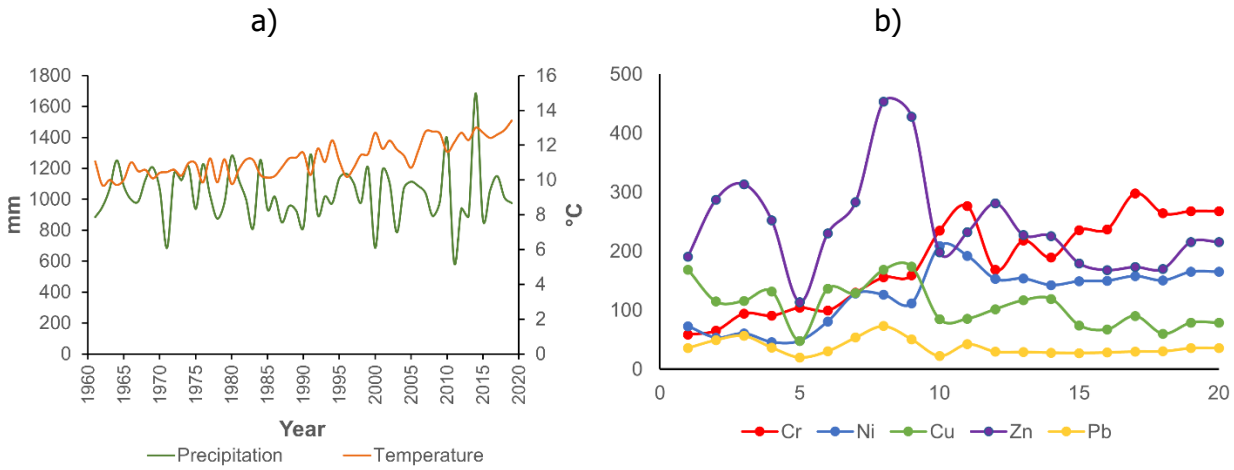

Fig. 1. a) Average precipitation and temperature values at the Vrbas River (1961-2020); b) Concentration change of some trace elements from the first to the last sampling point.

Correlation between analyzed parameters indicate that surface runoff is the main source of transport of pollutants in the Vrbas River. Since the climate data indicate increase in precipitation intensities, it can be predicted that there will be an increase of particle bound metal transport in urban part of the Vrbas watercourse towards the Sava River, and finally reaching the Danube. The impact of raising temperature has an indirect effect of increasing of chemical weathering leading to metal release in soils and sediments. All these effects will cause water and sediment quality degradation and indicate that adapted management of watercourses as a source of drinking water supply is necessary.

A MULTITEMPORAL NDVI ANALYSIS FOR UNDERSTANDING THE ANTHROPIC INFLUENCE ON THE RECENT EROSION DYNAMICS IN THE UPPER ORCIA VALLEY (CENTRAL ITALY)

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Mediterranean environments turn out to be extremely shaped by human actions, and many landscapes that currently look natural are the result of centuries of land domestication. Previous decadal studies have highlighted the intense land transformation that the Tuscan landscape of the Upper Orcia Valley, in central Italy, underwent during the last century. The area is characterized by accelerated erosion landforms, such as *calanchi* and *biancane* badlands, that have been diffusely levelled for land reclamation. A recent insight into the archive of the Land Reclamation Authority of the area, funded in 1929, has allowed an in-depth comprehension of the reclamation works started almost 100 years ago. Consequently, the multitemporal analysis of the erosion rates shows a decreasing trend for the last decades but a parallel increase of mass wasting processes.

In order to better understand the contribution of the land cover and use changes to this erosion dynamics, the results of a multitemporal geomorphological survey and the analysis of the land use changes were compared to the spatio-temporal computation and analysis of the NDVI (Normalize Different Vegetation Index), commonly used in the ecological field as an indicator of the green biomass effects on soil erosion.

NDVI was computed on Landsat and Sentinel multispectral imageries (Landsat 1-2-4-5-8, and Sentinel-2), selecting every 10 years the images acquired in spring and winter seasons, within the 1975-2021 time interval. The computed NDVI values were classified in four categories as i) no vegetation, ii) sparse, iii) moderate and iv) dense vegetation, interpreting the first class as including bare lands typical of badland areas.

The NDVI analysis revealed a general decrease of bare lands and a considerable increase of dense vegetation cover. The overlay with the multitemporal geomorphological mapping showed a recolonisation by forests along the main riverbeds and on the badland areas. A general decrease of sediment supply from hillslopes can be linked to the observed channel narrowing and incision trend along the main rivers. These results can be explained by the progressive increased land use for agricultural purposes, artificial reforestation but also by the gradual abandonment of rural areas, which has led, recently, to the reconquest of broad-leaved forests during the last decades.

GULLY EROSION IN AREAS AFFECTED BY WILDFIRES AND SALVAGE LOGGING IN NW PORTUGAL: PRELIMINARY RESULTS

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Fire plays a key role in the ecology of many ecosystems, having been present throughout the history and the development of society. However, the increased frequency, magnitude and extent of wildfires, over the past decades, have become a major societal and environmental concern across the world.

As far as Portugal is concerned, the occurrence of forest fires has also shown an increasing trend, characterized by a significant increasing in the number of ignitions and burnt area over the last decades. Forest fires therefore constitute one of the most relevant environmental problems and are frequently considered the major cause of soil degradation and desertification.

In fact, the destruction of vegetation by forest fires makes soils vulnerable to erosion by promoting the removal of nutrients and mineral components. This significant and continuous degradation of soil, especially recognized in the Mediterranean areas, makes the implementation of slope protection measures urgent in order to mitigate the effects of forest fires and reduce the loss of soil and nutrients.

Another factor affecting and aggravating soil erosion of areas affected by wildfires is salvage logging. Frequently, extensive burned areas are submitted to this practice, leaving soils unprotected and severely mobilized and damaged by machinery operation.

Although it is not an innovative theme, known for quite some time, the truth is that the scientific production related to this topic is quite small.

In the present study case, we analyzed an area in the municipality of V. N. Famalicão, located in the northwest of Portugal, where a wildfire burned 155 hectares of eucalyptus globulus stands in July 2022. The natural characteristics of the burned area, with steep slopes, shallow soils, affected by significant and concentrated values of rainfall (especially during the month of December 2022), reveal a high risk of soil erosion.

Several patches of forest were subject of salvage logging after fire, including the use of heavy machinery, resulting in severe impacts on soil structure, soil compaction, especially on temporary roads used for trees removal ("skid trails").

In order to evaluate the impact of salvage logging on soil erosion, the study areas were surveyed with an Unmanned Aerial Vehicle (UAV), with the objective of producing high resolution surface elevation outputs (DEM) and allow the evaluation of erosion dynamics produced by the logging practices. Other surveying techniques were implemented in order to complement and validate the modeling procedures and outputs obtained from the DEM data. The continuous monitoring of the study areas also made it possible to obtain a photographic record of the evolution of erosive processes and the development of gullies.

Although the study is still at an embryonic stage, it is already possible to point out some results of the ongoing work. Indeed, there has been a marked development of soil erosion processes in areas affected by wildfire and subsequently subjected to mechanized timber removal. The mechanized removal processes generated soil compaction, preferentially concentrated on the paths used for timber extraction, which ended up acting as preferential lines of surface runoff processes. These processes were favored by the occurrence of periods of heavy rainfall, triggered after the wood removal. Areas subjected to wood removal after periods of heavy rainfall did not suffered intense water erosion processes.

As a result of the combination of these factors, the development of large gullies and, consequently, very significant sediment removal values were recorded. Preliminary surface modeling processes already demonstrate high erosion rates occurring in the study areas.

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DENUDATIONAL LANDFORMS IN THE FIRST 100 GEOHERITAGE SITES

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Denudation is the name for the processes of erosion, leaching, stripping, and reducing the mainland due to removal of material from higher to lower areas like valleys, river valleys, lakes and seas with a permanent filling of low lands. Denudational landforms are landforms created by the process of denudation over long periods of time through the gradual removal of rock and soil. Denudation can be caused by one or multiple erosional agents and various natural forces, such as running water, wind, glaciers, and waves. The speed and type of denudation can vary, depending on factors such as the climate, geology, and topography of the area, and even human activity. Examples of denudational landforms include among others such spectacular landforms like canyons, gorges, valleys, badlands, cliffs, arches, peneplain as well as also microforms like tafoni, solution pans, hoodoos etc. It is difficult to find universal criteria for classifying denudative forms, but it generally depends on the specific processes and factors that shaped them. Nevertheless, the most important denudational landforms are:

1. Erosional landforms: landforms created by the erosive action of running water, such as canyons, gorges, waterfalls, river valleys, gullies, badlands.
2. Glacial landforms: landforms created by the erosive action of glaciers, such as U-shaped valleys, hanging valleys, cirques, arêtes, horns.
3. Coastal landforms: landforms created by the erosive action of waves and currents (abrasion), such as sea cliffs, sea caves, bays, fjords, and wave-cut platforms.
4. Aeolian landforms: landforms created by the erosive action of wind, such as desert pavement, yardangs, gobbets and ventifacts, deflation hollows and blowouts
5. Karst landforms: landforms created by the dissolution of rock, such as sinkholes and swallow holes, caves, springs, limestone pavements, disappearing streams, domes and towers, and poljes.
6. Volcanic landforms: landforms created by erosive volcanic activity, such as calderas, crater lakes, and lahars.
7. Slope landforms: landforms created by gravity assisted by other factors: landslides, rockslides, rockslide-debris flows, mudslides, debris flows, slumps, creep, and avalanches.

Some of the listed landforms are so outstanding that they have been recognized by International Union of Geological Sciences, which included them in "The First 100 IUGS

Geological Heritage Sites". Some of these geosites will be introduced during the presentation: Siccar Point, Phlegrean Fields Volcanic complex, Giant's Causeway and Causeway Coast, Taburiente Caldera, Grand Canyon, sea cliffs on the Basque coast, Torres del Paine, Cameroon Volcano, Ulmen Maar, Cotacachi-Cuicochoa volcanic complex, Santorini caldera, Cappadocian Volcanic Province, Uluru Inselberg, Sugar Loaf, Shilin karst, Bemaraha Tsingy, La Puerta del Diablo, Iguazu/Iguacu Waterfalls, Victoria Falls, Dry Falls and the Channeled Scabland, Jutulhogget canyon, Engadine rockglaciers, Lut Desert, Vajont landslide, Škocjan Caves, Sac Actun cave.

FROM NATURAL PROCESSES TO GEOHAZARDS – PALAEOFLOOD HYDROLOGY IN THE JUDEAN DESERT EPHEMERAL STREAMS AS TOOL TO IMPROVE RISK ASSESSMENT

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The Judea Desert constitutes a distinctive hydrological region characterized by steep bedrock ephemeral streams draining eastward to the Dead Sea Valley. The hydrological data for these streams are partial and scarce, leading to poor estimation of magnitude and frequency of floods. The lack of data is particularly significant when it comes to risk assessment for infrastructure. The current study is based on Palaeoflood Hydrology which uses geomorphological evidence for past real floods that accumulate in typical natural traps, along the course of the streams for hundreds and thousands of years. Those evidences indicate on the minimum water elevation of the flood enabling discharge calculations using HECRAS hydraulic engineering software. The ages of the floods are determined by radiocarbon and OSL dating of the flood deposits. These hydrological palaeoflood data enables to reconstruct the history of the floods in the streams including the largest event that occurred in the stream during the last hundreds to thousands years. By combining these data with measured and historical data (if any), a long, solid database can be reconstructed. The largest flood that occurred in the stream can serve as a control on regional envelope curves and rainfall runoff models such as PMP-PMF.

The streams in this study are: Darga (71 km^2), Arugot (217 km^2), Ze'elim (250 km^2) and Rahaf (55 km^2), along with Heimar (450 km^2) and Ashalim (35 km^2) from previous study. The duration of the reconstructed palaeoflood records are 210, 410, 250, 700, 300 and 7600, respectively. The maximum reconstructed palaeodischarges were 300, 830, 900, 1250, 1100 and 400 m^3s^{-1}, respectively in relation to the maximum measured peak discharges of about 140, 530, 680, 525, 540 and 100 m^3s^{-1}, respectively.

Frequency analyses using Max and FLDFRQ3 programs with the integrated data (systematic and palaeo) shows is some cases a significant decrease in the discharge values for low probabilities, while in others, the opposite trend was obtained. In all streams, the values for the integrated data are significantly more reliable as indicated by the value of the standard error.