



L-Università ta' Malta
Institute of Earth Systems

2026

EARTH SYSTEMS

RESEARCH ABSTRACTS



FOREWORD

The ethos of the Institute of Earth Systems has always centered on the understanding of environmental challenges through the integration of diverse scientific perspectives. The projects presented in this booklet reflect this commitment, showcasing the breadth, depth, and relevance of research undertaken by our students across a wide range of environmental themes.

The abstracts collected here explore topics that are both locally significant and globally relevant. From investigations into air quality, hydrological processes, and marine environments to studies of biodiversity conservation, sustainable consumption, environmental governance, and cultural heritage preservation, these projects highlight the complex interactions between natural systems and human activities. Together, they demonstrate the importance of adopting holistic approaches when seeking to understand and address contemporary environmental issues.

A common thread running through these studies is the recognition that environmental challenges rarely exist in isolation. Effective solutions require an appreciation of ecological, social, economic, and technological dimensions, as well as the ability to draw upon knowledge and methodologies from multiple disciplines. The research presented here reflects this philosophy, illustrating how interdisciplinary inquiry can generate valuable insights and support evidence-based decision-making.

Beyond their academic contribution, these projects represent the dedication, curiosity, and hard work of our students. They have engaged with real-world problems, applied rigorous research methods, and developed skills that will serve them well in their future careers. Their work demonstrates not only academic excellence but also a commitment to contributing positively to society and the environment.

This collection serves as a testament to the vibrant research culture fostered within the Institute of Earth Systems and to the important role that emerging researchers play in advancing environmental knowledge. We hope that the abstracts presented here will inspire discussion, collaboration, and continued exploration of the challenges and opportunities that shape our rapidly changing world.

As you read through these contributions, we invite you to reflect on the value of interdisciplinary thinking and the essential role of research in building a more sustainable and resilient future.



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LinkedIn Profile

PROMOTING SUSTAINABLE FASHION THROUGH REPAIR AND UPCYCLING: AN EXPLORATORY STUDY AT THE UNIVERSITY OF MALTA.

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The fast fashion industry is a major driver of environmental pollution with global textile waste emerging as one of the most pressing environmental challenges of modern consumer society. Underlying this crisis is 'planned obsolescence', whereby garments are intentionally produced at low-quality to accelerate disposal and replacement. While circular practices like thrifting are gaining traction among younger generations, repair and upcycling practices which are crucial for reducing waste at source, remain largely marginal.

This study investigated repair and upcycling behaviours, perceptions and barriers among University of Malta students and tested whether university-led skill-building workshops could foster pro-environmental behavioural change. An explanatory sequential mixed-methods design was employed, combining a survey of 153 students, structured workshops and three follow-up focus groups conducted three months later. Results revealed a clear value-action gap: students strongly endorsed repair and upcycling as environmentally and practically valuable, yet engagement remained minimal. Since most already owned basic repair tools, material accessibility was not the primary obstacle. Barriers instead clustered into three dimensions: practical (lack of skills, time and financial resources), structural (dominance of cheap alternatives) and psychological (anticipatory failure anxiety and low self-efficacy). The workshops partially addressed barriers of proximity, time, financial costs and confidence. However, no participants reported independent repair or upcycling activity in the three months following the intervention, indicating the insufficiency of one-off initiatives.

This study recommends institutionally-embedded opportunities at both university level and early education, including visible on-campus repair initiatives, curriculum integration through a mandatory 'Green Skills' module and targeted digital communication to normalise repair cultures among younger generations.

Keywords: Sustainable fashion, Clothing repair, Upcycling, Value-action gap, Social Practice Theory, University students, Mixed-methods research.



(a)

(b)

(c)

Trash to Trend campaign activities: (a) display table showcasing upcycled projects; (b) shared workshop and thrift-shop room setting; (c) workshop participant practising on a sewing machine.



ASSESSING THE FUNGAL CONTAMINATION OF PAPER ARTEFACTS IN MUSEUM RESERVE STORAGE.

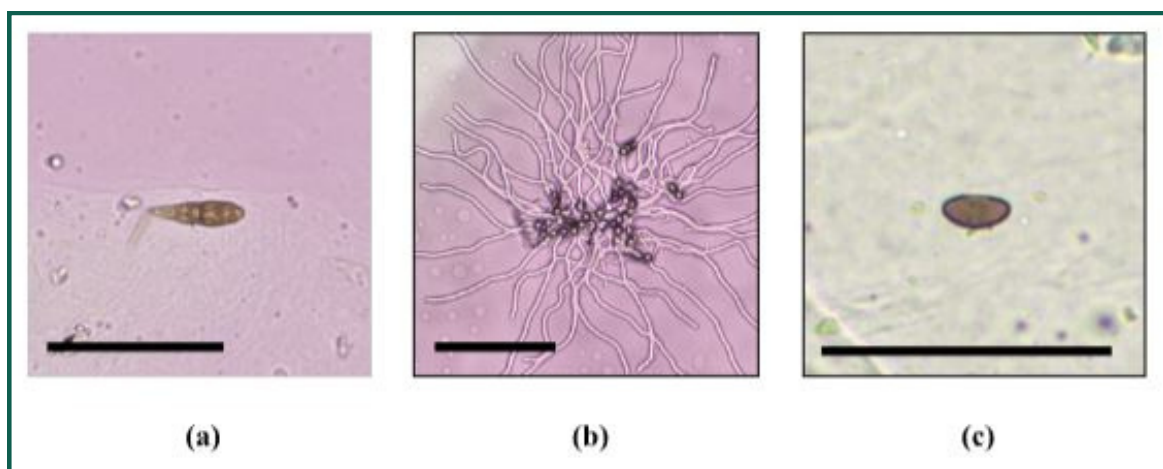
Calleja, Daniel (1), Gambin, Belinda (1)

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Fungal communities pose a significant threat to paper artefacts of cultural and historical importance, often proliferating under favourable environmental and nutritional conditions, such as within museum paper repositories. Their development is influenced by both macro- and microclimatic factors, as well as storage methods. The role of preventive conservation has gained recognition in reducing fungal-induced biodeterioration, with monitoring and the subsequent implementation of site-specific measures often being advantageous.

This study assessed variations in fungal counts and taxa within the reserve collection of a Maltese museum, particularly within its plan chests. It also considered its transitional areas, which included a drying room used to isolate mould-infested paper artefacts. This was achieved using adhesive-coated spore traps and by combining passive-gravimetric, active- volumetric, and surface sampling methods, alongside thermohygrometric monitoring and plan chest use self-reporting. The results revealed that the thermohygrometric conditions remained near established environmental set-points, except within the drying room, potentially facilitating the continued viability of mould-infested artefacts. Airborne *Aspergillus/Penicillium* spp. were prevalent, this was followed by *Chaetomium* spp., *Alternaria* spp., and *Cladosporium* spp. among the fungi identified. The highest fungal counts were found within the plan chests, yet elevated counts remained transient. Statistical analyses were additionally performed, reporting a negative association between *Aspergillus/Penicillium* spp. and absolute humidity within the plan chests. Nonetheless, unaccounted non-routine activities may have affected such findings. Based on the results, site-specific recommendations were provided, namely lowering the reserve's temperature and the drying room's relative humidity, alongside the development of standard operating procedures for mould detection on paper artefacts.

Keywords: Environmental control, Fungal-induced biodeterioration, Museum storage, Paper artefacts, Preventive conservation.



Photomicrographs of selected airborne fungal taxa: (a) *Alternaria* spp.; (b) *Aspergillus/Penicillium* spp. spores and hyphae; (c) *Cladosporium* spp.; scale bar: 50 µm.

MONITORING NUTRIENT DYNAMICS IN RUNOFF FOLLOWING RAINFALL EVENTS IN AN AGRICULTURAL CATCHMENT.

Carpinato, Sofia (1), Mamo, Julian A. (1)

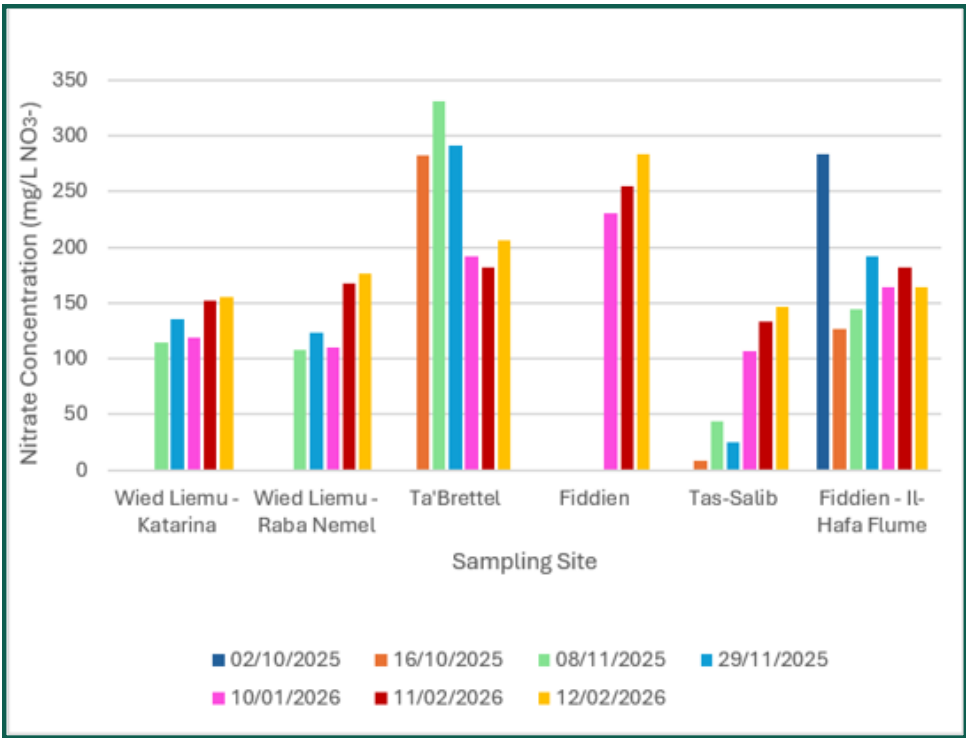
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Malta is designated as a Nitrates Vulnerable Zone with limited freshwater resources due to nutrient contamination from agricultural runoff. Monitoring surface water and soil quality is critical to prevent the deterioration of existing freshwater resources and reduce risks to the environment and human health.

This study assesses temporal and spatial nutrient variations in surface water within Malta’s key agricultural catchment; Wied il-Għasel. Runoff and soil samples were collected between September and March to analyse nutrient levels and other quality parameters via in-situ and laboratory analysis, linking land cover and local contamination sources to water quality.

Findings reveal high nitrate contamination in surface waters, peaking at 331 mg NO₃ - /L. This is primarily driven by excessive fertiliser application on surrounding fields which is reflected in the soil samples. Nutrient concentrations fluctuated upstream to downstream based on land cover and rainfall-runoff events, highlighting the need for continuous monitoring and stricter agricultural regulations to protect Malta’s vulnerable freshwater resources.

Keywords: Agricultural runoff, Rainfall, Water quality, Spatiotemporal variation, Nitrates Vulnerable Zone.



Temporal variation in nitrate concentration across sample sites.



INVESTIGATING THE FACTORS AFFECTING THE PM_{2.5-10}/PM₁₀ RATIO TO IMPROVE PM₁₀ MEASUREMENT FROM PARTICLE DEPOSITION DATA.

Farrugia, Nicola (1), Scerri, Mark M. (1)

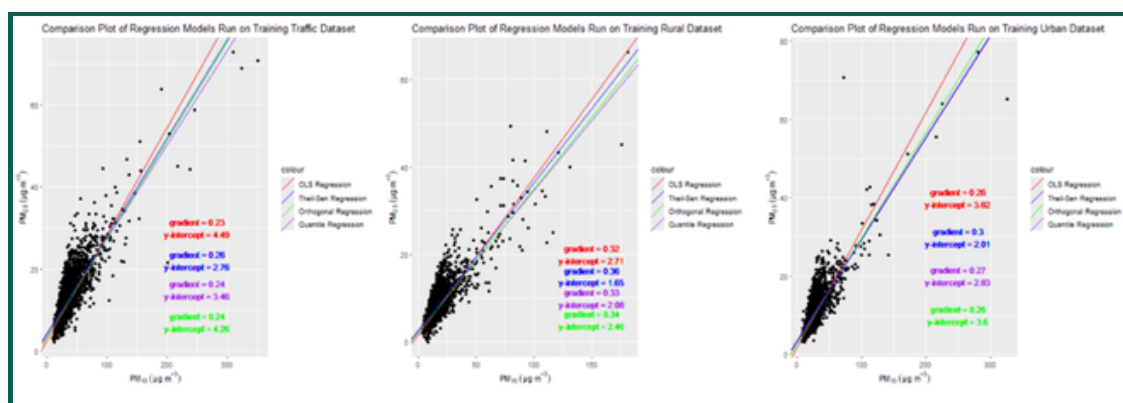
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Monitoring of Airborne Particulate Matter (APM) in Malta is carried out at five fixed gravimetric stations, as per requirements of Directive (EU) 2024/288. Financial and logistical constraints limit expanding this network, prompting the use of low-cost passive deposition samplers, like the Sigma-2, for high-resolution spatial data. These samplers estimate PM₁₀ concentrations by scaling the deposited coarse fractions (PM_{2.5 - 10}) of PM₁₀ using the ratio coarse fraction/PM₁₀. This ratio depends on the PM_{2.5}/PM₁₀ ratio that is derived from nearby reference stations as a scaling factor. Consequently, the accuracy of this method depends on the predictive precision of the scale factor. This study evaluates how Saharan dust events, seasonality, and station type (spatial variability) influence the PM_{2.5}/PM₁₀ ratio, aiming to optimize scale factor determination and improve dry deposition measurement accuracy.

Using daily PM₁₀ and PM_{2.5} data from the Environment and Resources Authority (ERA), group comparisons and permutation-based ANOVA testing were carried out to quantify the impacts of these factors on particulate concentrations and their ratio. All factors tested were found to produce significant effects on the ratio, although station type was found to be the primary driver of variance. However, the selection of the optimal scaling approach is based on predictive performance rather than variance explanation alone.

To identify the optimal regression technique to be utilised when determining the ratio, the predictive accuracies of different scale factors when applied to a test subset were evaluated by comparing scaled estimates to observed values. The scale factors utilised were equivalent to the gradient values obtained when a training dataset was fit to the following regression models: OLS, Theil-Sen, orthogonal and quantile. When applied to the full dataset, performance differences between the models were found to be marginal, however when applied to station-specific subsets Theil-Sen consistently produced the lowest error metrics. Thus, the incorporation of station-specific data and the application of robust regression techniques, such as Theil-Sen, is expected to improve the accuracy of PM₁₀ estimates derived from dry deposition methods.

Keywords: Air Pollution, Air Quality Monitoring, Passive Depositional Sampling, Airborne Particulate Matter, Group Analysis, Model Evaluation.



Comparison plots showing the different regression coefficients obtained when OLS, Theil-Sen, orthogonal and quantile regression are applied to PM₁₀ and PM_{2.5} measurements from traffic (left), rural (centre) and urban background (right) stations.

MAPPING BUTTERFLY DISTRIBUTION IN HABITAT HOTSPOTS ON THE ISLAND OF GOZO (RHOPALOCERA – LEPIDOPTERA).

Fenech, Sarah (1), Cassar, Louis F. (1)

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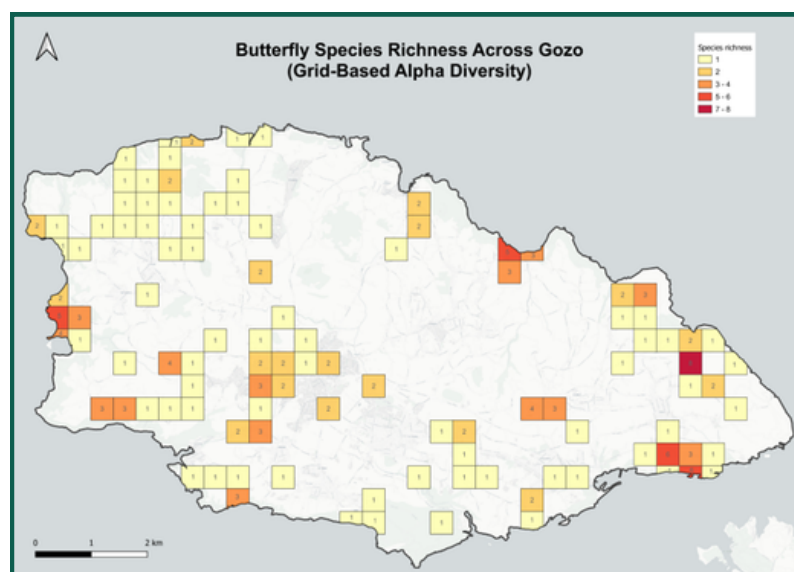
Butterflies are widely recognised for their significance as bioindicators. However, their spatial distribution remains poorly documented across small Mediterranean islands. This study maps butterfly distribution across the island of Gozo, assesses habitat and biotope characteristics in terms of species occurrence, and explores the existence of connectivity between habitat patches.

A series of walkover field surveys was undertaken over 44 days between July 2025 and April 2026 at 11 pre-selected sites of ecological significance. In total, 399 individuals representing 13 species were recorded. Their spatial distribution was subsequently examined and mapped using Geographic Information System (GIS) analysis.

Species richness was highest in mosaics of garrigue, steppe and agricultural land, particularly at Dwejra, Ramla Bay, and the Qala sites (Taċ-Ċawl and Wileġ). Grassland specialist species including *Coenonympha pamphilus* and *Maniola jurtina hyperhispulla*, both of which face significant declines, were recorded exclusively at the Qala sites. Seasonal distribution analysis reveals peak activity in autumn and spring, demonstrating seasonal patterns with influxes of migratory species including *Vanessa cardui* and *Colias croceus* during the bi-annual passage between North Africa and Europe, with the Maltese islands acting as a crucial mid-sea migratory corridor stepping stone.

Despite some limitations with the sampling, this study provides an important baseline for spatial information on butterfly distribution on Gozo. Increasing pressure from land-use change and overdevelopment risk fragmenting vital habitat refugia, especially for specialist and migratory species (latter group is crucial in augmenting resident populations), highlighting the urgent need for long-term butterfly monitoring to inform conservation planning.

Keywords: Butterfly distribution, Bioindicators, Habitat hotspots, Mediterranean islands, Spatial analysis, Conservation baseline.



Butterfly species richness using a grid calculation (500m x 500m) and counting distinct species.



BARRIERS AND ENABLERS TO ECO-CERTIFICATION IN MALTA'S SME HOTEL SECTOR.

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The steep increase in tourism experienced by the Maltese islands in recent years has been accompanied by a number of environmental pressures and consequences, therefore emphasising the important position that the hospitality industry plays in safeguarding the environment.

Eco-certification was introduced as a way to structurally guide hotel managers into making their facility as sustainable as possible, offering both environmental and financial benefits. However, the implementation of this certification amongst small and medium sized hotels in Malta is not so common. This study assessed the awareness, perceived value and impact of eco-certification from the perspective of hotel managers in Malta.

A series of semi-structured interviews were held with hotel managers and other relevant representatives, resulting in the identification of various barriers, namely: fragmented information, perceived ineffectiveness, resistance to change, operational and administrative burden and financial constraints, all of which hinder to various degrees, the uptake of eco-certification amongst SME hotels in Malta. Furthermore, a number of enabling factors also emerged from the interviews, including : simplified procedures, financial incentives, perceived profitability and market appeal, and perceived benefits.

These main themes were analysed using NVivo® software, and the following suggestions aimed increasing the uptake of eco-certification amongst SME hotels emerged: policy based approaches, such as setting certain environmental standards or requirements for SME hotels, improved guidance in order to increase knowledge and awareness on the topic, and support structures and SME tailored schemes in order to provide financial aid to the smaller hotels who are currently unable to pursue the certification due to monetary constraints.

Keywords: environmental and certification awareness, financial constraints, administrative burden, improved guidance and support structures, Maltese islands.

Theme	1	2	3	4	5
Sub-theme	Barriers to Obtaining & Maintaining Eco-Certification	Enablers to Obtaining & Maintaining Eco-Certification	Environmental Awareness	Existing Environmental Measures within SME Hotels	Suggestions
1	Fragmented Information	Simplified Procedures	Environmental Awareness & Personal Values	Sustainable Practices	Policy Based Approaches
2	Perceived Ineffectiveness	Financial Incentives	Certification Awareness	Environmental Managers	Improved Guidance
3	Resistance to Change	Perceived Profitability & Market Appeal	Cultural Values		Support Structures & SME Tailored Schemes
4	Operational & Administrative Burden	Perceived Benefits			
5	Financial Constraints				

Summary table of thematic results & analysis of interviews.



UNDERSTANDING TEMPORAL DYNAMICS OF METEO-MARINE PARAMETERS AT THE ĆIRKEWWA MARINE PARK.

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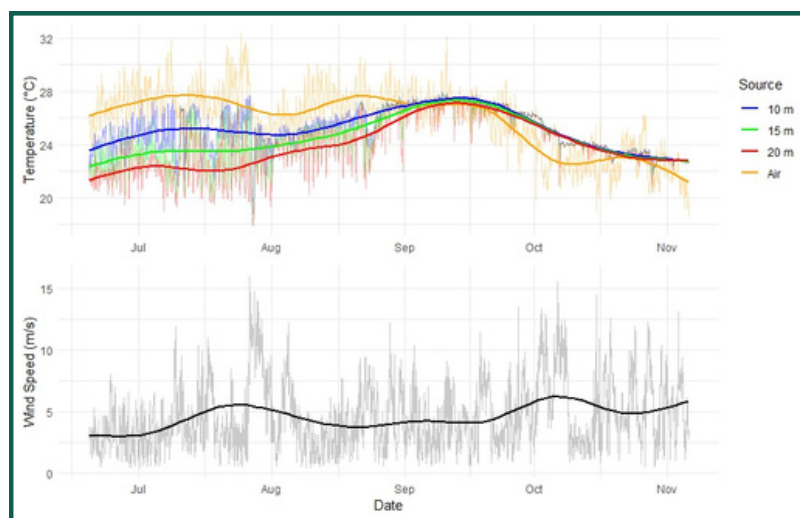
This study investigates the temporal variability of key meteo-marine parameters within the Ćirkewwa Marine Park (ĆMP), Malta, through the integration of in-situ observations and modelled datasets. This site was selected due to its ecological significance and exposure to dynamic coastal processes, providing an appropriate setting to assess atmosphere-ocean interactions.

Particular emphasis is placed on subsurface sea temperature variability and the extent to which model outputs accurately represent observed conditions. A multi-method approach was employed, involving the deployment of temperature loggers at depths of 5 m, 10 m, 15 m, and 20 m to collect high-resolution hourly measurements. Following the loss of the 5 m logger, analyses were based on observations from the remaining depths. These measurements were complemented by meteorological parameters, including air temperature, wind speed, and direction, alongside model outputs from the Copernicus Marine Environment Monitoring Service (CMEMS).

The combined datasets were analysed to evaluate temporal trends, vertical stratification, and the influence of atmospheric forcing on water column dynamics. Results demonstrate clear seasonal variability, with temperatures increasing from early summer to a peak in September, followed by a gradual decline into autumn. A persistent vertical gradient was observed, indicative of stratified conditions, although episodic wind events exceeding 5 m/s promoted short-term mixing and partial disruption of the thermocline. While modelled and observed datasets showed general agreement in near-surface trends, discrepancies became increasingly pronounced with depth, with CMEMS consistently underestimating deeper temperatures. This highlights limitations in the capacity of models to resolve fine-scale coastal processes and vertical structure.

However, the study is constrained by its relatively short temporal coverage and limited spatial resolution, which restrict the generalisability of the findings. Despite these limitations, it provides a valuable high-resolution baseline for the ĆMP and underscores the importance of sustained, multi-depth monitoring and rigorous model validation to enhance understanding of coastal dynamics and inform effective marine management strategies.

Keywords: ĆMP, sea temperature variability, atmosphere-ocean interactions, water column stratification, CMEMS model validation.



Temporal variability of air temperature and water temperatures at 10 m, 15 m, and 20 m within the ĆMP, alongside wind speed.



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ASSESSING HABITAT CONNECTIVITY AND CONSERVATION STRATEGIES FOR BRACHYTRUPES MEGACEPHALUS IN MALTA.

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The Giant Sand Cricket, *Brachytrupes megacephalus* (Lefèbvre 1827), is native to the Mediterranean and to the Maghrebian Sahara, and is of conservation concern in Malta due to increasing habitat fragmentation. This study evaluates the conservation status, distribution, habitat connectivity, and population structure of the Ġhadira population and the fragmented Aħrax metapopulation on the northern coast of Malta.

Bioacoustic surveys, habitat mapping, field observations, and GIS analyses were used to assess occupancy, density, dispersal potential, and movement barriers. Seasonal observations investigated habitat utilisation, while a pilot translocation exercise explored the feasibility of ex-situ population establishment.

Results reveal extensive habitat fragmentation and a reduction of occupied area when compared with past investigations, particularly within the Aħrax metapopulation, where several previously recorded areas are no longer occupied. Habitat suitability is associated with substrate characteristics, vegetation cover, and exposure to climatic factors. Roads, rubble walls, and drainage infrastructure appear to reduce connectivity and constrain dispersal. In contrast, the Ġhadira population exhibits relatively high densities, with one occupied field supporting approximately one burrow per 1.89 m². Seasonal observations indicate movement between habitats within the reserve's precincts and adjacent agricultural land, while behavioural observations suggest increased intraspecific competition in restricted habitats.

The translocation trial demonstrated the importance of receptor-site suitability and a higher number of founder individuals for future conservation interventions. Predation by stray cats was also identified as a significant threat. These findings highlight the need to ensure connectivity, protection and restoration of dunal habitats, and implementation of long-term monitoring and adaptive management. The study provides updated ecological information and practical recommendations to support the long-term persistence of *B. megacephalus* in Malta.

Keywords: species distribution, habitat fragmentation, barriers to movements, wildlife corridors, coastal dune systems, conservation.



A male *B. megacephalus* stridulating at the mouth of its burrow.



UNDERSTANDING SEDIMENT TRANSPORT AND DEPOSITION IN THE LIEMU AND FIDDIEEN CATCHMENTS.

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This study aimed to investigate the dynamics of suspended sediment transport and deposition in the Liemu and Fiddien catchments. Forming part of the larger Għasel catchment, these sub-catchments, located in Rabat and Dingli respectively, are dominated by agricultural land use, with dispersed pockets of urban fabric throughout the landscape.

Suspended sediment concentrations were measured at three points along the watercourse following precipitation events in order to assess how concentrations vary between sampling points, and with precipitation intensity. Deposited sediment was also quantified at three sites over an area of 113.1 cm² using sediment traps to obtain estimates of the annual deposition rates. Values for suspended sediment concentrations ranged from 1 µg/L to 2746 µg/L. This variability was explained by a combination of geomorphological properties of the areas surrounding the sampling points, and discharge. For deposited sediment, annual sedimentation rates at the chosen deposition sites ranged from 7 kg/m² to 53 kg/m² and once again, surrounding geomorphological features affected these values. Additionally, a sieve analysis was carried out on the collected sediment to assess size variations between suspended and deposited sediment and between different sampling points.

Deposited sediment contained a larger representation of coarse sediment (>2 mm) while suspended sediment contained a larger percentage of fine sediment. While limited by a short sampling period, this study provides baseline sediment values for Maltese streams, and global intermittent rivers and ephemeral streams - IRES where such site-specific values remain scarce.

Keywords: Liemu and Fiddien Catchments, Suspended Sediment, Deposited Sediment, IRES.



A typical sample collected to quantify suspended sediment concentration.

A METEOROLOGICAL ANALYSIS OF RECENT EXTREME WEATHER EVENTS IN BULGARIA .

Ivova Vrazhalska, An-Nikol (1), Galdies, Charles (1)

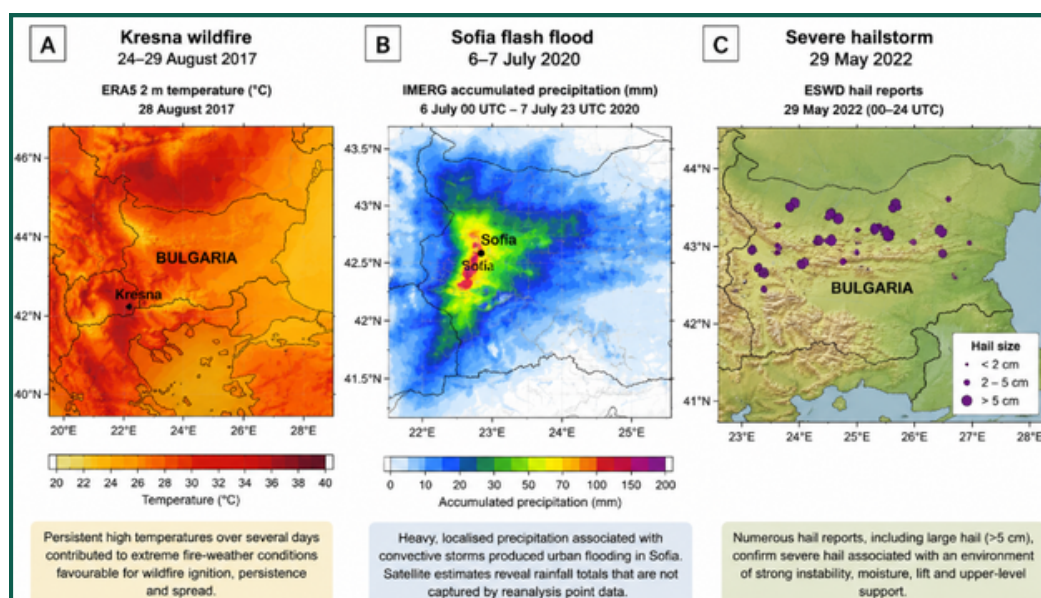
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Climate change represents one of the most pressing challenges of our time, with far-reaching consequences for the environment, human health, and economies worldwide. Increasingly frequent and intense hydro-meteorological hazards have demonstrated the need for a better understanding of the atmospheric conditions that drive extreme-weather events and their impacts. This study examines three recent extreme-weather events in Bulgaria: the Kresna wildfire of 24–29 August 2017, the Sofia flash flood of 6–7 July 2020, and the severe hailstorm of 29 May 2022. Using a comparative event-based framework, it explores how different atmospheric mechanisms can generate contrasting hazards within the same national setting.

The Kresna wildfire is interpreted as a multi-day fire-weather episode characterised by high temperatures, low atmospheric moisture, limited rainfall, and wind conditions favourable to fire persistence and spread. The Sofia flash flood is analysed as a localised convective event affecting an urban environment, demonstrating that reanalysis point-rainfall data alone are insufficient to explain observed impacts. The hailstorm case highlights the combined influence of atmospheric instability, moisture availability, vertical motion, and upper-level support, with independent severe-weather records confirming hail occurrence.

To reconstruct each event, the study integrates ERA5 reanalysis data, archived meteorological maps, satellite-based precipitation estimates, station observations, and independent verification sources. The findings show that robust interpretation of extreme-weather events depends on the triangulation of multiple datasets rather than reliance on a single model field. Overall, Bulgarian extreme weather is best understood through hazard-specific analyses that link atmospheric conditions, local environmental settings, and observed impacts. The study demonstrates the value of combining reanalysis products, archive weather maps, and independent event evidence in the assessment of wildfire risk, convective flooding, and severe hail in Bulgaria.

Keywords: Bulgaria, extreme weather, wildfire, flash flood, hailstorm, ERA5, Wetter3, OGIMET, IMERG, ESTOFEX, ESSL, convective storms, fire weather.



The three Bulgarian extreme weather events analysed in this study: A) High temperature conditions associated with the Kresna wildfire; B) accumulated precipitation during the 2020 Sofia flash flood, and (C) the 2022 severe hailstorm.

**AWARE BUT ABSENT: UNDERSTANDING MALTESE YOUTH
DISENGAGEMENT FROM ENVIRONMENTAL ACTIVISM.**

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Despite widespread environmental awareness among young people, participation in collective environmental activism remains persistently low. While previous research has identified a range of factors contributing to this disengagement, these factors are often highly context- dependent. This qualitative study investigates the barriers that deter Maltese youth aged 18-24 from engaging in environmental activism, addressing a notable gap in the literature within a small-island context. Four semi-structured focus groups were conducted with 26 participants who self-reported limited or no prior involvement in environmental activism. Data were analysed using Braun and Clarke’s (2006, 2021) thematic analysis framework.

Four key themes emerged from the analysis: distrust in political institutions and a perception that activism yields little tangible change; concerns about reputational and professional repercussions within Malta’s small and highly interconnected society; a tendency to individualise environmental responsibility, favouring low-risk private behaviours over collective action; and structural barriers, including time constraints, transport limitations, and limited institutional support.

The findings challenge dominant interpretations of the awareness-action gap, suggesting that youth disengagement is better understood as a rational and contextually grounded response to perceived inefficacy, social risk, and structural constraints rather than as a reflection of apathy.

This study contributes to ongoing debates on political trust, civic individualisation, and activism in small states, and offers recommendations for NGOs, educators, and policymakers seeking to bridge the gap between environmental concern and active participation.

Keywords: Environmental activism, youth engagement, awareness-action gap, perceived efficacy, political trust, structural barriers, Malta.

RESULTS		
1	Perceived inefficacy and structural distrust	<i>"I am very doubtful that politicians listen."</i> <i>"Corrupt politicians silence activists."</i>
2	Social risk and identity management	<i>"For your sake and career, you need to be careful."</i> <i>"I can lose more opportunities."</i>
3	Individualisation of responsibility and engagement	<i>"I do my responsibilities. That's enough."</i> <i>"I'd prefer to boycott."</i>
4	Structural and practical barriers	<i>"NGOs lack visibility and power."</i> <i>"I can't balance it all."</i>
5	Psychological barriers	<i>"Young people feel helpless."</i> <i>"There's no point."</i>

A figure depicting main perceived barriers to environmental engagement.



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