L-Università ta' Malta
Institute of Earth Systems

RESEARCH ABSTRACTS

Foreword

The compilation of abstracts in this book showcases the diverse and interdisciplinary nature of contemporary research conducted by the students and faculty at the University of Malta. Each project presented here exemplifies the integration of multiple scientific disciplines to address complex environmental, social, and technological challenges.

From the intricate analysis of food waste dynamics and the ecological impact of bee populations to the advanced modelling of groundwater systems and the exploration of sustainable energy solutions, these studies demonstrate the necessity of an interdisciplinary approach. They combine methodologies from geosciences, environmental science, sociology, and technology to provide holistic insights and innovative solutions.

For instance, the investigation into the impact of black carbon emissions on urban health interlaces atmospheric science with public health, while the study on ethical fashion consumption integrates psychology, sociology, and environmental science. Similarly, the examination of air pollution perceptions among university students bridges environmental monitoring with social science research techniques.

This interdisciplinarity not only enriches the research but also ensures that the findings are robust, comprehensive, and applicable in real-world contexts. Moreover, the skills and knowledge acquired through these interdisciplinary projects significantly enhance the employability of Earth Systems graduates, preparing them for a wide diversity of fields. Graduates are equipped to excel in roles ranging from environmental consulting and sustainable urban planning to public policy and renewable energy management, reflecting the versatility and relevance of their education.

As we delve into these abstracts, we are reminded of the power of interdisciplinary research in driving innovation and creating impactful change.

Contents

EVALUATING THE STORMWATER CAPACITY OF THE SANTA KATARINA VALLEY SYSTEM

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The study aims to assess the stormwater capacity of the Santa Katarina Valley through the use of field and bench studies. Situated within the Għasel catchment system, this valley features a diverse land use and is predominantly composed of globigerina limestone (GL) and, as a result, significantly influences hydrological processes. The site was selected due to its potential for groundwater recharge attributed to the presence of various water retention dams. The study employed a combination of methods including drone surveys, gauge board installations, and infiltration tests alongside generated models to measure the volume of water reaching the watercourse and being retained by the dams for various rainfall events (REs).

Results were used to estimate runoff coefficients of catchments draining to the various retention dams and the proportion of water retained, which infiltrated into the ground, and that lost to evaporation. Through the analysis of results, it was evident that for large REs, significant precipitation, generally above 10 mm – 20 mm, was necessary for notable increases in volume. Recharge typically occurred within a short time frame after REs. Upon comparing infiltration test results with standing water level data, it was evident that lower coralline limestone had both a higher porosity and permeability than GL. Observations emphasized differences in water level responses across the studied basins, with data from the groundwater monitoring site in the vicinity (< 1 km) showing potential interactions between the Valley and the underlying groundwater aquifer. The Penman equation was chosen to evaluate evaporation from an open water surface since it provided a better understanding of how the climatic data influences the water retained in the basins (0 mm/day – 14 mm/day).

Generated models and runoff coefficients compared with literature provided a clear breakdown of RE dynamics. Similar to many studies, numerous limitations such as image interpretation challenges and uncertainty regarding uncontrollable conditions were noted.

Keywords: Santa Katarina Valley, Għasel Catchment System, Rainfall Event, Stormwater capacity, Recharge, Retention basins.

Wied il- Għasel, basin 0 discharge gauging point during the precipitation event of August 30th 2023

INVESTIGATING USE OF SUSTAINABLE MENSTRUAL PRODUCTS AMONG UNIVERSITY STUDENTS IN MALTA.

Apostolov, Izabella (1); Conrad, Elisabeth (1)

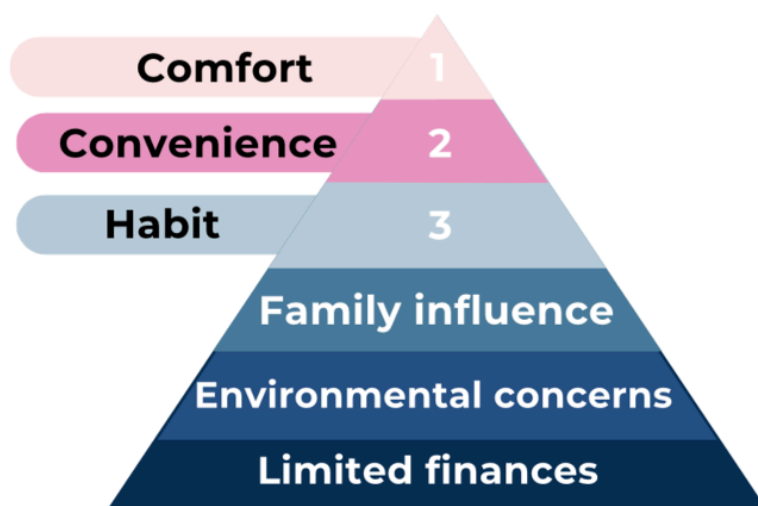(1) Institute of Earth Systems, University of Malta, Msida, Malta.

Disposable menstrual products generate significant environmental impacts, whereas reusable menstrual products (RMPs) offer a more sustainable and potentially more cost-effective alternative in the long term. Notwithstanding, several studies around the world suggest a continuing prevailing preference for disposable products.

This study investigated the use of menstrual products among students at the University of Malta, aiming to understand preferred products, barriers to increased adoption of reusable menstrual products (RMPs), and possible solutions. Employing a sequential mixed-methods design, the research combined quantitative data from a survey of 386 students with qualitative insights from two focus group discussions.

Results revealed that disposable products such as sanitary pads and tampons are the preferred choice due to comfort, convenience, and habit. In contrast, RMPs such as menstrual cups, reusable cloth pads, and period underwear have lower adoption rates mainly due to insufficient education and misconceptions about use and hygiene. Participants also expressed significant concerns about the practicality of using RMPs and the related social stigma, particularly regarding public restrooms. The influence of advertising, family members, and peers also emerged as critical factors affecting menstrual product choices.

The study highlights the need for comprehensive educational and awareness programs from trusted sources to address knowledge gaps and misconceptions. Improvements in public restroom facilities, enhanced product availability in local markets, and financial support measures such as subsidies should also be considered to encourage a shift towards more sustainable alternatives. Increased use of RMPs could potentially contribute towards the achievement of several United Nations Sustainable Development Goals.

Keywords: Reusable menstrual products, Disposable menstrual products, Adoption rates, UN Sustainable development goals, Education and awareness.

Reasons behind the choice of menstrual product ranked by order of preference

INVESTIGATING THE APPLICABILITY OF USING THE DINEOF ALGORITHM FOR GAP-FILLING IN SATELLITE DATA.

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Earth observation data from satellites is crucial for monitoring environmental changes and supporting sustainability initiatives. However, gaps in satellite data can significantly undermine the data's usefulness and reliability. The primary objective of this research is to address these gaps using the Data Interpolating Empirical Orthogonal Functions (DINEOF) technique. The study specifically targets chlorophyll-a data from the SENTINEL-2 satellites covering the western coast of South Africa and the Maltese Islands. To evaluate the effectiveness of the DINEOF algorithm in reconstructing missing data, the study introduces artificial gaps into the dataset. It then assesses the algorithm's performance through calculating the root mean square error (RMSE).

The findings indicate that the DINEOF algorithm effectively fills gaps of varying sizes with low RMSE values, thereby preserving the continuity and integrity of the data. This work advances the application of DINEOF in remote sensing and environmental research, bolstering more effective disaster response strategies and enhanced global sustainability management.

Keywords: DINEOF Algorithm, Satellite Data Gaps, South Africa, Malta, Chlorophyll-a Data.
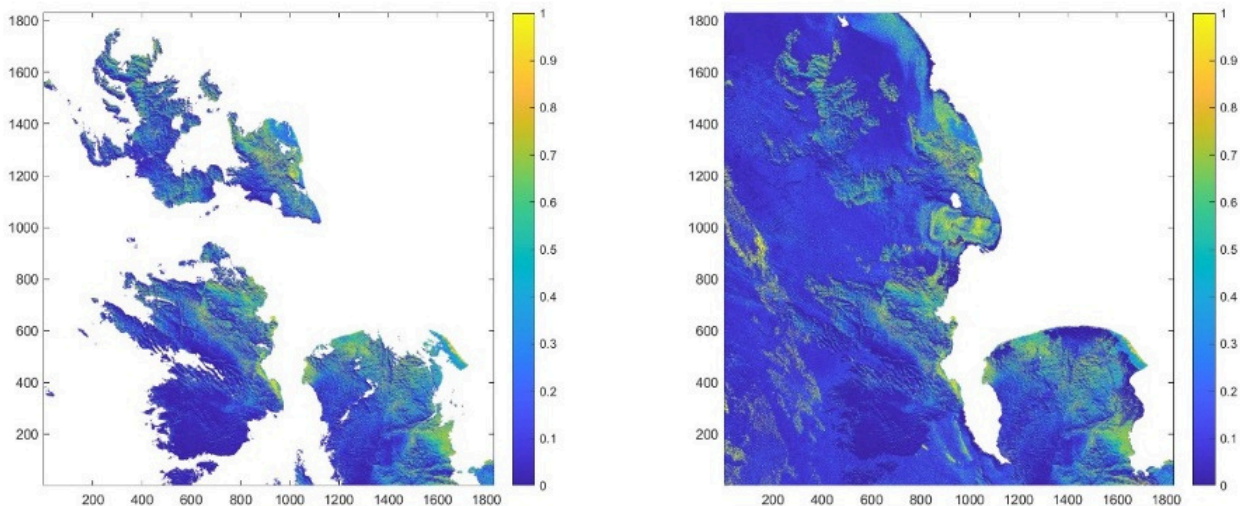
Comparative visualisation of pre (left) and post (right) DINEOF algorithm gap-filling of South African coastal waters with high cloud cover density

CLASSIFICATION OF FOOD WASTE IN A LIMITED SET OF MALTESE HOUSEHOLDS.

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This study investigates the classification and quantification of food waste within Maltese households to understand its composition, seasonal variation, and the factors influencing its generation. The research adopts a mixed-method approach, integrating both quantitative and qualitative data collection techniques. Quantitative data was collected by directly measuring food waste in 30 participating households across five districts in Malta over four seasons. The food waste was categorised into avoidable, potentially avoidable, and unavoidable waste. The data was analysed using permutational ANOVA to identify significant differences in food waste generation rates across districts and seasons. Qualitative data was gathered through semi-structured interviews and focus group discussions to explore household behaviours and attitudes towards food waste.

The study found significant district-based variations in avoidable food waste generation, with the Northern Harbour District exhibiting lower rates due to specific waste-reducing practices like composting and feeding leftovers to animals. Seasonal variations indicated higher food waste in autumn and lower rates in winter. The thematic analysis of the interviews revealed key drivers of food waste, such as inadequate meal planning, improper food storage, and a lack of awareness about food waste reduction strategies. Participants expressed emotional responses like guilt and frustration when discarding food, highlighting the moral and ethical dimensions of food waste.

Meanwhile, the focus group highlighted practical challenges in incorporating potentially avoidable food waste items into daily meals, despite recognising their value in reducing waste. Based on these findings, the study recommends comprehensive education and awareness programmes to enhance consumer knowledge on food waste management. Promoting practical tools such as meal planning applications and community-based food-sharing initiatives can further mitigate food waste. Future research should expand the sample size and explore long-term changes in food waste behaviours to inform more effective policy interventions.

Keywords: Household Food waste, Avoidable/Potentially Avoidable/Unavoidable Food Waste, Drivers of food waste generation, Seasonal & Regional variations, Food waste behaviours.

*kg/resident per year of FW
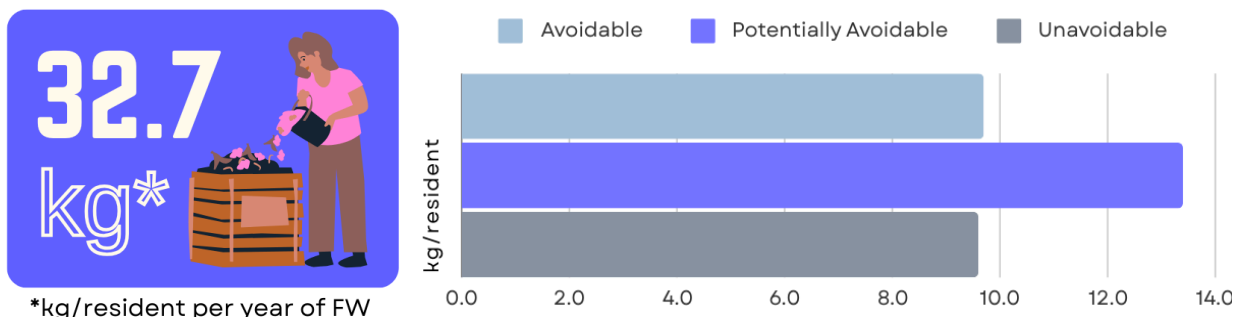
Household food waste generation rate disaggregated by type of food waste

CHARACTERISATION OF HONEY FROM *APIS MELLIFERA LIGUSTICA*: A CASE STUDY FROM CENTRAL MALTA

Ferò, Emma (1); Gambin, Belinda(1)

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This study investigates the botanical characterisation of honey produced by *Apis mellifera ligustica* colonies in central Malta, focusing on the predominant floral sources and comparing pollen content between honey samples and pollen pellets collected within the same season.

Melissopalynology techniques were employed to analyse ten honey samples, with results indicating a high level of Fabaceae taxa along with some Brassicaceae and Euphorbiaceae taxa. Variations in bee preferences are seen when comparing findings between pollen pellet loads from a previous study and this study's honey samples; these variations may be impacted by plant availability and abundance along with nutritional composition. Certain plants, such as Convolvulus, showed differences between the pollen pellets and nectar (honey), whereas other plants, like *Malva sylvestris*, were noticeably absent from both.

This study provides insights for beekeepers with respect to local ecosystems by highlighting bee foraging patterns. The results enhance our comprehension of the complex relationship that bees have with local floral resources, which is essential for maintaining bee populations and maximising honey production in the area.

Keywords: Melissopalynology, Fabaceae, Nutritional composition, Pollen and Nectar.

Apis mellifera ligustica
(source: Ben Caledonia, 2014)

MODELLING GROUNDWATER BEHAVIOUR IN THE RABAT-DINGLI PERCHED AQUIFER THROUGH MONITORING DISCHARGE AT THE WIED IL-BUŻBIEŻ SPRING

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This study employs a multidisciplinary approach to model the dynamics of groundwater recharge in the Rabat-Dingli Perched Aquifer, with a focus on discharge at the Wied il-Bużbież Spring in Malta. The aim is to understand how precipitation variability, land use, and subsurface characteristics influence groundwater recharge processes on the Maltese islands.

The methodology involved mapping geological strata, studying meteorological conditions, conducting hydrological measurements at the spring, geoprocessing data, and numerical groundwater modelling using MODFLOW-2005. This approach facilitated the identification of recharge zones and the development of a groundwater model.

Results from the study highlight the significant impact of precipitation patterns, land cover, geology, and abstraction, providing a useful framework for managing groundwater resources in water-scarce Mediterranean regions amid climate change.

Keywords: Groundwater recharge, Rabat-Dingli Perched Aquifer, Wied il-Bużbież Spring, MODFLOW-2005, Groundwater dynamics

Discharge and precipitation for hydrological year 2022/2023

INVESTIGATING STUDENTS' PERCEPTIONS OF ETHICAL FASHION AND HOW THESE INFLUENCE PURCHASE DECISIONS

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The fast fashion industry poses a variety of ethical concerns across environmental, animal welfare, societal, and human rights realms. Ethical fashion has emerged as an alternative driven in part by the growing ethical consciousness of consumers and increasing expectations for suppliers to prioritise quality and sustainability. The Gen Z generation may be considered to exemplify this push for more ethical consumption. At the same time, it is known that there is often a discrepancy between consumer beliefs and actual purchasing behaviours.

This study sought to explore beliefs, motivations, and barriers influencing ethical fashion consumption among undergraduate and postgraduate Gen Z students at the University of Malta. A qualitative research design was employed with data collected through focus groups and analysed through thematic analysis. Findings reveal a general awareness of the negative impacts of fast fashion and related ethical concern among participants. However, actual purchasing behaviours were found to often fall short of fully aligning with these ethical concerns for various reasons. Financial constraints, accessibility issues, and scepticism of brands' ethical claims were identified as primary barriers. Social pressures and the limited availability of stylish, affordable ethical fashion options were also seen to hinder ethical consumption.

The study highlights the challenges of mitigating the attitude-behaviour gap, showing that this will require not only changes on the side of market suppliers but also in the mindset and expectations of fashion consumers.
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Keywords: Ethical Fashion, Ethical Consumerism, Fast Fashion, Consumer Beliefs, Attitude-Behaviour Gap

Word cloud depicting the occurrence of words utilised throughout all focus groups

UNIVERSITY STUDENTS' PERCEPTION OF AIR POLLUTION

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Air pollution poses a dual threat to both human health and the environment, necessitating urgent action to address its far-reaching impacts. This study investigates whether university students' perceptions of air quality align with actual conditions. The research methodology involved a survey distributed to undergraduate students from the University of Malta to assess their behaviours, attitudes, knowledge, and perceptions of air quality. Additionally, NO^2 concentration data was analysed using the Inverse Distance Weighting (IDW) method on QGIS to map the distribution of this harmful pollutant across the Maltese Islands.

The survey provided insights into students' concerns about air quality, their support for restrictive measures, and their perceptions of the main factors contributing to poor air quality. A key focus of the study was comparing the perceptions of students regarding how they perceive air quality - from very poor to very good - in their locality of residence with the actual NO^2 distribution across Malta and Gozo. The findings reveal that while students are generally aware of and concerned about air quality issues, their perceptions often do not align with reality.
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Keywords: Air pollution, Air quality perceptions, Nitrogen dioxide concentration, University students, Inverse Distance Weighting (IDW).
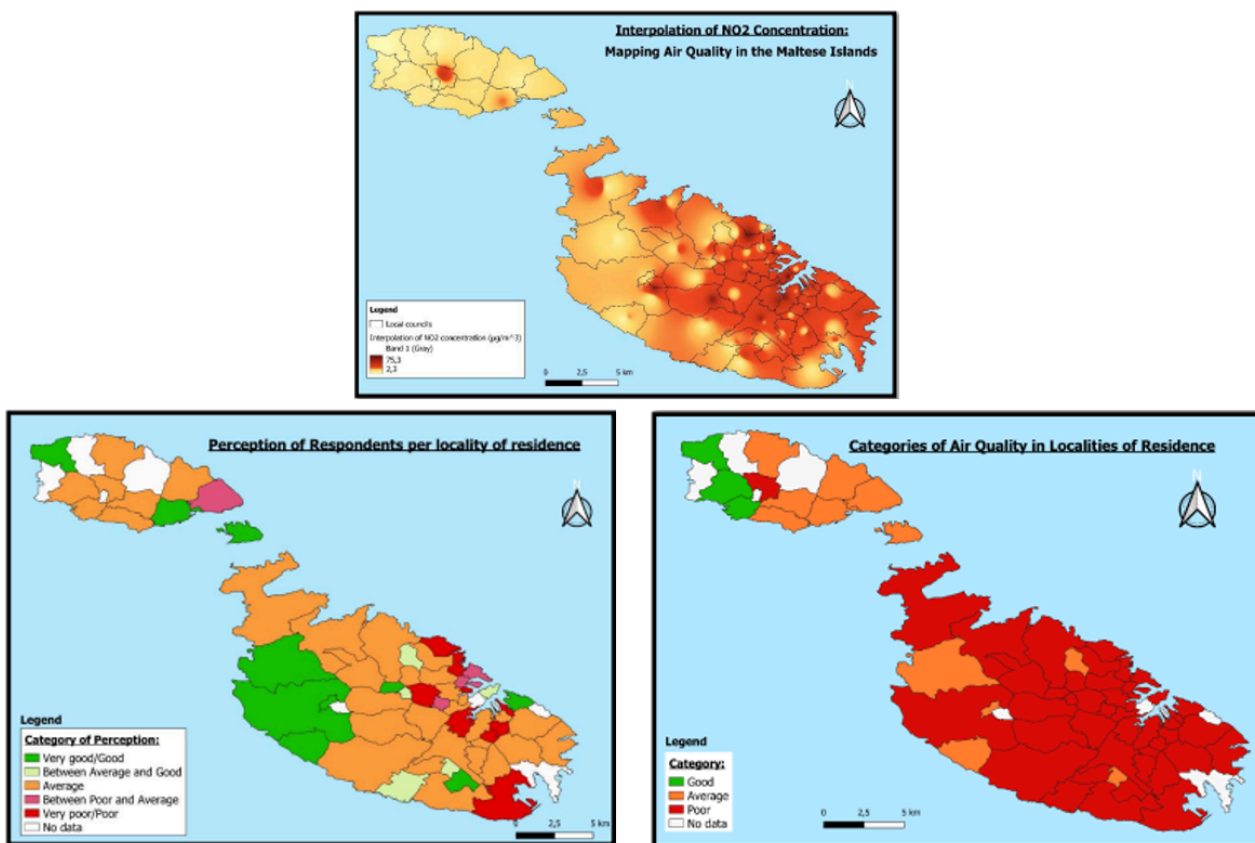
Top: IDW interpolation of the average NO^2 concentrations measured during 2016 to 2019 and 2022. Bottom-left: perception of air quality by locality. Bottom-right: air quality categorised by the WHO 2021 air quality guideline for annual NO^2 levels

ASSESSING THE FUTURE OF PHOTOVOLTAICS IN THE ISLAND OF GOZO

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The common perception that the Maltese Islands lack space for development often leads to the assumption that the only feasible option for renewable energy is offshore. However, this study challenges that notion by identifying the potential of onshore solar photovoltaic installations in Gozo. The methodology integrated GIS-based spatial analysis to identify optimal inland locations for photovoltaic (PV) installations, with questionnaires targeting Gozitan residents to gauge their level of acceptance of this technology.

Results demonstrated that there is still ample space to exploit onshore before considering the possibly more expensive PV offshore option. Moreover, the findings indicated that Gozo has high solar energy potential, and the identified spaces are capable of accommodating PV systems that can potentially generate up to 87% of the island's total electrical energy needs, requiring only 0.9% of the total area of the island. Even with strict adherence to grid proximity and policy regulations, the potential remains significant at 18%—nearly double the current PV installed capacity.

This work has shown that community engagement indicates high acceptance of renewable energy initiatives, particularly for solar energy, which is seen as the most effective route to sustainable energy independence. This enthusiasm aligns with the broader European Union goals for climate neutrality, suggesting that Gozo could realistically aim for 100% renewable energy reliance through a mix of renewable energy technologies and a strong commitment to improving energy efficiency. This study underscores the necessity of re-evaluating energy production and consumption strategies to maximise the renewable energy share of the island and enhance sustainability.

Keywords: Gozo, photovoltaics, GIS-based spatial analysis

Analysis of the potential of installation PVs in Gozo
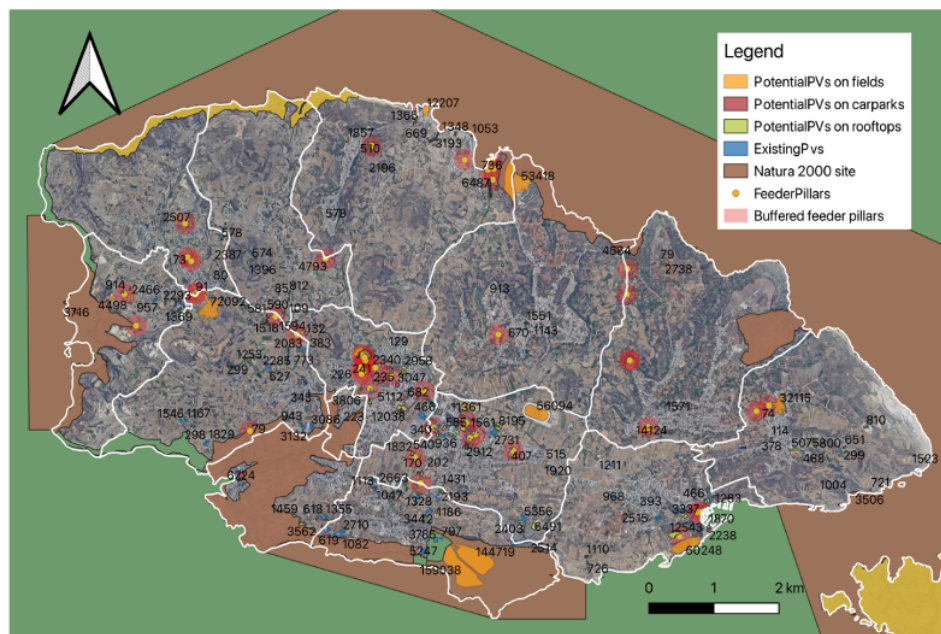
INVESTIGATING THE INCREASE OF EUROPEAN BEE-EATERS *MEROPS APIASTER* OVER MALTA AND THEIR PREY AVAILABILITY DURING MIGRATION

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This project investigates the increasing presence of the European bee-eater *Merops apiaster* over Malta during migration periods and explores the availability of their prey. Strategically located between Europe and Africa, Malta serves as a crucial stopover for migratory birds, including the bee-eater. This research aims to fill gaps in the understanding of local migration numbers and dietary habits of the European bee-eater, which are essential for effective conservation strategies. Field observations were conducted in key habitats, complemented by historical data analysis and photographic evidence of prey items.

This study reveals a significant increase in bee-eater sightings over the past decades, attributed to conservation efforts in southern Europe and reduced hunting pressures in Malta following the enforcement of the EU Wild Birds Directive. Photographic evidence dispels the misconception that bee-eaters primarily consume bees, highlighting their opportunistic feeding behaviour on a variety of insects such as dragonflies, moths, and butterflies.

These findings underscore the ecological importance of the European bee-eater as a predator of airborne insects and its role in local biodiversity. This research concludes with recommendations for continued monitoring and public education to support conservation initiatives. This study not only contributes to the ecological knowledge of migratory patterns and dietary adaptability of bee-eaters but also provides valuable insights for policymakers and conservationists in managing and protecting avian species in Malta.

Keywords: Avian Migration, Prey Availability, Field Observations, Dietary Analysis, Population Dynamics
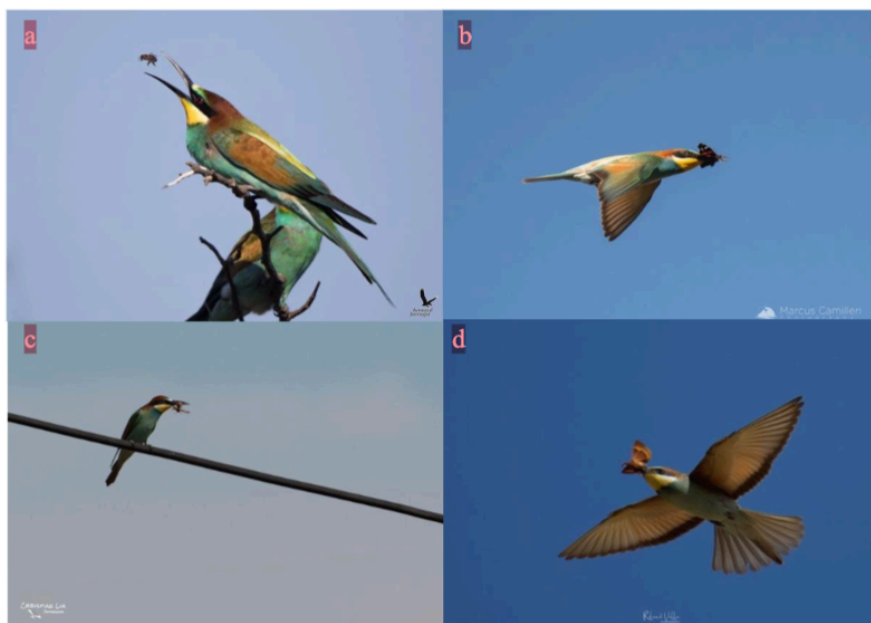
Samples of photographic evidence of European bee-eaters observed in Malta, holding a variation of prey items a) *Apis mellifera* b) *Vanessa atalanta* c) *Vespa orientalis* d) *Lasciocampa quercus*

EXPOSURE TO BLACK CARBON IN THE INNER HARBOUR AREA

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Residents living in the Isla creek and the surrounding areas have been expressing their concerns about pollutant emissions, particularly from the cruise liners at berth in the harbour, at least since summer 2018. International NGOs have taken random spot measurements of, inter alia, ultra-fine particles in the area. These spot measurements were widely reported in the media but are of limited scientific significance.

This project analyses data gathered over a year for a pollutant, Black Carbon (BC), known for its negative repercussions on human health. This data was analysed for variability, source, and drivers of BC concentrations in an urban setting that is not prone to heavy traffic flows. 95,730 verified BC 5-minute averaged values out of a possible 123,551 were analysed for a data collection rate of 77%. Significant seasonal fluctuations in BC levels were determined; concentrations peak in different seasons and exhibit decreased values in other seasons. The time-series analysis highlights frequent spikes in BC concentrations predominantly affecting the 95th percentiles, particularly during winter. Box plots indicate that while daily median BC levels are generally below 5 µg/m³, there are numerous outliers suggesting occasional high exposure events for residents. Polar plots reveal a correlation between elevated BC concentrations and wind directions from the northwest and west, implicating the Grand Harbour's shipping activities as a significant source of BC pollution. The generalised linear model (GLM) explains 31% of the variability in BC levels with wind speed, wind direction, and the number of stationary and moving ships being significant predictors.

The findings emphasise that while the overall BC concentrations align with urban background levels, the frequent high-concentration episodes potentially pose health risks. Overall, this project underscores the impact of maritime activities on urban air quality and the necessity for continuous monitoring and advanced analytical methods to mitigate health risks associated with BC exposure.
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Keywords: Air pollution and Shipping, Air quality data Analysis, Black Carbon, Exposure, Inner Harbour Area.

Geolocated polar plot showing the relationship of incidence of high
BC concentration in Isla with wind speed and wind direction

INVESTIGATION OF PHYSICAL OCEAN PARAMETERS ALONG THE WATER COLUMN AT IL-ĦOFRA Ż-ŻGĦIRA, DELIMARA.

Paris, Samuel (1); Gauci, Adam (2)

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(2) Department of Geosciences, Faculty of Science, University of Malta, Msida, Malta.

This project presents an extensive study conducted in the marine environment of il-Ħofra ż-Żgħira at Delimara, focusing on the variarions in temperature, salinity, and pH within the water column, particularly in proximity to thermal effluent discharges of the Delimara power station. In-situ measurements and satellite data were used to investigate the relationship between physical ocean parameters and thermal pollution from coastal power stations.

The primary aim of this project was to understand how thermal effluents influence marine physical parameters, integrating existing observational technologies. The methodology involved direct data acquisition via the Quanta Hydrolab probe and data visualisation through Geographic Information Systems (GIS), providing an understanding of coastal marine ecosystem dynamics. Significant findings include thermal stratification within the bay's shallow depth attributed to thermal effluents altering the water column's thermal properties, variation in the salinity patterns due to environmental and anthropogenic factors, and stable pH levels. Correlation of in-situ temperature measurements with satellite-derived data validated local data collection methods and highlighted satellite imagery's utility in spatial analysis for environmental monitoring.

This project enhances scientific understanding of thermal pollution's impacts on marine environments and establishes a methodological framework for environmental monitoring and research. It emphasizes the need for ongoing surveillance and adaptive management strategies to mitigate adverse ecological impacts, contributing to sustainable marine biodiversity stewardship.

  This work provides a foundational reference for future research, aiding environmental scientists and policymakers in balancing industrial activities with marine conservation goals.
.
Keywords: Marine environment, Thermal effluent discharges, *In-situ* measurements, Thermal stratification, Environmental monitoring.

The researcher measuring temperature, pH and salinity of the water column

THE EXTINCTION OF EXPERIENCE: EXPLORING NATURE CONTACT AND CONNECTEDNESS AMONGST UNIVERSITY STAFF AND STUDENTS

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The theory of Extinction of Experience (EoE), first introduced by Pyle in 1978, suggests a decreasing trend in human-nature interactions over time. This study investigates nature contact, nature connectedness, and pro-environmental behaviours among students and staff at the University of Malta.

The aim of this study was to explore generational differences and to provide an empirical foundation for evaluating the EoE hypothesis locally. A survey was distributed to a combined population of 376 respondents, measuring frequency, quality, and duration of various aspects of nature contact (intentional, incidental, indirect, childhood), nature connectedness using the Nature Relatedness Scale (NR-21), and pro-environmental behaviours. Results indicate significant age-related differences in nature connectedness and pro-environmental behaviours, with lower scores in younger age groups. Nature contact showed no significant differences across age groups, although indirect contact was most common for all. Significant correlations were found between nature connectedness, pro-environmental behaviours, and childhood nature contact. The quality of natural areas visited was consistently rated poorly, potentially being a cause for reduced motivation for intentional contact.

This study highlights the importance of quality nature contact and early childhood experiences in promoting long-term environmental stewardship and the effect of nature connectedness on fostering pro-environmental attitudes. The findings provide partial but inconclusive support for the EoE hypothesis.
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Keywords: Nature Contact, Nature Connectedness, Pro-environmental behaviours, Childhood Nature Contact, Extinction of Experience.
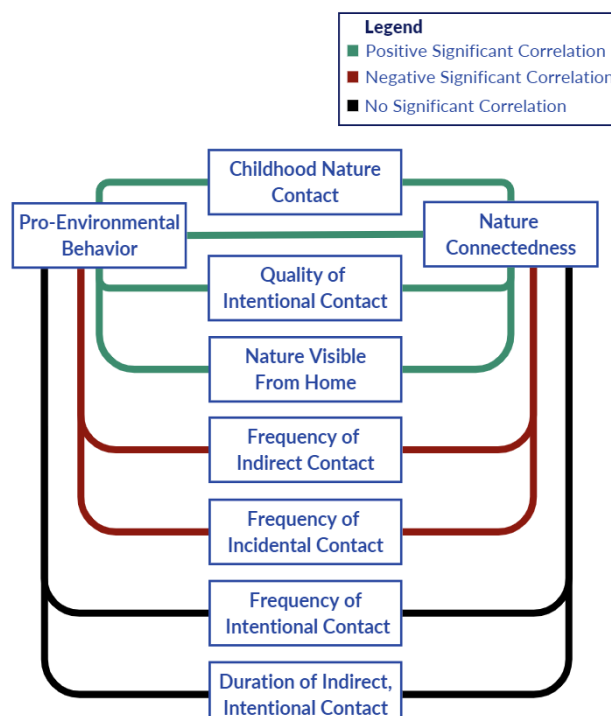
Correlations found between Nature Relatedness, Pro-Environmental Behaviours and various types of Nature Contact

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