Manging the Dangers of Soil Erosion in Gozo

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Introduction

Food security is becoming an increasingly important issue for small island states because of climate change, which has recently been exacerbated from armed conflicts in regions deemed to be the world's primary source of staple food crops (Brown et al., 2008). With changing weather patterns, Mediterranean islands are experiencing ever increasing incidences of flooding and extended drought conditions, which impacts the crops they rely on.

Our most recent research shows how, on the basis of an analysis, Malta's latest climatological trends could in effect lead to a fall in the productivity of principal crops in around 54% of Malta's usable agricultural area (Galdies & Meli, 2022). We have showed how the period 1946–2020 is characterized by a mean annual air temperature anomaly of + 0.17 °C per decade and a corresponding reduction of –6 mm per decade in the total yearly precipitation. This study reveals how this climate period was accompanied by a significant decrease in revenues from grape (down by 69%), olives, wine and wheat (down by 22%) production, amongst other crops. This reduced sustainability of local agricultural productivity is adversely affecting the livelihoods of Maltese and Gozitan farmers.

Food Security in Small Island States Under a Changing Climate

As a small island state, Malta is highly dependent on imports for its food security. With the rise of global warming and climate change, small island countries become more vulnerable to food insecurity due to changes in agricultural productivity and crop production. So far the public's perception has been that climate change is a problem that would happen in the future. However, this is not the case anymore since climate change is already happening here and now and it is already having an impact on our everyday lives. Climate change is already having an impact on food prices across the world, leading to increased food insecurity for many people around the world. In February 2022, the FAO Food Price Index increased by 3.9% from January 2022 to come to an average of 140.7 points. This is equivalent to an increase of 20.7% above the corresponding month in 2021, which is so far considered to be an all-time high (FAO, 2022). This justifies why local authorities need to be cognisant of how changes in climate will impact small island states, and work towards solutions that help maintain their food security.

This need is becoming even more relevant in view of the ongoing conflict in Ukraine which supplied a big portion of the global wheat trade, which is now at risk. Fearing shortages in staple foods as well as natural gas (which is a key ingredient in nitrogen-based fertilisers like urea), countries are already turning inward, which could ultimately leave less food for those in need.

Climate Change Impact on Local Agriculture

Climate change is a global phenomenon and it has an impact on all aspects of life. Agriculture is no exception to that. A change in climate will have an impact on the future of food production, which will have a huge influence on the world population. As the temperature rises, there is an increased risk of starvation and famine. In fact, climate change could result in declines in crop yields, reduced quality and nutritional value, and increased pest damage. Farmers are already experiencing climate change's negative effects as they have seen changes to the weather patterns that have thrown off their farming schedules and made it difficult to produce enough. This means that we are going to see more food shortages in the future because it will be difficult to grow crops with higher levels of CO2 in the atmosphere.

Malta's climate change projections for Malta point to a reduced availability of natural freshwater

resources in the future (Galdies and Vella, 2019). This work is based on the analysis of eleven CMIP5 climate change model projections for 2050 and 2070. The analysis of an ensemble of climate model outputs over a single one (contrary to the practice of other local researchers) provided a robust evaluation of the possible climate change attribution to local agriculture. Our study showed how the expected losses in productivity and food quality will continue to be significant in the coming years. As a result, the distribution of the already stressed local arable land will change, modifying production patterns and economics. Locally, any of the current fragmented adaptation measures that are being applied to this sector expose a lack of awareness of the nature of the agriculture-specific changes that are expected to occur on the basis of the multi-model projections and on their variability.

Soil Erosion as Another Detrimental Factor for Food Security

Soil erosion is one of the most significant threats to food security anywhere in the world. Soil is a natural resource, and its protection is important for both current and future generations. Soil is made up of organic matter, minerals and water. While this organic matter provides food for crops, minerals constitute a vital source of nutrients for plants. Moreover, soil plays an important role in both water and carbon cycle, and actively participates in carbon dioxide sequestration, which in turn also help in climate regulation.

In 2016, EuroStat's estimated that erosion-prone land in Europe, which is equivalent to 43 million hectares, suffers from moderate to severe soil erosion. These soils are being washed away from the fields by rain or rivers and streams, leading thus to a reduced crop yield. A European-wide study conducted in 2015 placed Malta as having a mean soil loss rate higher than the European average (Panagos et al., 2015).

According to Forbes (2018), soil erosion washes away 8 billion dollars every year worldwide. This may seem like insignificant to some, but when you look at the effects of agricultural land lost, it becomes quite a serious matter. This is why soil erosion can lead to a loss in food security and increase in food prices. It constitutes part of the problem associated with undernourishment of 842 million people, which is equivalent to about 9.9% of the global population (FAO, 2021).

Common Causes of Soil Erosion

Soil erosion is the process of soil being gradually worn away by the action of water and wind. The most common cause of soil erosion is due to water flow, which can cause soil erosion through processes like sheet erosion, rill erosion and gully erosion (Behera et al, 2020). This process can be taken to an extreme due to landslides and major floods. The other major cause of soil erosion is that caused by wind, which can cause soil erosion by blowing away loose particles from the surface of a slope or depositing material on a slope that was not there before. This can cause soil to be blown away from a surface in small particles and take nutrients with it. While wind (aeolian) erosion is a natural process that will occur, even without human interference, this process can be triggered by changes in land cover type coupled under increasing drought conditions.

Estimates of Soil Erosion Rates in a Principal Watershed in Gozo under Current and Future Climatic Conditions

A recent study aimed at making an estimate of the current and future annual soil erosion rate in the Ramla watershed in Gozo was published in the renowned scientific Journal Catena (Galdies et al, 2022). Ramla's erosion rate was estimated using the Revised Universal Soil Loss Equation (RUSLE; Renard et al, 1997; Millward and Mersey 1999; Park et al., 2011) using a Geographic Information System (GIS) platform (fig. 1). This study introduced a completely new approach at national scale, such as the inclusion of the highest possible Digital Elevation Model (DEM) data (ERDF 156 data, 2013) as well as the use of downscaled climate model projections reflecting the future precipitation projections over Gozo that have been derived from eight different CMIP6 climate change models. The consideration of climate change attribution stemmed from the fact that the climate of the Ramla watershed will be subject to significant changes in the future.

Specific hydrological sub-watersheds were identified within the study area that warrant

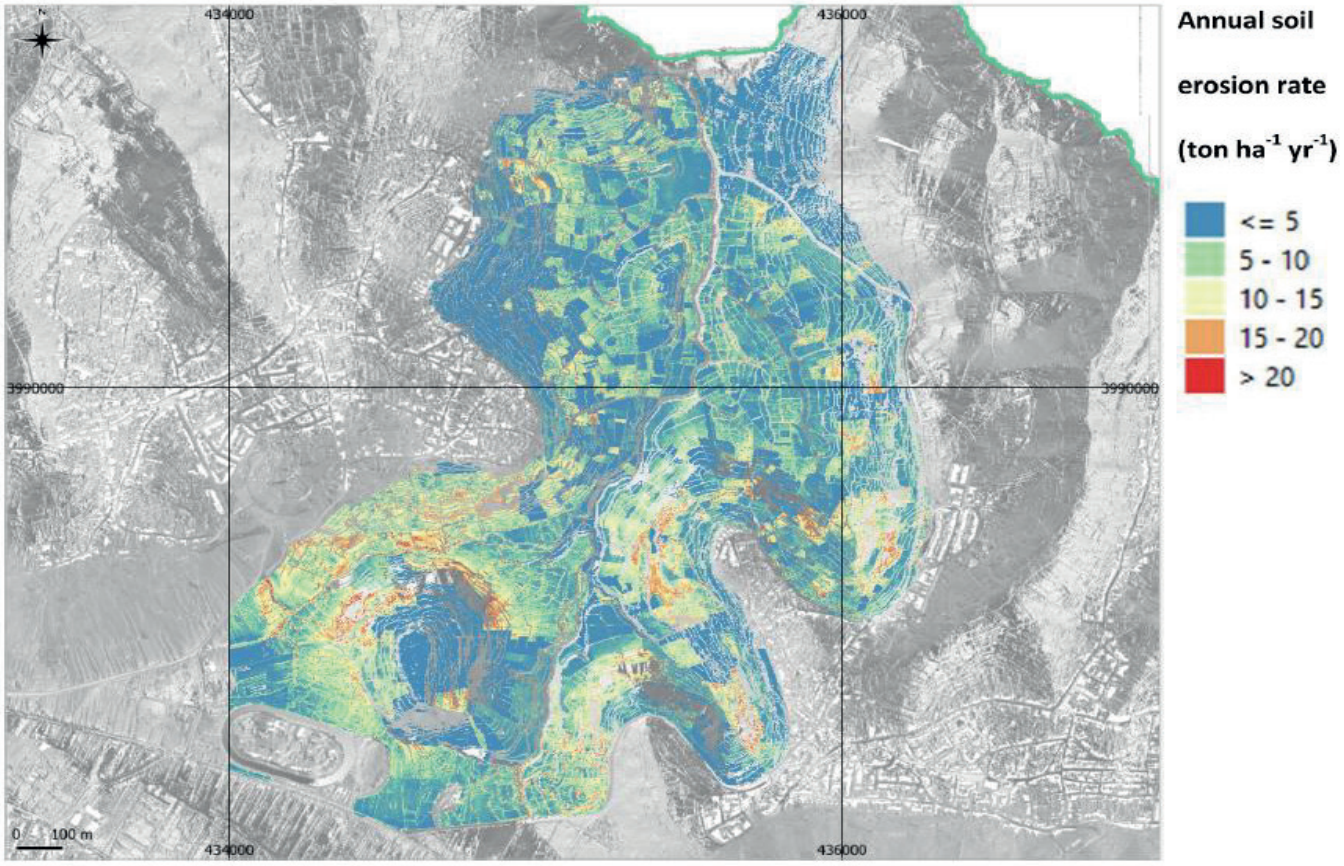

Figure 1. Soil erosion risk map of the Ramla watershed.

urgent considerations. This climate change impact analysis (conducted for the periods 2021–2040; 2041–2060; 2061–2080 and 2081–2100) showed for the first time, that the estimated annual soil loss within the Ramla watershed, as a percentage of its total area, varies from low (85.1%), to moderate (13.3%) and high (1.6%). Within a climate change context, a projected reduction in the annual soil erosion rate has been estimated for the period 2080–2100, ranging from −5 ton ha− 1 yr− 1 (under sustainable and "green" pathway SSP126) to −6 ton ha− 1 yr− 1 (under the fossil-fuelled development SSP585). These results are to be interpreted within an understanding of the underlying controlling processes, the relative spatial and temporal variations, and of possible future climate scenarios. Still, this GIS modelling work is seen as the first study which can be used to provide some objective guidance on the reduction of potential soil losses within the Ramla watershed. Our estimated soil loss and the mapped hotspots resulting from this study can assist in a fuller management plan for the sustainability of this watershed.

Similar studies are ongoing over other parts of Gozo.

Why Conservation Programmes are Important to Farmland from Soil Erosion

Conservation programmes are important because they help to protect the farmland that is available. There are many ways to prevent soil erosion from happening or worsening further. Locally-assisted farmers can apply a number of practices aimed at reducing soil erosion around the edges of their farmland They can also plant particular trees or shrubs on their property to help with soil retention. However, this needs to be done under expert advice in view of the delicate ecological balance of erosion-prone sites. Farmers should also keep in mind that they should never plough too close to the edge of their field because this will cause more erosion than if they had ploughed farther away from the edge of their property.

It is being strongly recommended that holistic conservation programs aimed specifically at reducing soil erosion are launched as soon as possible. In view of its topographical nature and soil type, Gozo is particularly prone to soil erosion, and therefore ideally suited to take up such programmes, aimed at the holistic preservation of soil, water, air

quality by respecting their ecological integrity and connectivity. These programmes should also provide a way for farmers to get loans and other resources so that they can continue their work as well as make sure that they are not putting themselves in financial risk. The results and recommendations of a 2015 study that studied the beliefs, concerns and attitudes of Gozitans can be extremely helpful to select those farmers that are ready to invest in new practices aimed at adapting to a harsher climate.

Conclusion

The estimation of soil erosion in the Ramla watershed is unique in that for the first time, there is now a study that provides objective guidance to minimise potential soil losses within this ecological and agriculturally sensitive area. Our estimated soil loss and its spatial distribution can assist local authorities to come up with a fuller and detailed management plan for the sustainability of the Ramla watershed. This study moves away from the coarser studies made at the pan-European (Panagos et al., 2015) and at national level (ERA, 2018).

Unless properly managed, the estimated soil erosion occurring in the Ramla valley may continue to have serious environmental and agricultural consequences. Any selected conservation measures that may be selected to minimise this danger must take onboard the future impacts posed by a changing climate such as increased evaporation rates, higher temperature, and the increased occurrence of rainfall extremes.

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