

SUMMARY OF ARTICLE: [HTTPS://DX.DOI.ORG/10.12795/REA.2023.I45.02](https://dx.doi.org/10.12795/rea.2023.i45.02)

Adaptive capacity of the GIAHS territory of Axarquía (Malaga) through Nature-based Solutions

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KEYWORDS

Soil erosion
GIAHS
Adaptative capacity
Lifestyle
Mediterranean
NbS

Soil degradation in Mediterranean areas hinders sustainable agricultural activity, especially in a context of global change, where soil loss rates are increased by changes in the rainfall dynamics. The area declared as “Important World Agricultural Heritage System” (GIAHS) dedicated to the raisins of Axarquía (Malaga) is identified as a territory of special fragility against these processes. This study aims, on the one hand, to determine the susceptibility to soil erosion and, especially, to know what role nature-based solutions (NbS) are playing in the adaptive capacity of this territory. The erosive potential of precipitation and soil losses expected under the context of current climate change has been analysed for the SIPAM territory of Axarquía de Málaga, and to determine the role played by NbS in their adaptive capacity. Specifically, this work identifies the risks linked to the vulnerability and susceptibility of the territory to recent rainfall dynamics and identify the main adaptation mechanisms that the inhabitants have implemented to guarantee food security and survival. To this end, the rainfall dynamics have been statistically analyzed, with data downloaded for the nine meteorological stations of the Hidrosur SAIH Network located in the region.

For that, 60 samples of surface soil (0 cm – 10 cm), both altered and unaltered (metal cylinder of 100 cm³), distributed homogeneously by the extension of the SIPAM territory were collected. Starting with Revised Universal Soil Loss Equation (RUSLE) is a scientific model widely used in current environmental research to estimate annual rates of soil loss (t ha⁻¹ year⁻¹) at a given site.

GIAHS of Axarquía is located in the easternmost sector of the province of Malaga (southern Spain). A qualitative methodology has been developed for the evaluation of NbS that obeys both an agricultural and ecosystem pattern, having as its axis the concept of efficiency, which in our case has to come from the hand of its traditional use in the framework of an activity that has been leaving its mark on the landscape for centuries. The references consulted and analysed provide enough support for a methodological approach to the NbS, considering that it is an area in which man-environment relations have been occurring over decades, if not centuries. The method to approach the approach to the NbS of the GIAHS, has had two phases, a first ecosystem approach, and a second agricultural approach.



In the current context of climate change, the ability of this GIAHS territory and, in specific terms, the vineyard, to adapt to extreme situations depends on the limitations of infrastructures, availability of resources and agricultural regulations that may exist. However, the agricultural use of this area has existed for centuries, with situations that have required significant resilience and that have turned these territories into "laboratories" to show this dynamic. Thus, they are especially noteworthy, for their greater use and reproduction throughout the territory: the stony dry walls, drains or "asagüaeras", the "ahoyás", the slabs or "canchales", the "apuerqueo" and the "paseros" themselves. These are territorial practices that have been doing over many generations and have been maintained for more than five centuries. The results derived from climate analysis in the GIAHS area follow the trends identified and published in the Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC, 2021). These speak of an increase in the number of extreme weather events, including anomalous maximum and minimum temperatures, tropical and equatorial nights, dry gusts, sea level rise, increased torrential rainfall, etc. There is a decrease in annual rainfall and a concentration of rain in events of greater intensity, leading to greater erosivity of rain and high rates of soil loss. However, the agricultural practices and the different structures identified are considered sustainable strategies to adapt to this type of natural risks, conforming as NbS.

This GIAHS area, where the vineyard occupies a large part of the territory, reaches very high grade of soil losses, with critical situations in this type of use that reproduce in vineyards of most mediterranean countries. This is mainly due to the fact that erosion processes are very intense in ecogeomorphological systems where vegetation cover is removed and, in this case from the vine, the adventitious vegetation is removed that leaves the soil bare and totally unprotected, which favors high rates of erosion. That is why, if a comparison is carried out between the distribution of the vineyard and the rates of soil erosion, there is a clear correlation between both variables, being these vine areas the ones that lose more tons of soil per hectare and year. In this sense, despite high values, studies carried out by the regional administration itself for a regional scale show final values very similar to those obtained in this research.

All climate change scenarios in the mediterranean imply the need to significantly increase water inputs for agricultural areas, which can increase costs, and economic and social conflicts, it is important to highlight the vulnerability and technical and social limitations for the adaptation of the Mediterranean region to drought and water scarcity. In this sense, the viticulture of Axarquía has shown over centuries a great adaptive capacity. Climate change indicators indicate a special incidence of water risks, so measures that help reduce vulnerability to climate risks and take advantage of opportunities must include the different levels of the productive system: farmers, markets, and the public sector. It would therefore be essential to assess how the public and private sectors are involved in the externalisation of risks, especially in disaster situations, even more so to consider the cultural heritage, the heritage received and passed from generation to generation by farmers, through a whole series of proposals and NbS, of an adaptive nature, in order to reduce the implications of geoenvironmental problems in the context of climate change.

The succession of erosive processes has resulted in a very complex agricultural practice in the GIAHS area, where historically a multitude of strategies for adaptation and improvement of production have been introduced and which, currently, are clear examples of NbS. These practices have a multiple function, being inclusive tools with the management of the territory, with various socio-ecological benefits and that suppose a clear strategy of risk reduction and adaptation to climate change. In this sense, the weight of local solutions that use elements of traditional nature-based practices in the face of these risks is remarkable, since they can be more appropriate, accepted and successful than approaches that are based solely on bringing "new" interventions from abroad.

In short, GIAHS in Axarquía has enabled evidence-based learning to support the adoption of NbS approaches in similar circumstances. Thus, it has also provided information on the types of challenges encountered in implementing these strategies on the territory. That is why, in these areas where cultural, economic, landscape and agricultural tradition plays a transcendental role, it is necessary to promote integrated and intersectoral approaches so that the role of NbS is successful, and attention must be paid to communication and cooperation strategies between different territorial actors.