Preserving the Mediterranean diet through holistic strategies for the conservation of traditional farming systems

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Abstract The Mediterranean diet is described by the UNESCO Cultural Heritage of Humanity website (http://www.unesco.org/culture/ich/en/RL/00884) as encompassing more than just food of the various cultures. These diets are embedded in bio-cultural landscapes that are at risk from global markets, industrial agriculture, invasive species and climate change, and yet little research aimed at conserving this Mediterranean agricultural heritage is being conducted. A focus on preserving traditional Mediterranean agricultural systems provides unique opportunities to link UNESCO-SCBD's Joint Programme on Biological and Cultural Diversity (http://www.cbd.int/lbcd/) and FAO's Globally Important Agricultural Heritage Systems initiative (GIAHS, http://www.fao.org/giahs/) with the goal of developing strategies and policy to preserve this heritage and the food production systems that are its basis for future generations. An important step in this direction is the development of holistic ecosystem-level assessments of the stability and resilience of traditional Mediterranean farming systems to evolving global change including climate change and shifting economic patterns and associated landscape transformations. A holistic approach is an important step to ensure ecologically sustainable development, conserve cultural identities, improve farming community livelihood, preserve agro-biodiversity, and ensure the continued provision of vital ecosystem services for humanity.

Keywords: traditional Mediterranean farming systems, agricultural heritage systems, physiologically based demographic models (PBDMs), global change, resilience to climate change.

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1 Introduction

Cradle to the development of some of the largest and most powerful civilizations in the world, the Mediterranean Basin has witnessed millennia of interactions between humans and ecosystems, particularly through agriculture (Blondel 2006), with associated evolving dietary patterns that resulted in what we now call Mediterranean diet. In 2010, the United Nations' Educational, Scientific and Cultural Organization (UNESCO) first recognized the Mediterranean diet as an Intangible Cultural Heritage of Humanity (http://www.unesco.org/culture/ich/en/RL/00884) that encompasses "a set of skills, knowledge, rituals, symbols and traditions concerning crops, harvesting, fishing, animal husbandry, conservation, processing, cooking, and particularly the sharing and consumption of food". Embedded as they are in bio-cultural landscapes (Hong et al. 2014), these dietary patterns are but one aspect of traditional Mediterranean food systems (Kuhnlein and Receveur 1996) that in turn are grounded on traditional farming systems such as olive, grape and cereals, with olive being of particular ecological, economic, social and cultural (e.g., landscape) relevance (Loumou and Giourga 2003). In contrast to the increasing homogeneity in global food supplies with implications for food security, Mediterranean dietary patterns bring about significant health benefits (Khoury et al. 2014), and are increasingly linked to a reduced ecological footprint (Capone et al. 2013) that can be used as a metric of how sustainable Mediterranean farming systems are. However, little research aimed at conserving Mediterranean agricultural heritage systems is being conducted despite ongoing threats to their persistence such as global markets, industrial agriculture, invasive species and climate change (see e.g., Rosenzweig and Tubiello 1997; Souissi et al. 2013; Alessandri et al. 2014; Ponti et al. 2015).

Traditional agricultural systems have evolved through centuries of humans-nature interactions and continue to provide local food security, harbor high levels of genetic and organismal biodiversity free of transgenic contamination, and are living libraries of indigenous knowledge and management of systems that are the foundation for contemporary and future agricultural innovations and technologies (Koohafkan and Altieri 2011; Lansing and Kremer 2011; Nicholls and Altieri 2012). Worldwide, a panoply of ecologically based small farm agricultural systems feed at least 70% of the world population (i.e., global food security) and account for over a half of the agricultural output used for domestic consumption (i.e., food sovereignty) in Africa, Asia and Latin America (Altieri 2008; ETC action group on erosion 2009; Rosset 2011). However, the world now faces an era of climate change of global dimension and impact (Koohafkan et al. 2012), particularly in the developing countries where local knowledge systems and agricultural practices and techniques remain the dominant coping mechanisms/responses to climate change (Morton 2007; Altieri and Koohafkan 2008). Climate change is a developing additional level of complexity that adds to risks posed by global markets, industrial agriculture and invasive species, and together these interacting fac-

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tors will make the world's traditional agroecosystems unprecedentedly hard to manage.

There is little doubt that traditional farming systems will be impacted by climatic change despite adaptations to cope with extremes of current climate (Altieri and Koohafkan 2008; Koohafkan 2009; Beddington et al. 2012). The level of resiliency to extreme climatic events that have occurred over the last two decades has been closely linked to the level of on-farm biodiversity of small farms (Altieri et al. 2012; Altieri and Nicholls 2013). However, a major challenge is to assess the limits of this resiliency in the face of climatic change, and for this the tools of ecosystem modeling and analysis and GIS will be useful. We note, however, that assessing the impacts of climate change in traditional faming systems, especially in small farm systems, is a far greater challenge than in conventional monocultures because of the lack of standard definitions and data, the greater complexity of the farming systems, and their vulnerability to a range of climate-related and other stressors (Morton 2007; Koohafkan and De La Cruz 2011).

A focus on preserving traditional Mediterranean agricultural systems provides unique opportunities to link UNESCO-SCBD's Joint Programme on Biological and Cultural Diversity (http://www.cbd.int/lbcd/) and FAO's Globally Important Agricultural Heritage Systems initiative (GIAHS, http://www.fao.org/giahs/) with the goal of developing strategies and policy to preserve this heritage including the food production systems that are its basis for future generations (Fig. 1). This chapter illustrates how an important step in this direction would be the development of holistic ecosystem-level assessments of the stability and resilience of traditional Mediterranean farming systems to evolving global change including climate change and shifting economic patterns and associated landscape transformations. A holistic approach would help guide ecologically sustainable development, conserve cultural identities, improve farming community livelihood, preserve agro-biodiversity, and ensure the continued provision of vital ecosystem services.

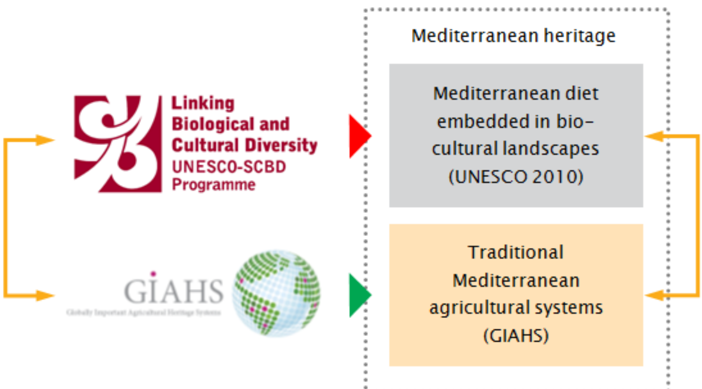

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Figure 1. Conceptual graph illustrating how the UNESCO-SCBD's Joint Programme on Biological and Cultural Diversity (http://www.cbd.int/lbcd/) and the FAO's Globally Important Agricultural Heritage Systems initiative (GIAHS, http://www.fao.org/giahs/) may be linked with the goal of developing strategies and policy to preserve the traditional Mediterranean agricultural heritage.

2 Traditional Mediterranean farming systems

Because of isolation in a multitude of small and diverse river basins generated by a broken topography (Halstead 1987), most rural peoples of the Mediterranean Basin were forced until quite recently to rely for survival on wheat, olives, milk, cheese, wine, meat from domestic and wild animals, a wide range of domestic and wild fruits, as well as a variety of wild products that could be found in shrublands and woodlands (Blondel 2006). Many local land use systems emerged across the Basin, and the endless redesign of Mediterranean landscapes through traditional land use systems had an overall beneficial influence on biological diversity in the region (Blondel and Aronson 1995). Highest biological diversity probably never occurred in pristine oak woodlands but in systems that were moderately modified by man (see e.g., Gómez-Campo 1985; Blondel and Aronson 1995) such as traditional agro-silvo-pastoral systems (Fig. 2). Such pattern supports the diversity-disturbance hypothesis that intermediate levels of disturbance promote biological diversity (Huston 1994). Furthermore, many of today's agroforestry systems have often replaced natural forests (Scarascia-Mugnozza et al. 2000), with humans exerting a profound influence on forests virtually everywhere on the globe, and hence "natural" defined as "without human influence" is an almost entirely hypothetical notion, despite the fact that productive systems rely on natural biodiversity as their foundation and source of resilience (McNeely 2004).

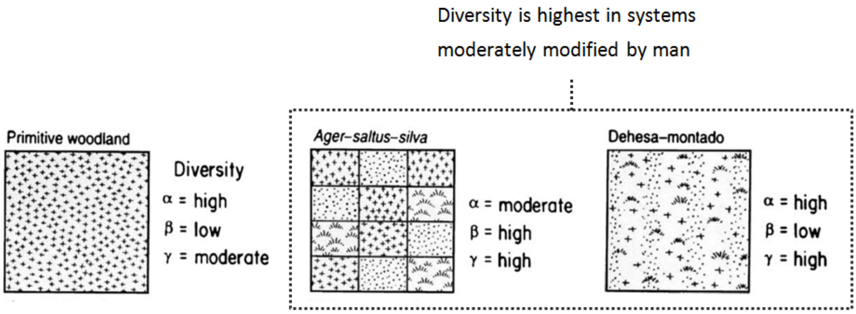

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Figure 2. Levels of the three components of diversity, namely α-diversity (within habitat), β-diversity (between habitat) and γ-diversity (regional), in primitive woodlands and in two ancient land use systems in the Mediterranean region: the *Sylva-saltus-ager* (woodland-pasture-field) system that was widespread during the Roman empire and is arguably the most influential and well-known of all ancient systems in the region, and the savannah-like *Dehesa-montado* system, typical of the Iberian peninsula and of many islands such as Sardinia (Italy). Cultivation, grazing, and harvesting of forest products are practiced according to a different spatial arrangement in the two systems, as the three activities are conducted in separate areas in the *Sylva-saltus-ager* system, whereas they are combined within a single area in the *Dehesa-montado* system. Highest overall level of diversity is found in these traditional agricultural systems that also show a high degree of resilience (modified from Blondel 2006). The text to the right of each system denotes levels of α, β and γ diversity.

Traditional farming systems like olive remain of great importance in many areas of the Mediterranean Basin even if they are often restricted to marginal areas, as they form a consistent landscape component within a variety of arable or pastoral land uses (Eichhorn et al. 2006). This is especially the case for silvo-arable systems like the olive groves of central Italy (e.g., in Umbria, a relatively dry, hilly region) (Bertolotto et al. 1995) or the *dehesas* and *montados* typical of southwestern Spain and Portugal but also abundant in Sardinia, Italy (Joffre et al. 1988; Grove and Rackham 2003) (see also Fig. 2), where the trees themselves define the landscape even if they are not the dominant landscape component (Eichhorn et al. 2006). The pre-Roman practice of intercropping olives with cereals, vegetables and fodder crops still survives on several thousands of hectares in Italy, Greece, and Spain, making olive a consistent element in the landscape throughout southern Europe (Lelle and Gold 1994; Papanastasis et al. 2009). Mediterranean agroforestry systems such as olive are relatively poorly studied in terms of their economic importance and role in preserving local and regional biodiversity, with agroforestry itself having mostly been considered a feature of the tropics (see Rodríguez et al. 2009). However, the role of temperate agroforestry systems in reconciling productivity with environment protection is gaining attention (see e.g., http://www.agforward.eu/), as it simultaneously addresses issues of considerable importance to the future of European agriculture (Eichhorn et al. 2006; Smith et al. 2013).

Olive inhabits a variety of different landscapes ranging from olive trees interspersed in natural forest vegetation to intensive monocultures, with many intermediate cases (Kizos and Koulouri 2010). Although olive has proven an environmentally sustainable farming system through millennia when growing as an agroforestry tree across the Mediterranean Basin, this traditional crop is not per se a guarantee for sustainability. An assessment of soil erosion rates in olive orchards performed by Vanwalleghem et al (2011) in Andalusia, Spain over a 250-year period since 1752 using historical records and field measurements of relic tree mounds, showed that olive cropping that lasted only 153 to 291 years in areas previously covered by Mediterranean forest resulted in a 29% to 40% loss of the total soil depth compared to the total soil depth of other current soil profiles. Erosion rates increased throughout the whole period except during 1935-1970 when inter-

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cropping olive with wheat or barley between rows (likely due to increased local food demand driven by the Spanish Civil War and the autarkic policy of the Franco regime) resulted in the lowest soil loss rates over the 250-year period (Vanwalleghem et al. 2011). Highest soil loss rates occurred from the year 2000 onward, because herbicides were adopted to control weeds that in combination with superficial harrowing during summer, decreased tillage erosion but reduced surface cover and roughness greatly enhancing water erosion (Vanwalleghem et al. 2011; see also García-Orenes et al. 2012).

Olive is the most emblematic plant species across Mediterranean cultures and landscapes (Loumou and Giourga 2003; Terral et al. 2004) and forms the basis of the Mediterranean rain-fed agroforestry system (Pasternak 2001), one the oldest (Renfrew 1973; Zohary and Spiegel-Roy 1975; Yasuda 1997; Blondel 2006), most ecologically-sustainable rain-fed agroecosystems worldwide (Lüttge 2010). As such, cultivated olive provides a model to design sustainable rain-fed systems for the semiarid Africa (Pasternak 2001), including regions such as the Sahel (Pasternak and Schlissel 2001). Olive culture historically played an important role in rural development and poverty alleviation in marginal areas across the Middle East and North Africa (Lybbert and Elabed 2013) and parts of Europe (Fleskens and de Graaff 2010). Economic and social viability and persistence of this well-documented cosmopolitan agroecosystem have important implications for preventing and ameliorating desertification that is a major environmental threat to the whole Mediterranean region (Mtaita et al. 2001; Geeson et al. 2002; Schröter et al. 2005; de Graaff et al. 2010; de Graaff et al. 2011) under global climate change.

Farming communities in the Mediterranean Basin have developed traditional olive agroecosystems that ingeniously mimic the local subtropical dry forest ecosystems adapted to shallow soils and unreliable rainfall typical of the Basin (FAO 2001; see also Ponti et al. 2014). These olive based agroecosystems have been in use for many centuries without depleting the resource base, and hence illustrate that agricultural sustainability may be achieved when natural habitat complexity is emulated (Blondel 2006) at multiple spatial scales (Benton et al. 2003). It illustrates how systems that successfully mimic nature should seek complementary species according to the so called "M5" golden rule (Making Mimics Means Managing Mixtures) (Dawson and Fry 1998). Research has shown that the prevalent coevolved natural secondary plant associations of an area can provide a model for designing multispecies crop mixtures (Ewel 1976; Altieri and Letourneau 1982; Ewel et al. 1982; Altieri et al. 1983). This is why the recent debate on sustainable vs. ecological intensification goes beyond pure semantics, as ecological intensification involves a landscape approach to designing multifunctional agroecosystems that are both sustained by nature and sustainable in nature (Tittonell 2014).

The below ground side of this story revolves around the ubiquitous soil glycoprotein glomalin. Until studies in 1996 by the United States Department of Agriculture (USDA) (Wright et al. 1996), glomalin was assumed an unidentifiable constituent of soil organic matter (Comis 2002). It is now known that this very stable molecule is produced by and abundantly coats the hyphae of arbuscular

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mycorrhizal (AM) fungi, and is highly correlated with increased stability of soil aggregates, as it binds soils particles together (Rillig 2004). Researchers speculate that abundant glomalin makes soil favorable to the symbiotic relationship of AM fungi and almost all vascular plants (Wright and Upadhyaya 1998). Long-established olive tree plantations common throughout Mediterranean landscapes feature a variety of root-associated AM species (Calvente et al. 2004) as well as a stable glomalin carbon pool that protects soil aggregates and enhances carbon sequestration (Ramachandran Nair et al. 2010; Emran et al. 2012; Pardini and Gispert 2013). This is especially important on shallow marginal soils in the Mediterranean Basin such as in terraced olive groves that require very low levels of agricultural management and where abandonment and the associated periodical wildfire occurrence trigger soil degradation processes (Gispert et al. 2013). However, the turnover times of the gomalin pool in the soil is on the order of decades, and hence the beneficial effects of glomalin on soil aggregate stability are slow to recover after soil degradation such as erosion by water (see Rillig 2004). This long turnover also means that management changes that are detrimental to the glomalin pool (e.g., tillage, see Wright et al. 1999) will affect soil aggregate stability for decades (Rillig 2004) and increase the loss rate of agricultural soil.

Abandonment of traditional farming systems as driven across the Mediterranean by shifting economic patterns increasingly leads to loss of biodiversity and ecosystem services. For example, a field experiment conducted in a long-term observatory located in Sardinia that is representative of local Mediterranean agroforestry systems, Bagella et al (2014b) concluded that a complex landscape made of a variety of contrasting agro-silvo-pastoral land uses ranging from marginal cork oak forests to intensively managed grape monocultures, and including animal grazing in secondary grasslands, is able to buffer the impact of most intensive land uses on above ground biodiversity via specific below ground biodiversity. This study was one of the first to attempt an assessment of how maintaining the typical Mediterranean landscape diversity including traditional farming systems is important for conserving biodiversity and ecosystem function at the landscape level (Bagella et al. 2014b). These systems are the backbone of the regional food system, but only if actively managed they can promote sustainable use and conservation of bio-cultural diversity (Bugalho et al. 2011) including the Mediterranean diet. An appropriate ecosocial context is therefore needed that provides human activity with the capacity to enhance plant biodiversity via traditional farming systems (Bagella et al. 2014a). For example, novel economic incentives that pay for ecosystem services are required to complement and replace a number of agri-environmental payment schemes that have been implemented in the recent past with checkered success (Pretty 2008). A related question is whether carbon offset credits such as those provided under the so called REDD (i.e., reducing emissions from deforestation and forest degradation, see http://www.un-redd.org/) mechanism would be appropriate for supporting the mitigation potential of traditional farming systems, as it addresses but one of a panoply of benefits (i.e., ecosystem services) that these systems provide (Altieri and Nicholls 2013).

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Mediterranean agricultural heritage systems including olive are at risk from global markets, industrial agriculture, invasive species and climate change, and yet currently little research aimed at conserving these systems is being conducted. A recent analysis using the Köppen-Geiger climate classification provided a first robust assessment of future northward and eastward expansions of the Mediterranean climate in the Euro-Mediterranean region and western North America, and posit a significant displacement of the southern margins of these climate (e.g., in southern Europe) by an arid type climate during the 21st century (Alessandri et al. 2014). This evidence points to the importance of developing holistic ecosystem-level assessments of the stability and resilience of traditional Mediterranean farming systems to climate change (Ponti et al. 2014).

3 Holistic assessment of olive under climate change

In this section, we explore the use of physiologically based demographic models (PBDMs) in a geographic information system (GIS) context for holistic ecosystem-level assessments of the stability and resilience (Gutierrez 1996) of traditional Mediterranean farming systems to climate change. The Mediterranean Basin is a climate change hotspot of global relevance (Giorgi 2006; Diffenbaugh et al. 2007; Diffenbaugh and Giorgi 2012) where warming of about +2°C will likely occur between 2030 and 2060 (Giannakopoulos et al. 2009) with unknown bio-economic impact on major crop systems including olive. Climate change will alter the interaction of olive with its herbivorous pests, and understanding these shifts is crucial to assessing the ecological and economic impacts. In contrast with mainstream assessments of climate change impact on agricultural and other ecosystems that have omitted trophic interactions (van der Putten et al. 2010), PBDMs in a the context of a GIS have the capacity to estimate the impacts of climate warming on the interactions of olive and its major obligate pest, the olive fly *Bactrocera oleae* (Gutierrez et al. 2009; see Daane and Johnson 2010 for a comprehensive review on olive fly).

How to analyze the tripartite ecological, economic, and social effects of climate change has been vexing and largely unexplored, and olive is one of the first agroecosystems where these different factors have been analyzed holistically, albeit with different level of precision, using process-based modeling tools such as PBDMs (Ponti et al. 2014). The underlying assumption of the models is that all organisms in all trophic levels, including the economic one, are consumers that have similar resource acquisition (inputs) and allocation (outputs) priorities (Gutierrez et al. 1994; Gutierrez 1996; Regev et al. 1998). Based on analogies, the dynamics of say olive and olive fly can be captured using the same resource acquisition and birth-death rates sub-models imbedded in an age-mass structured population model (i.e., the PBDM). Resource acquisition (i.e., the supply, *S*) is a search process driven by organism demand (*D*), while allocation occurs in priority

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order to egestion, conversion costs, respiration, and reproduction, growth, and reserves. The ratio *S/D* is greater or equal to zero but always lower than unity due to imperfect consumer search, and in the model scales maximal growth rates of the species in a time-place varying manner. At high resource levels, *S/D* tends to unity. The model for olive is a canopy model with subunit populations of leaves, stem, root, and healthy and attacked fruit.

The olive system model simulates the age-mass structured population dynamics of plant subunits and of olive fly numbers (Gutierrez et al. 2009). The olive model predicts flowering phenology controlled by vernalization, the age-structured dynamics of growth and yield, and fruit mortality due to temperature and fly attack. Olive fly biology is closely linked to olive fruit phenology, age and abundance. The effects of temperature on vital rates of olive fruit and the fly are captured by normalized concave scalar functions that approximate the net of *S* corrected for metabolic costs across temperature (Gutierrez et al. 2009). Several weather data sources can be used to drive weather-driven PBDMs (see Ponti et al. 2013), including satellite remote sensing (e.g., Neteler 2010) and state-of-the-art regional climate change projections (e.g., Artale et al. 2010; Dell'Aquila et al. 2012), while GRASS GIS (see http://grass.osgeo.org) (Neteler et al. 2012) is used to perform geospatial analysis and produce maps.

The bio-economic analysis of olive was driven by daily weather scenarios that include a fine scale representation of topography and the influence of the Mediterranean Sea on regional climate (see Ponti et al. 2014). Climate warming will affect olive yield and fly infestation levels differently across the Basin (not shown, see Ponti et al. 2014), and hence local profitability and system stability, resulting in regional economic winners and losers (Fig. 3a). Instead of the commonly-used production and damage control function approach, the economic impact of climate warming was assessed using a process-based PBDM as the production function. Profitability of family olive farms in many marginal areas of Europe and elsewhere in the Basin will decrease, leading in some cases to abandonment. These farms are critical to conserving soil, maintaining biodiversity, and reducing fire risk. The analysis showed that understanding the interactions of olive and olive fly is critical to estimating the ecological and bio-economic effects of climate change on olive culture across the Mediterranean Basin, and provides a template for assessing climate impacts in other traditional Mediterranean farming systems such as grape, with extant and potential new invasive pests. The study suggests that climate warming could have far greater impact on less heat and drought tolerant crop systems such as grape and wheat (Ponti et al. 2014).

An additional step in this analysis would be to investigate to what extent areas where olive is grown that are projected to be at risk from climate change (see Fig. 3a) are also located in vulnerable environments such as those prone to soil erosion. Global datasets that may be used to this end include those resulting from the assessments by Oldeman et al (1991), Batjes (1996), and Reich et al (2001). Oldeman et al (1991) performed the first Global Assessment of Soil Degradation (GLASOD) that although based on untested expert judgment, has been the most

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influential appraisal of land quality in terms environmental policy (Sonneveld and Dent 2009). Batjes (1996) used a water erosion model similar to the universal soil loss equation (Wischmeier and Smith 1978), and evaluated model output against GLASOD, showing fair geographic agreement. Reich et al (2001) combined global soil and climatic data via GIS analysis, and assigned each soil unit a vulnerability class using soil moisture regime as a proxy for erosivity, based on how soils are known to behave under certain prevailing climatic conditions (see http://1.usa.gov/1AnepoQ). We used the more recent map of water erosion by Reich et al (2001) as it attempts a quantitative assessment of global erosion extent and its causative parameters, including a human population density layer as a proxy for land management intensity. Human population is a particularly important risk factor in biodiversity hot spots such as the Mediterranean Basin. (Cincotta et al. 2000). This dataset was made available on request by Paul F. Reich (Soil Science Division, USDA Natural Resources Conservation Services), and was imported, processed and mapped using GRASS GIS (GRASS Development Team 2014). We mapped this water erosion dataset (including four erosion classes: low, moderate, high, and very high) for the observed distribution of olive in the Mediterranean Basin as estimated by Ponti et al (2014), and the resulting map shows that about 30% of the land where olive is currently grown is very highly vulnerable to water erosion (Fig. 3b), 30% is very vulnerable, 14% is moderately vulnerable, and only about 4% has low vulnerability, with no vulnerability class assigned to about 17% of the land in the dataset used (e.g., the Nile river area is assigned to the "dry" class, with no particular water vulnerability). Based on projected bio-economic impact of climate warming (Fig. 3a) and soil vulnerability to water erosion (Fig. 3b), we mapped hot spots of ecosocial vulnerability across the Mediterranean Basin as areas having projected negative change in profit and high to very high vulnerability to water erosion (Fig. 3c). These hot spots of ecosocial vulnerability cover 13.6% of the total olive area (i.e., the area mapped in Fig. 3a).

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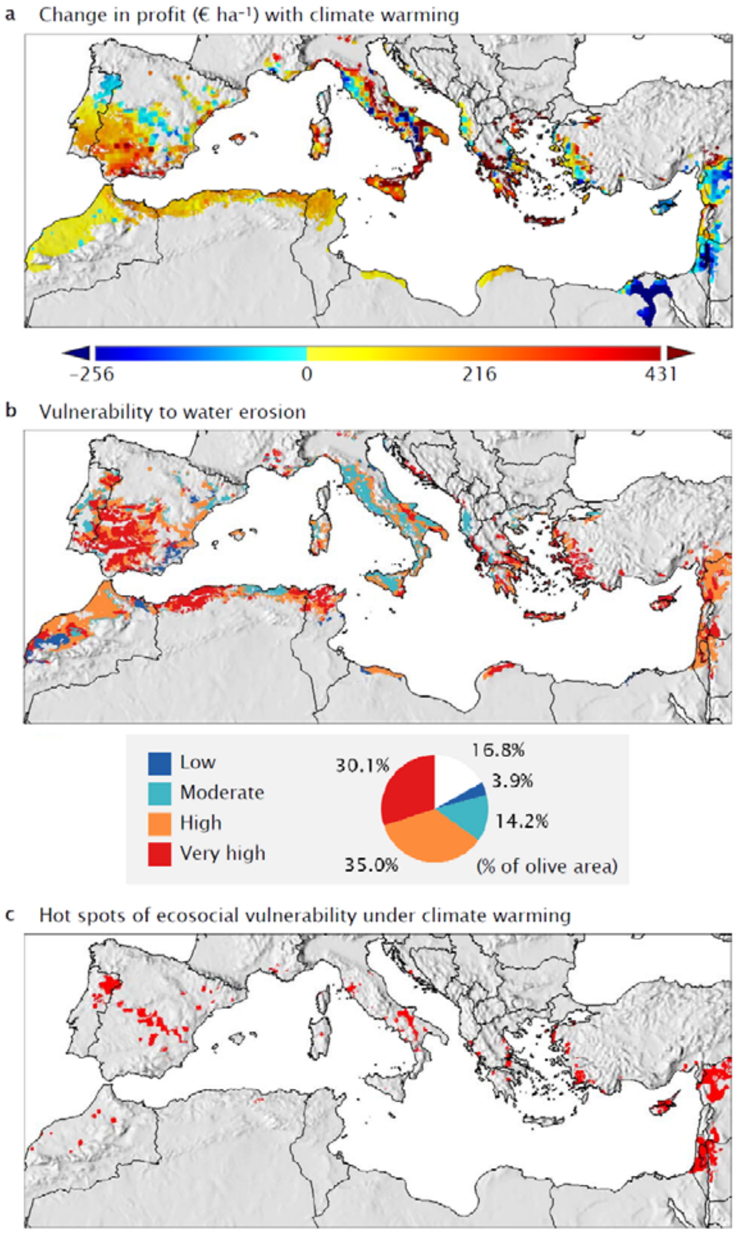

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Figure 3. Understanding eco-social resilience to climate warming in olive across the Mediterranean Basin. **(a)** Bio-economic multitrophic impact of climate warming on olive and olive fly as measured by projected change in profit (€ ha^{-1}) under an A1B climate scenario with +1.8 °C warming (from Ponti et al. 2014). To improve data visualization, statistical outliers were identified using the boxplot function in R (see www.r-project.org/) and mapped with darker blue/red shades indicated by the triangles at the extremes of the color legend. The full data interval is [−914.7, 3,000.0]. **(b)** Soil vulnerability to water erosion (data from Reich et al. 2001) within the observed distribution of olive (data from Ponti et al. 2014). **(c)** Hot spots of eco-social vulnerability across the Mediterranean Basin are defined as areas with projected negative change in profit (blue areas in subfigure a) and high to very high vulnerability to water erosion (respectively orange and red areas in subfigure b).

4 Conclusions

An important step for developing strategies and policy to preserve the heritage of traditional Mediterranean agricultural systems is the development of holistic ecosystem-level assessments of their stability and resilience to evolving global change including climate change and shifting economic patterns and associated landscape transformations. Using olive as an prominent case study, we illustrated a physiologically-based weather-driven geospatial approach that is holistic in nature, and has the capacity to lay the groundwork for ecosystem analysis of system sustainability. Knowledge gathered via holistic ecosystem-level assessments such as the one illustrated here can be used to support interdisciplinary field methodologies designed to help farmers prepare for climatic variability (see e.g., Altieri et al. 2011; Rogé et al. 2014). Sound knowledge of the ecological processes that underpin the sustainability of traditional Mediterranean farming systems is an important prerequisite, but resilience to global change including climate change requires more than applying a set of practices: the challenge in both intensive and marginal agriculture and in small to large scale farms, is to reinstate social organization and collective strategies in farmer communities that make full use of holistic knowledge about food systems (Altieri et al. 2014; MacMillan and Benton 2014; Martínez-Torres and Rosset 2014).

Preserving the Mediterranean diet through holistic strategies for the conservation of traditional farming systems holds potential to help meet multiple concurrent goals in Mediterranean biodiversity, climate change, and eco-social hot spots by ensuring ecologically sustainable development, conserving cultural identities, improving farming community livelihood, preserving agro-biodiversity, and supporting food systems that are more healthy and secure, as well as continuously providing vital ecosystem services. Linking the UNESCO-SCBD's Joint Programme on Biological and Cultural Diversity to the FAO's Globally Important Agricultural Heritage Systems initiative represents a unique opportunity for developing strategies and policy to preserve the Mediterranean heritage.

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