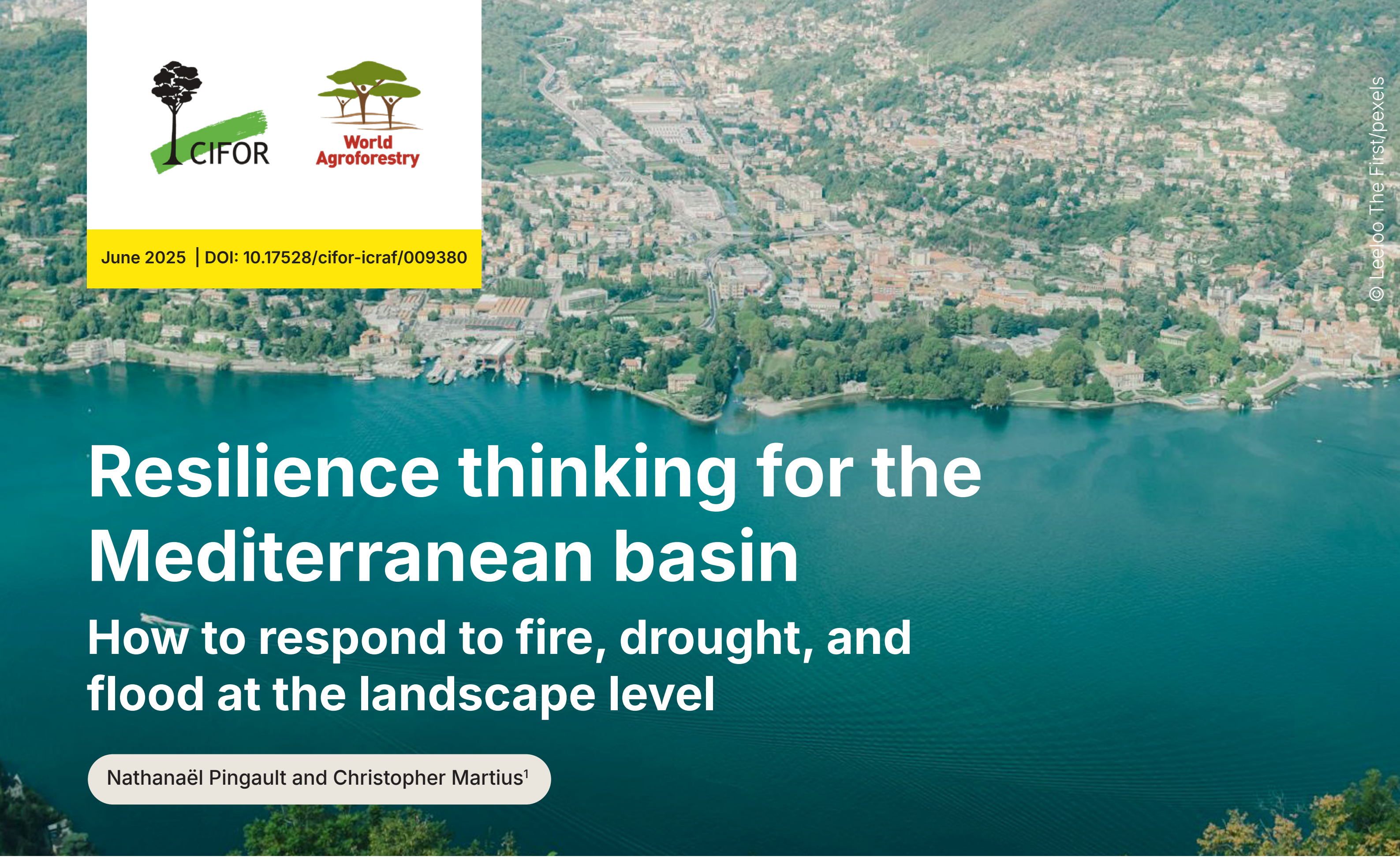

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Resilience thinking for the Mediterranean basin

How to respond to fire, drought, and flood at the landscape level

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Key messages

1. **The Mediterranean Basin, home to around 7% of the world's population, is highly vulnerable to climate change, and thus urgently requires enhancing landscape resilience.** Rising temperatures, demographic pressure, and unequal access to resources – especially between the North and South – are converging to create systemic risks for people and ecosystems.
2. **Increased incidence of wildfires, droughts, and floods – amplified by climate change – has been and is transforming Mediterranean landscapes.** Their frequency, intensity, and cascading effects are undermining food security, ecosystem services, carbon sequestration, and livelihoods, particularly in rural areas. Without proactive resilience-enhancing strategies, these risks will deepen and exceed adaptive capacity of the region's landscapes.
3. **Operationalizing resilience requires defining what to make resilient, to which hazards, and for whose benefit.** This paper advances that agenda by applying the "Resilience of what, to what, for whom?" framework to Mediterranean rural landscapes, offering a foundation for practical assessment and planning.
4. **Tailored resilience strategies are needed for the distinct contexts of the Northern and Southern Mediterranean.** In the North (Southern Europe and Türkiye), priorities include restoring mosaic rural landscapes, managing wildfire risk through proactive strategies to reduce fuel load, and reinvigorating low-intensity land uses. In the South (North Africa and parts of the Middle East), resilience efforts should focus on sustaining extensive pastoral systems, improving water retention and drought resilience of cropping systems, and enhancing infrastructure for climate-adapted agricultural practices. Differentiated policies should reflect the contrasting land use, demographic, and climatic pressures across subregions.
5. **Inclusive and equitable governance remains a critical dimension of resilience building, particularly in light of power asymmetries and differing stakeholder priorities.** While the brief underlines the importance of inclusive processes and avoiding elite capture, a deeper exploration of governance structures and capacities across the region – especially their variation by context – will be essential to inform implementable strategies.

Keywords: *Mediterranean landscapes; Landscape resilience; Wildfires; Droughts; Floods*

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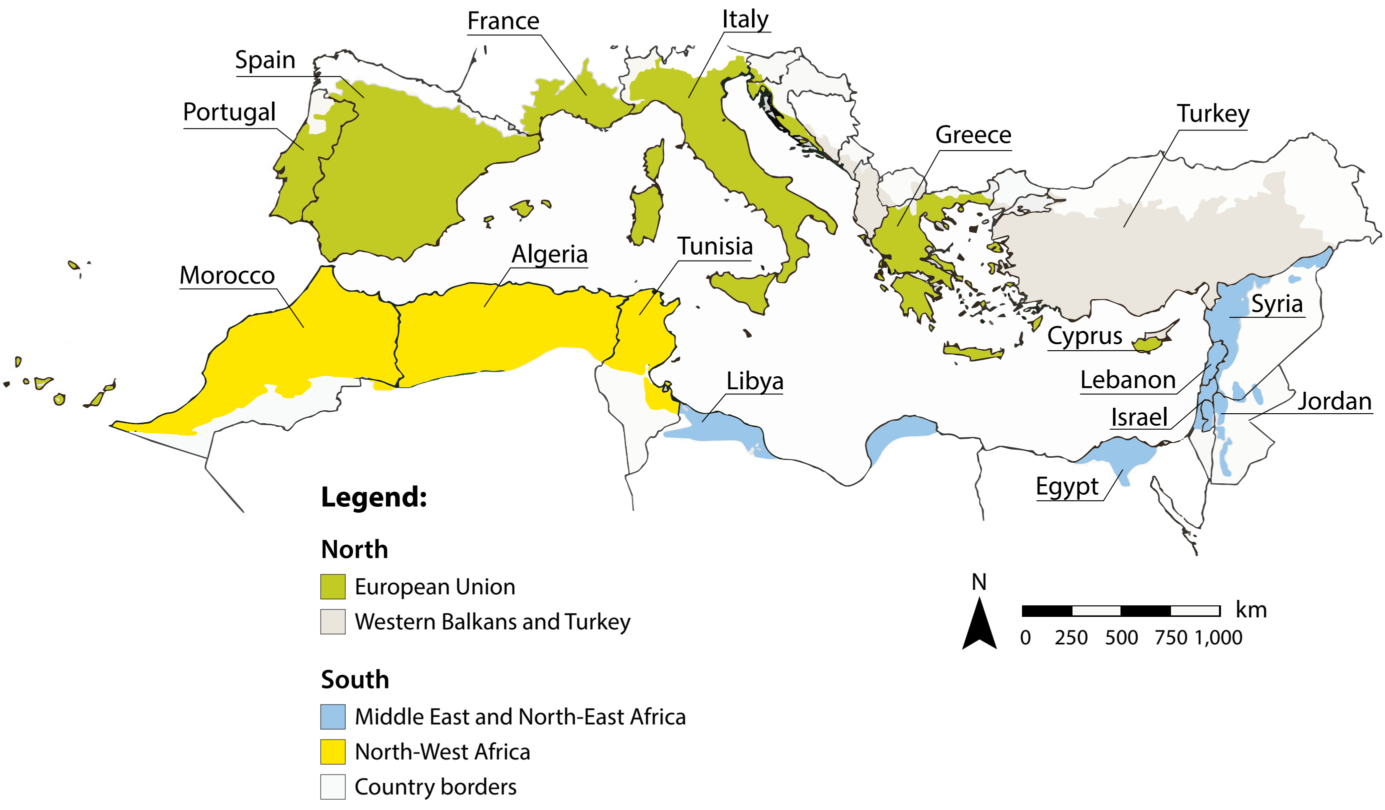

Figure 1. Extent of the Mediterranean biome in the Mediterranean basin
Source: Own rendition based on Malek et al. (2018).

Introduction

With 542 million inhabitants in 2020, the Mediterranean Basin (**Figure 1**) ranks among the world's most densely inhabited regions. Its population is expected to reach 657 million by 2050 and 694 million by 2100, which will further increase pressure on land, water, and natural resources (Ali et al. 2022). The region has a documented history of continuous and increasing human pressure on natural resources (land and water). This history extends over millennia, since agriculture came into being about 10,000 years ago and the first urban civilizations emerged about 6,000 years ago in Egypt and Mesopotamia.

Climate change poses particularly severe risks to the Mediterranean Basin (Ali et al. 2022). Using pollen-based reconstructions of climate and ecosystem spatiotemporal dynamics during the Holocene, Guiot and Cramer (2016) predicted that Mediterranean ecosystems can remain within their Holocene range of variability (a climate range compatible with human prosperity over approximately the last 10,000 years) only if global warming stays below +1.5°C.

Accelerating climate change (EC 2018; WMO 2023a) increases the risks to humans and ecosystems in the Mediterranean area. Indeed, the most recent assessment report of the Intergovernmental Panel on Climate Change (IPCC AR6) points to alarming trends. It affirms the current surface temperature in the Mediterranean region is already 1.5°C higher than in pre-industrial times, a difference far above the global average of 1.1°C. It also notes that future warming in the region is expected to occur 20% faster than the world average (Ali et al. 2022; IPCC 2023).

According to the European Copernicus observatory, each month between June 2023–January 2024 was the warmest ever recorded for the respective month at the global level. In early 2024, for the first time, the global mean temperature for 12 consecutive months (February 2023–January 2024) exceeded the threshold of 1.5°C above the pre-industrial era (EC 2024). The Mediterranean region is therefore about to enter unknown territory in terms of climatic conditions and ecosystem changes. Specifically, risks for people, economies, and ecosystems associated with the IPCC (2018) five "Reasons for Concern"[2] are expected to increase with the level of global warming.

2 The IPCC (2018) special report on global warming of 1.5°C assessed the level of risks under different warming scenarios focusing on the five following "Reasons for Concern": (i) unique and threatened systems; (ii) extreme weather events; (iii) distribution of impacts; (iv) global aggregate impacts; and (v) large-scale singular events.

In this context, strengthening landscape resilience – i.e. the ability of landscapes to endure, adapt, and transform under changing conditions while maintaining their core structure, functions and identity – is urgently needed to tackle the "triple challenge" of supporting a growing global population, addressing climate change, and reversing biodiversity loss and ecosystem degradation (Baldwin-Cantello et al. 2023; Pingault and Martius 2024).

Resilience thinking serves as a practical and useful framework for understanding the ways in which social-ecological systems withstand, respond to, and reshape themselves amid disturbances—whether predictable or not (Pingault and Martius 2024). Here, we apply resilience theory specifically to Mediterranean landscapes. Operationalizing the concept of resilience and translating theory into policy and action requires answering three questions that play a central role in the resilience literature: "Resilience of what?" (social-ecological system, landscape, community or entity of concern); "Resilience to what?" (drivers, stressors, shocks, and disturbances) (Carpenter et al. 2001; Folke et al. 2010; Biggs et al. 2012); and "Resilience for whom?" (actors, interests, power dynamics, distribution of costs and benefits) (Lebel et al. 2006). The next sections will successively address these three questions in the context of the Mediterranean region.

Resilience of what?

The answer to the first question delineates the geographical, sectoral, or thematic boundaries of the social-ecological system of interest. There is no unique definition of the precise area covered by the Mediterranean Basin, nor a list of countries to be included. The Mediterranean Action Plan of the United Nations Environment Programme (UNEP/MAP) gathers 21 Mediterranean countries and the European Union (UNEP n.d.). The FAO General Fisheries Commission for the Mediterranean involves 22 Mediterranean member countries and the European Union, as well as six cooperating non-contracting parties (FAO n.d.). The IPCC AR6, focusing on climate, defines the Mediterranean Basin only as a loose area illustrated on a map (Ali et al. 2022, Figure CCP4.1 p2238).

Political and administrative boundaries of what is called the Mediterranean Basin have also varied across the centuries. Furthermore, ecological boundaries of ecosystems and agroclimatic zones will likely vary under future climate change. If the focus of interest is landscape resilience (i.e., the resilience of ecosystems and of the communities living in or depending on them), then a suitable definition identifying the Mediterranean Basin as the area covered by a Mediterranean biome makes sense. Following the indications given in **Figure 1**, this biome spreads over 23 countries[3] that can be grouped into two subregions: (1) Europe (i.e. European Union, Western Balkans and Türkiye) in the North; and (2) Middle East and North Africa (MENA)[4] in the South.

The Mediterranean biome includes a wide diversity of landscapes experiencing varying intensity of human management – from undisturbed natural ecosystems to highly managed urban environments. At a general level, Mediterranean landscapes can be grouped into three broad categories: (i) urban landscapes; (ii) seascapes; and (iii) rural landscapes (agriculture and forestry). This paper focuses on these rural landscapes, which experience varying levels of human management (from natural and semi-natural to extensively or intensively managed rural landscapes).

FAOSTAT data, collected at national level, offer only a rough view of landscape diversity across the Mediterranean Basin, as the Mediterranean biome covers only part of some countries (see **Figure 1**). Finer, spatially explicit local data are needed to study landscape heterogeneity and resilience. However, FAOSTAT data for 2021 still provide useful insights,[5] making evident a striking contrast between the northern and southern shores of the Mediterranean Sea.

Landscapes in the North have evolved under human influence over millennia. Most of them are managed, more or less intensively, to address various human needs (e.g., production, conservation, recreation). Agricultural lands cover almost half and forests almost a third of total land area. The remaining part, (classified under "other land"), covers less than a fifth of total land area. This includes human settlements and infrastructures, and the last natural ecosystems that are neither forest nor agriculture and that may be less affected by human activities.

By contrast, in the South, agriculture (less than 20% of total land area) and forest areas (less than 2%) are limited by water scarcity and elevated temperatures. Most of the land (almost 80%) falls under "other land". Beyond concentrated human settlements, "other land" covers large areas of uninhabited and unused desertic lands.

In the North, cropland has expanded to cover 63% of agricultural land, leaving only 37% to permanent meadows

3 Portugal, Spain, France, Italy, Malta, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania, North Macedonia, Greece, Türkiye, Cyprus, the Syrian Arab Republic, Lebanon, Israel, Jordan, Egypt, Libya, Tunisia, Algeria and Morocco. Strictly speaking, this definition also includes the micro-states of: Andorra, Monaco, the Holy See, and the Republic of San Marino, as well as the British Overseas Territory of Gibraltar.

4 For this study, as indicated in **Figure 1**, the MENA subregion also includes Israel. However, Israel is included in the FAO region of Europe and Central Asia; and Israel closely resembles European countries in terms of socioeconomic development, technology, education, and political institutions.

5 For land use, see: https://www.fao.org/faostat/en/#data/RL (last update 13 July 2023; extraction 31 January 2024). For crops (area, production, and yield), see: https://www.fao.org/faostat/en/#data/QCL (last update 27 December 2023; extraction 31 January 2024).

and pastures. In the South, this proportion is reversed: cropland covers 30% of total agricultural land, and permanent meadows 70% because secure access to water (mainly through irrigation) determines the few places where cultivation is possible. According to FAOSTAT, only two crops – wheat and barley – each account for more than 10% of total cropland area in the Mediterranean Basin compared to three dominant crops globally: wheat, maize, and rice. Only 10 crops cover each more than 1% of total cropland in the Mediterranean Basin against 17 at the global level. These figures suggest a lower diversity in Mediterranean cropland area.

However, while the global top five crops include only cereals (wheat, maize, rice, and barley) and soybean, the top five crops in the Mediterranean (wheat, barley, olives, maize, and grapes) are more diverse. They include two permanent crops, which could be positive for agrobiodiversity and landscape resilience.

The difference in the average yield gap between the northern and southern shores of the Mediterranean Sea is striking – more than 2 for olives and 3.5 for barley. Within the top 10 Mediterranean crops, only grapes and almonds show higher average yields in the South. This yield gap can be explained partly by soil and climate conditions, especially by more severe water scarcity and poorer soils in the South. Other factors are contrasted levels of access to fertilizers, crop protection products, machinery and equipment, technology, and education, as well as differences in farm income or average size.

Resilience to what?

In complex social-ecological systems, landscape resilience approaches must address many different disturbances. These disturbances can be grouped under three main categories: (i) single events, including extreme events, such as war, economic crisis, or natural disasters; (ii) variations in periodic cycles, such as seasonal precipitation patterns or fire regimes; and (iii) continuous and progressive changes like current and future climate changes (Pingault and Martius 2024).

This section provides some insights on natural disasters in Mediterranean landscapes, focusing on wildfires, droughts, and floods identified in Ali et al. (2022) as significant matters of concern. Not only these three hazards spread at landscape scale, threaten forest and agricultural landscapes and affect local communities across the Mediterranean Basin. But also, their increasing frequency and intensity are clearly and largely attributable to climate change.

Between 1970 and 2021, almost 12,000 disasters induced by extreme weather, climate- and water-related events were registered globally (WMO 2023b). Such disasters caused over 2 million deaths and economic losses of USD 4.3 trillion. Globally, floods and tropical cyclones were the first causes of natural disasters (respectively, 45% and 35% of reported disasters; 16% and 38% of reported deaths; 32% and 38% of reported economic losses). However, taken together, droughts and heat waves were the foremost global cause of mortality (43% of deaths). In Europe, over the same period, 1,784 climate- and water-related disasters were reported. Floods and storms were the leading cause of economic losses, while most deaths were due to extreme temperatures (WMO 2021; Acrgis n.d.).

Wildfires

From 2002 to 2016, an average of 4.2 million km² burned annually worldwide (Giglio et al. 2018). Wildfires play a natural role in the resilience and regeneration of ecosystems such as forests and rangelands (e.g., Holling 1973, 1986). However, excessive and uncontrolled fires can lead to loss of human and animal life, respiratory illnesses, destruction of infrastructure and severe ecosystem degradation (IPCC 2022, 243, 271).

Climate change is expected to increase the frequency, size, and intensity of wildfires by lengthening the fire season and amplifying the key drivers of wildfires – heat, fuel load, and ignition – through higher temperatures, reduced precipitation, and more frequent droughts and heatwaves (Moritz et al. 2012; Huang et al. 2014; Jolly et al. 2015; Jia et al. 2019; Jones et al. 2020; Vafeidis et al. 2020; IPCC 2022, 243). In turn, wildfires emit significant amounts of greenhouse gases (GHGs) – CO_2, CH_4, N_2O – and short-lived climate forcers (e.g., aerosols, ozone, volatile organic compounds), reinforcing climate change (van der Werf et al. 2017; Jia et al. 2019).

Historical data and models suggest strong links between climate, vegetation, and fire activity over the past 12,000 years (Jones et al. 2020). Jolly et al. (2015) documented a nearly 20% increase in global average fire season length from 1979 to 2013 across one-quarter of vegetated land resulting from climate change.

However, the relationship between climate and fire is complex and not exempt of trade-offs. While warmer and drier conditions increase vegetation flammability thus facilitating ignition and increasing the risk and intensity of wildfires – direct effect –, they may also hamper vegetation growth, thus reducing the fuel load and limiting fire spread during the following fire season – indirect effect – (Batllori et al. 2013; Turco et al. 2018; Jia et al. 2019; Vafeidis et al. 2020).

Fire behaviour also varies by land cover. In forests, fuel aridity correlates with temperature and is determinant to explain current burned area. Conversely, in non-forested areas, rainfall boosts biomass growth and thus future fire risk (Abatzoglou et al. 2018). Effective fuel load management is therefore critical to wildfire resilience (Vafeidis et al. 2020; Xanthopoulos 2023).

Historically, fire suppression policies reduced fire incidence in the short term but led to fuel build-up and the loss of natural firebreaks.

This created conditions for unprecedented fires, which were larger and more destructive, and much harder to control – a phenomenon known as the "fire paradox" (Holling 1986; Arévalo and Naranjo-Cigala 2018; Xanthopoulos 2023).

The European Commission's Joint Research Centre (JRC) monitors wildfires via two near real-time early warning systems: the European Forest Fire Information System[6] and the Global Wildfire Information System (GWIS n.d.). Since 2000, the JRC has published annual wildfire reports.[7] The 2022 edition (San-Miguel-Ayanz et al. 2023), covering 45 countries in Europe and MENA, reported 1.4 million hectares burned – a 20% increase over 2021. With nearly 900,000 hectares burned, 2022 was the second-worst fire season in the European Union. The report identifies recent extreme fire events as clear evidence of climate change impacts.

The IPCC AR6 (Ali et al. 2022; IPCC 2022, 271) lists Mediterranean Europe among the regions most at risk for increased fire frequency, burned area, and longer fire seasons. Wet cold winters promote biomass growth, increasing fuel for summer fires, while hot, dry summers and strong winds raise flammability and ignition risks (Batllori et al. 2013; Vafeidis et al. 2020). Climate models project that, under +1.5°C warming, annual burned area over Mediterranean Europe could increase by over 40% and may double or triple under a +3°C scenario (Turco et al. 2018). Heat-induced wildfire frequency could rise by 14% under RCP4.5 and by 30% under RCP8.5 by century's end (Ruffault et al. 2020).

Yet, non-climatic drivers – such as fire management, land-use change and urbanization – often have an even greater influence on wildfire impacts than climate change alone (Turco et al. 2017, 2019; IPCC 2022, 245; Xanthopoulos 2023). While fire hazard is increasing, improved prevention and management may help explain the declining forest area burned in Europe from 1985 to 2011 (Turco et al. 2016, 2018; Ali et al. 2022). In contrast, rural depopulation and agricultural land abandonment have raised fuel loads and reduced firebreaks, increasing fire risk in Southeastern Europe and the Middle East (Xanthopoulos and Nikolov 2019).

The JRC estimates that 96% of EU wildfires are caused by human actions – whether accidental or deliberate – highlighting the central role of public awareness and prevention. In 2022, for instance, fires in Morocco larger than 50 ha made up just 4% of fire events. However, they accounted for 96% of total burned area, underscoring the importance of early warning and rapid response systems (San-Miguel-Ayanz et al. 2023; Xanthopoulos 2023).

6 In 2015, the European Forest Fire Information System became part of the European Copernicus Emergency Management Service. See: https://effis.jrc.ec.europa.eu/

7 See https://effis.jrc.ec.europa.eu/reports-and-publications/annual-fire-reports for annual fire reports.

Droughts

Unlike long-term water scarcity or permanent aridity, drought is defined by its temporary nature (Rossi et al. 2023). Drought comes in multiple, interrelated forms. *Meteorological droughts* – defined as prolonged periods of low precipitation – can lead to *hydrological droughts*, where water storage, streamflow, and soil moisture decline. When water stress begins to affect vegetation growth or survival, *agricultural or ecological droughts* occur (Wilhite and Glantz 1985; Tramblay et al. 2020; Vafeidis et al. 2020; Douville et al. 2021; IPCC 2022, 579).

Droughts are complex social-ecological events shaped by both natural and human drivers. Natural drivers include precipitation deficit, rising evapotranspiration and wind, and reduced soil moisture and water retention capacity, while human factors include land and water management (van Loon et al. 2016; Tramblay et al. 2020; Rossi et al. 2023). Their impacts can be direct, indirect, or cascading, and may manifest far beyond the original location or time of onset (Tramblay et al. 2020; Hagenlocher et al. 2023; Rossi et al. 2023).

While future precipitation remains difficult to model precisely (IPCC 2022, 597), experts broadly agree that the Mediterranean Basin will experience a long-term decline in rainfall beyond historical variability under all climate scenarios (Barcikowska et al. 2018; Rojas et al. 2019; Tramblay et al. 2020; Ali et al. 2022). Analyzing tree-ring carbon and oxygen isotopes in relict and living oaks, Büntgen et al. (2021) demonstrated that the recent European summer droughts are unprecedented in the past two millennia and likely linked to anthropogenic warming.

These increasingly dry conditions, combined with higher evapotranspiration under global warming, are already intensifying the frequency, duration, and severity of agricultural and ecological droughts across the Mediterranean.[8] Impacts range from falling crop yields and declining fruit and wine quality – affecting, in turn, wine tourism – to widespread stress on forests and ecosystems (Valverde et al. 2015; Tramblay et al. 2020; Vafeidis et al. 2020; Ali et al. 2022; IPCC 2022, 580, 739).

Drought-induced ecosystem shifts – such as vegetation browning or mass tree mortality – can in turn alter local to global temperature, wind, and precipitation patterns. This occurs through feedback affecting albedo, surface roughness, GHG emissions, carbon storage, and energy and water fluxes between land and atmosphere (Jia et al. 2019).

8 Even under the ambitious mitigation targets of the Paris Agreement, Mediterranean droughts could become 5 to 10 times more frequent compared to the recent past (Naumann et al. 2018).

This trend toward aridification[9] – expected to be most severe in Northwest Africa, the Iberian Peninsula, and Greece – could surpass the magnitude of past millennial-scale changes and impose hard limits to adaptation (Guiot and Cramer 2016; Schleussner et al. 2016; Tramblay et al. 2020; IPCC 2022, 608, 649). Under a +4°C warming scenario without adaptation, annual drought-related economic losses in the European Union and the United Kingdom could rise from EUR 9 billion today to over EUR 65 billion by 2100. Agriculture is the most affected sector, accounting for 60% of all drought-related economic losses in Mediterranean Europe (Naumann et al. 2021).

The European Drought Observatory (EDO), part of the Copernicus Emergency Management Service, provides 10-day updates and long-term datasets on drought conditions (weather, vegetation, and soil) across Europe and MENA (EDO n.d.). Since 2011, the EDO has documented 24 severe drought events[10] – half of them since 2021 – highlighting the accelerating toll of climate change. The resulting shorter recovery windows between successive drought events, such as the 2022–2023 sequence, increase ecosystem vulnerability and amplify future risks (Toreti et al. 2022, 2023; Rossi et al. 2023).

To support risk assessment and planning, the JRC has developed a European Drought Risk Atlas (Rossi et al. 2023). Using machine learning and expert input, it evaluates current and future drought risks,[11] as well as impacts across five key systems: rainfed and irrigated agriculture, public water supply, energy production, inland transport, and terrestrial and freshwater ecosystems. A complementary database of drought impacts since 1977 will also be made publicly available to enhance preparedness and response strategies.

Floods

While IPCC AR5 (Collins et al. 2013) promoted the idea that wet regions would get wetter and dry regions drier, AR6 regards this analysis as overly simplistic (Douville et al. 2021; IPCC 2022, 608). Instead, there is strong scientific consensus that heavy precipitation events will become more frequent and intense with rising global temperatures (Seneviratne et al. 2021). In the Mediterranean Basin, while overall rainfall is projected to decline, precipitation is expected to become more erratic and unpredictable, increasing the risk of extreme weather events – especially flash floods in the northern Mediterranean region (Llasat et al. 2016; Vafeidis et al. 2020; Ali et al. 2022).

Flash flood risk, however, is not determined by rainfall patterns alone. Other local factors include watershed size and topography, urbanization, land-use changes and land management practices, soil structure and permeability, the presence of karst systems, and pre-existing soil moisture levels. These highly local variables make it difficult to detect broad regional trends in flash flood hazard clearly attributable to climate change, even with increased frequency and intensity of extreme precipitation events. Nonetheless, growing populations, urban sprawl, and land degradation have increased the vulnerability of Mediterranean communities to floods, amplifying the risks of injury, death, and financial losses (Gaume et al. 2016; Amponsah et al. 2018; Tramblay et al. 2019; Vafeidis et al. 2020; Ali et al. 2022; IPCC 2022, 573).

Floods also pose serious public health risks, especially for vulnerable populations. Standing water and runoff can promote bacterial outbreaks, algal blooms, and parasite transmission, while worsening access to safe water, sanitation, and hygiene (WHO 2017; Vafeidis et al. 2020).

To monitor and forecast these risks, the European Flood Awareness System (EFAS)[12] provides real-time flood forecasts across Europe and, more recently, the entire Mediterranean. With the 2020 update (EFAS 4.0), temporal resolution improved from daily to six-hourly, and the 2023 update (EFAS 5.0) refined spatial resolution from 5 km to approximately 1.4 km. While real-time data sets are restricted to EFAS partners, all datasets are made publicly available after 30 days.

Beyond inland flooding, the Mediterranean coastline faces growing threats from sea level rise, coastal erosion, and saltwater intrusion in coastal aquifers. Sea level in the Mediterranean rose by an average of 1.7 mm/year during the 20th century and accelerated to around 2.4 mm/year between 1993 and 2012 (Wöppelmann and Marcos 2012; Bonaduce et al. 2016). Projections estimate a rise of 15–33 cm by 2050 and up to 1.1 metres by 2100, depending on the climate scenario. This rise could be even greater if Greenland or Antarctic ice sheets collapse. Crucially, sea level rise is now considered irreversible over centuries to millennia, regardless of near-term mitigation efforts (Ali et al. 2022).

Mediterranean communities are particularly vulnerable due to their adaptation to an environment with minimal tidal fluctuation. As a result, the coastline is densely populated and urbanized. Today, one-third of the region's population lives in coastal zones – a number that could grow by 130% by 2100, especially in southern countries (Reimann et al. 2018a). Much of this infrastructure sits just metres above sea level, leaving it highly exposed to even modest sea level increases (Vafeidis et al. 2020; Ali et al. 2022).

9 By 2100, under RCP8.5, Mediterranean arid zones could increase by almost 400,000 km2, more than twice their current extent and three times the size of Greece (Barredo et al. 2018; Tramblay et al. 2020).

10 As of 27 February 2024. https://joint-research-centre.ec.europa.eu/european-and-global-drought-observatories/drought-reports_en

11 Where, in line with IPCC (2023) definitions, the level of risk is the result of the interaction between hazard, exposure, and vulnerability.

12 The EFAS has been fully operational since autumn 2012 and is integrated into the European Copernicus Emergency Management Service. See: https://www.efas.eu/

Without significant investment in coastal protection and adaptation, economic losses from coastal flooding could increase by two to three orders of magnitude by 2100 (Vousdoukas et al. 2018; Vafeidis et al. 2020). In some areas, particularly under high-emissions scenarios, the costs and feasibility of adaptation may become prohibitive. The IPCC expresses low confidence in regional long-term adaptive capacity, especially beyond 2100 or under scenarios of rapid ice-sheet collapse (Ali et al. 2022).

The consequences for agriculture and tourism – two key sectors in the Mediterranean economy – will be profound. The region is the world's top tourist destination, hosting 330 million visitors in 2016, or one-third of global tourism (Tovar-Sánchez et al. 2019; Ali et al. 2022). The agriculture sector (including forestry and fishing) – although its contribution to gross domestic product has declined[13] – remains vital for food security, rural livelihoods, and water resource management. Coastal erosion, flooding, and seawater intrusion threaten both water quality and agricultural productivity, potentially rendering some areas unfit for cultivation.

Coastal tourism is also at risk: the characteristic Mediterranean sandy beaches are increasingly eroding and could vanish entirely in some locations. Coastal ecosystems will suffer as well (Ali et al. 2022). Cultural heritage is under threat, too. Most UNESCO World Heritage sites in low-lying Mediterranean areas are already at risk from flooding or erosion, and sea level rise will increase these risks by 2100 (Reimann et al. 2018b).

Resilience for whom?

Diversity and redundancy are key components of resilient systems, but they involve trade-offs and costs (Pingault and Martius 2024). This brings into focus deeper questions about who gains and who loses from resilience-building efforts. It matters not only who benefits from increased resilience, but also who shoulders the burden – whether in terms of financial cost, restricted choices, or heightened vulnerability. Decisions about what should be made resilient – and to what stressors – are shaped by value judgements, conflicting interests, and political priorities. Making such decisions involve defining which system states are considered desirable, which outcomes are worth preserving or pursuing, and which risks must be accepted or avoided – not easy questions.

Equally important is the question of who holds the power to make these decisions. Whose knowledge and perspectives inform the framing of resilience goals? Who decides which trade-offs are acceptable? These questions are not merely technical – they are fundamentally normative and political. Influenced by their values, interests, and experiences, different actors and stakeholder groups may hold divergent views about which futures are feasible, fair, or even imaginable, and what constitutes a desirable or feasible system state (Walker et al. 2006). Pingault and Martius (2025) proposed a systematic framework to assess the feasibility and desirability and prioritize alternative mitigation options in land use and food systems.

Ultimately, asking "resilience for whom?" requires confronting the politics of inclusion, voice, and legitimacy in decision making. The question exposes power asymmetries, as dominant actors may shape resilience strategies in ways that reflect their own priorities while marginalizing less powerful groups. When elites capture decision making, resilience-building efforts risk reinforcing inequalities rather than reducing them (Lebel et al. 2006; Nelson et al. 2007; Davoudi 2012; Ensor et al. 2016; Cinner and Barnes 2019).

Approaches like adaptive co-management and decentralized governance are often proposed to address these asymmetries (Nelson et al. 2007). While promising, these approaches are not immune to manipulation and power may be redistributed in appearance rather than in practice (Brockhaus and Angelsen 2012; Sarmiento Barletti and Larson 2019). Genuine inclusion requires more than formal participation: it demands attention to voice, equity, and influence in shaping outcomes.

Considering synergies and navigating trade-offs is important in this context – not only across development goals, sectors, and scales, but also among stakeholder groups, both local and distant. Integrated approaches to resilience and sustainability aim to find desirable and feasible "win-win" outcomes that balance conservation and development.[14] Yet, most decisions create both winners and losers. Even well-designed processes are unlikely to equally satisfy all interests.

In this context, a more grounded principle may be to strive for "more winners, fewer losers". This implies embracing negotiation, compromise, and transparency. Inclusive and well-facilitated decision-making processes can help identify potential conflicts early on. This would allow for co-created strategies that maximize collective gains while minimizing – or offering fair compensating for – losses (McShane et al. 2011; Sayer et al. 2014; Reed et al. 2020, 2021). While ideal outcomes may not always be possible, legitimacy and fairness in the process can foster more durable and broadly supported resilience strategies.

13 According to FAOSTAT, in 2021, in average for the 23 countries of the region, agriculture at large represented only 3.2% of gross domestic product (GDP) but still 11.5% of total employment. Agriculture remains important in some countries like Morocco and Albania (34.6% of total employment); or in the Syrian Arab Republic (20.6% of total GDP). See: https://www.fao.org/faostat/en/#data/MK (last update 5 December 2023, accessed 4 March 2024); https://www.fao.org/faostat/en/#data/OEA (last update 17 July 2023, accessed 4 March 2024, data on employment based on ILO modelled estimates).

14 See for instance the literature developed around the notion of integrated landscape approaches (e.g., Reed et al. 2020, 2021).

Conclusion: Towards a coherent resilience agenda for the Mediterranean

The Mediterranean Basin is at the frontline of global climate change. The region is warming faster than the global average, and facing converging pressures from land degradation, water scarcity, and biodiversity loss, as well as demographic changes and rural exodus. This demonstrates both the urgency and complexity of building social-ecological resilience. These pressures are not distributed evenly: vulnerabilities are shaped by geography, land-use history, socioeconomic conditions, and access to natural, technical and financial resources, infrastructure, institutions, and governance. In this context, the concept of resilience, applied with nuance, offers a unifying framework to understand and respond to interlinked environmental, social, and economic risks.

A key insight is that resilience must be operationalized through differentiation. There is no one-size-fits-all solution for Mediterranean landscapes. The North and South face distinct stressors and institutional contexts, requiring tailored interventions. In the North, depopulated rural areas and intensifying wildfire regimes demand renewed investment in mosaic landscapes, invigorated low-intensity land uses, and fire-smart landscape planning. In the South, resilience hinges on sustaining extensive pastoral systems, improving water management and drought tolerance of crops, and reinforcing early warning and rural infrastructure systems. Climate-smart practices in both regions must be backed by coherent, inclusive policies that integrate land, water, and biodiversity planning. Yet, North-to-South differences are only a larger trend; smaller differences need to be addressed in locally contextualized approaches, too.

Moreover, resilience is about managing both biophysical hazards and trade-offs. Whether between competing land uses, short- and long-term gains, or conservation and production goals, resilience planning inevitably creates winners and losers. This raises fundamental questions of equity, legitimacy, and agency. Decisions about “what” and “whom” to make resilient are inherently political. They must be approached with full awareness of power asymmetries, participatory gaps, and the risks of elite capture. Inclusive governance – while challenging to implement – remains essential for durable and just resilience outcomes.

In parallel, technology must be seen not as a panacea but as an enabler. Early warning systems, smart irrigation, remote sensing, and drought-resilient seeds all offer potential, but their impact depends on the institutions and capacities that surround them. Without equitable access, local adaptation, and robust feedback loops, even the most advanced tools may widen rather than narrow resilience gaps. Investing in context-appropriate innovation and knowledge systems is thus a core pillar of resilience.

The region’s resilience strategy must also embrace anticipatory planning and cross-sectoral integration. This includes strengthening the links between science, policy, and practice; aligning local resilience strategies with national and regional adaptation frameworks; and ensuring that resilience-building efforts are sustained over time. Efforts should go beyond managing immediate risks and focus on building the enabling conditions for long-term transformation, especially in rural areas where adaptive capacity remains lowest.

As the Mediterranean climate crosses critical and sometimes irreversible thresholds and is susceptible to enter completely unknown territory, the resilience of its landscapes will define the sustainability of its societies. This paper shows that resilience is not a fixed goal but a negotiated, contested process rooted in ecological realities, institutional capacities, and social choices. Building resilience means not just weathering disturbances, but transforming systems to be more adaptable, more regenerative, and fairer. It also means embracing differentiated, context-sensitive strategies, managing the inevitable trade-offs, and prioritizing governance structures that are inclusive, transparent, and accountable. Only by grounding resilience in both biophysical and political realities can Mediterranean countries build futures that are viable, just, and climate smart.

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CIFOR-ICRAF

The Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF) harnesses the power of trees, forests and agroforestry landscapes to shift the trajectories of three global issues – biodiversity, climate change and food security – supported by our work on equity and value chains. CIFOR and ICRAF are CGIAR Research Centers.

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