CHAPTER 7. SOCIETAL TRANSFORMATION FOR A SUSTAINABLE FUTURE

Coordinating Lead Authors: Mohamed BEHNASSI (Morocco, Italy), Elisa FURLAN (Italy), Feliu LÓPEZ-I-GELATS (Spain)

Lead Authors: Rachid MRABET (Morocco), Désirée A.L QUAGLIAROTTI (Italy), Mar SATORRAS (Spain), Eirini SKRIMIZEA (Greece)

Contributing Authors: Miquel MONÉS (Spain)

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Key messages as a basis for the Executive Summary

- Climate change in the Mediterranean acts as a core component of a global polycrisis. It constitutes a foundational, systemic threat that cascades across ecological, economic, political, and social domains through complex, transboundary, and compounding social-ecological interactions.
- Accelerating climate risks necessitate a shift from incremental adjustments toward transformative approaches. Conventional, sector-specific adaptation and coping strategies are increasingly insufficient; building effective regional resilience asks for targeting the root causes of vulnerability and thoroughly reorganising resource governance and institutional frameworks.
- The conceptualisation of transformation has shifted from a reactive adaptation alternative to an integrated paradigm for Earth system stability. Prompted by the recognised limits of incremental strategies under severe warming trajectories, the concept systematically links climate action with broader socio-ecological transitions. It provides the operational tools required to navigate global environmental crises and keep socio-ecological systems within a safe operating space.
- Translating transformation theory into practice requires structured, non-linear, and flexible methodological frameworks. Methodologies such as strategic foresight and Dynamic Adaptive Pathways Planning are critical to map adaptable solution spaces, allowing policymakers to navigate deep uncertainty while avoiding permanent or costly technological and structural lock-ins.
- The assessed case-study literature documents more transition processes and transformative potential than consolidated transformations. Most of the 69 cases involve partial, sectoral, local, or regionally bounded changes, while systemic changes and cases classified as transformations are less frequent.
- The evidence base is uneven across the Mediterranean. Most assessed cases are concentrated in Western Mediterranean countries, especially France, Italy, Spain, while southern and eastern Mediterranean contexts are much less represented. This limits the extent to which findings can be generalised across the whole region.
- Documented transformation and transition processes are often place-based and institutionally mediated. Public authorities are the most frequently identified agents of change, while local communities, rural livelihood groups, and ecological systems are more often identified as vulnerable groups, intended beneficiaries, or systems at risk. Farmers, fishers, and rural producers are a notable exception, appearing both as vulnerable actors and as active agents of change.
- Agri-food systems, environmental pressures, and mixed knowledge systems are central in the assessed evidence. Agri-food systems are the most frequently documented domain, while environmental and climate-related pressures are the most frequently reported drivers. Most cases also involve mixed knowledge, combining scientific, institutional, experiential, and locally grounded understandings of change.
- Transformative potential is more often documented where local initiatives are connected with supportive governance, participation, knowledge exchange, resources, and long-term institutional support. Conversely, fragmented governance, weak coordination, limited resources, entrenched socio-economic regimes, and difficulties in sustaining collective engagement constrain the consolidation, scaling, and durability of transformation and transition processes.
- The future of the Mediterranean will be shaped by the interaction of climate change, environmental degradation, demographic dynamics, technological innovation, geopolitical uncertainty and evolving governance arrangements. These interacting drivers create multiple plausible futures ranging from fragmentation and escalating vulnerability to cooperation, resilience and regenerative development. Scenario-based approaches provide an essential framework for navigating uncertainty, assessing systemic risks and identifying robust pathways capable of remaining effective across contrasting future conditions.
- Future Mediterranean resilience will depend on transformations across a limited number of highly interconnected strategic systems, particularly water, food, energy, marine and coastal systems, cities and territories, and governance, finance and knowledge systems. The growing

interdependence among these domains means that sector-specific responses are increasingly insufficient, requiring integrated approaches capable of managing cascading risks, trade-offs and synergies across social, ecological and economic systems.

- Transformation in the Mediterranean requires coordinated action across multiple governance levels, from local communities and territories to national institutions and transboundary cooperation frameworks. Effective transformation depends on strengthening agency capacities, policy coherence, adaptive governance, participatory decision-making and cross-border collaboration capable of addressing asymmetries in vulnerability, adaptive capacity and access to resources across the region.
- The Water–Energy–Food–Ecosystems (WEFE) nexus constitutes one of the most powerful integrative entry points for Mediterranean transformation. By explicitly addressing interdependencies among resource systems, the WEFE approach provides a practical framework for reducing maladaptation risks, enhancing policy coherence, maximising co-benefits and aligning climate adaptation, biodiversity conservation, food security, energy transitions and sustainable development objectives.
- Transformation pathways should be understood not as a separate policy agenda but as the integrative framework through which climate adaptation, mitigation, biodiversity conservation, sustainable resource management, economic resilience and social justice can be pursued simultaneously. As climate and environmental pressures intensify, proactive investments in resilience, ecosystem restoration, adaptive governance and systemic transformation have the potential to increasingly generate greater long-term benefits than delayed or fragmented responses, while reducing the risk of crossing critical ecological and socio-economic thresholds.

The evidence presented throughout MAR2 highlights that climate change in the Mediterranean region constitutes a foundational systemic threat that cascades across ecological, economic, political, and social domains through complex social-ecological interactions. The report has also emphasised the inherently transboundary character of both climate risks and climate responses. Transboundary climate risks can propagate across borders and generate impacts in distant countries and regions through multiple pathways, including biophysical, financial, trade, human mobility, and geopolitical channels (Benzie et al. 2016; Opitz-Stapleton et al. 2023). Likewise, adaptation actions undertaken to enhance resilience in one location may unintentionally generate new risks elsewhere if vulnerabilities are displaced rather than reduced. As discussed in previous chapters, climate change does not occur in isolation but interacts with other global environmental crises, notably biodiversity loss and pollution, as well as with broader socio-economic and geopolitical challenges. These interconnected crises reinforce one another through shared drivers, positive feedbacks, cascading effects, and compounding impacts that threaten both planetary and human well-being. In this perspective, climate change is not simply one crisis among many but a central component of the global polycrisis in which multiple environmental, social, economic, and political disruptions interact in ways that often amplify risks beyond the sum of their individual effects. Furthermore, the systemic nature of Mediterranean vulnerabilities is particularly evident in the Water-Energy-Food-Ecosystems (WEFE) nexus, which has emerged throughout this report as a defining feature of both vulnerability and resilience in the region. Within the WEFE nexus, efforts to address challenges in a single sector may inadvertently shift pressures to other sectors or generate unintended trade-offs. Climate change further intensifies these existing pressures and interdependencies, with far-reaching implications for water security, food production, energy provision, ecosystem functioning, and human well-being (MedECC 2024b). At the same time, disruptions originating in the WEFE nexus can generate positive feedback that exacerbate climate risks and deepen existing social and environmental vulnerabilities. Taken together, these characteristics suggest that addressing climate change in the Mediterranean requires moving beyond incremental and sector-specific responses towards transformative approaches capable of addressing the systemic, transboundary, and interconnected nature of regional risks. Such approaches must account not only for the direct impacts of climate change, but also for its interactions with other environmental, socio-economic, and geopolitical crises and for the cascading dynamics that increasingly define the Mediterranean polycrisis.

In this setting, Chapter 7 synthesises current knowledge on social–ecological transformations relevant to the Mediterranean and concludes the MAR2 report with a forward-looking perspective of pathways toward sustainability. Integrating findings from previous chapters with insights from scientific literature, regional policy frameworks, documented transformation experiences, and foresight studies, it conceptualises transformations in the Mediterranean and assesses how they emerge across sectors and scales, and the conditions that support or hinder them. The chapter identifies areas of convergence, uncertainty, and knowledge gaps, and synthesises opportunities for systemic, just, and collective approaches that may contribute to resilient and sustainable futures in the Mediterranean. Transformation (Section 7.1) is firstly conceptualised by clarifying its meaning, scope, and operational dimensions for the specific context of Mediterranean social–ecological systems, and by reviewing key overarching frameworks and methodological approaches used to study and promote transformative change. It then explores how transformation unfolds on the ground (Section 7.2), appraising evidence of transformation processes toward sustainability in diverse Mediterranean contexts, capturing from these experiences common features, enabling conditions, persistent barriers and gaps still occurring across sectors, territories, and governance levels. Building on this empirical knowledge, the chapter examines potential transformative futures (Section 7.3), including plausible scenario narratives for the Mediterranean and the levers of transformation operating at multiple scales to achieve the desired future. The chapter concludes by distilling actionable principles and systemic transformation pathways (Section 7.4) tailored to the Mediterranean context, providing a synthesis roadmap intended to support both scientific understanding and policy-relevant action on transformation in the Mediterranean region.

7.1 Conceptualisation of transformation in the Mediterranean context

7.1.1 Conceptualisation of transformation for sustainable futures

Building on early contributions from sustainability transitions and resilience scholarship in the early 2000s (Rotmans et al. 2001; Geels 2002; Walker et al. 2004; Nelson et al. 2007; Folke et al. 2010), scholarly interest in transformation and its relationship with climate change has expanded significantly over the past two decades, gaining increasing prominence across diverse strands of scientific literature and within major global and regional assessment processes addressing environmental challenges (Feola 2015; IPCC 2022; IPBES 2024; UNEP 2025). It has also become central to debates on planetary boundaries, ecological and social tipping points, and Earth system stability, which emphasise the risks associated with crossing critical thresholds beyond which socio-ecological systems may experience irreversible degradation, systemic disruption, or the loss of essential functions (Lenton et al. 2008; Rockström et al. 2009; Dow et al. 2013; Lenton et al. 2025).

While this expanding literature has enriched debates on the meaning, scope, and characteristics of transformative change, it has also generated persistent conceptual ambiguity regarding how transformation can be identified and distinguished from incremental forms of climate action in both theory and practice (Feola 2015; Pelling et al. 2015; Termeer et al. 2016; Few et al. 2017; Engbersen et al. 2024; UNFCCC 2024a; de Castro et al. 2025).

To reconstruct the evolution of the concept of transformation in the context of climate change, we conducted a systematic scoping review aimed at identifying key conceptual contributions across adaptation, mitigation, resilience, socio-ecological transitions, and broader sustainability scholarship. Relevant literature was retrieved from the Web of Science and Scopus databases using a search strategy designed to capture the diverse ways in which transformation has been conceptualised in relation to climate change and sustainability challenges. The final search string was structured as follows:

('transform' OR 'transformative change' OR 'transformative adaptation' OR 'transformational adaptation' OR 'transformative resilience' OR 'societal transformation') AND ('climate change' OR 'climate action' OR 'sustainability') AND ('social system*' OR 'ecological system*' OR 'social-ecological system*' OR 'socio-ecological system*').*

This search strategy was designed to capture literature addressing transformative processes across adaptation, mitigation, resilience, and sustainability domains, while ensuring relevance to social, ecological, and coupled social-ecological systems. The search was limited to peer-reviewed publications from 2005 onwards, reflecting the period during which transformation emerged as an increasingly prominent concept within climate change adaptation, sustainability transitions, resilience, and broader sustainability scholarship. Non-English documents, items outside the defined time period, and document types other than articles, reviews, and assessments were excluded. Given that some foundational contributions to sustainability transitions and resilience research predate the widespread adoption of transformation-related terminology, the review was complemented by backward and forward citation tracking of highly cited seminal publications. This additional step enabled the inclusion of influential works that have shaped contemporary understandings of transformation but may not be captured through keyword-based searches alone. The search yielded 1,741 documents in total. All records were screened by title and abstract to assess eligibility for inclusion in the final review, following predefined inclusion and exclusion criteria. The resulting body of literature was subsequently analysed to identify major conceptual developments, recurring themes, and evolving interpretations of transformation over time.

Drawing on the selected publications, a growing body of research traces the emergence of transformation within climate change research to adaptation scholarship. Concerns over the limits of conventional coping and incremental adaptation strategies under accelerating climate change have prompted attention to more fundamental forms of change. Such concerns became particularly salient in discussions surrounding high-emissions scenarios and warming trajectories exceeding 4°C (Smith et al. 2011). Under these conditions, transformation came to be viewed not merely as an alternative adaptation strategy, but as a necessary response when existing system configurations are no longer capable of sustaining desired functions, livelihoods, and levels of well-being in the face of climate change (Folke et al. 2010; Pelling et al. 2010; Park et al. 2012; Kates et al. 2012; Pelling, et al. 2015; Few et al. 2017; Wilson et al. 2020).

Critical social science literature on environmental change has expanded understandings of climate risk by arguing that addressing it requires not only impact reduction, but also attention to the social, economic, and institutional structures that produce and reproduce vulnerability over time and space (Pelling 2011; Ribot 2011; Few et al. 2017; Fedele et al. 2019). Building on these insights, vulnerability is conceptualised not simply as a function of environmental exposure, but as a condition produced through economically, socially, and politically structured inequalities that shape differential sensitivity and adaptive capacity. Within this framing, transformative adaptation is understood as adaptation that goes beyond incremental adjustments by engaging with these structural conditions (Ribot 2011; Fedele et al. 2019).

The concept then evolved into an integrated framework linking adaptation, mitigation, and sustainable development, where transformation is associated with shifts in development pathways, governance systems, and socio-economic structures shaping emissions, vulnerability, and sustainability outcomes (Grin et al. 2010; O'Brien et al. 2014; Olsson et al. 2014; Hajer et al. 2015; Pelling et al. 2015; Gillard et al. 2016; Termeer et al. 2017; O'Brien 2018; Berrang-Ford et al. 2021; UNEP 2024). This approach moves beyond conventional distinctions between mitigation and adaptation, framing climate action as a catalyst for wider socio-ecological transformations capable of advancing environmental sustainability while also addressing questions of social justice, equity, and human well-being (Tschakert et al. 2013; Novy and Barlow 2022).

The rising centrality of transformation in scientific debates has been consolidated by global and regional environmental assessment processes, which have played a key role in bridging scientific knowledge and policy discourse. Institutions such as the IPCC, IPBES, UNEP, and MedECC have synthesised and systematised insights emerging from the academic literature while progressively expanding the concept into a broader framework for addressing climate change, biodiversity loss, sustainability transitions, and socio-ecological development. The evolution of the concept of transformative change within the IPCC literature reflects a profound shift in the way climate change itself has been understood over time. Across successive assessment cycles and Special Reports, climate change progressively moved from being framed as an environmental and technological problem to being recognised as a systemic socio-economic and governance challenge requiring deep structural transformation. A decisive turning point occurred with the

Special Report on Managing the Risks of Extreme Events and Disasters (SREX) (IPCC 2012), which reframed adaptation through the lens of systemic risk governance. SREX introduced transformational adaptation as part of a continuum ranging from incremental adjustments to more profound forms of systemic change, marking a shift from adaptation as a set of technical measures toward a process involving resilience, governance, learning, and longer-term societal transformation. These developments were consolidated in the Fifth Assessment Report (AR5), which introduced key concepts such as climate-resilient pathways, transformational versus incremental adaptation, and adaptation limits (IPCC 2014). The Sixth Assessment Report (AR6) further develops this conceptualisation by defining transformation as a 'change in the fundamental attributes of natural and human systems' and positioning it at the core of climate-resilient development pathways, which seeks to advance adaptation, mitigation, and sustainable development in an integrated manner (IPCC 2022). A distinctive contribution of AR6 is its stronger emphasis on adaptation limits and the consequences of delayed climate action, highlighting how rising climate risks progressively constrain available adaptation options. Change is no longer portrayed exclusively as a deliberate pathway toward desirable futures; it may also emerge as a reactive and often undesirable process when insufficient climate action forces socio-ecological systems to reorganise under escalating risks and declining adaptive capacity. Across Working Groups and chapters, the concept is addressed through multiple and complementary lenses, associating it with systemic socio-ecological change (Begum et al. 2022), climate-resilient development pathways (Schipper et al. 2022), socio-technical transitions (Lecocq et al. 2022), and broader sustainability transformations (Denton et al. 2022). Collectively, these perspectives highlight diverse scales, drivers, and manifestations of transformative change, while reinforcing the need for fundamental shifts in social, economic, institutional, and technological systems to address climate change. At regional level, MedECC's contribution lies primarily in contextualising existing transformation narratives within the specific environmental and socio-economic realities of the Mediterranean region. Its Special Reports - the Climate and Environmental Coastal Risks (MedECC 2024a) and the Climate–WEFE nexus (MedECC 2024b) - illustrates how the concept of transformation is being translated within the specific socio-ecological challenges of the Mediterranean region. While they draw extensively on the conceptual foundations established by the IPCC, they emphasise different dimensions of transformation and therefore provide complementary perspectives on the changes required to address climate risks. The Special Report Climate and Environmental Coastal Risks (MedECC 2024a) approaches transformation primarily through the concept of climate-resilient development pathways, defined as trajectories that integrate sustainable development, poverty eradication, and inequality reduction with equitable adaptation and resilience-building across scales in a changing climate. Such pathways explicitly engage with the ethical, equity, and feasibility dimensions of the deep societal change required to substantially reduce emissions, limit global warming, and enable desirable and liveable futures. By contrast, the Special Report on the Climate–WEFE nexus (MedECC 2024b) adopts a different lens, foregrounding governance and resource interdependencies as the main arena for systemic change. Transformation is understood less as a pathway and more as a process of institutional and societal reorganisation capable of managing the complex interactions between water, energy, food, and ecosystems. Accordingly, transformative change focuses on institutional coordination and the management of cross-sectoral trade-offs. In particular, the report situates transformative solutions for WEFE components along a continuum of response options ranging from incremental to transformative, spanning scientific and technological innovation as well as socio-ecological and behavioural change. Taken together, the two reports reflect a shared understanding of transformation as systemic, multi-scalar, and aligned with sustainability and equity objectives, while differing in their primary analytical entry points: development pathways in the case of coastal risks, and governance and resource interdependencies in the case of the WEFE nexus.

Parallel developments in sustainability literature suggest that addressing global environmental crises, potentially driven by self-reinforcing dynamics, requires deep systemic change. Closely aligned with the IPCC, the recent IPBES Thematic Assessment Report on the underlying causes of biodiversity loss and the determinants of transformative change and options for achieving the 2050 vision for biodiversity, further advances the conceptualisation of transformative change. It frames it as both urgent and necessary to address the interconnected crises of biodiversity loss, climate change, pollution, and ecosystem

degradation (IPBES 2024). A distinctive contribution of the assessment is its explicit distinction between reformative and transformative approaches. Whereas most conservation and sustainability efforts seek to improve existing systems, the report argues that addressing the root causes of biodiversity loss requires fundamental changes in the structures, values, and practices that shape human–nature relations. Accordingly, transformative change is defined as a process of system-wide shifts across three interrelated dimensions: views (ways of seeing, thinking, and knowing), structures (ways of organising, regulating, and governing), and practices (ways of doing, behaving, and relating). While each dimension offers a potential entry point for change, the assessment emphasises that profound and enduring transformations emerge when shifts occur across all three in a mutually reinforcing manner. The report further identifies a set of deeply embedded and interconnected drivers that perpetuate unsustainable trajectories, including disconnection from and domination over nature and people, concentrations of power and wealth, and the prioritisation of short-term material gains. Building on this diagnosis, IPBES strengthens the normative foundations of transformative change through four guiding principles aimed at halting and reversing biodiversity loss and achieving the 2050 Vision for Biodiversity '*Living in Harmony with Nature*': equity and justice; pluralism and inclusion; respectful and reciprocal human–nature relationships; and adaptive learning and action. In this perspective, transformative change is conceived as a whole-of-society and whole-of-government process that requires collective engagement across multiple domains of decision-making and action. The UNEP Seventh Global Environment Outlook (GEO-7) further extends the concept as a central framework for addressing the convergence of multiple human-induced environmental crises, including climate change, biodiversity loss, land degradation, pollution, and waste (UNEP 2025). The report emphasises that these crises are deeply interconnected and mutually reinforcing, increasing the risk of crossing critical planetary tipping points. Within this context, transformative change is framed as an urgent, system-wide response required to stabilise Earth systems while advancing human well-being, economic prosperity, and environmental sustainability. GEO-7 conceptualises transformation as an integrated process operating across interconnected socio-economic, socio-technical, and socio-ecological systems. It identifies five key systems requiring change—economic and financial systems, energy systems, food systems, materials and waste systems, and environmental systems—and argues that coordinated transitions across these domains are essential to reduce environmental pressures, strengthen resilience, and generate synergies between climate action, biodiversity conservation, and sustainable development. Overall, GEO-7 reinforces the understanding of transformative change as a systemic, multidimensional, and governance-intensive process requiring coordinated action across environmental, economic, technological, institutional, and social systems.

The tipping point and planetary boundaries literature emphasises that transformative change is required to avoid crossing critical Earth system thresholds and remain within a safe operating space, calling for a shift from managing known risks to navigating uncertainty and from incremental adjustments to fundamental systemic change (Lenton et al. 2008; Rockström et al. 2009a; Rockström et al. 2009b; Lenton 2011; Steffen et al. 2015; Lenton et al. 2025). It also links transformation to the concept of positive tipping points, whereby targeted interventions can trigger self-reinforcing systemic shifts toward sustainability (Lenton et al. 2025). Within this perspective, transformation is understood as a fundamental reconfiguration of socio-ecological, governance, and energy systems, guided by principles of resilience, equity, and Earth system justice (Dow et al. 2013; Díaz et al. 2019; Richardson et al. 2023).

The growing prominence of transformational adaptation within the scientific literature has increasingly translated into its recognition in international climate governance, particularly within the UNFCCC process. COP28 and COP30 illustrate a gradual shift from conceptual introduction to political consolidation, and finally to implementation-oriented mainstreaming of transformational adaptation, albeit without achieving definitional convergence. The COP28 decision adopted in Dubai in 2023 explicitly recognised the importance of both incremental and transformational adaptation and called for strengthening capacities to support both approaches (UNFCCC 2023). It also requested the UNFCCC Secretariat to further develop conceptual understandings and approaches for assessing transformational adaptation, reflecting the growing relevance of the concept within international adaptation policy. In response, the Secretariat produced a technical report in 2024 reviewing existing definitions, conceptual approaches, and

methodological challenges associated with transformational adaptation and defining transformative actions as those capable of generating 'rapid change at scale' (UNFCCC 2024a). However, the report also highlighted the diversity of interpretations in the scientific literature and underscored the absence of a universally agreed definition, reflecting ongoing debates on the scale, depth, and normative dimensions of transformative change. Despite these efforts, discussions during COP29 in Baku confirmed that transformational adaptation remains a contested concept within international negotiations. While Parties reiterated the importance of both incremental and transformational pathways, limited progress was made towards establishing a shared understanding of transformation meaning, operationalisation, and implications. For some actors, transformational adaptation implies fundamental changes in development pathways, institutions, and socio-economic systems, whereas for others it remains difficult to distinguish from more ambitious forms of incremental adaptation. COP29 advanced the Baku Adaptation Roadmap, seeking to strengthen adaptation implementation and elevate its political profile within the climate regime (UNFCCC 2024b). The roadmap has also been seen by some Parties as a potential platform for further dialogue and knowledge exchange on transformational adaptation. COP30 further reinforces the political centrality of adaptation while simultaneously exposing the continued lack of consensus on the meaning and operationalisation of transformational adaptation. Beyond the adaptation agenda itself, references to transformational approaches have increasingly emerged across multiple UNFCCC negotiation streams, including the New Collective Quantified Goal on Climate Finance (NCQG), the revision of National Adaptation Plan (NAP) guidance, the operationalisation of Loss and Damage arrangements, and the Second Global Stocktake. Similarly, at the European level, the EU Mission on Adaptation to Climate Change, launched in 2021 to accelerate climate resilience across Europe, explicitly builds on the IPCC conceptualisation of transformational adaptation and promotes a shared understanding of adaptation across EU-funded research and innovation initiatives. Within this framework, incremental adaptation is understood as a gradual and often sector-specific process focused on addressing immediate climate risks through discrete measures, whereas transformational adaptation is framed as a whole-of-society approach that addresses the structural drivers of vulnerability, fosters change across interconnected socio-ecological systems, and aligns adaptation efforts with broader sustainability and equity objectives, with the aim of ensuring that no individual, community, or sector are left behind (Cools et al. 2024).

Within multilateral climate finance institutions, the Climate Investment Funds (CIF) provide one of the most operationalised conceptualisations of transformational change, defining it as a 'fundamental change in systems relevant to climate action with large-scale positive impacts that shift and accelerate the trajectory of progress toward climate-neutral, inclusive, resilient, and sustainable development pathways' (CIF 2022). This working definition represents an evolution from earlier formulations focused more narrowly on market transformation, reflecting instead a broader systemic understanding of change as a process that reshapes interconnected ecological, social, economic, political, and technological systems in ways that enable climate action and sustainable development. A distinctive contribution of the CIF framework is its explicit recognition of the distributive and political dimensions of transformation, acknowledging that transformational processes generate uneven costs and benefits across actors, sectors, and territories, thereby making considerations of equity, inclusivity, and just transition central to their design and implementation.

Foresight exercises such as MED 2050 (Plan Bleu 2025) contribute to the debate on transformation by exploring long term socio-ecological trends, risks, and opportunities in the Mediterranean region up to 2050. Although the study does not explicitly adopt the language of transformative change, it addresses processes of systemic change through its emphasis on integrated and cross-sectoral responses aimed at enhancing resilience, reducing vulnerability, and advancing sustainability. In this respect, MED 2050 complements existing conceptualisation on transformation by highlighting how long-term development trajectories may shape both the opportunities and constraints for transformative change in the Mediterranean region.

Recent scholarship increasingly situates transformative change within the context of a global polycrisis characterised by the interaction of multiple, interconnected environmental, social, economic, and

geopolitical challenges (WEF 2013; Simpson et al. 2021; IPBES 2024; Lawrence et al. 2024; Rakowski et al. 2025). This condition of cascading crises challenges existing governance arrangements and raises questions about the capacity of current sustainability strategies and policy frameworks to respond to accelerating and compounding risks. Within this context, transformation is increasingly understood not only as a pathway towards sustainability but also as a necessary condition for navigating systemic risks and building resilience in an increasingly uncertain world. Recent contributions argue that both incremental and transformative capacities are essential for responding to the global polycrisis, as societies must simultaneously cope with immediate shocks while addressing the structural drivers of long-term vulnerability and unsustainable trajectories. In this way, they highlight the need for governance approaches capable of anticipating, absorbing, adapting to, and ultimately reshaping socio-ecological systems under deep uncertainty and accelerating change (Richardson 2025; Søgaard Jørgensen et al. 2026).

The growing recognition of the polycrisis has also stimulated new conceptual developments around transformative resilience. The European Environment Agency (EEA) has introduced transformative resilience as a set of interrelated capacities required to govern sustainability transitions under conditions of interacting crises (EEA 2024). In this framing, resilience extends beyond the ability to absorb disturbances and recover from shocks, encompassing the capacity to reorganise systems, institutions, and development trajectories towards more sustainable, equitable, and resilient futures. The concept is particularly relevant for key sustainability transitions, including the decarbonisation of energy systems, the shift towards a circular economy, and just transitions across sectors and territories. At the same time, the polycrisis perspective reinforces the need for integrated approaches capable of addressing the interconnected nature of climate, biodiversity, and equity challenges. Recent work on integrated transformative scenarios argues that addressing the climate–nature–equity polycrisis requires analytical frameworks that transcend sectoral boundaries and explicitly account for interactions, trade-offs, and synergies across multiple dimensions of sustainability (Pereira et al. 2026). From this perspective, transformative change emerges both as a response to and a condition for navigating the polycrisis, requiring profound shifts in social, economic, political, and ecological systems that extend well beyond incremental adaptation and conventional policy interventions.

Collectively, as illustrated in Figure 7.1, this body of literature shows how transformation has evolved from a concept initially rooted in climate adaptation and concerns over the limits of incremental responses to climate change into a broader framework for understanding and guiding systemic socio-ecological change. This evolution can be understood as a series of overlapping and mutually reinforcing developments across peer-reviewed literature, global and regional assessment processes, governance arenas, and financial institutions (including climate investment frameworks such as CIF). These developments include: (1) an initial focus on coping strategies and the limits of incremental adaptation, (2) a broadening of the lens towards the root causes of vulnerability, (3) the integration of adaptation, mitigation, and sustainable development, (4) system-oriented thinking through nexus approaches and interconnected global environmental challenges, (5) the incorporation of thresholds thinking, including planetary and social boundaries and tipping points; and (6) more recent framings centred on emergent complexity, including foresight, global polycrisis, and transformative resilience.

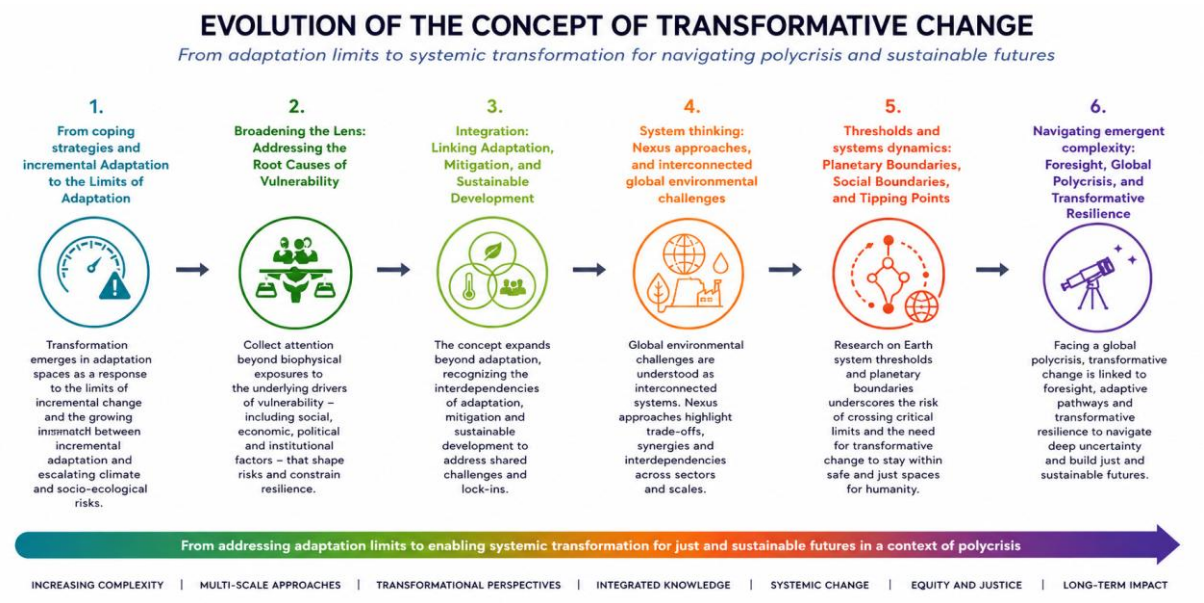


Figure 7.1 | The evolution in time of the concept of transformative change.

Despite this growing conceptual and policy relevance, academic and political debates on transformation remain characterised by limited convergence, with persistent divergences regarding its definition, significance, and practical implications. This lack of agreement has slowed progress in its operationalisation within international governance processes. As a result, a key challenge emerging from both scientific and policy discussions is the need to bridge the gap between conceptual development and practical application, by advancing more explicit approaches to operationalising transformative change in the context of climate action (Moore et al. 2014; Godfrey-Wood and Naess 2016; Termeer et al. 2016; Berrang-Ford et al. 2021; Engbersen et al. 2024; Yang et al. 2026).

Table 7.1 | Synthesis table assessing the evolution of the concept of transformative change in climate action. Source: authors' own elaboration 2026.
This assessment aims to trace the evolution of the concept of transformative change in the context of climate action, drawing on a review of heterogeneous sources. The objective is not to propose a single, fixed definition, but to clarify how transformative change has been conceptualised, operationalised, and implicitly framed across different scientific, policy, and assessment contexts, and how these perspectives inform climate action in the Mediterranean region.
Scope and objectives: The table synthesises key international and regional sources that have contributed to shaping the understanding of transformative change in climate action. It captures: the terminology used across sources; the core conceptualisation of transformative change; its key characteristics; the context and focus in which transformation is discussed; and the relevance for the Mediterranean region. By presenting these elements in a comparative format, the table highlights both convergences and differences across sources, as well as shifts over time from implicit to more explicit and operational uses of the concept.
Methodological approach : A plural and multi-source assessment approach is adopted to reflect the diverse epistemic and policy arenas in which transformative change has emerged. The sources considered include global scientific assessments (e.g. IPCC, IPBES); regional assessments (e.g. MedECC); foresight studies (e.g. MED 2050; Global Tipping Points Report); policy-oriented and technical documents (e.g. FAO working papers); and peer-reviewed scientific literature. This diversity of sources is essential because transformative change is a multi-dimensional and evolving concept that cannot be fully captured through a single type of evidence.
Reading the table: The table should be read as an analytical mapping exercise, rather than as a ranking of sources. Differences across entries reflect variations in scale (global, regional, sectoral), purpose (assessment, foresight, policy support, theory-building), and degree of explicitness in defining transformative change. Together, these sources provide a foundation for developing an operational, Mediterranean-relevant understanding of transformative change in climate action.

1

Source	Type of source	Terminology used	Definition/concept of transformative change	Key characteristics	Context and focus	Mediterranean relevance
1. Origins: From Coping Strategies and Incremental Adaptation to the Limits of Adaptation						
Folke et al., 2010; Pelling et al., 2010; Smith et al., 2011; IPCC, 2012; Kates et al., 2012; Park et al., 2012; Pelling, et al., 2015; Few et al., 2017; Wilson et al., 2020	Peer-reviewed scientific articles; IPCC Special report	Conventional coping strategies; Incremental adaptation; Limits to adaptation (soft and hard); Transformative adaptation; deliberate and forced transformation	Incremental adaptation is typically characterized by small-scale, short-term, and often reactive adjustments; transformational adaptations can be classified into three types: those implemented at a much larger scale or intensity, those that are entirely new to a specific region or resource system, and those that fundamentally transform places by shifting locations.	Explicitly planned and implemented or autonomous; responsive or anticipatory; technological or behavioural; may alternatively include: fundamental changes in institutional arrangements, priorities, and norms.	A necessary response when conventional coping strategies and incremental adaptation are no longer sufficient under accelerating climate change. In such conditions, existing system configurations may fail to sustain key functions, livelihoods, and well-being, making fundamental systemic change required rather than gradual adjustments.	Critical in the Mediterranean due to its high exposure and vulnerability and insufficient effectiveness of conventional coping strategies and incremental adaptation.
2. Broadening the Lens: Addressing the Root Causes of Vulnerability						
Pelling, 2011; Ribot, 2011; Few et al., 2017; Fedele et al., 2019	Peer-reviewed scientific articles	Transformative adaptation; social and ecological vulnerabilities	Transformative adaptation is understood as adaptation that goes beyond incremental adjustments to address the root causes of vulnerability	Tackles structural drivers of vulnerability (inequality, marginalization, governance failures); emphasizes social justice, empowerment and institutional transformation; seeks long-term	Vulnerability is conceptualised not simply as a function of environmental exposure, but as a condition produced through economically, socially, and politically structured inequalities that shape differential sensitivity and adaptive capacity	Critical in the Mediterranean that is considered highly vulnerable to the impact of climate change

Source	Type of source	Terminology used	Definition/concept of transformative change	Key characteristics	Context and focus	Mediterranean relevance
				resilience through systemic change.		
3. Integration: Linking Adaptation, Mitigation, and Sustainable Development						
Grin, Rotmans, and Schot, 2010; Tschakert et al., 2013; O'Brien et al., 2014; Olsson, Galaz, and Boonstra, 2014; Hajer et al., 2015; Pelling et al., 2015; Gillard et al., 2016; Termeer et al., 2017; O'Brien, 2018; Berrang-Ford et al., 2021; Novy and Barlow, 2022; IPCC, 2014 – AR5; IPCC, 2022– AR6; MedECC, 2024a; UNFCC, 2023; 2024a; 2024b; European Commission, 2021; CIF, 2023; UNEP, 2024	Peer-reviewed scientific articles; Global and regional assessment report; Governance Processes; Financial Institutions	Transformative change, transformational adaptation, transformative development pathways	A change in the fundamental attributes of natural and human systems, including paradigms, goals, and values, aimed at enhancing adaptation, sustainable development, and poverty reduction	Systemic, cross-sectoral, multi-dimensional; linking climate action with SDGs; normative orientation toward desirable futures; gender and climate justice; urgent adaptation	Broad climate change context: adaptation, mitigation, sustainable development; considers societal, ecological, and technological systems.	Basis for Mediterranean adaptation and mitigation strategies and planning.
4. System thinking: Nexus approaches, and interconnected global environmental challenges						
MedECC, 2024b; IPBES, 2024; UNEP, 2025	Peer-reviewed scientific articles; Thematic global and regional assessment reports	Transformative governance, transformative adaptation, transformative solutions	Fundamental shifts in structures, paradigms, goals and values to halt global environmental crises; Systemic reorganization of WEFE systems, integrating governance, adaptation, and resource interdependencies.	Multi-dimensional; cross-sectoral; equity-oriented; reciprocity with nature.	Addressing the convergence of multiple human-induced, deeply interconnected, and mutually reinforcing environmental crises, including climate change, biodiversity loss,	High relevance for Mediterranean, providing principles and entry points for transformative action in Mediterranean biodiversity, land use, and socio-ecological systems; Directly relevant as the WEFE nexus is essential in the

Source	Type of source	Terminology used	Definition/concept of transformative change	Key characteristics	Context and focus	Mediterranean relevance
					land degradation, pollution, and waste. Addressing the WEFE trade-off	Mediterranean to address strong cross-sectoral interdependencies, enabling transformat climate action that maximizes synergies, manages trade-offs, and prevents maladaptation across water, energy, food, and ecosystems
5. Thresholds and systems dynamics: Planetary Boundaries, Social Boundaries, and Tipping Points						
Lenton et al., 2008; Rockström et al., 2009a; Rockström et al., 2009b; Lenton, 2011; Dow et al., 2013; Steffen et al., 2015; Díaz et al., 2019; Richardson et al., 2023; Lenton et al., 2025	Peer-reviewed scientific articles	Transformative change; planetary boundaries; safe operating space; thresholds; tipping points (negative and positive)	Rapid and fundamental transformation of social–ecological–technological systems towards sustainability, driven by positive tipping points and framed around Earth system justice, including intergenerational, intragenerational and interspecies justice. Within this perspective, transformation is understood as a fundamental reconfiguration of socio-ecological, governance, and energy systems, guided by principles of resilience, equity, and Earth system justice	Emphasis on positive tipping points as self-reinforcing shifts in policies, technologies, finance, behaviours accelerating systemic change; strong normative orientation towards sustainability and Earth system justice.	Avoid crossing critical Earth system thresholds and remain within a safe operating space, shifting from managing known risks to navigating uncertainty and from incremental adjustments to fundamental systemic change	High relevant: Provides a conceptual basis for understanding non-linear risks and opportunities for rapid systemic change in Mediterranean social–ecological systems, supporting the identification of leverage points and positive tipping points relevant for climate mitigation, adaptation and resilience in the region.
6. Navigating emergent complexity: Foresight, Global Polycrisis, and Transformative Resilience						
WEF, 2013; Simpson et al., 2021; EEA, 2024;	Peer-reviewed scientific articles;	Polycrisis; systemic risks; cascading	Transformation is understood not only as a	Integrated, multi-sectoral	Global polycrisis characterised by the	Highly relevant, as the Mediterranean constitutes a

Source	Type of source	Terminology used	Definition/concept of transformative change	Key characteristics	Context and focus	Mediterranean relevance
Lawrence et al., 2024; Plan Bleu, 2025; Rakowski et al., 2025; Richardson, 2025; Søgaard Jørgensen et al., 2026	Annual global risk assessment report; Foresight/Scenario based report	impacts; transboundary risks; positive feedback loops; incremental and transformative adaptation; transformative resilince	pathway towards sustainability but also as a necessary condition for navigating systemic risks and building resilience in an increasingly uncertain world. Both incremental and transformative capacities are essential for responding to the global polycrisis, as societies must simultaneously cope with immediate shocks while addressing the structural drivers of long-term vulnerability and unsustainable trajectories	management of interconnected risks to reduce vulnerability and enhance resilience	interaction of multiple, interconnected environmental, social, economic, and geopolitical challenges	microcosm of interconnected global systemic crises

1

7.1.2 Frameworks and methodological approaches

The inherently multidimensional nature of Transformative Climate Action (TCA), and its conceptualisation as a set of systemic outcomes, transformative processes, or long-term development pathways, has progressively driven the emergence of analytical frameworks and methodological approaches designed to capture its complexity in a structured and comparable way to facilitate its operationalisation in policy and practice. These frameworks seek to translate transformation from an abstract theoretical concept into manageable, trackable, and implementable actions. From the state-of-the-art knowledge, analytical dimensions have emerged as a conceptual bridge between broad definitional approaches and the need to operationalise and empirically assess transformational change across different contexts, scales, and governance settings.

Building on early contributions from sustainability transitions and resilience scholarship, one of the foundational analytical frameworks for understanding transformation toward sustainability is grounded in the adaptive cycle heuristic. Originating in regime transitions and resource management studies and later being a core part of social–ecological systems research, the adaptive cycle conceptualises transformation as a dynamic, non-linear process unfolding through four idealised phases: renewal, growth, conservation, and release (Walker et al. 2004). Rather than depicting change as a linear progression, this framework emphasises cyclical patterns of stability, accumulation, disruption, and reconfiguration in complex systems. As articulated by Pelling and Manuel-Navarrete (2011), this perspective helped extend resilience thinking beyond a narrow focus on system persistence, foregrounding the potential for endogenous social processes, experimentation in informal systems, and shifts in power relations to drive deeper transformations. At the same time, the framework underscored the multi-scalar nature of transformation, where change at one level or sector may reinforce resilience elsewhere, as captured by the concept of panarchy. Despite its limitations, particularly its initial under-theorisation of power and agency, the adaptive cycle provided an early and influential lens for framing societal transformations for sustainability.

Within the IPCC AR6 the evaluation of transformational adaptation has been structured around four key dimensions allowing to capture the: (1) depth of change, referring to the extent to which adaptation reflects major shifts in system structure, functions, or goals, beyond incremental adjustments, (2) scope or scale of change, indicating the degree to which adaptation is implemented widely, across geographic areas, sectors, or institutional levels, (3) speed of change, describing the rate at which adaptation measures are deployed and produce tangible systemic impacts, and (4) limits of change, reflecting the extent to which adaptation challenges or overcomes soft limits, such as resource, knowledge, or governance constraints that may otherwise inhibit change. For each dimension, AR6 provides operational descriptors to classify adaptation potential as low, medium, or high, allowing for a nuanced assessment both at the level of individual dimensions and collectively (‘overall transformational potential’).

In addition to the IPCC AR6 dimensions, the Climate Investment Funds (CIF) have developed a programmatic framework for TCA, designed to operationalise transformational adaptation at the national scale (CIF 2023). The CIF framework specifies five dimensions of transformational adaptation, emphasising that actions are expected to: (1) be relevant to context and beneficiaries, highlighting the dynamic relationship between desired goals, local context, and available opportunities, (2) lead to systemic change, encompassing fundamental shifts in system structures and functions, interconnections within and between systems, and power dynamics, (3) accelerate the speed of change, leveraging windows of opportunity while ensuring a just transition, (4) be scalable across multiple dimensions such as governance levels, policy domains, geographic coverage, stakeholder groups, and the public–private continuum, and (5) be sustainable, ensuring no backsliding and promoting robustness, resilience, and stakeholder integration, adapting over time to evolving circumstances.

Pathways for transformative change describe the trajectories through which societies, institutions, and communities implement systemic changes to address climate risks while pursuing sustainable development objectives. However, designing these trajectories becomes significantly more complex under conditions of deep uncertainty, where stakeholders lack a consensus or precise data regarding future scenarios and their

occurrence probabilities, impacts, and system values. In such uncertain contexts, predictive, top-down planning often leads to systemic failures or costly infrastructure lock-ins (Haasnoot et al. 2024). To address this challenge and operationalise these transformative trajectories, the Dynamic Adaptive Pathways Planning (DAPP) framework has emerged to map flexible climate adaptation solution spaces over extended time horizons (Haasnoot et al. 2013; Haasnoot et al. 2024). The core methodology of DAPP is highly structured and follows an iterative, staged approach. The process begins with scoping and context assessment, defining system goals, vulnerabilities, and success criteria across multiple indicators with active stakeholder participation in the implementation of these tasks (Haasnoot et al. 2024). Practitioners then focus on identifying Adaptation Tipping Points, which represent the boundary conditions (or thresholds) at which a specific adaptation measure or policy tends to meet its regulatory, environmental, or social mandates (Haasnoot et al. 2013). Once these thresholds are established building on scientific knowledge and stakeholders' input, the methodology maps the solution space by generating alternative sequences of actions over time. These co-constructed pathways are frequently visualised using a transit map format (metro map), highlighting investment options, path dependencies, and potential transfers to alternative metro routes (Haasnoot et al. 2024). Recent extensions increasingly combine DAPP with strategic foresight tools (e.g. visioning and backcasting approaches), enabling the design of Climate Resilient Development Pathways that explicitly link immediate adaptation actions to broader, long term societal transformations (Haasnoot et al. 2024).

To complement this adaptive flexibility with a systemic, multi-sectoral governance approach, the GEO-7 framework (UNEP 2025) provides a highly compatible structural environment for designing and anchoring these transformation pathways. It combines six guiding principles that support the design of effective and robust solution pathways (target policies at whole system; combining innovation with phase-out; align present prospects with future perspectives; handle uncertainty; mobilise diverse actors; and recognising the political nature of change), and five transformation levers (governance; economic and financial systems; social and cultural dimensions; knowledge and innovation; and capability). The transformation pathways are then operationalised through a 7-steps methodology that spans from initial goal setting and solution mapping to contextual evaluation, lever selection, action planning, and actor mapping. The framework is grounded in multiple scientific perspectives, socio-ecological, socio-technical, and socio-economic, ensuring a comprehensive understanding of system dynamics. Mostly important, it also recognises the critical role of indigenous and local knowledge in informing sustainable and equitable transformation pathways, highlighting that transformational pathways must be context-specific and regionally tailored, while maintaining alignment with global environmental goals.

However, operationalising transformation at a regional and transnational scale involves frameworks able to couple targeted research and development with localised governance mechanisms, as exemplified by the European Commission's Mission on Adaptation to Climate Change (MACC) (European Commission 2021). This framework defines a highly structured, objective-driven transformational journey designed to orchestrate system-wide innovations across multiple European regions and communities (European Commission 2021). Within this framework, the path toward climate resilience does not rely solely on technical adaptation solutions; it is driven and supported by specific enabling conditions, acting as vectors for innovation and transformation, and serving as cross-cutting analytical support dimensions required to accelerate systemic change and prevent structural barriers. Based on the MACC plan, these enabling dimensions are structured around four interconnected strategic dimensions including: (1) knowledge and data: centred on facilitating access to digital services, scenario modelling, and advanced local climate risk profiles, ensuring data are interoperable and reusable to inform adaptation strategies, (2) governance and engagement: focused on promoting inclusive and deliberative governance, capable of stimulating continuous dialogue between citizens and stakeholders to ensure an equitable and just transition while avoiding structural barriers; connected with the previous dimension, (3) behavioural change: oriented toward understanding and triggering systemic leverage points and social tipping points, fostering widespread leadership and shifting action models at both individual and collective levels, and (4) finances and resources: aimed at mobilising sustainable resources at scale, developing financial risk strategies, and unlocking public and private capital to support regions in achieving climate reliance goals. To translate

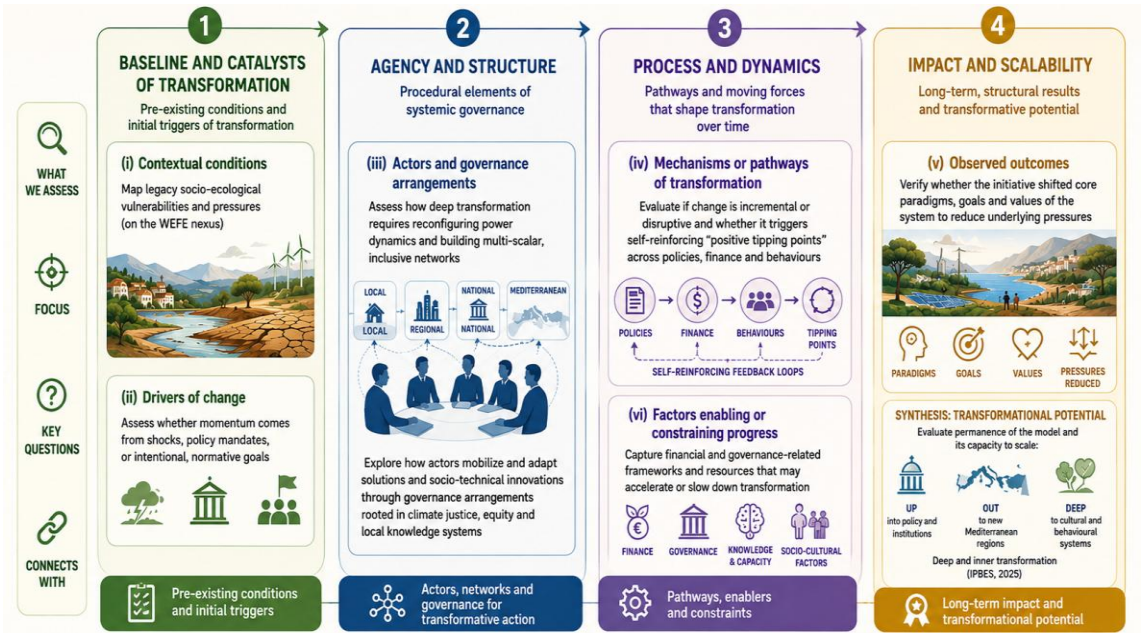
these theoretical dimensions into trackable and manageable actions, the four enabling conditions must be integrated directly into the methodological steps that define the European Mission Journey to climate resilience. Aligned with Haasnoot et al. 2014, this structured pathway consists of six operational steps, divided into the Mission's three core strategic objectives: Objective 1, focused on preparing and planning for climate resilience, which includes Step 1 on better understanding climate change–related risks; Objective 2, aimed at accelerating transformations to climate resilience, which encompasses Step 2 on mobilising support and engagement, Step 3 on formulating shared visions and transformative pathways, and Step 4 on orchestrating innovation and testing transformative solutions; and Objective 3, dedicated to demonstrating systemic transformations to climate resilience, which includes Step 5 on creating impact at scale and Step 6 on creating cross-border value (European Commission 2021).

7.1.3 Operationalising transformative climate action in the Mediterranean: an assessment framework

A central implication emerging from the literature is that TCA is context specific. Although common principles and overarching objectives may guide transformational pathways, what constitutes transformative change, and the processes through which it unfolds, are highly contingent upon the characteristics of the socio-ecological systems in which they occur. Furthermore, interventions that may be considered transformative in one context may represent only incremental adjustments in another. This inherent context specificity provides the rationale for adopting both a Mediterranean-specific working definition and an analytical framework capable of translating broad conceptual understandings of transformation into an operational approach for empirical assessment. Drawing on the literature review on the evolution of transformation for climate action, a working definition tailored to the Mediterranean context is therefore proposed. The definition seeks to reconcile two equally important yet partially competing objectives: ensuring conceptual clarity to facilitate policy uptake and accessibility, while preserving the analytical depth and normative nuance required to capture the multidimensional, systemic, and context-specific nature of transformation.

TCA is here defined as a subset of climate action that enables fundamental change in socio-ecological systems by addressing the structural drivers of climate risk and vulnerability, while supporting transitions towards climate-resilient, climate-neutral, inclusive, and sustainable development pathways (Haasnoot et al. 2013, 2024). This definition is grounded in the recognition that climate risks and responses are inherently systemic in nature (IPCC 2012). Moving beyond narrow, incremental measures, TCAs aims to achieve a ‘good life for all within planetary boundaries’ (O'Neill et al. 2018) by addressing the root causes of climate change and the underlying social, economic, and institutional drivers of vulnerability, thereby responding to the interconnected challenges of the contemporary polycrisis (Rockström et al. 2009; Novy and Barlow 2022). It is guided by principles of equity, reciprocity with nature, and justice, including intergenerational, intragenerational, and interspecies dimensions (IPBES 2024). It draws upon diverse knowledge systems, including scientific, local, and Indigenous knowledge, while seeking to avoid maladaptation, path dependency, and socio-ecological lock-ins. At the same time, it also aims to generate synergies and co-benefits across sectors and policy domains, thereby supporting broader sustainability objectives, including the Sustainable Development Goals (SDGs), as well as integrated approaches such as the Water-Energy-Food-Ecosystems (WEFE) nexus. A central implication of this definition is the inherently context-specific nature of TCA. While common principles and objectives may guide transformational processes, pathways to transformation vary across socio-ecological systems and are shaped by their socio-cultural, economic, environmental, governance, and financial characteristics. Differences in vulnerabilities, adaptive capacities, development priorities, and institutional contexts further determine both the opportunities and constraints for transformation. Consequently, the levers of change, implementation pathways, and outcomes of TCA inherently differ across sectors, countries, and regions, assuming different shapes able to reflect the diverse needs, and priorities emerging from different cases.

To bridge the gap between the conceptual discussion presented in Section 7.1.1 and empirical practice, as represented in Figure 7.2, an analytical framework structured around four sequential macro-systemic dimensions has been developed.



2 **Figure 7.2 | Operational framework for assessing transformative climate action in the Mediterranean.**

3 These dimensions represent key phases and components of transformative climate action and provide the
4 overarching structure through which six assessment criteria of transformation (i–vi) are operationalised.
5 Together, they enable a robust and comprehensive assessment of Mediterranean case studies to identify the
6 extent to which they exhibit characteristics of transformative socio-ecological change towards sustainability
7 (Section 7.2). These four dimensions and their related criteria can be summarised as follow:

8 **(1)** Baseline and catalysts of transformation: This dimension groups the criteria related to pre-existing
9 conditions and initial triggers of transformation. Within this pillar, the criterion of (i) Contextual
10 conditions maps out legacy socio-ecological vulnerabilities (such as pressures on the WEFE nexus),
11 while the criterion of (ii) Drivers of change evaluates whether the initial momentum stems from acute
12 system shocks, policy mandates, or intentional, normative goals. Crucially, this pillar connects
13 directly with Chapter 2 'Drivers of change and state of the environment'.
14 **(2)** Agency and structure: This dimension centres on the procedural elements of systemic governance.
15 It houses the criterion dedicated to (iii) Actors and governance arrangements, assessing how deep
16 transformation requires the reconfiguring of power dynamics and the building of multi-scalar,
17 inclusive networks. In this setting, it explores how actors mobilise to operationalise the available
18 adaptation solutions and socio-technical innovations detailed in Chapter 4 'Adaptation options and
19 enablers', adapting them through governance arrangements rooted in climate justice, equity, and
20 local knowledge systems.
21 **(3)** Process and dynamics: This dimension tracks the concrete pathways and moving forces that shape
22 the transformational process over time. It unites the criterion of (iv) Mechanisms or pathways of
23 transformation (evaluating whether change is incremental or disruptive, and whether it triggers self-
24 reinforcing 'positive tipping points' across policies, finance, and behaviours) with the criterion of (v)
25 Factors enabling or constraining progress. Aligned with Chapter 6 'Policies, governance, economic
26 instruments and financing transition', this criterion systematically captures the governance-related
27 and financial frameworks and resources that may accelerate or slow down transformational
28 processes.
29 **(4)** Impact and scalability: This dimension is oriented toward long term, structural results. It includes the
30 criterion of (vi) Observed outcomes to verify if a given initiative successfully shifted the core

paradigms, goals, and values of the system to reduce the underlying pressures. It concludes with a dedicated synthesis of Transformational Potential to evaluate the permanence of the model and its capacity to scale up into policy, out to new Mediterranean regions, or deep into cultural and behavioural systems (deep and inner transformation; IPBES 2024).

Table 7.2 details this analytical framework, showing how each systemic dimension anchors its respective analysis criteria alongside the key conceptual characteristics derived from the literature in Section 7.1.1, and targeted guidance questions to direct case study evaluations in Section 7.2.

Table 7.2 | Dimensions, criteria, and guiding questions for transformation analysis.

Dimension	Analysis criteria	Key characteristics / Guiding questions for CS analysis
1. Baseline and catalyst of transformation	(i) Contextual conditions	• **Key characteristics** (from literature): Socio-ecological vulnerabilities; multi-sectoral risks; regional/local structural vulnerabilities; exposure to WEFE (Water-Energy-Food-Ecosystems) nexus pressures.
		• **Guidance questions:** What are the baseline environmental, social, or economic conditions of the system? What pre-existing vulnerabilities or cross-sectoral dependencies exist in the case study context?
	(ii) Drivers of change	• **Key characteristics** (from literature): Urgency and near-term action requirements; strong normative orientation toward desirable futures; multi-causal triggers.
		• **Guidance questions:** What triggered the transformation process? Is the change a response to an acute crisis/shock (forced/deliberate), or is it driven by policy mandates, technological breakthroughs, or grassroots pressure?
2. Agency and structure	(iii) Actors and governance arrangements	• **Key characteristics** (from literature): Adaptive governance; multi-scalar networks (local, national, regional); social innovation; inclusivity; equity-oriented frameworks; gender and climate justice.
		• **Guidance questions:** Who are the primary stakeholders and across what scales do they operate? How is power distributed, and how inclusive are the decision-making arrangements? Is there evidence of institutional restructuring?
3. Process and dynamics	(iv) Mechanisms or pathways of transformation	• **Key characteristics** (from literature): Non-incremental, deep structural change; cross-sectoral and multi-dimensional integration; positive tipping points (self-reinforcing shifts in policies, finance, technologies, or behaviors); agroecological pathways.
		• **Guidance questions:** How does the transformation take place? Is the pathway incremental or disruptive? Are there self-reinforcing mechanisms accelerating systemic change, or shifts in institutional arrangements, priorities, and norms?
	(vi) Factors enabling or constraining progress	• **Key characteristics** (from literature): Financial and technological resource availability; strong leadership; social trust; institutional or regulatory barriers; behavioral inertia; resistance from vested interests.
		• **Guidance questions:** What specific enablers accelerated progress? Conversely, what systemic constraints, bottlenecks, or cultural/political pushbacks did the initiative face?
4. Impact and scalability	(v) Observed outcomes	• **Key characteristics** (from literature): Systemic impacts; fundamental shifts in natural and human system attributes (paradigms, goals, and values); linking climate action with biodiversity conservation, equity, and sustainable development goals.
		• **Guidance questions:** What are the tangible and intangible results? Did the outcomes alter the fundamental attributes or goals of the system? Are there any positive or negative unintended consequences?
	(vi) Transformational potential	• **Key characteristics** (from literature): Feasible; systemic; multi-scalar intensity; scale and depth (scaling up into policy, scaling out to new regions, scaling deep into cultural values).
		• **Guidance questions:** Is the observed change permanent or temporary? Does this model show the capacity to be replicated or scaled, or is it entirely place-specific? What is its overall potential to shift the wider system's paradigm?

Unpacking knowledge presented in Section 7.1.1, this four-dimensional operational framework, with its analysis criteria and guiding questions, allows bridging the gap between high-level transformation theory and the empirical analysis of transformation in action. Moreover, by moving systematically from baseline vulnerabilities and risks to long term scalability potential, the proposed framework ensures that the Mediterranean case studies in Section 7.2 are evaluated not just on their immediate outputs, but on their genuine potential to trigger permanent, systemic and inner change.

7.2 Unpacking transformation and transition pathways on the ground

Building on the conceptual discussion of transformation developed at the beginning of this chapter, this section examines how the domain of transformation and transition towards sustainability is documented in empirical studies across the Mediterranean. The assessment is based on a systematic review of peer-reviewed case-study literature, and a structured coding of documented sustainability-oriented transformation and transition processes across the Mediterranean.

The section assesses a spectrum of observed transformation and transition processes, including socio-technical transitions, governance innovations, shifts in social-ecological practices, and place-based

initiatives that may contain transformative elements or potential. In this sense, transformation is treated as an analytical question rather than an empirical given. The purpose of the section is therefore both to describe examples of transformation or transition, and to assess the extent to which these changes reorient existing development pathways, address underlying drivers of vulnerability and unsustainability, and alter the relationships between social, ecological, institutional and technological systems (see previous sections of Chapter 7). By synthesising evidence across different Mediterranean settings, scales, and sectors, the section identifies recurrent patterns, enabling conditions and constraints that shape transformation and transition pathways on the ground.

This cross-cutting assessment complements the sectoral and risk-focused analyses presented elsewhere in MAR2, by focusing on how sustainability-oriented transformation and transition processes unfold in practice, and why they often remain difficult to consolidate, scale up or sustain. The insights derived from this synthesis inform the identification of systemic enablers and barriers relevant to Mediterranean policy and governance frameworks. They also provide an empirical foundation for the forward-looking analysis of pathways and principles for transformative action developed in Section 7.4.

7.2.1 Selection and scope of the assessed evidence

The systematic literature review that comprises the basis of the present assessment employed the search terms derived from transformation and transition-related concepts commonly employed in recent international climate and environmental assessments, including transformative adaptation, transformative change, systemic transformation, systems transitions and transformations towards climate resilience - fundamentally IPBES (2024) and IPCC (2022) (see Section 7.1). These terms were combined with geographic filters covering Plan Bleu Mediterranean countries and sub-regions. This approach ensured consistency between the conceptual framing of transformation outlined in Section 7.1 and the regional scope of MAR2. The review was guided by the question: what drives, enables and constrains sustainability-oriented transformation and transition processes in Mediterranean socio-ecological systems? The methodological details of this systematic review are included in the Annex 7.1 attached at the end of this chapter.

The final set of cases (see Annex 7.2) provides a diverse, though not exhaustive, representation of sustainability-oriented transformation and transition processes across Mediterranean socio-ecological contexts, sectors and governance settings. It forms the empirical basis for the synthesis presented in Sections 7.2.2 and 7.2.3.

7.2.2 Transformation pathways in practice across the Mediterranean

7.2.2.1 Geographical distribution and nature of documented change

This subsection assesses how sustainability-oriented transformation and transition processes are documented across the 69 case studies retained for this assessment in the 66 papers examined. The cases cover a range of institutional settings and policy domains, including energy systems, coastal and marine management, food and agricultural systems, water governance, and socio-economic resilience. Across this body of literature, transformation and transition processes are rarely presented as isolated interventions. Rather, they typically involve interactions among actors, institutions, policy frameworks, knowledge systems and place-based socio-ecological conditions.

The evidence base should be interpreted with caution, as the assessed cases are unevenly distributed across Mediterranean sub-regions and countries (Figure 7.3). Most case studies were identified in Western countries—73% of them—compared with 20% and 7% in eastern and southern Mediterranean, respectively. In fact, Spain, Italy and France comprise 75% of all case studies. This concentration reflects uneven research coverage and data availability and limits the extent to which findings can be generalised across the whole Mediterranean region. By contrast, the case studies are more evenly distributed across settlement contexts, with 37% located in urban areas, 21% in peri-urban areas and 42% in rural areas.

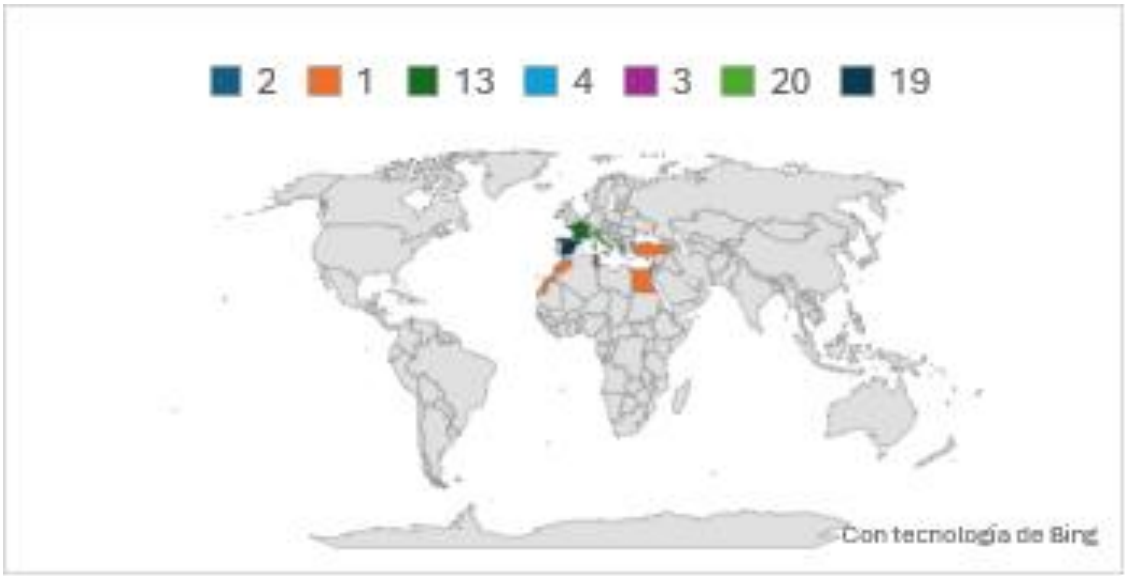


Figure 7.3 | Geographical distribution of assessed case studies by country. Source: author's own elaboration.

The assessed literature documents a spectrum of sustainability-oriented transformation and transition processes, rather than a uniform set of transformations and transitions. Two thirds of the cases concern practice changes or sectoral changes, while only 12% were either governance reform or cross-sectoral change, and only 11% were classified as systemic changes, and only 13% were identified as transformations. Most cases are therefore better understood as transition processes, partial changes or initiatives with transformative potential. At the same time, 68% of the transitional cases envision or enable a broader transformative horizon. This suggests that the empirical literature on the Mediterranean more often documents partial, sectoral or emergent change processes rather than consolidated transformations, while still providing evidence of pathways through which transformative change may develop over time.

7.2.2.2 Agents, vulnerable groups, and scales of change

Public institutions and government actors are the most frequently identified leading agents of change in the assessed cases, appearing in 50.7% of the sample. These include municipalities, local and regional authorities, national governments, ministries, and public policy initiatives, indicating the central role of public governance in documented sustainability-oriented change processes. Farmers, fishers, agricultural organisations, and producer networks form the second most frequent group of leading agents, appearing in 15 cases, or 21.7% of the sample. This reflects the importance of land-based livelihoods, fisheries, and food systems in the assessed Mediterranean literature. Civil society actors, including local communities, citizens' initiatives, social movements, cooperatives, NGOs, and grassroots organisations, are identified as leading agents in 14 cases, or 20.3% of the sample. Research and knowledge-based actors, including research groups, universities, research consortia, and international organisations, are identified as leading agents in cases, or 5.8% of the sample. The private sector or industry appears as the primary agent of change in one case, or 1.4% of the sample. Overall, the assessed evidence suggests that documented sustainability-oriented transformation and transition processes in the Mediterranean are mainly led by public governance actors, agri-food and livelihood stakeholders, and civil society actors. Market-led transformation or transition processes are rarely documented in this sample.

The degree of institutionalisation varies across the assessed cases. More than half of the initiatives are at least partly institutionalised, around one third are primarily associated with collective action, and a smaller share remains mainly discursive. This suggests that many documented transformation and transition processes have moved beyond ideas, framings, or isolated experiments and have entered formal or semi-formal governance arrangements. The Montpellier urban food-system case, for example, shows how civil-society food aid and local food innovations became connected to municipal and metropolitan food policy, public funding, territorial governance spaces, and resource exchange among food aid organisations, local

producers, distribution actors, research actors, and public institutions (Felici and Mazzocchi 2022). The Mals case in northern Italy illustrates another form of partial institutionalisation, where a local anti-pesticide movement combined civic mobilisation, networking, meaning-making, and a legally binding referendum to challenge pesticide-intensive apple production and influence local food governance (Holtkamp and van Mierlo 2022). Together, these cases indicate that institutionalisation can involve both public-policy integration and the formalisation of claims emerging from collective action.

The direction of change also varies across the assessed cases. Bottom-up, bottom-linked, and top-down processes account for 26%, 39%, and 26% of the sample, respectively. The relatively high share of bottom-linked cases indicates the importance of hybrid governance arrangements, in which public institutions, local actors, and intermediary organisations interact to support, translate, or scale sustainability-oriented change. The Montpellier and Mals cases illustrate different forms of such hybridity. Montpellier shows a collaborative pathway linking civil-society food initiatives with metropolitan food policy, while Mals shows a more contentious pathway in which civic actors sought institutional change through direct democracy and alliance-building, while facing resistance from incumbent agri-food regime actors (Felici and Mazzocchi 2022; Holtkamp and van Mierlo 2022).

The knowledge systems mobilised in the assessed cases reinforce this hybrid character. Most cases (64%) report the use of mixed knowledge, combining scientific expertise with experiential, local, or practice-based knowledge. A smaller share relies primarily on scientific knowledge (21%), while another group draws mainly on local ecological knowledge (15%). The prevalence of mixed knowledge indicates that documented transformation and transition processes often involve the combination of technical expertise with institutional, experiential, and locally grounded understandings of change.

The comparison between agents of change and vulnerable groups indicates how documented transformation and transition processes are framed in the assessed literature. Local residents and local communities are the most frequently identified vulnerable groups or intended beneficiaries, appearing in 26 cases (37.7%). These include urban residents, consumers, low-income households, energy-poor populations, vulnerable social groups, and communities exposed to environmental degradation, climate impacts, or declining quality of life. Farmers, fishers, and rural livelihood groups form a second major category, appearing in 23 cases (33.3%). Environmental and ecological systems, including biodiversity, forests, water resources, soils, landscapes, and climate itself, are identified as vulnerable systems in 14 cases (20.3%). Overall, the assessed cases suggest that sustainability-oriented transformation and transition processes in the Mediterranean are frequently framed around the protection of local residents and communities, the sustainability of rural livelihoods, and the safeguarding of ecosystems, with social and environmental vulnerabilities often addressed together.

There is only partial overlap between the actors identified as leading agents of change and those identified as vulnerable groups or intended beneficiaries. The strongest overlap is found among farmers and rural producers, who appear both as agents of change and as vulnerable groups. This is particularly evident in agri-food, water, and land-use cases, where actors affected by climate change, market instability, or resource degradation are also involved in developing alternative practices or governance arrangements. By contrast, local residents and local communities appear more frequently as vulnerable groups or intended beneficiaries (38%) than as leading agents of change (20%). Public authorities are the dominant agents of change, appearing in 51% of cases, but are rarely identified as vulnerable actors. Research organisations and universities play a facilitating or catalytic role in several cases but are not identified as vulnerable groups or intended beneficiaries. Overall, the assessed evidence suggests that many documented sustainability-oriented transformation and transition processes in the Mediterranean are institutionally mediated: they are often promoted through governance, policy, or knowledge-based interventions in relation to communities, livelihoods, or ecosystems exposed to risk, rather than emerging directly from those most affected.

The predominance of local and regional cases further reinforces the place-based character of these pathways. More than half of the cases occur at the local scale (52%) and 15% at the regional scale, while one third operate at the national scale. No international cases were identified in the assessed sample.

7.2.2.3 Sectors and drivers of change

Agri-food systems constitute the most frequently documented sector in the assessed sustainability-oriented transformation and transition cases, appearing in 39 cases (52%). These cases address short food supply chains, agroecology, local and organic food production, sustainable public procurement, food justice, alternative food networks, producer–consumer reconnection, and territorial food governance. Energy transitions and decarbonisation pathways are addressed in 13 cases (17%), including renewable energy deployment, citizen energy communities, energy cooperatives, coal phase-out processes, forest bioenergy initiatives, and national low-carbon transition strategies. Biodiversity and nature management are identified in eight cases (11%), including cases addressing drought, floods, landslides, pollution, biodiversity loss, urban greening, and integrated resource management. Urban-centred transformation and transition processes are reported in 10 cases (13%).

The drivers shaping these processes are multiple and often interacting. Environmental and climate-related pressures are the most frequently reported drivers, appearing in 39 cases (56.5%). These include climate change, drought, water scarcity, biodiversity loss, pollution, ecosystem degradation, overexploitation of natural resources, and decarbonisation needs. This indicates that environmental and climate pressures are a major context for documented sustainability-oriented transformation and transition processes in the assessed Mediterranean literature.

Economic and livelihood challenges form a second major group of drivers, identified in 24 cases (34.8%). These include declining profitability in agriculture and fisheries, unemployment, economic crises, tourism dependence, market competition, food price inflation, rural depopulation, and the need to create new economic opportunities. Social justice, inequality, and quality-of-life concerns are also reported in 18 cases (26.1%), including poverty, food insecurity, energy poverty, social exclusion, unequal access to resources, labour conditions, public health concerns, gender inequality, and demands for more inclusive governance. Governance, policy, and institutional drivers are identified in 15 cases (21.7%), including EU Green Deal and climate policies, food procurement regulations, energy democracy agendas, land governance reforms, and decentralisation initiatives. Governance, policy, and institutional drivers are identified in 15 cases (21.7%), including EU Green Deal and climate policies, food procurement regulations, energy democracy agendas, land governance reforms, and decentralisation initiatives.

External shocks and crises are reported in 13 cases (18.8%). These include wars, political conflicts, earthquakes, floods, landslides, Storm Alex, COVID-19, and geopolitical disruptions. The coded cases suggest that such shocks rarely operate in isolation, but interact with longer-term environmental, socio-economic, and political pressures. For example, one Palestinian case documents participatory work on plant knowledge and agrobiodiversity conservation in a context shaped by political conflict, war, industrialisation, extractive pressures, and loss of agrobiodiversity (Streit Krug et al. 2021). In Egypt, a food-system transformation case links water scarcity, drought, climate change, high population density, declining food self-sufficiency, and dependence on global food markets (Terwisscha van Scheltinga et al. 2021). These examples indicate that many documented transformation and transition processes are shaped by interacting drivers rather than by a single factor.

7.2.2.4 Enabling conditions and barriers

The most frequently reported enabling conditions are collaboration, participation, and multi-actor networks, identified in 46.4% of the assessed cases. These include stakeholder cooperation, participatory governance, citizen engagement, collective action, social movements, community mobilisation, transdisciplinary collaboration, and alliances among public authorities, civil society actors, researchers, and producers. Supportive governance, policies, and institutional frameworks form a second major group of enabling conditions, appearing in 40.6% of cases. These include municipal leadership, national and EU policies, regulatory frameworks, public procurement schemes, Just Transition mechanisms, climate strategies, public funding, and institutional coordination structures. Knowledge, learning, and innovation capacities are identified in 24 cases (34.8%), while social capital, shared values, and community

commitment appear in 18 cases. Financial resources and economic opportunities are mentioned less frequently, in 12 cases, but remain important for making new practices viable.

The assessed cases suggest that enabling conditions often operate in combination rather than as separate factors. In the Galician coastal fisheries case in Spain, decentralised governance created space for fishers, shell fishers, fishers' associations, and the regional administration to participate in marine-resource management (Villasante et al. 2021). Scientific and technical support helped connect local ecological knowledge and everyday harvesting practices with exploitation plans, territorial user rights, and legally recognised marine protected areas. In Spain's coal phase-out case, transformation and transition processes were supported by national policy, EU funding, dedicated institutional structures, local and regional mobilisation, and cultural heritage initiatives addressing the social and territorial impacts of energy restructuring (Sanz-Hernández et al. 2025). These cases indicate that enabling conditions to become more effective when resources, institutions, knowledge, and social commitment are connected to specific territorial vulnerabilities and development pathways.

The most frequently reported barriers mirror many of these enabling conditions. Institutional and governance constraints appear in 33 cases (47.8%). These include fragmented governance, weak coordination, bureaucratic procedures, insufficient policy integration, lack of strategic planning, regulatory obstacles, limited institutional capacity, and political discontinuity. Socio-economic regimes and market structures are reported as barriers in 40.6% of cases, including industrialised food systems, carbon-intensive energy systems, tourism lock-ins, agricultural intensification, market concentration, global competition, land financialisation, dependence on conventional value chains, and the dominance of incumbent actors. Resource limitations and economic constraints appear in 22 cases, including lack of funding, insufficient staff, limited infrastructure, restricted access to land, rising operational costs, and constrained municipal budgets. Social and cultural barriers are reported in 20 cases, including consumer habits, individualism, resistance to behavioural change, lack of trust, gender inequalities, limited participation, and cultural attachment to existing ways of life. Knowledge and learning barriers appear in 14 cases.

Several cases illustrate how these barriers operate in practice. In Tunisia's cement sector, a donor-supported low-carbon transition initiative promoted energy efficiency, renewable energy, and alternative fuels, but its transformative potential was constrained by incumbent industry influence, finance gaps, weak experimentation, and insufficient long term learning mechanisms (Boodoo and Olsen 2018). In Cyprus, attempts to rethink the tourism system were constrained by the lock-in of a mass coastal tourism model, dependence on foreign markets and investment, and weak comprehensive crisis governance (Boukas and Ziakas 2014). In Tuscany, efforts to build a regional multi-stakeholder food platform faced fragmentation among local food-governance initiatives, limited resources, uncertain institutional anchoring, and difficulties in sustaining stakeholder engagement beyond the design phase (Berti et al. 2023).

Overall, the assessed evidence indicates that barriers rarely operate as isolated obstacles. Fragmented governance can reduce coordination capacity; weak institutional anchoring can limit continuity; resource constraints can restrict scaling; and incumbent regimes or market structures can narrow the space for alternatives. This helps explain why many documented sustainability-oriented transformation and transition processes remain partial, local, or project-based, even when they mobilise strong networks, knowledge, and social commitment. The evidence therefore suggests that governance capacity, cross-sectoral coordination, social learning, and long-term institutional support are important for turning promising initiatives into more durable and scalable pathways of change.

7.2.2.5 SDG mapping and synthesis

The SDG mapping further illustrates the multidimensional character of sustainability-oriented transformation and transition processes in the assessed literature (Figure 7.4). The most frequently addressed goals are SDG12 on responsible consumption and production, SDG2 on zero hunger, SDG11 on sustainable cities and communities, SDG13 on climate action, and SDG15 on life on land. This pattern reflects the prominence of agri-food, urban, climate-related, and biodiversity-linked transformation and

transition processes in the assessed case studies. The lower visibility of other SDGs should not be interpreted as evidence of limited relevance in the Mediterranean region, but rather as an indication of how the reviewed case-study literature frames and documents sustainability-oriented change.

The SDG mapping should be interpreted as an indication of how transformation and transition processes are framed in the assessed case-study literature, rather than as a full assessment of SDG synergies and trade-offs. As highlighted in broader climate assessments of IPCC AR6, adaptation and transformation processes may generate co-benefits across SDGs, but they may also involve trade-offs, particularly where climate, biodiversity, energy, land-use, livelihood, and equity objectives interact (Bednar-Friedl et al. 2022).

Overall, the assessed evidence suggests that sustainability-oriented transformation and transition processes in the Mediterranean are commonly associated with combinations of place-based initiatives, institutional support, multi-actor coordination, knowledge exchange, and resource mobilisation. These combinations appear particularly important where documented cases move beyond isolated practice changes towards broader transition or transformation pathways. However, the evidence does not indicate that such combinations automatically produce systemic transformation. Rather, transformative potential is more frequently documented where local practices are connected with supportive governance arrangements, participatory processes, and efforts to address underlying drivers of vulnerability and unsustainability.

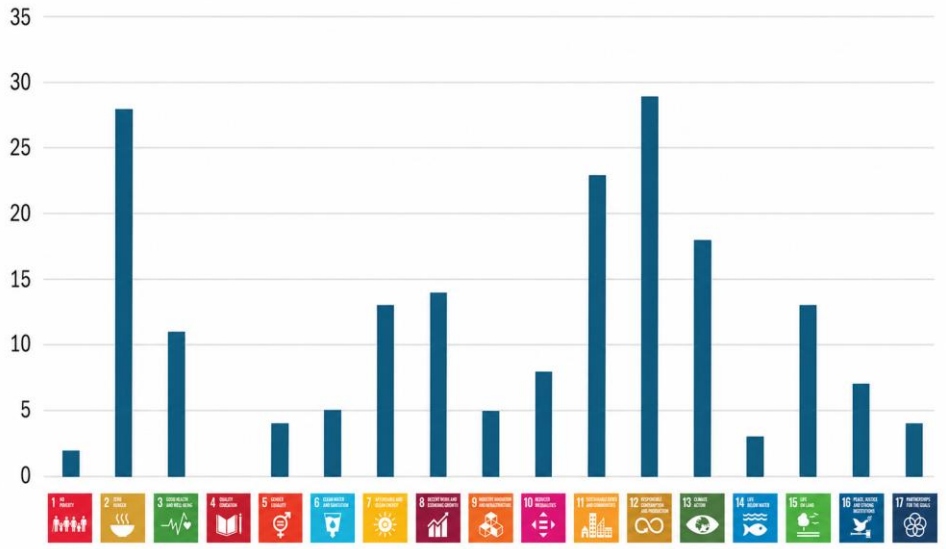


Figure 7.4 | SDGs addressed by the transitions or transformation case studies examined. Source: authors' own elaboration. Note. Please keep in mind that more than one SDGs could be addressed with a single initiative.

At the same time, the assessed evidence is consistent with broader assessment findings of IPCC AR6 that adaptation and sustainability responses are more often incremental than transformative, and that far-reaching systemic change remains difficult to document, especially in societal systems (Bednar-Friedl et al. 2022). Most documented changes remain partial, sectoral, local, or regionally bounded. Many cases are better understood as transition processes, emerging initiatives, or sustainability-oriented reconfigurations with transformative potential, rather than as consolidated transformations. This is consistent with the predominance of practice and sectoral changes in the sample, the relatively small share of systemic changes, and the limited number of cases classified as transformations. The evidence therefore points to an emerging and uneven landscape of transformation and transition pathways in the Mediterranean, rather than to widespread or fully established transformations.

The assessment also highlights that transformation, and transition pathways are often mediated through institutions, organised actors, and policy frameworks. Public authorities are frequently identified as leading agents of change, while citizens, local communities, rural livelihood groups, and ecological systems are more often identified as vulnerable groups, intended beneficiaries, or systems at risk. This partial mismatch

suggests that many documented transition processes are promoted in relation to vulnerable groups and systems, rather than being directly driven by those most exposed to climate, environmental, or socio-economic pressures. An exception is found among farmers, fishers, and rural producers, who appear both as vulnerable actors and as active agents of change in several agri-food, water, and land-use cases.

The evidence further suggests that enabling conditions and barriers are closely connected. Collaboration, participation, supportive governance, knowledge exchange, social commitment, and resources are frequently reported as enabling conditions. Conversely, institutional fragmentation, weak coordination, entrenched socio-economic structures, limited resources, knowledge gaps, and difficulties in sustaining collective engagement are commonly reported as barriers. This indicates that sustainability-oriented transformation and transition processes in the Mediterranean are constrained not only by the availability of initiatives or ideas, but also by the difficulty of embedding, coordinating, resourcing, and sustaining them across scales and over time.

Overall, the assessed literature provides evidence of transition processes and transformative potential in the Mediterranean, particularly in agri-food, urban, climate-related, and biodiversity-linked domains. However, it also shows that transformation remains difficult to consolidate, scale, and sustain. The strength of the evidence varies across countries, sectors, and sub-regions, with a strong concentration of documented cases in Western Mediterranean countries. These uneven evidence patterns should be considered when drawing broader conclusions about transformation pathways across the Mediterranean region.

7.2.3 Synthesis of transformation and transition pathways in the assessed literature

The assessed cases do not point to a single or linear model of transformation in the Mediterranean. Instead, they suggest several recurring configurations through which sustainability-oriented change is documented across different sectors and territories. These configurations should be understood as illustrative pathway types rather than fixed categories: many cases combine elements of more than one pathway, and their transformative potential depends on how local initiatives, institutional arrangements, knowledge systems, resources and vulnerability concerns interact over time. The pathways below therefore provide a synthesis of patterns observed across the case-study evidence, while recognising the partial, uneven and context-specific character of transformation and transition processes on the ground.

7.2.3.1 Place-based food-system reconfiguration

Several cases document efforts to reconnect production, consumption, and territorial governance through short food supply chains, agroecology, public procurement, food democracy, and local food networks. These pathways often combine civil-society mobilisation, producer networks, municipal or regional support, and concerns about food security, rural livelihoods, public health, and biodiversity. Examples include urban and territorial food-policy initiatives, pesticide-reduction movements, and localised food-governance experiments.

7.2.3.2 Governance-mediated resource and ecosystem transitions

A second pathway involves changes in the governance of natural resources, biodiversity, fisheries, water or land. These cases often emerge in response to ecosystem degradation, climate impacts, resource scarcity or livelihood pressures. They tend to rely on co-management, decentralisation, participatory planning, scientific and local knowledge, and formal or semi-formal institutional arrangements. Their transformative potential depends on whether new practices become embedded in durable governance frameworks and whether they can address wider political-economic pressures.

7.2.3.3 Just and low-carbon transition pathways

Some cases focus on energy transitions, coal phase-out, renewable energy, energy communities or low-carbon industrial change. These pathways are shaped by national and EU policies, public investment, local

mobilisation, employment concerns, and contestation over who benefits and who bears the costs of transition. The evidence suggests that low-carbon transition processes become more socially grounded when they address territorial identity, livelihoods, skills, institutional capacity and local development futures, rather than focusing only on technological substitution.

7.2.3.4 Urban and territorial resilience pathways

Urban and peri-urban cases include superblocks, nature-based solutions, climate adaptation planning, green infrastructure, food access, mobility and public-space reconfiguration. These pathways often combine municipal leadership, planning innovation, citizen engagement and climate-risk concerns. Their transformative potential is strongest when interventions move beyond isolated projects and become linked to broader changes in land use, mobility, social inclusion, ecosystem restoration and urban governance.

7.3 Enabling transformative futures

This section examines how the Mediterranean region can navigate accelerating climate, environmental, geopolitical and socio-economic pressures by moving toward inclusive, resilient and regenerative futures. Adopting a forward-looking and exploratory perspective, it combines scenario-based analysis of plausible regional pathways under deep uncertainty with an assessment of transformation levers operating across multiple scales—from communities and local initiatives to regional, national, and transboundary governance arrangements. Rather than offering predictive or deterministic forecasts, it develops decision-relevant pathways that illuminate how interacting risks, asymmetries in vulnerability, and differing governance choices may shape future trajectories. Recent foresight exercises such as MED 2050 by Plan Bleu and the EU Patways2Resilience programme (2026) emphasise the importance of adaptive, participatory scenario-building to guide policy under uncertainty (Plan Bleu 2025a; European Commission 2026a).

The analysis underscores how multi-scalar agency capacities, cross-border cooperation, and integrative “entry points” for change can accelerate climate-resilient and socially just transformation across the Mediterranean. The Regional Climate Change Adaptation Framework (RCCAF 2026– 2035), adopted under Barcelona convention, provides a science-based platform for mainstreaming adaptation into national and local planning, scaling nature-based solutions, and mobilising climate finance (UNEP/MAP 2025a). Similarly, the Cairo Declaration (COP24) reaffirmed commitments to decouple economic growth from environmental degradation, extend marine protection to 30% by 2030, and strengthen inclusive governance for a just green transition (UNEP/MAP 2025b). At the socio-economic interface, the EU’s Pact for the Mediterranean (EESC 2026) calls for civil society and private sector engagement to ensure that cooperation delivers shared prosperity. These developments highlight that sustainability, resilience and regeneration are not abstract ideals but increasingly operational frameworks shaping Mediterranean futures.

7.3.1 Future scenarios for the Mediterranean

7.3.1.1. Rationale for a Scenario-based Approach

The Mediterranean region is a climate, biodiversity and socio-political hotspot (Lionello and Scarascia 2018; UNEP and Plan Bleu 2020; Filho and Manolas 2022; Ferreira et al. 2024a; Plan Bleu 2025a). In this regard, the linear projections are insufficient to capture the compound and cascading risks emerging from land-sea interactions, climate change, demographic dynamics and uneven development trajectories (Korhonen-Kurki et al. 2025). Scenario analysis enables (1) exploration of plausible futures under uncertainty, (2) identification of robust strategies across multiple risks and futures, (3) stress-testing against systemic shocks of policies and investments (Myers and Kitsuse 2000; Maier et al. 2016; Star et al. 2016; Guaita García et al. 2020; Geels et al. 2023; Oriol et al. 2024). In other terms, scenarios are not predictions but structured narratives linking drivers, decisions and outcomes or impacts. This is consistent with MED 2050, which treats foresight to explore uncertainties, disruptions, and transition pathways rather than to forecast a single Mediterranean future (Plan Bleu 2025a). This foresight logic is now reinforced by the MSSD 2026–

2035, which updates the regional policy framework for translating long term sustainability pathways into coordinated Mediterranean action (UNEP/MAP 2025c).

De Castro et al. (2025) argue that sustainability transformations must be understood through processes, practices, and pathways with explicit attention to power relations, justice, co-production and cross-scale dynamics. Scenario analysis therefore helps not only to imagine alternative futures, but also examine how different actors, institutions, and practices may enable or constrain transformative pathways.

In the Mediterranean, these uncertainties are intensified by the convergence of climate, environmental and socio-political risks, which interact in non-linear ways and generate cross-border spillovers. The region is already recognised as a climate and biodiversity 'hotspot', facing strong warming and drying trends, accelerating sea-level rise, ecosystem degradation, and highly uneven vulnerabilities between northern, southern and eastern shores (Ali et al. 2022; Dittus et al. 2024; Toreti et al. 2024; Zerefos et al. 2024). At the same time, structural socio-economic challenges, demographic imbalances, political instability and rapid urbanisation compound exposure to shocks and constrain adaptive capacity, especially in the southern and eastern Mediterranean (Ali et al. 2022). In such a context, scenario analysis becomes a critical tool for understanding how multiple stressors and inequalities may co-evolve and for identifying strategies that remain viable across divergent trajectories. In fact, long term Mediterranean climate evidence confirms the need for scenarios that consider systemic risks such as hotter conditions, altered precipitation, drought, heatwaves and extreme events as structural drivers of future transformation pathways (Tramblay et al. 2020; Zerefors et al. 2024).

Global tipping-point research further showed that every additional fraction of warming increased the risk of crossing irreversible Earth-system thresholds. Mediterranean scenarios should therefore treat climate overshoot as a systemic risk-management issue, not only a long-term global concern (Lenton et al. 2025).

Past foresight and scenario exercises for the Euro-Mediterranean space have shown that future regional pathways are highly sensitive to geopolitical dynamics, economic integration, and governance arrangements, as illustrated by work following the 2011 Arab uprisings and the European financial crises (Ayadi and Sessa 2013; Sanna and Le Tellier, n.d.). More recently, the notion of a global "polycrisis" – where climate change, pandemics, and wars interact to destabilise food, energy and water systems – has underlined the need to explore systemic risk propagation and potential tipping points in the Mediterranean Water–Energy–Food (WEF) nexus (Otto et al. 2020; Quagliarotti 2023; Rockstrom et al. 2024; UNEP 2025; Lenton et al. 2025). Also, this WEF-nexus logic reinforces recent calls for a renewed strategic Pact for the Mediterranean, especially where green energy, digital system, climate adaptation, food security, investment and co-owned governance are treated as mutually reinforcing pillars rather that isolated agendas (Ayadi and Forouheshfar 2025*).* According to Markantonis et al. (2019), key regional and sub-regional multilateral institutions have been addressing or have expressed an interest in exploring the nexus approach, including the European Union (EU), the Regional Cooperation Council (RCC), the League of Arab States (LAS), Union for the Mediterranean (UfM), and the Barcelona Convention (UNEP/MAP).

The latest UNEP (2025) report strengthens this rationale by showing that current development trajectories are environmentally and socially unsustainable. For the Mediterranean, this means that scenarios should not only describe possible futures. They should also test the consequences of continuing fragmented, sectoral and short-term responses. The GEO-7 supports a shift from risk diagnosis to solution pathways that connect strategies and actions. This reinforces the need for Mediterranean scenarios that examine cascading risks and identify integrated pathways for resilient and just transformation. Recent water-availability modelling confirms that Mediterranean scenarios must move from general climate-risk narratives to basin-scale WEFE stress analysis. Water scarcity will directly condition food security, urban resilience, ecosystem protection and regional cooperation (Garrote et al. 2025).

Scenario-based approaches therefore help move beyond linear risk assessments, toward understanding bundles of interacting risks and opportunities, and how they may be shaped by different governance choices and degrees of cooperation (Korhonen-Kurki et al. 2025).

Furthermore, scenario analysis supports the co-design of transformation pathways, rather than only assessing incremental adaptation or mitigation options. Emerging global work on sustainable development pathways demonstrates that multiple societal strategies – such as innovation-driven "green growth", sufficiency-based "resilient communities", or strong state-led "global commons" governance – can each attain substantial progress toward SDGs and climate targets, while differing in their distributional impacts, reliance on technology, and socio-cultural feasibility (Soergel et al. 2024). For the Mediterranean, scenarios offers a way to systematically explore how contrasting mixes of market-led innovation, community resilience, and cooperative multilateralism might translate into distinct regional futures, highlighting associated trade-offs, co-benefits and feasibility constraints.

Finally, scenario processes are not purely analytical; they also play a deliberative and capacity-building role. They create arenas where scientists, policymakers, civil society, and private actors can co-produce knowledge, articulate diverse visions of desirable futures, and identify levers for transformative change (Bennett et al. 2021; Moallemi et al. 2024). This aligns with Caniglia et al. (2021), who argue that sustainability transformation requires action-oriented knowledge built through plural ways of knowing, shared problem framing, experimentation and learning. By making explicit different value systems, priorities and risk perceptions, scenario exercises help to navigate tensions between regional pathways, clarify where interests converge, and build shared ownership of long-term strategies—an essential condition for enabling transformative futures in a fragmented and contested space such as the Mediterranean (Engelke 2016; Bennett et al. 2021; Scoones et al. 2020).

7.3.1.2. Scenario framework and axes of uncertainty

The scenario framework has been created or designed to illustrate and capture the key uncertainties and driving forces affecting or shaping the long-term future of the Mediterranean, while the context remains policy- and information relevant to decision-makers (Plan Bleu 2017). Rather than trying to list every possibility of uncertainty, the framework identifies two high-impact or high-uncertainty dimensions that have repeatedly been demonstrated in scientific assessments, regional foresight studies, and stakeholder dialogues (Schneidewind et al. 2016). This method is consistent with best practices established through global environmental assessment methodologies (e.g. IPCC, IPBES, GEO) where only a small number of alternative scenarios are developed to evaluate systemic risk, trade-offs, and transformation strategies or pathways (O'Neill et al. 2014).

In line with these practices, the Mediterranean scenario framework explicitly focuses on a limited set of structurally different futures that span the most critical uncertainties while remaining anchored in empirically grounded drivers and existing policy debates. Rather than producing probabilistic forecasts, it seeks to construct a "space of plausible pathways" within which robust and transformative strategies can be identified. This space is informed by regional assessments of climate risks and vulnerabilities (Ali et al. 2022), foresight on socio-economic and geopolitical developments (Ayadi and Sessa 2013; Sanna and Le Tellier, n.d.; Engelke 2016), and integrative ecosystem research across Mediterranean climate regions (Caniglia et al. 2021; Arranz et al. 2024). By systematically combining these strands of knowledge, the framework aligns with the broader objective of enabling climate-resilient development pathways and regenerative trajectories for the region.

The first axis of uncertainty can be conceptualised around the degree of regional cooperation and governance integration versus fragmentation and unilateralism. At one end of this spectrum, enhanced cooperation is characterised by strengthened multilateral institutions, integrative research and data-sharing, coordinated management of shared marine and terrestrial ecosystems, and mutually beneficial WEF-nexus arrangements (Malagó et al. 2021; Arranz et al. 2024; Quagliarotti 2023). At the other end, governance is dominated by national interests, weak coordination and contested sovereignty, limiting the ability to manage transboundary risks such as migrations, maritime security, climate impacts and biodiversity loss (Engelke 2016; Ali et al. 2022). This axis strongly conditions whether local and national efforts can be scaled and harmonised into coherent Mediterranean-wide transformation pathways.

In other terms, scenario assessment should track climate-SDG synergies and trade-offs. This is important because climate actions can support water security, food systems, health, cities and biodiversity but poorly designed measures may also deepen inequality or shift burden onto vulnerable groups (Pradhan et al. 2025).

This cooperation axis also has a legal dimension. Fragmented futures are marked by weak regulatory coordination, inconsistent standards, and sectoral mandates. Cooperative futures require harmonised rules, shared monitoring systems and institutions able to manage transboundary risks (Kotzé et al. 2022; Korhonen-Kurki et al. 2025).

The second axis relates to the depth and orientation of socio-ecological transformation, ranging from incremental, efficiency-oriented change within prevailing development models to far-reaching, sufficiency- and justice-oriented transformations. This axis can be strengthened by distinguishing a Mediterranean green-growth decarbonisation from sufficiency-oriented transformation. A green-growth pathway would prioritise renewable energy, cleaner production, efficient irrigation, digital monitoring, low-carbon mobility, and greener coastal infrastructures. These measures are necessary, but they remain insufficient if they do not reduce resource pressure, inequality and dependency between northern, southern and eastern mediterranean shores. Lauer and Llases (2026) showed that a greener-growth pathway can achieve rapid technological decarbonisation, but may still leave structural inequalities, high consumption pressures and environmental constraints unresolved. The authors proposed that a sufficiency-oriented Mediterranean pathway would go further. It would combine decarbonisation with redistribution, convergence, reduced material demand and well-being within ecological limits. This supports the distinction between shallow efficiency improvements and deeper transformative futures for the Mediterranean region. This second-axis is also supported by GEO-7, which distinguishes between technology-focused and behavioural-focused and justice-oriented transformation pathways. The Geo-7 report supports the integration of these pathways for the Mediterranean to avoid social inequality, territorial asymmetries while advancing adoption of sustainable diets, circular consumption, social protection, healthy lifestyles and inclusive governance. This axis should also include food consumption and dietary change as the Mediterranean diet provides a concrete sufficiency-oriented pathway. It links health, lower environmental footprints, cultural identity, local food economies and reduced pressures on land, water and biodiversity resources (Lorca-Camara et al. 2024). This helps connect behavioural transformation with food-system resilience, rather that treating food security only as a production problem.

Recent evidence from European climate citizen assemblies gives this second axis a stronger democratic and policy foundation. Lage et al. (2023) found that, across eleven European climate citizen assemblies, 39% of the mitigation recommendations included sufficiency confirming that sufficiency-oriented transformation should not be framed as a marginal or politically unrealistic scenario. It should be considered a legitimate pathway linking material demand, wellbeing, social justice and ecological limits.

Incremental futures prioritise technological innovation, green growth and partial sectoral reforms, often relying on market mechanisms and digital solutions while leaving underlying consumption and production patterns considerably intact (Soergel et al. 2024; UNEP 2025; Kazanskaia 2025). Transformative futures, by contrast, emphasise regenerative economies, equitable resource distribution, reduced material throughput, and strong social protection, supported by community-led governance, nature-based solutions and systemic shifts in norms, values and institutions (Furlan et al. 2025; Casarejos 2020; Moallemi et al. 2024). According to de Castro et al. (2025), a regenerative future also requires changes in everyday practices, institutions and values to support long term visions and hence connecting regenerative thinking with practical transformation pathways.

Geels et al. (2023) clarify that these pathways become transformative when they reconfigure consumption-production systems including infrastructures, institutions, markets, practices and power relations. De Castor et al. (2025) further emphasised that transformation unfolds through processes, practices, and pathways across stages and scales. Frensen et al. (2025) added that transformation should not be assessed only by speed and scope, but by justice, direction and the question of who benefits. In fact, these authors cautioned that environmental governance often privileges forms of change that are rapid and system-wide, while giving less attention to what is being transformed, how transformation occurs, and for whom it produces benefits

or burdens. This is especially relevant in the Mediterranean basin, where rapid technological or policy responses may be necessary but insufficient if they do not address underlying inequalities, institutional lock-ins, historical vulnerabilities, and asymmetries between northern, southern and eastern shores. In practice, Mediterranean trajectories will *likely* combine elements along this axis, but the scenarios distinguish futures where structural lock-ins are fundamentally challenged from those where they persist. Consequently, transformative scenarios should be assessed not only according to their capacity to accelerate action, but also according to their direction, depth, justice implication and ability to reconfigure the social, ecological and political relation that produce vulnerability.

Across all scenarios, adaptive capacity acts as a critical conditioning factor shaping the severity of risks and the effectiveness of societal responses. Differences in institutional effectiveness, financial resources, scientific and technological capabilities, monitoring systems, infrastructure quality, social protection mechanisms, and governance capacities considerably determine whether similar climate and environmental pressures translate into manageable stresses or systemic crises (Hölscher et al. 2020; IPCC 2022; Korhonen-Kurki et al. 2025). These asymmetries are particularly pronounced across the Mediterranean, where countries and territories differ significantly in their ability to anticipate, absorb, adapt to, and recover from climate and environmental shocks. Consequently, Mediterranean futures will depend not only on the degree of cooperation and the depth of transformation, but also on the distribution of adaptive capacities within and between countries.

Positioning the Mediterranean within this two-dimensional space yields a small set of archetypal scenarios that can be qualitatively and, where possible, quantitatively elaborated. For example, a “cooperative–transformative” quadrant would depict futures where strong regional governance, integrative research and cross-border solidarity enable sufficiency-oriented, resilience-building strategies, including large-scale deployment of nature-based solutions, integrative land–sea planning and inclusive low-carbon transitions (Furlan et al. 2025; Arranz et al. 2024; Soergel et al. 2024). A “fragmented–incremental” quadrant, in contrast, would describe a continuation of business-as-usual trends with uneven adaptation, persistent inequalities and escalating systemic risks in a context of weak coordination and recurrent crises (Ali et al. 2022; Quagliarotti 2023). Intermediate combinations allow exploration of more mixed outcomes, including innovation-led but socially uneven futures, or solidarity-driven but resource-constrained pathways. Importantly, the six MED 2050 scenarios can be used as a robustness check for this framework, ranging from inertia, crisis and fragmented growth to blue-green cooperation, a Mediterranean-specific sustainable model and the sea as a global common (Plan Bleu 2025a).

Importantly, this framework is designed to be iterative and participatory, allowing for updates and refinements as new evidence, shocks or political developments emerge. It provides a common reference for linking scenario narratives to concrete levers of transformation at multiple scales, as elaborated in Section 7.3.2, by clarifying how local innovations, regional planning, national reforms and cross-Mediterranean cooperation may play out under different combinations of cooperation and transformation depth (Hölscher et al. 2020; Bennett et al. 2021; Granberg et al. 2019). By doing so, it enables decision-makers and stakeholders to (1) stress-test proposed policies and investments against contrasting futures, (2) identify robust, no-regret measures, and (3) strategically target interventions at critical ‘entry points’ and ‘engines’ of change that can accelerate desirable pathways even under deep uncertainty (Moallemi et al. 2024).

These engines of change can be interpreted as positive tipping interventions. In the Mediterranean, the most relevant include fossil-subsidy reform, decentralised renewable energy, carbon-neutral cities, climate finance, emissions disclosure, sustainable diets, climate and environment education and social norm shifts (Otto et al. 2020; Lenton et al. 2025).

Despite the existence of positive tipping interventions and transformative opportunities, the assessment highlights that adaptation and transformation capacities are not unlimited. Under high-emission pathways, accelerating warming, water scarcity, ecosystem degradation, sea-level rise, and compound extreme events may exceed the coping capacities of communities, sectors, and ecosystems (MedECC 2020). Delayed action increases the likelihood of crossing critical ecological, social, and economic thresholds, leading to irreversible losses and significantly narrowing future development options (IPCC 2022; Lenton et al. 2025). Consequently,

transformation should be viewed not only as an opportunity to enhance sustainability and well-being, but also as a necessity to avoid escalating systemic risks.

Finally, the framework recognises the "patchwork" nature of global and regional transformations, where different sub-regions, cities and sectors follow distinct pathways that interact to produce emergent outcomes for people and nature (Bennett et al. 2021). In the Mediterranean, this implies that sub-regional scenario elaborations—for northern, southern and eastern shores; for coastal megacities and rural hinterlands; for marine, coastal and inland ecosystems—are needed to capture heterogeneity in vulnerabilities, capacities and aspirations. Yet, by situating these differentiated trajectories within a shared scenario space, the framework supports a more coherent understanding of how diverse pathways may generate conflicts, synergies or spillovers, and how they might be navigated in ways that advance inclusive, resilient and regenerative futures for the Mediterranean as a whole. As a specific example, Barbosa et al. (2019) showed how green and blue infrastructure planning can support cost-effective restoration and conservation across political borders.

7.3.1.3 Strategic domains shaping Mediterranean futures

While the scenario framework identifies the major uncertainties that may shape Mediterranean futures, the evidence synthesised throughout *Chapters 2 to 6* suggests that future trajectories will ultimately be determined by transformations occurring within a relatively small number of highly interconnected strategic systems. These systems constitute the principal arenas where climate change, environmental degradation, socio-economic development, technological innovation and governance choices interact, generating both risks and opportunities for long term sustainability and resilience. Recent Mediterranean foresight and assessment work reinforce this aspect by showing that plausible future to 2050 will depend not only on climate exposure, but also on the capacity of societies to reorganise water, food, energy, coastal, urban and governance systems under conditions of deep uncertainty (IPCC 2022; MedECC 2024; Plan Bleu 2025a).

Among these domains, water systems emerge as the most critical and primary determinant of future Mediterranean trajectories. The region already faces chronic water scarcity and is projected to experience increasing water scarcity and drought risk, declining precipitation, growing hydrological variability in many sub-region and rising competition among agricultural, urban, industrial and ecosystem demands. Recent basin-scale assessments underline that water scarcity is not a stand-alone resource issue, it directly conditions food security, ecosystem integrity, energy generation, urban resilience, health and cross border cooperation (MedECC 2020; 2024; Garrote et al. 2025). The 2024 drought episode further illustrated the systemic character of water risk, with impact across parts of North Africa, the Iberian Peninsula and Mediterranean islands (Toreti et al. 2024). Future pathways will therefore depend heavily on the ability to improve and combine cooperative water governance, demand management, efficient water allocation and regulation, drought preparedness, ecosystem protection, and management of trade-offs across sectors.

Food systems constitute a second strategic domain. The assessment highlights that Mediterranean food systems face simultaneous pressures from climate change, land degradation, biodiversity loss, changing consumption patterns, demographic growth and dependence on international markets. Future food security will depend not only on agricultural productivity but also on the capacity to accelerate agroecological transitions, improve resource efficiency, reduce food losses and waste, promote sustainable dietary patterns and strengthen the resilience of regional and local food systems. The future of the Mediterranean Diet, as both a cultural asset and a sustainability pathway, is particularly significant in this regard. From a scenario perspective, food systems are also a key WEFE nexus arena where land and marine resources pressures, dietary shifts, trade dependency can amplify geopolitical vulnerability under crisis conditions (IPCC 2022; MedECC 2024; Plan Bleu 2025a).

Energy systems represent another central arena of transformation. The Mediterranean is positioned between major energy-producing and energy-consuming regions, but its energy future remains marked by fossil-fuel dependence, unequal and climatic-risk exposed infrastructure capacity, fragmented markets, accelerating pressures for decarbonisation and uneven access to finance. At the same time, the region has high potential for solar, wind, and other renewable energy development. Future trajectories will therefore

be shaped by the speed, inclusiveness and territorial distribution of the energy transition, as well as by the ability and capacity to align energy security, climate mitigation, economic development and social equity objectives. Recent WEFE evidence also showed that energy transition pathways cannot be assessed only through carbon metrics: renewable deployment, hydropower decline, desalination, irrigation pumping, grid integration and land-use demand all generate interactions with food, water and ecosystems (Drobinski et al. 2025; MedECC 2024). Integrated regional planning and policy harmonisation are therefore essential to avoid shifting pressures from one sector or shore of the Mediterranean to another.

Marine and coastal systems occupy a similarly strategic position. The Mediterranean Sea is simultaneously a source of biodiversity, food production, economic activity, cultural identity and regional connectivity. Yet marine ecosystems are increasingly affected by warming, acidification, sea-level rise, pollution, habitat degradation and overexploitation of natural resources (von Schuckmann et al. 2025). The future sustainability of the blue Mediterranean economy will depend on the capacity to reconcile fisheries, tourism, maritime transport, renewable energy development and ecosystem conservation within integrated land-sea governance frameworks.

Urban and territorial systems constitute another major transformation domain. Mediterranean cities concentrate population growth, economic activity, infrastructure investments, and climate exposure. Coastal urban areas are particularly vulnerable to heatwaves, water stress, sea-level rise, coastal erosion, flooding, and extreme events. The way cities manage land use, mobility, housing, public space, green infrastructure, water resources and energy systems will significantly influence both mitigation and adaptation outcomes. More broadly, territorial development patterns will shape future inequalities, migration dynamics and resilience capacities across the region.

The assessment further highlights the strategic importance of governance, finance, and knowledge systems as enabling domains that condition transformation across all sectors. Institutional effectiveness, policy coherence, legal frameworks, scientific capacity, access to finance, monitoring systems, participatory governance and cross-border cooperation strongly influence the ability of societies to anticipate risks, coordinate action and implement long term transitions. Differences in these enabling capacities explain a significant share of the observed asymmetries in vulnerability and adaptive capacity across the Mediterranean. However, the adoption of the MSSD 2026-2030 and the regional climate change adaptation framework for the Mediterranean marine and coastal areas signals a shift toward more implementation-oriented regional cooperation, adaptation mainstreaming, and stronger resilience planning (UNEP/MAP 2025a,b).

Importantly, these strategic domains cannot be understood in isolation. Their interactions generate reinforcing feedbacks, cascading effects and systemic risks that increasingly characterise Mediterranean futures. Water scarcity affects food production, ecosystem integrity, and energy generation; energy choices influence climate mitigation, water demand, and economic competitiveness; urban expansion alters ecosystem services and resource consumption patterns; marine degradation affects food security, tourism, and coastal livelihoods. Consequently, future resilience will depend less on sector-specific performance than on the capacity to govern interdependencies, manage trade-offs, and maximise synergies across interconnected systems (MedECC 2024; UNEP 2025).

Taken together, these strategic domains provide the operational interface between the scenario framework presented above and the transformation levers discussed in the following sections. They represent the principal areas through which Mediterranean societies can either reinforce existing patterns of vulnerability, fragmentation and maladaptation or accelerate pathways toward more resilient, inclusive and regenerative futures. For this reason, the scenario framework should not be used only to describe contrasting futures, but also to stress-test sectoral and cross-sectoral strategies, identify no-regret measures, and clarify where cooperation, finance, knowledge and governance reforms can unlock systemic transformation across the basin (Plan Bleu 2025a; UNEP 2025).

7.3.2 Levers of transformation at multiple scales

7.3.2.1 Multi-scalar governance and agency capacities

Transitioning the Mediterranean region toward inclusive, resilient and regenerative futures requires activating transformative levers that operate simultaneously across local, regional, national and transboundary scales, and that align governance, knowledge, agency, and socio-technical change. In fact, the transition from MSSD 2016–2025 to MSSD 2026–2035 shows a shift from a broad strategic framework toward a renewed implementation-oriented agenda for resilience, sustainability, and regional cooperation (UNEP/MAP 2016; UNEP/MAP 2025c).

Rather than relying on linear interventions or isolated sectoral reforms, transformative pathways depend on addressing the institutional lock-ins and power asymmetries, the development of new agency capacities, multi-actor coalitions, and adaptive institutions capable of navigating uncertainty, thresholds, and entrenched lock-ins (Hölscher et al. 2020; Geels et al. 2023). These capacities emerge through mixed governance arrangements that combine decisive regulation, market mechanisms, sustainability accounting, and bottom-up community decision-making, thereby enabling systemic innovation with multiple social–ecological benefits and reinforcing social resilience (Hölscher et al. 2020).

At the local and community scale, transformation is driven by social learning, empowerment, and the nurturing of 'seeds' of sustainability—innovations, practices and institutions that prefigure alternative futures and can diffuse across networks and geographies (Bennett et al. 2021; Caniglia et al. 2021). Local initiatives such as nature-based solutions, community-led governance, sustainable agriculture and social entrepreneurship contribute to behavioural shifts, equity, and local ownership, while strengthening regenerative and resilience-building practices (Furlan et al. 2025; Kazanskaia 2025). Actions taken locally may also produce long term cascading effects that radiate across time and scales, reinforcing regenerative trajectories when supported by enabling institutional and financial environments (Casarejos 2020). However, local action alone is insufficient when structural constraints, path dependencies or socio-economic vulnerabilities persist; scaling-up requires cross-scale alignment and integrative governance. For instance, agricultural transformation is shaped by the diversity of farming systems. Intensive systems may have a greater capacity to adopt technological adaptation options, while traditional extensive systems often require stronger support for collective learning, biodiversity management, and the protection of cultural knowledge (Nguyen and Virdis 2025). This is particularly important in the Mediterranean region, where pastoral systems, irrigated agriculture, horticulture and greenhouse farming face different climate and biophysical risks and adaptation capacities.

The preservation, restoration and sustainable management of natural capital constitute a foundational transformation lever across the Mediterranean and provide a critical bridge between local initiatives and broader systemic change. Ecosystems underpin the resilience of Mediterranean societies by delivering essential services including water regulation, soil fertility, coastal protection, carbon sequestration, fisheries productivity, climate regulation and cultural values. The assessment presented throughout this report shows that the degradation of terrestrial, freshwater, coastal, and marine ecosystems increases systemic vulnerability, reduces adaptive capacity, and raises the economic and social costs of climate change. Conversely, ecosystem restoration and nature-based solutions generate multiple co-benefits across climate adaptation, mitigation, biodiversity conservation, food security, public health, and territorial resilience. Protecting natural capital should therefore be viewed not as a sectoral environmental objective, but as a strategic investment in long term resilience and sustainable development. At the same time, the scale and interconnectedness of Mediterranean ecosystems require governance arrangements capable of coordinating action beyond local boundaries and across administrative, sectoral, and ecological systems (MedECC 2024; Plan Bleu 2025b).

Legal and regulatory frameworks are therefore central to Mediterranean transformation. Korhonen-Kurki et al. (2025) showed that transformative governance depends on several mechanisms: collaboration, leadership, plurality, empowerment, innovation and shared vision. These mechanisms are highly relevant for the Mediterranean because climate adaptation, water allocation, renewable energy, coastal planning,

biodiversity protection and food system reform all require rules that coordinate actors across sectors and scales. Law should not be treated only as a constraint. It can also create mandates, clarify responsibilities, secure participation, protect vulnerable groups and institutionalise long term transformation.

The regional and metropolitan scale offers critical leverage for connecting fragmented initiatives, addressing intersecting adaptation gaps, and amplifying local successes into broader systemic shifts (Barbosa et al. 2019; Granberg et al. 2019; Plan Bleu 2025a). Regional institutions are positioned to bridge organisational remits and knowledge domains, synthesise lessons across territories, and challenge stagnated or path-dependent policies by mobilising coalitions and shared visions. This scale can support transformative adaptation by coordinating infrastructure, ecosystem restoration, and land–sea interactions, while mediating trade-offs across jurisdictions and sectors (Granberg et al. 2019). In the Mediterranean context—where multiple risks accumulate across climate, biodiversity, demographic, and socio-economic systems—regional governance also plays a pivotal role in structuring cooperation, solidarity mechanisms, and resource-sharing arrangements across asymmetrically affected territories (Ali et al. 2022; Plan Bleu 2025a).

At the national scale, levers of transformation relate to policy coherence, structural reforms, and transition-enabling institutions. Evidence from scenario-based transition research indicates that different societal strategies – innovation-driven, sufficiency-oriented, or commons-oriented – can each advance sustainability and climate objectives, though they differ in reliance on technology, behaviour change, or strong public governance (Soergel et al. 2024). National governments act as catalysts and coordinators of acceleration processes, establishing foundational conditions (funding architectures, regulatory frameworks, social protection systems) that unlock agency among civil society, science, and industry (Moallemi et al. 2024). Yet these pathways also face socio-cultural feasibility challenges, particularly when they entail deep shifts in energy and food consumption patterns or redistribution of resources and opportunities (Soergel et al. 2024).

Intergenerational renewal should be treated as a cross-sectoral resilience capacity because Mediterranean transformation depends on renewing skills, leadership, entrepreneurship and institutional memory across agriculture, water, energy, tourism, coastal planning and local governance. In agriculture, this challenge is especially visible, but the same logic applies to other sectors that need younger professionals, new skills, digital innovation, viable enterprise structures, local business dynamism, access to land and finance, and broader territorial development strategies (European Commission 2026b; Calafat-Marzal et al. 2026).

Law is a central lever of transformation. It can steer change by setting long term goals, standards, and monitoring duties. It can accelerate change through public procurement, climate laws, biodiversity rules and circular-economy incentives. It can also slow change when procedures, property rights, fragmented mandates or legal uncertainty protect unsustainable practices (Soininen et al. 2021). Mediterranean transformation therefore requires legal frameworks that enable innovation while protecting accountability, justice and participation.

Across transboundary and pan-Mediterranean scales, transformation levers are activated through cooperation, foresight, and integrative knowledge systems. Cross-regional scenario and foresight exercises demonstrate that transformation unfolds amid uncertainty, geopolitical shifts, and polycrises that affect food, energy, and water security as interconnected systems (Ayadi and Sessa 2013; Engelke 2016; Quagliarotti 2023). Anticipatory governance requires shared scenario frameworks, stress-testing of policies, and long-term strategic coordination, which can reveal opportunities for decarbonising resource systems, mainstreaming climate risk into decision-making, and strengthening intra-regional partnerships based on comparative advantages (Ayadi and Sessa 2013; Quagliarotti 2023). At the same time, integrative research across ecosystems, regions, and political boundaries is essential for identifying tipping points, common resilience mechanisms, and desired future conditions for Mediterranean socio-ecological systems (Arranz et al. 2024).

7.3.2.2 Cross-cutting processes and integrative entry points

A further cross-cutting lever concerns the integration of diverse knowledge, practices, and institutional perspectives, together with the deliberate orchestration of complementary “entry points’ for change.

Caniglia et al. (2021) provide a useful basis for this argument. In the Mediterranean, action-oriented knowledge should combine scientific evidence, policy expertise, local ecological knowledge, civil-society perspectives and private-sector innovation. This is essential because environmental and sectoral risks are experienced differently across shores. Norström et al. (2020) and later Ligtermoet et al. (2025) clarified that action-oriented knowledge must be co-produced through context-based, pluralistic, goal-oriented, reflexive and interactive processes. In the Mediterranean, this means that co-production should not start only with data collection but with careful reflection on purpose, positionality, power relations, and the design of inclusive processes linking scientific evidence, local experience, policy expertise, and stakeholder dialogue to produce shared, practical and trusted transformation pathways.

Comparative transition research demonstrates that transformative acceleration rarely emerges from a single reform instrument or governance tier, but instead from synergistic interactions among policies, social innovations, and collective action processes that reinforce one another across time and scales (Moallemi et al. 2024). These entry points include governance reform, mission-oriented innovation ecosystems, social equity and inclusion mechanisms, and resilience-oriented infrastructures that buffer systems against shocks while enabling experimentation and adaptive learning. When activated in combination, they form mutually reinforcing “engines of change’ that stabilise emergent sustainability pathways and increase their capacity to endure political, economic, or environmental disruption (Caniglia et al. 2021; Moallemi et al. 2024).

Regulatory reform should be considered or treated as a cross-cutting entry point. The Mediterranean sustainability challenges cut across legal silos. Earth system law helps frame these issues as connected parts of one social-ecological system. This is useful for the Mediterranean because climate, water, food, energy and migration pressures interact across borders and cannot be governed through isolated rules. Many transformation barriers are legal and institutional: fragmented water laws, weak enforcement, overlapping coastal mandates, unstable investment rules, limited public participation, and short-term planning cycles. Hence, according to Soininen et al. (2021), law can be a brake or an accelerator of sustainability transition. Korhonen-Kurki et al. (2025) caution that law is often oversimplified in transformation debates, although legal systems can both enable and block change. A transformative Mediterranean pathway therefore requires adaptive and coherent legal frameworks that support experimentation, accountability, cross-sector coordination and justice.

This evidence also sharpens the governance message that the bottleneck is not only public acceptance but institutional willingness and policy design. In fact, Lage et al. (2023) concluded that the scarcity of sufficiency in official climate policy does not mainly reflect a lack of legitimacy, but rather political reluctance, short-term policymaking incentives and competing interests. Mediterranean transformation strategies should therefore combine deliberative democracy with stronger regulatory capacity: citizen assemblies, scenario dialogues, and co-design processes can help legitimise difficult measures, while law, fiscal rules and planning standards translate them into enforceable change across mobility, food systems, buildings, energy use and consumption.

In the Mediterranean, where climate risks, socio-economic inequalities and geopolitical pressures intersect, such integrative acceleration processes are particularly relevant. In other terms, the WEF(E) nexus should be treated as one of the main integrative entry points for the mediterranean transformation. In fact, this should be considered as a no-regret Mediterranean entry point ensuring resilience and regional solidarity (Plan Bleu 2025a). Quagliarotti (2023) argues that the region must shift the WEF nexus from a vicious circle of trade-offs to a virtuous cycle of synergies. UNEP (2025) also reinforces the need to treat Mediterranean transformation as a connected system of entry points rather than a list of separate sectoral measures. It therefore supports a Mediterranean approach based on policy coherence, adaptive learning, co-produced knowledge and cross-sectoral monitoring.

The WEFE nexus emerges as one of the most robust integrative frameworks identified throughout this assessment. The evidence synthesised across *Chapters 2 to 6* demonstrates that water availability increasingly conditions food production, ecosystem integrity, energy generation, urban development, and human well-being. At the same time, decisions taken in any one of these domains often generate cascading effects across the others. Future transformation pathways will therefore require governance approaches

capable of simultaneously managing interdependencies, avoiding maladaptation, addressing trade-offs, and maximising co-benefits across water, energy, food and ecosystem systems. As climate and environmental pressures intensify, the WEFE nexus provides a practical framework for translating systems thinking into coordinated action across sectors, scales and territories (Markantonis et al. 2019; Quagliarotti 2023; MedECC 2024; Plan Bleu 2025a).

The evidence from the Mediterranean region provides further support for the need to view transformation as a portfolio of connected entry points. The mutual reinforcement of soil degradation, water scarcity, food insecurity, wildfire risk, pressure on the coastline and urban heat within the basin (Ferreira et al. 2024b,c; El Bilali and Ben Hassen 2024; Brandimarte and Borgström 2024) suggests that a comprehensive approach to Mediterranean transformation would integrate soil conservation, improving water use efficiency, agro-ecological management, wildfire prevention, coastal planning and use of nature-based solutions in urban areas through an integrated WEFE and land-sea governance framework.

Portfolio-based transformation strategies allow actors to move beyond isolated pilot initiatives toward systemic reconfiguration of land–sea interfaces, resource systems, and territorial development models. This implies strategically linking nature-based solutions with digital infrastructures, digital monitoring platforms, circular economy and knowledge observatories, enabling evidence-informed decision-making and continuous feedback between practice, science, and governance (Barbosa et al. 2019; Caniglia et al. 2021; Furlan et al. 2025). These observatories should not function only as data repositories. They should become learning infrastructures where evidence is translated into action through co-design, experimentation, monitoring and feedback between researchers, institutions and local actors (Caniglia et al. 2021). It also links local adaptation with regional security and transboundary cooperation.

It is also essential that monitoring systems do not track only environmental indicators. They should also identify whether climate and environmental actions generate SDG co-benefits or trade-offs across water, food, energy, health, biodiversity, cities, inequality and partnerships (Pradhan et al. 2025).

Sustainability learning should also be treated as an entry point for transformation, because the Mediterranean future requires citizens, professionals, and institutions able to work with uncertainty, values, interdisciplinarity, and action-oriented knowledge (Skarstein and Wolf 2026).

In the region, cleaner production and circular-economy strategies must also be socially and intentionally adapted. They cannot be transferred as uniform technical packages across the basin. Northern Mediterranean countries often have stronger regulatory systems, market instruments and monitoring capacities. southern and eastern Mediterranean countries often face tighter financial constraints, weaker enforcement capacity and stronger dependence on community-based action, local knowledge and international cooperation. Moharaj and Balabantaray (2026) showed that cleaner production and circular-economy adoption depend on governance frameworks, economic incentives, cultural norms, knowledge and capacity-building, and technology acceptance. For the Mediterranean, this means that cleaner production, water-saving technologies, waste reduction, renewable energy and sustainable tourism strategies will only scale if they are locally accepted, institutionally supported and adapted to different coastal, urban and island contexts. At the same time, deliberative and participatory processes – such as visioning exercises, scenario dialogues, and co-design workshops – create spaces where diverse worldviews, community needs, and cultural identities can be articulated, negotiated, and translated into shared adaptation pathways (Bennett et al. 2021; Furlan et al. 2025).

These cross-cutting processes are essential for addressing asymmetries in vulnerability and adaptive capacity across Mediterranean sub-regions. By embedding equity, inclusion, and social justice as explicit entry points, portfolio strategies help ensure that transformation does not reproduce existing spatial or socio-economic disparities, particularly between northern and southern shores or urban and rural areas (Ali et al. 2022; Kazanskaia 2025). Mechanisms such as community-led governance, youth engagement, and social entrepreneurship strengthen local ownership and redistribute agency, while regional and national institutions provide enabling policy architectures, funding pipelines, and coordination structures that sustain collective action across territories (Kazanskaia 2025; Moallemi et al. 2024).

Furthermore, integrative entry points enhance long term system resilience by fostering redundancy, diversity, and flexibility in socio-ecological and economic systems. Combining ecosystem-based adaptation, circular economy strategies, and regenerative resource management creates multiple benefit streams—biodiversity protection, livelihood security, climate mitigation, and health co-benefits—which increases the robustness of transformation trajectories under uncertainty (Furlan et al. 2025; Soergel et al. 2024). These approaches are reinforced by intermediary structures—regional platforms, boundary organisations, research networks—that broker knowledge across sectors and jurisdictions, support capacity-building, and help navigate trade-offs and contested interests (Granberg et al. 2019; Barbosa et al. 2019; Caniglia et al. 2021; Arranz et al. 2024).

Insights from *Chapter 6* suggest that investments in resilience should not be viewed solely as costs associated with climate adaptation and risk reduction. They can generate multiple resilience dividends through avoided losses, reduced exposure to future hazards, improved public health outcomes, enhanced ecosystem services, increased productivity, strengthened social cohesion and greater institutional preparedness (UNEP 2025). As climate and environmental risks intensify across the Mediterranean, the economic, social, and ecological costs of delayed action are expected to exceed the costs of proactive adaptation and transformation in most sectors and territories. This reinforces the importance of treating resilience-building not only as a defensive strategy but also as a development opportunity capable of generating long term co-benefits across multiple policy objectives (IPCC 2022).

Critically, cross-cutting entry points also foster continuous adaptive learning and reflexivity. Transition dynamics are rarely linear; they evolve through experimentation, failure, institutional negotiation, and emergent opportunities. Integrative approaches therefore emphasise iterative monitoring, co-production of knowledge, and collective reflection, enabling actors to recalibrate priorities, identify unintended consequences, and realign strategies as conditions change (Bennett et al. 2021; Casarejos 2020). While Moallemi et al. (2024) helped identify entry points and engines of change and Bennett et al. (2021) showed that local seeds of sustainability can support alternative futures. Geels et al. (2023) explained how these seeds may operate as niches that interact with regimes and landscape pressures. De Castor et al. (2025) added that these interactions must be understood as processes, practices and pathways across scales. Fransen et al. (2025) sharpen the governance implication: entry points are transformative only when they combine systemic innovation, structural reform and enabling capacities, while addressing distribution, participation and recognition. This learning orientation is particularly important in the Mediterranean context of polycrisis—where climate shocks, resource volatility, and geopolitical instability intersect—requiring anticipatory governance capable of operating under persistent uncertainty (Quagliarotti 2023; Engelke 2016), therefore avoiding a perma-crisis with all the associated consequences.

Legal systems also need adaptive capacity. Static rules are not sufficient under climate uncertainty, resource volatility, environmental risks. Mediterranean governance should therefore combine legal certainty with flexibility, periodic review, science-based thresholds, participatory procedures and mechanisms for revising policies as new risks emerge or last (Soininen et al. 2021; Korhonen-Kurki et al. 2025).

A justice-centred interpretation of transformative change further strengthens the identification of cross-cutting entry points. Scoones et al. (2020) and Fransen et al. (2025) distinguished between systemic, structural and enabling approaches to transformation. Systemic approaches focus on changing the interactions and feedbacks within socio-ecological or socio-technical systems; structural approaches address deeper political-economic relations, institutional arrangements and power asymmetries; and enabling approaches emphasise the capacities of individuals, communities and institutions to act differently. Applied to the Mediterranean, this means that transformative governance cannot rely only on system-wide technical solutions or rapid policy deployment. It must also confront structural inequalities, ensure inclusive participation, recognise differential vulnerabilities, and support the agency of local and marginalised actors. In this sense, justice becomes not only an additional criterion but a core condition for determining whether a pathway is genuinely transformative.

A resilient and sustainable Mediterranean pathway therefore requires not only technologies and policies, but also renewed human capacities, intergenerational skills, climate and environment literacy, scientific

understanding, local knowledge and the ability to act collectively under uncertainty and volatility. Taken together, these cross-cutting processes and integrative entry points form the operational backbone of transformative acceleration in the Mediterranean. They enable regions to align local adaptation pathways with broader societal and environmental objectives, ensure equitable benefit-sharing, and cultivate institutional cultures that value collaboration, plurality of knowledge, and long-term stewardship. By bridging silos, connecting scales, and mobilising diverse actors through shared transformative agendas, they support the emergence of resilient, regenerative, and socially just transition pathways capable of navigating the complex futures facing Mediterranean societies (Bennett et al. 2021; Moallemi et al. 2024; Furlan et al. 2025). These levers should help the region move toward desirable scenarios while avoiding futures marked by inertia, forced adaptation, fragmented growth and escalating crisis (Plan Bleu 2025a).

Taken together, the findings of *Chapters 2 to 6* suggest that the Mediterranean is entering a period of accelerated transformation shaped by the interaction of climate change, environmental degradation, demographic dynamics, technological innovation, geopolitical uncertainty and evolving governance arrangements. Future trajectories will depend on whether these interacting pressures reinforce fragmentation and vulnerability or stimulate cooperation, innovation and regenerative development. Transformation pathways therefore represent not a separate policy agenda but the integrative framework through which climate adaptation, mitigation, biodiversity conservation, sustainable resource management, economic resilience and social justice can be pursued simultaneously (Ali et al. 2022; Plan Bleu 2025a; UNEP 2025; Soergel et al. 2024).

The Mediterranean transformation agenda should therefore combine two interlinked logics: preventing negative ecological tipping points and deliberately triggering positive social, technological and institutional tipping points toward resilience, equity and land degradation and climate neutrality (Otto et al. 2020; Lenton et al. 2025).

Overall, the levers of transformation in the Mediterranean are multi-scalar, relational, and systemic. They depend on (1) empowered local communities and seeds of change, (2) regional governance capable of connecting and amplifying innovation, (3) national institutions that provide enabling regulatory and financial conditions, and (4) transboundary cooperation and integrative knowledge systems that navigate uncertainty and asymmetry. Activated together, these levers support robust transition pathways that are inclusive, regenerative, and resilient, and that enhance the capacity of Mediterranean societies to respond to accelerating environmental and socio-political pressures while shaping desirable long-term futures (Hölscher et al. 2020; Bennett et al. 2021; Ali et al. 2022).

7.3.3. Scenario elements for key sectors: food systems and blue economy

Transformative futures in the Mediterranean require sector-specific scenario elements that connect biophysical change with socio-economic pathways. The two-dimensional framework above – cooperation versus fragmentation, and incremental versus transformative change – should therefore be operationalised in sectors where pressures, trade-offs and distributed consequences are most visible. Food systems and the blue economy are priority domains because they sit directly at the interface of climate risk, livelihoods, biodiversity, water and energy demand, trade dependency and regional cooperation. This subsection does not add a separate scenario framework; it specifies how existing MED 2050 narratives can be tested through concrete sectoral pathways (Plan Bleu 2025a).

7.3.3.1. Food systems scenarios

Mediterranean Food systems face interrelated pressures from aridification, water scarcity, land degradation, biodiversity loss and volatile trade. Scenario evidence suggests that, under intermediate pathways such as SSP2-4.5, climate stress could reduce agricultural yields by about 10–30% by mid-Century in vulnerable crops and sub-regions, with the strongest risks in rainfed and water-stressed areas (MedECC 2020; IPCC 2022; Plan Bleu 2025a).

According to Plan Bleu (2025a), MED 2050 is valuable in that it interconnects six different futures as they relate to geopolitical, the environment, and governance dynamics and places food futures within the context of the WEFE nexus rather than only analysing food security in relation to agricultural production.

In pessimistic or business as usual pathways, such as MED 2025's "Inertia' or "Growth at all costs' narratives, intensification without nexus safeguards is predicted to worsen the existing loss of biodiversity, soil erosion, aquifer depletion, and dependence on food imports. In southern sub-regions, it is expected that rainfed crop production will decrease by 20%–40% by 2050, while fragmentation of governance and continuing North–South divides will increase food insecurity risks in those territories which are already facing increased stresses from lack of water resources. Aridification patterns may expand semi-arid zones by 10%–20% across North Africa alone (MedECC 2020; IPCC 2022; Plan Bleu 2025a). In an environment or framework characterised by weak cooperation, the possibility exists that import dependency will deepen due to trade interruptions and inequitable access to resources and subsequently lead to increased socio-economic tensions. Overall data from MED 2050 indicate that dependency on food imports in southern countries may be up to 30% higher by the year 2050 if the structures and systemic vulnerabilities that result in inequitable resource distributions are not addressed (Plan Bleu 2025a).

Advancing toward pathways mostly consistent with the optimistic narratives contained within both SSP1 and MED 2050's future visions (like the Euro-Mediterranean Partnership or Sustainable Mediterranean Model) could lead food systems to transition from a focus on maximising agricultural yields alone to developing agroecology or regenerative land management, diversified, sustainable farming practices and relying on circular bio-economy practices and associated water use efficient methods. If implemented in conjunction with subsidies for regenerative agricultural methods, sustainable land management practices and urban-rural linkages, the measures will result in stabilising agricultural yields, reducing greenhouse gas (GHG) emissions by approximately 15–25% and enhancing rural livelihoods (MedECC 2020; Plan Bleu 2025a).

Establishing cross-border knowledge networks and cooperative water-sharing mechanisms would be essential enablers. The strongest no-regret action to achieve the desired outcomes is through integrated WEFE planning systems. By using integrated WEFE planning, food systems will also be able to reduce trade-offs associated with irrigation, energy demand, ecosystem conservation or protection, food availability and may, in the Southern sub-regions of the Mediterranean, increase self-sufficiency in food production by 10–20%, if both innovation and improvements to water governance are made (Plan Bleu 2025a).

At the same time, food system transformations may also create maladaptation risks. Expanding irrigation indefinitely across entire basins, groundwater accounting isn't maintained, and energy – water price structures are not developed, dryland areas experiencing increased water withdrawals from groundwater reservoirs could see groundwater supplies depleted by 20%–30% by 2050, even though short-term yields from agricultural production would be improved (IPCC 2022; Plan Bleu 2025a). Therefore, food scenarios developed for food systems must address not only production, but also demand-side sufficiency, dietary changes, waste food reduction, soil restoration, improved farmer livelihoods, trade resilience and social safety net programs.

The most visionary scenario for the 'Mediterranean as a global commons' in 2050 would provide more than just predictable climate change impact on the region; it would also create a benefit of the basin as a whole through better collaboration, digital technology to support precision farming and advising land use, better and fair access to technology to reduce food waste and the severity of dry climate impacts. This type of progress would greatly improve resilience to drought. However, it has a relatively *low to medium level of confidence* because it requires an unprecedented level of cooperation, funding and trust within institutions (Plan Bleu 2025a).

The strongest message is that the future of Mediterranean food will not solely be determined by technological advancement, but rather by whether the north, south, and east shores of the Mediterranean can move away from fragmented development of adaptation and dependence on imported food through adopting a collaborative approach to WEFE governance, agroecological transition, sufficiency-oriented consumption practices and equitable technology innovation transfer. While the northern areas may take the

lead in terms of technology and financing, to develop transformational food security across the Mediterranean region there will be a need to provide support to those respective sub-regions that are being most severely affected by aridification, water stress and dependability risks.

7.3.3.2. Blue economy scenarios

The blue economy requires the same scenario logic because Mediterranean marine and coastal systems are being affected by warming, sea-level rise, coastal erosion, pollution, loss of biodiversity, overfishing, tourism pressure, and ports and shipping transitions. In fragmented and incremental futures, blue growth will *likely* remain an extractive enterprise, as there will be growing coastal urbanisation, mass tourism, and growing offshore energy and maritime transport industries, while marine protection, fisheries governance and pollution control will continue to be extremely unevenly distributed. There will also be increasing conflicts between economic uses of marine resources and the recovery of the ecosystems, especially in coastal communities that have limited capacity to adapt to change.

A transformative path to the blue economy would treat the sea as a shared ecological and economic commons by integrating all of the following: ecosystem-based marine spatial planning; establishment of effective marine protected areas; effective fisheries co-management; low-impact aquaculture; decarbonisation of the ports and shipping industries; creation of circular coastal economies; development of nature-based coastal protection systems; and climate-resilient tourism. The MED 2050 narratives include examples of each of these approaches with some key points that could provide useful guidance. Examples of the possible 'blue-green cooperation' and the 'Mediterranean as a global commons' scenarios would place emphasis on cross-border monitoring, data-sharing, enforcement capacity and availability of equitable finance, while the more fragmented scenarios would illustrate the lost opportunities and costs associated with delayed cooperation (Plan Bleu 2025a; UNEP/MAP 2025b).

The no-regret measures within this sector include restoring coastal ecosystems, developing integrated land-sea planning, protecting nursery habitats, creating sustainable seafood value chains, establishing early warning systems for marine heatwaves and developing participatory governance structures that include fishers, coastal municipalities, port authorities, tourism operators, and civil society.

Food systems and the blue economy are also not two separate sectoral boxes. They exist within a Mediterranean WEFE-land-sea nexus which means that allocation of freshwater (i.e. for agriculture) will impact both agricultural and coastal ecosystems. Demand for diets and seafood products will impact fisheries and aquaculture. Ports and tourism activities will influence demand for energy, land-use along coastlines, generate pollution, and hence marine ecosystem health will condition livelihoods food security. To ensure the proposed transformations are coherent across land, water, food, energy, and marine governance (i.e. so that the benefits and burdens of transformation are fairly shared among shores and social groups), sector-specific scenario analyses should be used to guide the implementation process.

7.4 Actionable principles and systemic transformation pathways for the Mediterranean

Building on the conceptual foundations (Section 7.1), empirical insights from real-case transformation experiences (Section 7.2), and the exploration of future-oriented scenarios and levers of change (Section 7.3), this concluding section synthesises key lessons learnt of Chapter 7 into a set of actionable principles and systemic transformation pathways tailored to the Mediterranean context. Rather than prescribing a single development model or trajectory, this section distils cross-cutting principles that may drive decision-makers, practitioners, and stakeholders in navigating transformation under uncertain scenarios, complexity, and deep socio-ecological interdependencies. It articulates how transformative pathways can be designed and implemented by aligning governance, behaviours, economic models and technological systems, while accounting for regional asymmetries, cultural diversity, and geopolitical realities characterising the Mediterranean. Entry points for transformative action are also introduced to provide an integrative roadmap linking scientific knowledge with policy-relevant guidance. [PLACEHOLDER: section to be drafted]

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[PLACEHOLDER: the references will be completed for the second order draft]

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Annex 7.1. Selection and scope of the assessed evidence

To support the assessment presented in the Section 7.2, a systematic literature review was conducted using targeted searches in Web of Science and Scopus. Search terms were derived from transformation and transition-related concepts commonly employed in recent international climate and environmental assessments, including transformative adaptation, transformative change, systemic transformation, systems transitions and transformations towards climate resilience (see Section 7.1). These terms were combined with geographic filters covering Plan Bleu Mediterranean countries and sub-regions. This approach ensured consistency between the conceptual framing of transformation outlined in Section 7.1 and the regional scope of MAR2.

The review was guided by the question: *what drives, enables and constrains sustainability-oriented transformation processes in Mediterranean socio-ecological systems?* The review process involved six steps: (1) definition of the research question and scope, (2) description of the inclusion criteria for case studies, specifically containing primary data, (3) selection of the relevant literature through searches conducted in Scopus and Web of Science on 24th December 2025, (4) extraction of case studies fulfilling the inclusion criteria, (5) development of the variables to characterise key dimensions of the question at stake, and coding of the case studies accordingly, and finally (6) synthesis of the main trends across the assessed evidence.

The search focused on publications since 2000 in English, French, Spanish, Italian and Greek. The specific search string employed was: ‘transformati* adaptation*’ OR ‘system* transition*’ OR ‘transformati* chang*’ OR ‘transformation* to climat* resilien*’ OR ‘system* transformati*’ (Topic) and mediterra* OR ‘South* Europ*’ OR ‘North* Afri*’ OR mena OR ‘Middle East* and North Afri*’ OR ‘Middle East*’ OR ‘Albania’ OR ‘Bosnia and Herzegovina’ OR ‘Croatia’ OR ‘Cyprus’ OR ‘France’ OR ‘Greece” OR ‘Italy’ OR ‘Malta’ OR ‘Monaco’ OR ‘Montenegro’ OR ‘Slovenia’ OR ‘Spain’ OR ‘Israel’ OR ‘Lebanon’ OR ‘Türkiye’ OR ‘Syria’ OR ‘Algeria’ OR ‘Egypt’ OR ‘Libya’ OR ‘Morocco’ OR ‘Tunisia’ OR ‘Palestine’ (Topic) and ‘sustainab*’ OR ‘environment*’ (Topic).

Cases were included when they provided primary empirical material on societal or socio-ecological change processes in Mediterranean contexts, and documented changes with potential relevance for broader sustainability transitions or transformations. These changes could involve governance, economic, social, technological or environmental reconfiguration. Sustainability and climate change could be explicit or implicit drivers of change, but did not need to be the sole focus of the study. To ensure comparability across cases and alignment with MAR2 as an evidence-based assessment, included cases were required to provide information on several analytical dimensions: contextual conditions, drivers of change, actors and governance arrangements, mechanisms or pathways of change, observed outcomes, and factors enabling or constraining progress (see Table 7.2 for further detail). This allowed the assessment to capture not only where change has occurred, but also how and under what conditions sustainability-oriented transformations and transitions emerge, advance or stall in Mediterranean settings.

Initially a total of 263 papers were identified across Web of Science and Scopus. Following deduplication and abstract screening, a subset of 168 peer-reviewed studies was retained for in-depth assessment. After full-text screening, a final set of 66 papers, comprising 69 cases, was included. Studies were excluded when they did not meet the inclusion criteria, particularly when they lacked primary empirical material, were not peer-reviewed scientific publication, or did not provide sufficient documentation of the transformation or transition process under assessment. The final set of cases provides a diverse, though not exhaustive, representation of sustainability-oriented transformation and transition processes across Mediterranean socio-ecological contexts, sectors and governance settings. It forms the empirical basis for the synthesis presented in Sections 7.2.2 and 7.2.3.

Table 7.2 | Coding dimensions used to assess case studies of sustainability-oriented transformation and transition processes in the Mediterranean.

Dimension	Coverage in the assessed literature
Data base	Web of science; Scopus
Year of publication	Since 2000
Country	Albania; Bosnia and Herzegovina; Croatia; Cyprus; France; Greece; Italy; Malta; Monaco; Montenegro; Slovenia; Spain; Israel; Lebanon; Türkiye; Syria; Algeria; Egypt; Libya; Morocco; Tunisia; Palestine
Mediterranean region	Eastern; Western; Southern
Rural-Urban	Rural; Peri-urban; Urban
Nature of the change	Practice change; Sectoral change; Governance reform; Cross-sectoral change; Systemic change
Transition/transformation	Transition without broader transformation; Transition enabling transformation; Transformation without explicit transition
Scale of the change	Local; Regional; National; International; Multi-scale
Main systems involved	Agri-food; Biodiversity; Energy; Water; Urban; Tourism
Main agents of change	Agent; Groups of agents; Informal institution; Governmental institution
Main vulnerable agents (exposure)	
Degree of institutionalization of the change	Discursive; collective action; partly institutional; institutional
Flow of the change	Top-down; Bottom-linked; Bottom-up
Main Knowledge systems involved	Local ecological (indigenous) knowledge; Mixed; Scientific
Drivers of vulnerability	Social; environmental; climate; economic; political
Enabling conditions	
Barriers and constraints	
SDGs addressed	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17

Annex 7.2. Full list of reviewed papers

Ahn, Y.-J., and Zuhriddin, Z. (2024). Perspectives on urban injustice: Revisiting social geographies of justice. Cities, 150, Article 105041. https://doi.org/10.1016/j.cities.2024.105041

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