Infrastructures of Mediterranean Sustainability: From Transition Ambitions to Material Realities

Marinos Stylianou

Sustainability transitions are frequently described through objectives, indicators and regulatory commitments. In the Mediterranean, however, a more demanding proposition becomes particularly visible: transition becomes consequential only when it acquires material, institutional and social form through the infrastructures that organise resource use, technological change, mobility, cultural participation, production and everyday work. This perspective is consistent with research that treats climate change as a problem requiring coordination across regional institutions and policy systems rather than as a sequence of isolated technical interventions. Mediterranean literature has likewise shown how climatic exposure, inherited urban structures and uneven economic development interact within a densely connected territorial system (Hoffmann et al., 2024; Salvati and Vardopoulos, 2024). The same systemic reasoning underpins contemporary work on futureproofed sustainability, in which the built environment, governance arrangements, environmental accounting and technological transition are treated as mutually dependent components of urban and regional resilience rather than as separate policy domains (Vardopoulos and Passas, 2025). Infrastructure therefore matters in an intentionally broad sense. It encompasses transport networks, waste conversion systems, data centres, cultural institutions, digital platforms, monitoring arrangements and the physical environments through which work and public services are performed. These are the structures through which sustainability ambitions become observable outcomes and through which their costs are ultimately distributed.

The fourth issue of Sustainability Research in the Mediterranean develops this material perspective through five contributions whose subjects differ markedly. They nevertheless converge around a common analytical question: what happens when sustainability moves from declaration to implementation? The first article by Tsavdaridou and Papadaki examine Greek music institutions and the relationship between cultural sustainability, social inclusion and digital innovation. Next article by Sotiropoulos, Michalopoulos and Xydis investigate an experimentally grounded pathway that converts institutional food waste into an upgraded bio oil precursor. The third one by Tsilikas studies Athens Metro Line 4 through the relation between predicted construction pressures, environmental follow up, material recovery and social relevance. The fourth article by Tsoromokos, Kritikos and Tsoromokos interrogate the resource implications of cloud infrastructure and technology supply chains under Mediterranean environmental constraints. Finally, the fifth article by Mavrakis and Apostolakis document the experiences of licensed tour guides. Their working conditions reveal that visitor infrastructure influences not only destination quality but also safety, occupational strain and professional retention. The coherence of the issue therefore lies less in sectoral similarity than in a repeated demonstration of what sustainability depends on. Physical systems, organisational capacities, measurement practices and lived environments are the means through which apparently abstract transition objectives are made operational.

The study by Tsavdaridou and Papadaki places this argument within the cultural sector through a comparison of the Thessaloniki Concert Hall, the Athens Concert Hall, the Thessaloniki State Symphony Orchestra and the Athens State Orchestra. It shows that social sustainability is more mature and institutionally visible than environmental sustainability across the organisations examined. Educational programmes, accessibility measures, community engagement and initiatives directed towards vulnerable groups form the strongest dimension of practice, whereas environmental action remains less consistently embedded in organisational structures. Digital innovation functions across this divide as a transversal enabling mechanism through archives, accessible platforms, immersive applications and new forms of audience interaction. Yet the study resists the increasingly common assumption that digitalisation is intrinsically sustainable, locating its value instead

Open University of Cyprus, CY
E-mail: marinos.stylianou@ouc.ac.cy

© 2026 River Publishers

in the institutional purposes it serves. Its broader contribution is to show that cultural sustainability depends on staffing, governance, financing and organisational competence as much as on public declarations. It also shows that technological innovation becomes meaningful only when it expands access, strengthens institutional memory or improves the social function of the organisation. In a Mediterranean context, cultural institutions operate simultaneously as custodians of heritage, public organisations and participants in urban economies. This anthropocentric interpretation is therefore particularly important because it situates sustainability within institutional transformation rather than within symbolic alignment with environmental or social objectives.

The experimental work of Sotiropoulos, Michalopoulos and Xydis transfers the same problem into the material metabolism of the circular economy by examining whether a continuous institutional food waste stream can become an energy bearing resource. Their linked hydrothermal liquefaction and catalytic hydrotreating sequence identifies operating conditions that improve both bio crude production and fuel quality. Under the reported optimum conditions, the nickel based treatment achieves a higher heating value of 40.8 megajoules per kilogram while reducing oxygen content. The significance of the study extends beyond process optimisation because it demonstrates the evidential requirements of circularity once waste valorisation moves from policy vocabulary into engineering practice. In that context, feedstock characteristics, conversion efficiency, product quality and intended use must all be specified if resource recovery is to be distinguished from simple diversion. This logic corresponds with work on circularity measurement that emphasises the need for indicators capable of tracing actual material recirculation rather than merely recording waste management activity (Papamichael et al., 2023a). It also has a clear methodological analogue in Stylianou et al. (2023), where tomato processing residues were converted into biochar and evaluated through their physicochemical characteristics and potential environmental applications. This provides a closely related example of how organic residues can acquire productive value when the conversion pathway and resulting material properties are explicitly demonstrated. The present paper extends that principle towards renewable fuel production and therefore connects waste management with energy security and institutional decarbonisation in a particularly tangible form.

Tsilikas examines an infrastructural system in which the long term sustainability benefits of metropolitan transport coexist with concentrated construction burdens experienced by particular neighbourhoods during delivery. The analysis of Athens Metro Line 4 compares anticipated pressures with environmental documentation from 2021 to 2025. It shows that management responses are recorded for the principal construction effects, including noise, vibration, dust, traffic disturbance and occupation of public space. At the same time, it maintains the crucial distinction between the existence of a management mechanism and proof of its quantitative effectiveness. That distinction is consistent with previous research on environmental impact assessment in Greece, which has identified a persistent difference between the formal completeness of the assessment framework and the effectiveness of implementation and follow up (Papamichael et al., 2023b). The paper adds an important material dimension by tracing excavation products and construction and demolition waste towards quarry restoration, fill applications, cement production and authorised recovery facilities. In doing so, it shows why apparently similar construction flows must remain analytically separated if circularity claims are to retain empirical meaning. Its treatment of social acceptance is equally careful because the study identifies the burdens and governance conditions that may shape public judgement without converting reported reactions into representative acceptance measures. This methodological restraint strengthens rather than weakens the sustainability argument, since it keeps prediction, documented condition, mitigation, material recovery and social response within their appropriate evidential boundaries.

The paper by Tsoromokos, Kritikos and Tsoromokos examines perhaps the most contemporary form of this problem by placing digital transformation inside the environmental limits of the Mediterranean rather than treating it as a dematerialised process. Through the contrasting corporate architectures of Microsoft and Apple, the study distinguishes the resource pressures associated with hyperscale cloud infrastructure from those associated with globally distributed hardware production. It shows how electricity demand, cooling requirements and potential water stress on one side interact with Scope 3 emissions, material sourcing, product life cycles and electronic waste on the other. This distinction is particularly consequential in Southern Europe, where investment in data infrastructure coincides with summer heat, water scarcity and seasonal pressure on electricity systems. Environmental performance therefore cannot be inferred from global corporate averages without attention to location, cooling technology, grid composition and local resource conditions. The conceptual relevance of Zorpas et al. (2026) is especially strong here. That study interrogates the environmental, social and resource costs embedded within technologies conventionally described as green. It demonstrates that decarbonisation itself remains

dependent on extraction, manufacturing and critical material supply chains. The present contribution applies a comparable caution to digital growth by asking not whether cloud computing or advanced hardware are technologically progressive, but whether their regional resource demands and downstream waste consequences are governed in ways compatible with Mediterranean ecological constraints.

Mavrakis and Apostolakis close the issue by shifting attention from infrastructure as a technological object towards infrastructure as an occupational environment. Their data paper documents 380 licensed tour guides across Greece and records perceptions and experiences concerning visitor site infrastructure, delays, injuries, fatigue, psychological strain, remuneration adequacy and intention to leave the profession. The use of two questionnaire conditions also permits investigation of framing effects associated with making the infrastructure and wellbeing relationship more salient. The importance of this dataset lies in the connection it establishes between destination infrastructure and the people whose work depends on it. Tourism research has often evaluated facilities through visitor satisfaction, accessibility or competitiveness while giving less attention to the occupational consequences experienced by frontline professionals. In a region where tourism is economically significant, heat, crowding, heritage sensitivity and seasonal concentration place recurrent pressure on visitor sites. The dataset creates a reusable empirical basis for examining whether inadequate physical environments translate into fatigue, service disruption, safety incidents or professional withdrawal. Its inclusion also reinforces the journal's commitment to evidence infrastructures themselves, since reusable datasets are not ancillary products of sustainability research but part of the scientific architecture through which claims can be tested, compared and extended.

Across these contributions, infrastructure emerges as the point at which the environmental, economic and social dimensions of sustainability cease to be conceptually separable. A cultural organisation may expand access through digital systems while acquiring new technological dependencies. A waste stream may become a renewable resource only when its conversion pathway is technically and materially credible. A metro project may generate long term mobility benefits while imposing concentrated short term burdens that require monitoring and transparent follow up. Digital infrastructure may enable economic transformation while intensifying demand for energy, water and critical materials. Tourism facilities may improve visitor experience while simultaneously shaping the physical and psychological conditions of work. These are not contradictions that invalidate transition, but they do demonstrate why sustainability cannot be assigned automatically to particular technologies, sectors or policy labels. The central scientific task is to make the underlying exchanges visible, including the externalities that remain outside conventional market or organisational boundaries. Long term sustainability depends precisely on the capacity to identify and internalise such costs rather than transfer them across places, populations or stages of a value chain (Kopsidas et al., 2026). The Mediterranean is particularly instructive in this respect. Climatic exposure, dense urbanisation, insularity, tourism intensity, cultural assets and uneven infrastructural capacity compress many of these trade offs into a relatively small and highly interconnected regional space.

This fourth issue therefore closes the first volume with a proposition that is simultaneously methodological and institutional. Sustainability is neither an abstract destination nor an intrinsic property of technological novelty. Rather, it is an achieved condition of systems whose material flows, organisational responsibilities, environmental effects and social consequences have become sufficiently visible to be governed. The contributions assembled here show that credible transition requires circular economy claims to be supported by material evidence and environmental assessment to continue beyond authorisation through meaningful follow up. Digital expansion must account for the resource infrastructures on which it depends, while cultural sustainability must enter organisational practice rather than remain confined to communication. Sustainable tourism must also recognise the quality of work alongside the quality of visitor experience. The value of Mediterranean sustainability research lies precisely in this capacity to expose the conditions under which desirable transitions succeed, fail or merely relocate their costs. By bringing technical, institutional and social perspectives into a common analytical frame, the present issue advances a form of scholarship concerned less with the rhetoric of transition than with the infrastructures through which a more durable transition can actually be made.

References

Kopsidas, O., Panagiotopoulos, P., Passas, I., Doukas, Y. E., Salvati, L., and Vardopoulos, I. (2026). Integrating externalities into economic systems for long term environmental sustainability. In Spatial analysis for complex territorial systems, pp. 201–213. Elsevier. https://doi.org/10.1016/B978-0-443-44133-2.00018-1

Papamichael, I., Voukkali, I., Loizia, P., Stylianou, M., Economou, F., Vardopoulos, I., Klontza, E. E., Lekkas, D. F., and Zorpas, A. A. (2023a). Measuring circularity. Tools for monitoring a smooth transition to circular economy. *Sustainable Chemistry and Pharmacy, 36*, 101330. https://doi.org/10.1016/j.scp.2023.101330

Papamichael, I., Tsiolaki, F., Stylianou, M., Voukkali, I., Sourkouni, G., Argirusis, N., Argirusis, C., and Zorpas, A. A. (2023b). Evaluation of the effectiveness and performance of environmental impact assessment studies in Greece. *Comptes Rendus Chimie, 26*, 199–220. https://doi.org/10.5802/crchim.218

Hoffmann Ribeiro, A., Sandrin, P., and Doukas, Y. E. (Eds.). (2024). Climate change in regional perspective. European Union and Latin American initiatives, challenges, and solutions. Springer. https://doi.org/10.1007/978-3-031-49329-4

Salvati, L., and Vardopoulos, I. (2024). Intricacies of Mediterranean urban and regional dynamics. *Euro-Mediterranean Journal for Environmental Integration, 9*(1), 277–292. https://doi.org/10.1007/s41207-023-00434-7

Stylianou, M., Laifi, T., Bennici, S., Dutournie, P., Limousy, L., Agapiou, A., Papamichael, I., Khiari, B., Jeguirim, M., and Zorpas, A. A. (2023). Tomato waste biochar in the framework of circular economy. *Science of the Total Environment*, 871, 161959. https://doi.org/10.1016/j.scitotenv.2023.161959

Vardopoulos, I., and Passas, I. (Eds.). (2025). Futureproofed sustainability amidst climate change polycrisis. Advancing SDGs and ESG for the cities of tomorrow. IGI Global. https://doi.org/10.4018/979-8-3373-2327-5

Zorpas, A. A., Economou, F., Naddeo, V., Stylianou, M., Voukkali, I., Vardopoulos, I., Tsiarta, N., Samanides, C. G., Zarra, T., Wern, B., Vyzikas, T., Inglezakis, V. J., and Samaras, P. (2026). The darkest shade of green transition. Energy Reports, 15, 109099. https://doi.org/10.1016/j.egyr.2026.109099