



Integral ecology and old-growth forests: a reading in the light of *Laudato si'*

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Abstract: This contribution explores the paradigmatic value of old-growth forests as a possible concrete expression of the principles of integral ecology set forth in *Laudato si'*. Adopting an interdisciplinary approach, the inquiry draws together Franciscan spirituality and certain currents of the Western philosophical tradition - from the Presocratics to Jonas - with the findings of contemporary forest ecology. Old-growth forests are interpreted not as mere objects of conservation, but as structures that embody a form of systemic stability in which cooperation operates alongside competitive dynamics without suppressing them, but integrating them. The essay further shows how the encounter between Emanuele Severino's critique of technology and the experimental evidence on mycorrhizal networks yields a vision of resilience grounded in the recognition of limit and interdependence, as an alternative to purely functional management models. Within this framework, forest complexity - with the due caution that precludes any mechanical transposition - can offer guiding criteria of discernment in the debate on the challenges of technological development, including artificial intelligence, and in the examination of the foundations of social organisation. Old-growth forests emerge, in conclusion, as a conceptual reference point of genuine consequence for approaching the environmental and civic crises of our time with greater awareness.

Key words: integral ecology; old-growth forests; *Laudato si'*; interdependence; technocratic paradigm.

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1. METHODOLOGICAL PREFACE

It is necessary, first of all, to situate this work within its precise horizon, with a candour that is equal to its limits. No causal explanatory model is proposed here, nor is any direct and normative transfer of ecological dynamics to social and technological systems intended. What is presented is a conceptual

and interdisciplinary essay in which the reference to old-growth forests serves - deliberately - a heuristic and interpretive function, not a demonstrative one. The parallelism suggested does not presuppose any immediate homology between ecological processes and social configurations; it aspires, rather, to bring to the surface, in a comparative key, certain critical questions about the premises

of contemporary models of organisation and development. Three clarifications are therefore necessary, in the interests of overall coherence.

The first concerns mycorrhizal networks and the so-called *Wood Wide Web*. The suggestive nature of this research demands a terminological rigour that carefully delimits its scope: the most recent literature (Karst et al., 2023) urges a clear distinction between biophysical flows and cooperative intentionality, thereby avoiding the risk of one-sided generalisations and anthropomorphic readings. In keeping with this critical orientation, the relevant studies are invoked here for the significance they retain in describing the relational dynamics of forest systems, and in no case as the foundation of arguments that exceed their established scope.

The second concerns the references to Nowak and Wilson, in the section on cooperation and competition. They appear as indicators of influential theoretical positions in the contemporary debate on cooperation - not as expressions of a fully settled consensus in evolutionary biology. The implications of multilevel selection and group selection remain, as is well known, the subject of lively specialist debate; their invocation here serves primarily a comparative and conceptual function.

The third clarification concerns the reference to artificial intelligence. It does not introduce a change of subject relative to the essay's core, but offers a domain of comparative application for the interpretive framework developed here. AI is invoked selectively - not to engage the full breadth of the technical and specialist debate, but solely to make explicit certain cultural implications of the technocratic paradigm in the light of the criteria of relation, limit, and responsibility that emerge from the ecological analysis.

2. INTRODUCTION

More than a decade after its promulgation, the encyclical *Laudato si'* has not ceased to interrogate - or to surprise. It is hardly astonishing that the first document of the ecclesial magisterium entirely devoted to the environmental crisis continues to generate profound interest, particularly when one considers the interpretive horizon within which Pope Francis situates the entire reflection: a systemic radicality that refuses any partial or sectoral reading.

The encyclical does not treat the ecological, economic, social, and cultural dimensions as autonomous and juxtaposed domains, but as structurally intertwined elements of a single framework of meaning. The environmental crisis, in this horizon, is not configured as a problem confined to the management of natural resources, but as the manifestation of a deeper fracture - one that pervades the prevailing models of development, forms of social organisation, and anthropological conceptions. This contribution enters into dialogue with that magisterium. Conceived as an essay of cultural and interdisciplinary reflection - not as a strictly experimental article - it brings into conversation the findings of philosophical thought, Franciscan spirituality, and contemporary forestry and ecological science. It explores the possibility of recognising in old-growth forests exemplary structures of interconnection, cooperation, and shared responsibility, capable of offering orienting criteria relevant to the environmental and civic debates of our time.

The distinctive proposal of this work is therefore this: to read old-growth forests not only as ecosystems of exceptional ecological value, but as conceptual reference points capable of rendering the paradigm of integral ecology concretely intelligible.

3. INTEGRAL ECOLOGY AS A CULTURAL PARADIGM

Integral ecology constitutes the structural axis of *Laudato si'* and one of its most original contributions to contemporary thought. The concept was already present in theological and philosophical reflection prior to the encyclical; what *Laudato si'* brings to it is, however, something qualitatively distinct: an unprecedented systemic force and magisterial authority that transform its cultural weight. Through this expression, Pope Francis outlines a relational vision of reality in which the environmental question appears inseparable from the social, economic, and cultural questions, and in which the natural environment and the human environment are understood as interdependent dimensions of a single complex system. The shift in perspective that follows is far-reaching.

The environmental crisis, within this framework, is not configured as an autonomous or sectoral phenomenon. The encyclical is unequivocal on this point: "We are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental" (Francis, 2015, n. 139). The dynamics of ecological degradation are inextricably linked to the growth of inequalities, the marginalisation of the most vulnerable populations, and the weakening of communal bonds. Integral ecology, therefore, does not merely broaden the horizon of traditional environmentalism: it calls for a comprehensive revision of the parameters through which progress, development, and well-being are generally evaluated - an operation that is, first and foremost, cultural, before it is political or technical.

At the heart of this approach lies the critique of the so-called technocratic paradigm: a reductionist vision oriented toward recasting

reality as a set of resources to be managed according to criteria of efficiency and profit. "The technocratic paradigm also tends to dominate economic and political life" (Francis, 2015, n. 109). The critique is not aimed at technology as such - that would be a position difficult to sustain, and in any case foreign to Francis's thought. It concerns, rather, the transformation of technical rationality into an exclusive criterion for interpreting reality: when instrumental efficiency becomes the measure of all judgement, both nature and the human person are subordinated to a functional logic that simultaneously generates environmental degradation and exclusion - what the Pope calls the "throwaway culture".

Consequently, *Laudato si'* invites a radical reconsideration of the categories of development and growth, in favour of an economy oriented toward care, responsibility toward future generations, and justice. Attention to the environment ceases to be an external constraint on development and is instead recognised as a condition of its long-term sustainability - a decisive logical reversal that has yet to gain the cultural recognition it deserves.

Integral ecology implies, finally, a substantial revision of contemporary anthropocentrism. The human being is not conceived as a subject separated from and elevated above the rest of creation, but as part of a web of relations that precedes and sustains it. What the encyclical terms the "common home" is not a sentimental metaphor - it is an ontological affirmation. "The human environment and the natural environment deteriorate together" (Francis, 2015, n. 48).

It is here that old-growth forests find their most fitting place. As ecological systems in which the interdependence of biotic and abiotic components manifests itself in mature and long-enduring forms, they make it possible to translate the paradigm of integral ecology into

an empirically observable context - showing how cooperation, the recognition of limit, and the distribution of functions belong not only to the ethical or symbolic lexicon, but are principles inscribed in the very processes of forest life.

4. THE PHILOSOPHICAL ROOTS OF INTERCONNECTION: THE UNITY OF THE COSMOS, INTERDEPENDENCE, RESPONSIBILITY

The idea of an inherently interconnected reality is not an exclusively contemporary acquisition. Its roots reach back into a long philosophical tradition that, from its very origins, has interrogated the relationship between the human being, nature, and the order of the cosmos. To return to those origins is not an exercise in mere erudition: the thread remains live, and certain fundamental tensions that run through contemporary debates find their first articulation there - sometimes with a clarity that the centuries have not eroded.

In archaic Greece, between the seventh and sixth centuries BCE, along the coasts of Asia Minor, one of the founding questions of Western thought took shape: whence does all that exists derive? It is the question of the *arché*, the first principle - understood as such not only in a chronological sense, but as the ontological foundation of reality. The philosophers of the Ionian school - Thales, Anaximander, and Anaximenes - are traditionally identified as those who first attempted an answer not through myth, but through the *logos* (cf. Reale, 1982). Thales identifies water as the constitutive principle of all things; Anaximander introduces the *ápeiron*, the indefinite and unlimited from which every entity draws its origin; Anaximenes traces the multiplicity of the real to air and its processes of rarefaction and condensation. The doctrinal differences among

these proposals are not negligible; what they share, however, is more significant: a unitary vision of the cosmos in which the human being does not occupy a separate and privileged position, but is part of a single natural reality. In that founding period, nature does not yet appear as opposed to culture, nor does rational inquiry dissociate itself from a symbolic and sacred dimension.

A similar intuition of the unity of the real, moreover, does not belong to the Greek tradition alone. It is appropriate at least to note - even if this cannot be the focus of reflection here - that it also surfaces, with different inflections, in numerous traditions of Oriental thought, such as Taoism or *Mahāyāna* Buddhism - particularly in its *Zen* form - where the world is conceived as a relational and dynamic process. Here, “emptiness” (*śūnyatā*) does not denote nothingness, but precisely that absence of rigid boundaries that allows every entity to be part of the other, in a radical negation of all ontological separation.

In the modern period - with all due distinctions of an epistemological and theological order - this line of thought finds in the philosophical system of Baruch Spinoza a formulation of extraordinary rigour. In the *Ethica ordine geometrico demonstrata*, the Dutch philosopher affirms the identity of God and nature through what has remained one of the most condensed expressions in the history of philosophy: “*Deus sive Natura*” (in the text of the *Ethica: Deus, seu Natura*; cf. Spinoza, 1677/1988, *Ethica*, IV, *prae fatio*). There exists a single substance, infinite and necessary, of which finite entities are but modes or expressions. Every being is therefore intrinsically relational, as part of a broader order that encompasses it. From this derives a conception of nature that radically excludes all forms of domination: the human being is nature, and what it inflicts upon nature falls back upon itself. This is a deduction Spinoza

does not develop explicitly in an ecological direction - it would be anachronistic to expect as much - but it anticipates with notable clarity certain implications of contemporary environmental ethics.

At this decisive crossing from ontology to ethics, in times closer to our own, stands the contribution of Hans Jonas. In *Das Prinzip Verantwortung* (Jonas, 1979/1990), the philosopher of responsibility shows how the power of human agency, amplified by modern technology, has reached a scale that bears upon the very conditions of life on the planet. Traditional ethical proposals - calibrated to a range of action limited in time and space - prove inadequate to address this unprecedented situation; Jonas accordingly affirms the necessity of an ethical principle capable of extending human responsibility to future generations and to the entire biosphere.

Technology is not condemned as such. The analysis is more nuanced: what is subjected to critical scrutiny is the hubris of technological humanity - the claim to unlimited domination that, paradoxically, renders visible the vulnerability of what it presumes to control (nature, the world). And it is precisely this vulnerability that grounds the moral obligation of care. Central to Jonas's account is his insistence on the recognition of the human being as *being-in-the-world* - a notion he inherits from Heidegger (1927/1976) and regrounds in biological terms - inseparable from the natural context that sustains it. In *The Phenomenon of Life: Toward a Philosophical Biology* (Jonas, 1966/1999), he clarifies how human freedom cannot be thought outside the biological and environmental conditions that make it possible - a position that resonates directly with certain findings of contemporary forest biology.

Presocratic thought, Spinoza's philosophy, and the ethics of Jonas thus converge on a single foundational intuition: reality is not

composed of isolated and juxtaposed entities. Being is structurally embedded in a web of mutual dependencies that precede it, constitute it, and bind it. This is not a marginal note: it is the presupposition upon which the entire framework of this reflection rests.

5. FRANCISCAN SPIRITUALITY: FROM THE CANTICLE TO UNIVERSAL FRATERNITY

The relational conception of reality, elaborated in philosophical thought and adopted by integral ecology as an interpretive structure, finds in Franciscan spirituality a formulation of an entirely different order: not abstract, but existential; not systematic, but incarnated in a form of life. The reference to Francis of Assisi is not a devotional interpolation into an otherwise secular reflection - it is the recovery of a critical resource that speaks directly to contemporary debate.

It is significant that Pope Francis explicitly identified the saint of Assisi as the principal inspirational source of *Laudato si'*. From the encyclical's opening pages, the pontiff writes: "[...] whose name I took as my guide and inspiration [...] He was particularly concerned for God's creation and for the poor and outcast" (Francis, 2015, n. 10). The proximity between care for creation and attention to human beings in conditions of fragility is not accidental: the two imperatives share a common ethical root - the principle of universal fraternity (cf. Edwards, 2016). It is this unity of origin that makes them something more than an ecological sensibility *ante litteram*.

The text that expresses this vision with the greatest power is the *Canticle of the Creatures*, composed by Francis of Assisi between 1224 and 1226. Here, nature is not the object of external contemplation: Francis enters into direct dialogue with it, in a form of recognition

that employs the language of kinship - sister, brother, mother: “Laudato si’, mi’ Signore, per sora luna e le stelle [...] per frate vento [...] per sor’acqua [...] per frate focu [...] per sora nostra matre terra [...] per sora nostra morte corporeale” (Francis of Assisi, ca. 1224–1226/2004; author’s translation: “Praised be You, my Lord, through Sister Moon and the Stars [...] through Brother Wind [...] through Sister Water [...] through Brother Fire [...] through our Sister Mother Earth [...] through our Sister Bodily Death”). This is not a poetic device. This grammar of proximity expresses an ontological position: all creatures participate in a single created reality and share an original dignity that precedes any utilitarian classification (cf. Sorrell, 1988). Creation, in this perspective, is not a set of resources available for use, but a community of subjects with whom it is possible - and necessary - to enter into relationship.

Laudato si’ radicalises this position: “Each creature possesses its own particular goodness and perfection [...] Man must therefore respect the particular goodness of every creature, to avoid any disordered use of things” (Francis, 2015, n. 69). With this statement, the encyclical takes up and brings to systematic consequences one of the most disorienting elements of the Franciscan vision: the overcoming of possessive anthropocentrism. The human being is not called to dominate creation, but to recognise itself as part of it. The earth does not belong to humanity; it is entrusted to it. The appropriate relation to the natural world is not that of one who possesses, but of one who tends - a distinction that, in its simplicity, has profound implications.

Franciscan spirituality thus introduces a conception of limit far removed from the privative connotation the term evokes in contexts dominated by the logic of optimisation. The limit, in this horizon, is not an absence: it is a generative condition. Recognising that one

is not the centre of the world opens the possibility of an authentic relationship with what is other - human or non-human. In this sense, the cosmic fraternity that runs through the *Canticle* is not romantic escapism, but a radical response to a form of thinking grounded in separation and appropriation.

In the year of the eighth centenary of Francis of Assisi’s death, this tradition demands to be read not as nostalgia for an idealised past, but as a critical reservoir for the present. The capacity to recognise value in what generates no profit, to attune oneself to the proper rhythms of nature, to embrace vulnerability as a constitutive trait rather than a flaw to be corrected: these are dispositions that the debate on sustainability cannot afford to ignore.

If we adopt this vision, old-growth forests acquire an additional dimension. The fraternity evoked by the *Canticle* finds in them a concrete ecological expression: the coexistence of different species, the mechanisms of cooperation among organisms, and the respect for nature’s own long timescales render empirically visible that relational logic which the integral ecology of *Laudato si’* proposes as an interpretive category. Old-growth forests, in this light, are not merely objects of study: they are places in which fraternity is inscribed in the very processes of life.

6. OLD-GROWTH FORESTS AS COMPLEX RELATIONAL SYSTEMS

Old-growth forests represent one of the most elaborate expressions of terrestrial ecological systems - not primarily for reasons of age. Their specificity is not measured in years, but in the degree of structural, functional, and relational maturity attained by the whole. An old-growth forest is not the sum of the trees that compose it: it is an organised system in

which biological complexity has been stabilised over processes unfolding across centuries.

At the structural level, these ecosystems are characterised by marked spatial heterogeneity: vertical stratification articulated over multiple layers, the coexistence of individuals of widely differing ages and dimensions, an abundance of deadwood in various stages of decomposition, and deep, biologically active soils (cf. Franklin et al., 1981; Lombardi et al., 2015; Piovesan et al., 2010). This variety is not a marginal or residual element: it is an essential condition for the functioning of the entire system. Structural diversity supports a functional diversity that promotes the coexistence of many species and the activation of multiple ecological niches - often impossible in more simplified environments.

A particularly significant feature is the continuity of ecological processes over the long term. Growth, senescence, and decomposition coexist without interruption, sustaining biogeochemical cycles without abrupt discontinuities. In this context, a situation arises that is only apparently paradoxical: elements that a productivist reading classifies as marginal or inactive - senescent trees, deadwood, fallen trunks - in fact perform first-order ecological functions. They regulate nutrient cycles, harbour highly specialised biodiversity, and contribute to hydrological regulation and soil stability. To eliminate them in the name of efficiency is, consequently, to deprive the system of part of its own mechanisms of structural integrity. A counterintuitive truth therefore emerges: old age does not coincide with decline. The oldest individuals are not an obstacle to regeneration - they perform regulatory functions, contribute to the conservation of ecological memory, and transmit to successive generations conditions favourable to the persistence of the system as a whole. This is not a metaphor: it is what field research documents.

This organisation challenges a widespread conception of forest functionality, one founded on the maximisation of production and the reduction of variability. In old-growth forests, stability does not derive from simplification, but from the active integration of complexity. The capacity to withstand disturbances - climatic, biological, mechanical - emerges from the interaction of differentiated components distributed across different spatial and temporal scales, not from the optimisation of a single productive variable.

It is here that the paradigmatic value of these ecosystems resides. They demonstrate that what endures is grounded in multiple relations - in part redundant, without a single centre of control or rigid hierarchy.

7. THE RELATIONAL FABRIC: EXPERIMENTAL EVIDENCE OF INTERDEPENDENCE AND SYSTEMIC IMPLICATIONS

In recent decades, the ecological and forestry sciences have undergone a paradigmatic shift toward a relational conception of ecosystems.

A central contribution in this direction comes from studies of subterranean mycorrhizal networks, described in both scientific and popular discourse as the *Wood Wide Web*. Research initiated by Suzanne Simard has shown how root systems are interconnected by fungal networks that facilitate the movement of carbon, nutrients, and biochemical signals (Simard et al., 1997, 2012). However, the very suggestiveness of these findings demands a terminological rigour that guards against the risk of anthropomorphic readings. If recourse to semantic categories drawn from human experience may facilitate popular communication, the most recent research (Karst et al., 2023) calls for critical caution. One must distinguish precisely between the mechanical functioning

of nature and the intentionality of collaboration. The understanding of ecosystemic connectivity, while confirmed in its material bases, must remain rigorously anchored to the objectivity of self-organising processes, avoiding psychological projections that could distort its analysis.

What matters here, for the coherence of the argument, is a specific observation: in these complex ecosystems, selective pressure for access to limited resources does not disappear, but is mediated by facilitation mechanisms that contribute to the overall structural integrity of the system. Ecological cooperation therefore does not emerge as an “ethical” alternative to competition, but as a strategy of biological stabilisation over the long term. Consolidated research (van der Heijden et al., 1998) indicates that the functional diversity and redundancy of subterranean networks are correlated with a greater capacity of ecosystems to absorb climatic and biological stress. Functional redundancy - often classified as inefficiency in linear optimisation models - proves here to be a fundamental resource for durability: it allows the system to maintain its functions even when individual components are weakened.

A particular role in this architecture is played by the oldest individuals, sometimes referred to as *mother trees*. Beyond the metaphorical resonance, these trees appear to function as fundamental nodes within the system and as centres of resilience in the face of disturbance: by virtue of the centrality and extent of their root systems, they modulate the distribution of resources and stabilise the structure of the plant community. Old age thus acquires a precise functional value: century-old individuals are not residues of a superseded past, but critical nodes that contribute to the relational stability of the system, modulating dynamics that would otherwise tend toward destabilisation.

To preserve an old-growth forest means, ultimately, to preserve a mode of functioning in which cooperation, variety, and the integration of limit are internal structural principles. Relation is not an accessory element, but the very foundation of ecological order. These systems are configured as self-organising structures (cf. Bateson, 1979/1984) in which stability emerges from distributed adaptive relations. The significance of these findings reaches beyond ecology: the principles observable in old-growth forests offer fruitful analogies for reflecting on the stability of other complex systems, including social and economic ones - suggesting that sustainability resides in the dynamic equilibrium among elements in relation, rather than in the relentless optimisation of single variables.

8. COOPERATION AND COMPETITION: EVOLUTIONARY LESSONS AND IMPLICATIONS FOR SOCIAL SYSTEMS

The evidence emerging from the study of old-growth forests invites a critical reconsideration of the weight attributed to competition in evolutionary processes and, more broadly, in the life of complex systems. For a long time, a certain Darwinian vulgate - one that Darwin himself would not have recognised as his own (cf. Darwin, 1859/1959, 1871/1992) - made competition the primary driver of evolution, relegating cooperation to a secondary or instrumental mechanism.

The most recent findings in evolutionary biology suggest a more articulated reading. Certain studies have shown that cooperation is not an exception to the selective principle, but a structural condition for the emergence of the higher levels of biological organisation. Though at the centre of intense methodological debate, the theoretical synthesis of Martin

Nowak proves particularly illuminating here: “Genomes, cells, multicellular organisms, social insects, and human society are all based on cooperation” (Nowak, 2006).

Within this framework - which also invokes the complex and much-debated intellectual legacy of Edward O. Wilson - selective pressure is reinterpreted not only in individual terms, but as a force capable of favouring the emergence of collective configurations. Wilson, in his effort to trace a “consilience” between the natural and human sciences (E. O. Wilson, 1998), had intuited how the logics of cooperation observable in biological systems might offer interpretive insights into the cohesion of social systems. Although his positions on multilevel selection - developed together with Nowak and Tarnita (cf. Nowak et al., 2010) - which led him to abandon so-called kin selection, were the subject of intense academic controversy, the intuition that evolutionary success is intrinsically relational remains central.

Further grounding is provided by David Sloan Wilson, principal architect of the modern theory of multilevel selection. Groups in which high levels of internal cooperation are achieved tend, over time, to prevail over those dominated by destructive competitive dynamics: “Selfishness beats altruism within groups. Altruistic groups beat selfish groups. Everything else is commentary” (D. S. Wilson & E. O. Wilson, 2007; cited in D. S. Wilson, 2015).

Significant insights in the same direction come from the cognitive and anthropological sciences: Michael Tomasello’s research on the evolution of human cognition has shown that the capacity for intentional cooperation - through forms of “shared intentionality” - represents one of the most distinctively human traits (Tomasello, 2014). Language and institutions do not emerge from purely competi-

tive processes, but from cooperative practices oriented toward common goals.

Taken together, these contributions indicate that cooperation is an organising principle characteristic of systems capable of enduring. Systems that privilege the maximisation of individual advantage tend to lose functional diversity and to exhibit structural fragility. Old-growth forests make it possible to observe how competition can be channelled within relational structures that limit its destabilising effects without annulling its selective role. Transposed to the social plane - necessarily with all the caution that an analogy between different domains demands - this observation suggests that the structural integrity of a complex system derives from the quality of its bonds and the capacity to integrate limit as a necessary condition of its own persistence.

9. TECHNOLOGY AND ARTIFICIAL INTELLIGENCE: THE QUESTION OF LIMIT AND HUMAN RESPONSIBILITY

In the context outlined thus far, the question of technology emerges as a matter of particular importance. Contemporary technologies, and artificial intelligence in particular, are not configured merely as operational instruments of growing power: they constitute a cultural environment that bears directly on the forms of human agency, the modes of social organisation, and the perception of the relationship between the human being and the world. This is not a peripheral observation.

Artificial intelligence offers relevant potential in environmental and forestry contexts as well: from ecosystem monitoring to the modelling of climate change, to support for decision-making processes in settings of high complexity. However, as *Laudato si’* has already made clear, the critical point does not reside

in the instruments as such, but in the cultural paradigm and anthropological framework that orient their development and deployment. When technology is embedded in a reductionist vision, it tends to impose itself as the exclusive criterion of rationality, privileging control, speed, and calculable efficiency.

The thought of Emanuele Severino, an influential theoretical philosopher of the twentieth century, offers valuable analytical tools for illuminating this point. In his account of the destiny of modern technology, Severino shows how it tends progressively to emancipate itself from the condition of means and to take its own development as its end. In this dynamic, technical instruments cease to be oriented by ends that transcend them: they become the ultimate criterion of rational action, driven by a logic of self-referential enhancement.

One element of this analysis that deserves particular attention is the “heterogony of ends” - a classical notion that Severino takes up and develops in *Il destino della tecnica* (Severino, 1998), and which is already present in the earlier *Legge e caso* (Severino, 1979): technical actions, designed to realise specific objectives, produce effects that exceed or contradict the original intentions. What begins as an instrument in the service of the person tends to structure itself as a process with its own logic, capable of redefining the very ends of action. The human being risks shifting from a subject who directs technology to a variable in its functioning - a passage that does not occur all at once, but through gradual adjustments that are difficult to identify at the moment they take place.

It is here that Jonas’s warnings acquire a resonance that time has not attenuated. The “principle of responsibility” does not arise from an ethic of caution - it arises from the recognition that the power of human action has reached a scale at which the entire bio-

sphere has become an object of technical decision, and thus of moral responsibility. But what Jonas diagnosed as risk, Severino carries to its most coherent consequences: technology is not simply an instrument that can be misdirected - it is a process that necessarily tends to make its own enhancement its own end, progressively withdrawing from any external authority. The heterogony of ends is not an anomaly of the system: it is its immanent logic. The ends for which technology is designed are gradually redefined by technology itself, which advances according to its own inertia - difficult to identify and to correct at the moment it manifests itself.

Artificial intelligence renders this dynamic particularly visible. Its capacities for machine learning, prediction, and optimisation tend to translate growing portions of human experience into terms of performance, calculation, and functional adaptation. The principal risk does not consist in a mechanical replacement of the human being, but in a progressive reduction of the complexity of the person to what is compatible with the technical systems in which it is embedded.

The comparison with mature ecological dynamics illuminates this orientation critically. While the technocratic paradigm privileges centralisation, standardisation, and performative acceleration, old-growth forests, as noted, show that the structural integrity of a living whole over time does not derive from single-minded optimisation, but from the full integration of limit. In such contexts, stability depends on the distribution of functions, the redundancy of connections, and the capacity to absorb uncertainty without collapsing. They suggest, in this sense, a criterion for evaluating technological growth: an increase in power does not always equate to progress - long-term sustainability resides, rather, in the capacity to harmonise development with the

relational equilibria and structural necessities of the whole. This is by no means to reject or devalue technology. The aim, rather, is to situate it within a framework coherent with the paradigm of integral ecology, in which innovation is evaluated according to its capacity to strengthen relationships, distribute responsibilities, and promote care. Applied to artificial intelligence, this perspective suggests that even this technology, if it is to contribute effectively to a more sustainable society, must be designed and governed as a relational instrument, embedded in a network of explicitly human ends and not left to evolve according to a purely performative logic.

10. CONCLUSIONS

This essay has brought into interdisciplinary dialogue the magisterium of *Laudato si'*, selected contributions from Western philosophical thought, the Franciscan spirituality of the *Canticle*, and certain recent findings of the ecological and forestry sciences. From the analysis, three fundamental insights have emerged, bound together within a single argumentative arc.

The first concerns the nature and value of limit: limit is not deprivation, but a generative condition. What endures is not grounded in limitlessness, but in its recognition and integration. The second concerns the structural value of cooperation: in complex systems, durability does not emerge from the optimisation of individual elements, but from the quality of the relations that connect them. Competition retains its selective role, but is integrated within cooperative dynamics that enhance its efficacy and contain its destabilising force. The third concerns the question of technology: the contemporary technocratic paradigm, with its drive toward performative maximisation and

hierarchical simplification, tends to transform instrumentality into an end and to reduce the subjects it should serve to variables in its own functioning. This systematic disavowal of limit - in nature, in the person, in future generations - paradoxically becomes an ever-deepening source of structural fragility.

The integral ecology of *Laudato si'* weaves these threads into a single framework: that of a relational vision of reality in which the natural environment and the human environment are not juxtaposed domains, but structurally interdependent dimensions of a single system. The crisis is neither merely ecological nor merely social: it is the symptom of a fracture in the assumptions through which contemporary societies interpret their own presence in the world. To recognise it as such is a necessary act of intellectual lucidity; to assume its implications in public debate and collective choices is a task that the present situation renders all but inescapable.

The lines of inquiry proposed below are not intended to replace the definition of technical and management protocols, which fall within the competence of specialist disciplines; they aim, rather, to offer a framework of cultural criteria and orienting questions within which such choices may be discussed with greater interdisciplinary awareness. From this perspective, the essay advances three focal issues for public and institutional debate: to what extent can forest planning treat complexity and extended timescales as cardinal criteria, rather than as constraints to be managed? How can governance models be constructed that are capable of orienting themselves toward the long term and of safeguarding intergenerational common goods? In what form can structured dialogue among diverse forms of knowledge become a shared practice of civic formation and discernment?

These are not rhetorical questions, nor does the author claim to answer them: they are

directions for reflection that urgently require the convergence of differentiated competencies and responsibilities - scientific, philosophical, legal, pastoral, and political - each with its own rigour, none sufficient on its own. Old-growth forests demonstrate this with eloquence: the structural integrity of a complex system does not derive from the supremacy of one component over the others, but from the quality of the connections among all of them.

In this dialogue, the forestry and environmental sciences hold an indispensable place: they possess the analytical tools and epistemological maturity that make them irreplaceable participants in any serious decision about the future of land and climate. The difficulty does not lie in their insufficiency, but in the limited receptiveness of certain institutional and economic environments to their contribution - a receptiveness that, at the current historical juncture, shows little sign of growing.

The interdisciplinary dialogue attempted in this essay - between theology, philosophy, ecology, and forestry science - is therefore not an academic exercise, but an effort to respond to a civic necessity. The fragmentation of knowledge reduces the collective capacity to interpret phenomena that no single discipline alone can fully encompass.

If reflection is to function as a cultural leaven and if debate is to carry in the public sphere the weight that the challenges of our time demand, interdisciplinary dialogue must not remain an occasional event: it must become a stable principle of governance in the face of complexity.

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