ΤΑ ΤΟΠΙΑ ΤΗΣ ΜΝΗΜΗΣ. Η ΚΛΑΣΣΙΚΗ ΠΟΛΙΣ ΚΑΙ Η ΑΝΑΛΥΣΗ ΤΩΝ ΑΣΤΙΚΩΝ ΟΙΚΟΣΥΣΤΗΜΑΤΩΝ

Λαούπη Α.

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Περίληψη

Ο στόχος της παρούσας εργασίας είναι διττός: α) η επεξεργασία ενός μεθοδολογικού και ιδεολογικού πλαισίου το οποίο ασχολείται με τις ποικίλες εκφάνσεις της ανάλυσης των αρχαιοπεριβαλλόντων, και β) η αξιολόγηση των αστικών οικοσυστημάτων με σημείο αναφοράς την αρχαία πόλι της Κλασσικής Περιόδου (5ος & 4ος αι. π.Χ.). Οι περιβαλλοντικές οντότητες που σχετίζονται με τη μελέτη των αρχαίων κοινωνιών, βιολογικών και πολιτισμικών, είναι τρεις: το οικοσύστημα (φυσικό & ανθρωπογενές), το περιβάλλον (γεωγραφικό, λειτουργικό, διαμορφωμένο & αντιληπτό), και το τοπίο (φυσικό, πολιτισμικό, αρχαιολογικό, 'παγωμένο στο χρόνο'ή μη οικείο). Ουδόλως περίεργα, τα πολιτισμικά τοπία αναγνωρίζονται σήμερα ως αναντικατάστατες πόροι με εξέχουσα παγκόσμια αξία. Προστασία των φυσικών και ανθρωπογενών οικοσυστημάτων σημαίνει, συνεπώς, την υπεράσπιση της πολυπολιτισμικότητας και της ανθρώπινης αξιοπρέπειας. Η συγκεκριμένη διεθνής αυτή τάση εκφράζεται πλέον ανοικτά από την παγκόσμια επιστημονική κοινότητα και την πλειοψηφία των εθνών, των οργανισμών, των φορέων και των τοπικών κοινοτήτων. Όλες οι επιστημονικές δραστηριότητες, θα έπρεπε, λοιπόν, να συμβάλλουν συνεργατικά και με τον καλύτερο δυνατό τρόπο, ώστε να διασφαλίζεται η κοινωνική συνείδηση και ευαισθητοποίηση για την αξιολόγηση και σωτηρία των Τοπίων της Μνήμης. Αντιστοίχως, η ανάλυση των τοπίων είναι παρούσα στα φιλοσοφικά έργα του Αριστοτέλη & Θεόφραστου, και ενσωματωμένη στη γεωγραφική, κοινωνική, οικονομική, πολιτική και πολιτιστική πραγματικότητα της Κλασσικής πόλεως, διότι, αφ' ενός η πόλις αντιμετωπιζόταν ως ένας ζωντανός οργανισμός, αφ' ετέρου η έννοια της διαχείρισης των οικοσυστημάτων λειτουργούσε ως άξονας αναφοράς στην καθημερινή ζωή των αρχαίων πολιτών. Στις πολυδιάστατες παραμέτρους της προαναφερθείσας ανάλυσης συγκαταλέγονται οι έννοιες της Φέρουσας Ικανότητας και της Πληθυσμιακής Πίεσης, καθώς και ποικίλες κατηγοριοποιήσεις των γεωπολιτικών ενοτήτων, η ανάλυση του 'κύκλου ζωής', η αειφόρος ανάπτυξη, ο αστικός μεταβολισμός, τα όρια των συστημάτων και η αστική ροή.

THE LANDSCAPES OF MEMORY.
CLASSICAL POLIS AND THE URBAN ECOSYSTEM ANALYSIS

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Abstract

The aim of this paper is twofold: a) the elaboration of a methodological and conceptual framework which deals with the various aspects of archaeoenvironments' analysis, and b) the urban ecosystems' assessment, a procedure referring to the Greek Classical Era (5th & 4th cent. B.C.). The environmental entities which are interrelated to the study of past communities, both biological and cultural, are three: the ecosystem (natural & human), the environment (geographical, operational, modified, perceived) and the landscape (natural, cultural, archaeological, 'fossil', unfamiliar). Not surprisingly, Heritage Landscapes are today acknowledged as irreplaceable sources with outstanding universal value. Protecting the natural and human ecosystems means, consequently, defending cultural diversity and human dignity. This worldwide need is now openly expressed by the international scientific community

and the majority of nations, organizations, agents and local societies. All scientific activities should coordinate in the best possible way, in order to insure the contribution of research to public awareness and sensitivity towards the evaluation and salvation of the Landscapes of Memory. On the other hand, landscapes' analysis is already present in the philosophical works of Aristotle & Theophrastos and integrated into the geographical, social, economic, political and cultural reality of the Classical polis, for the polis is treated as a living organism and the ecosystems' management functions as a pivotal axis of the daily life. Among the multi-dimensional parameters of analysis are the concepts of Carrying Capacity and Population Pressure, along with various categorizations within the geopolitical structures, the life-cycle analysis, the sustainable development, urban metabolism, system limits and urban flows.

Λέξεις κλειδιά: σύνθετα συστήματα, Οικοφιλοσοφία, πολυ-τοπία, αστικός μεταβολισμός

Key words: complex systems, Ecophilosophy, multi-landscapes, urban metabolism

1. Introduction: The systematic approach of Culture and Nature

The first attempt to tame topics that cross biological, ecological, physical and socio-cultural concepts is dated back to the 1990's, when a PhD. thesis under the general title "Attica of Classical Era as Human Ecosystem. The Eco-philosophy of Aristotle and various methodological issues of Environmental Archaeology" (unpublished, Athens University) began to take shape. This attempt had firstly to confront many misconceptions, for example that cities are separate from nature and not participating in the ecosystems' analysis, along with various methodological and practical issues, such as the lack of a framework within which to interpret empirical studies, if any. The lack of a comparative or reference framework ended when a systematic methodology had been chosen.

Main target was the analysis of the Classical city-state of Attica (due to the plentifulness of archaeological and philological evidence), within the schema of its natural, rural, urban and peri-urban landscapes. The works of Aristotle and Theophrastos offered an enormous help, because these philosophers filled the methodological gap between the physical and cultural systems. As it will be discussed at length in a later section of this paper, cosmos was considered as a unified, but diverse whole, whose inseparable aspects were the dualistic pairs (order/chaos, culture/nature). Landscape histories interest a wide range of social scientists, but particularly archaeologists, who are compelled to read the paleoecological records (i.e. Dalton, 1975; Hughes, 1976; Butzer, 1982; Wagstaff, 1987; Durham, 1991; Hughes, 1994, Lalland et al., 1999). Furthermore, the exploration of historical records may explain the growth and collapse of specific spatio-temporal structures, as it has been demonstrated by Tainter et al. (2003) in the case study of Roman Empire.

2. The concept of landscape, niche & hierarchy: Levels of complexity

International conferences have defined the term 'landscape' as 'the visualization' of abiotic and biotic elements and parameters within the environment, that exist in a given geographical area and have a strong relation to each other, the natural place of ecosystem's expression, an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors (European Convention, 2000; Palermo Declaration, 14-16 November 2003). This is only a glimpse into the vast world of landscapes, extended from Neurobiology to Astrophysics, for landscapes are created out of people's understanding and engagement with the world around them, constantly shaped and reshaped, always temporal, polyvalent and multivocal. They are not a 'record' but a 'recording' as they provoke memory and facilitate or impede action. They embrace both the untidiness of spatial temporalities and structural inequalities, as well as the past embedded in them (Bender, 2002).

The complex intersections of memory and landscape (e.g. material or idealized, mental, inner, symbolic, gendered, sacred, familiar, of diaspora, of loss, of silence) are registered on

the pathways of power, fiction, architecture, symbolism, gender, art, space's organization and death's reality. Thus, landscapes are no longer to be separated from human experience or seen as purely visual, instead they include movements, relationships, memories and histories through space and time (Feld and Basso, 1996). Modern archaeologists try to understand the landscapes that work and are worked on many different scales (Tilley 1994; Bender, 2001).

Respectively, complex systems are systems composed of many heterogeneous components that interact with each other in parallel. Natural complex systems self organize spontaneously to produce global patterns of behaviour that emerge from simple rules. The link between abstract computational models and physical, chemical, and biological systems is through non-equilibrium thermodynamics (Prigogine, 1980 & 1997). Natural open systems self organize by the dissipation of energy according to the second law of thermodynamics (Odum, 1983). Once conceived as a bleak process, energy dissipation is now known to create 'dissipative structures' that hasten dissipation (Prigogine, 1980). In open systems, dissipative structures may appear spontaneously in hierarchies of larger and smaller spatial and temporal scales. They are autocatalytic, meaning that the structure they form feeds back to capture and dissipate more energy. All the same, the study of complex human ecosystems is not necessarily human -centred, but rather focuses on the whole system complex dynamics of matter, energy, and information from all temporal and spatial scales, including those that are uniquely human.

Primary niche dimension may be analyzed into three major 'coordinates': time, habitat (space of habitation, action & reproduction) and resources. 'Niches' vary over time and form the landscapes of power, because some centres are more powerful (in population dynamics, sufficiency of resources, environmental parameters, settlements' organization, transportation lanes, urbanization's level, e.t.c.) than others. Human societies reflect environmental complexity, being 'hierarchical' in their nature (Kirsch in Schiffer, 1980; Renfrew, 1984).

Let us go back and examine thoroughly the ancient Greek authors. The term 'system' is used in ancient Greek language at least 2.500 years before our era. Demokritos (D.K. 135-136, Testimonia B5:Diodorus I.8.1 ff.) refers to the human societies as cultural systems analyzed into the subsystems of communication and symbolism. Aristotle analyzes the concept of system through spatial & temporal variations, along with observer's view. He also understands system's variables, the input of energy, the flow of energy and the transformation of matter, the concept of reversibility, the organization of space and information.

Furthermore, structural concepts/'laws' of Biogeography, Ecology, Bioclimatology, Meteorobiology Historical-geographical Pathology and other modern scientific fields already exist in the texts of Hesiod (e.g. Works & Days, 383-694), Herodotos (III.108) and the Hippocratic School (e.g. On winds, waters and places). Aristotle and Theophrastos were the founders of Human Ecology (i.e. concept of niche, ecosystem, agricultural systems). It is noteworthy that the teacher wrote an atlas of socio-political schemata, while the pupil wrote an environmental atlas of the ancient Greek world, combining, in this way, the methodological framework of socio-economic and ecological analyses.

Moreover, the Mycenaean city-states were autonomous physical, socio-economic and cultural entities dispersed within the Greek landscapes, with their city-centre, the rural and peri-urban space, the acropolis and the sanctuaries, the established political alliances and the commercial network. Later on, Homer describes the natural environments that characterized those centres, by giving different ecological elements for each of them (i.e. Catalogue of the Ships in Il., 494 ff.). In the Homeric narration about Achilles' shield (Il., XVIII.474-617), there is also a description of city's landscapes. Even the small rural communities of the Archaic Period, like the ones described in the Works and Days of Hesiod, maintain the basic functional elements of the periphery which refers to a core -nodal city (Scully, 1990: 2-3; Adams, 2001).

From the Homeric terms (polis, acropolis, asty, agora, gaia, aroura), gradually, the

perception of urban and peri-urban landscapes gets more and more differentiated (Pritchett, 1953 & 1956), including various spaces that reflect human management of the natural and modified environments: A. (1) soil that is appropriate for cultivation (agros), (2) cultivated field with cereals, vineyards and other vegetables (ge psile), (3) plot (gepedon), (4) forest of oaks (dryinon), (5) forest of pines (pityinon), (6) mountainous woody area (orgas), (7) cultivated area (aroura), (8) pasture land (nomos/nome), (9) woods (hyle), untouched, aboriginal landscape in the extremity of the city-state (eremia) and B. (1) sacred space / sanctuary (temenos), (2) city-center (asty around acrop**olis), (3) 'market place'** (agora), (4) city as centre of the periphery (polis), (5) land property (chorion), (6) garden (kepos), (7) house (oikia), (8) plot above which a house is built (oikopedon), (9) cheap & quickly constructed building (synoikia).

Consequently, the categorization of resources and the relevant human activities within the ecosystems of the polis in the form of balance: input/output (water supply, timber supply, agriculture, pastoralism, hunting, mining, energy sources, sewage disposal, climate exposure, pollution rates), along with the hierarchies within human society at geopolitical, religious, socio-economic, biological, cultural and administrative level, formed the complexity of ancient cities.

3. The many landscapes of the polis

Landscapes are not only natural but also very much cultural, shaping pe**ople's experiences** of both time and space. In addition, they are multi-temporal echoing collective memories (Tuan, 1974; Penning-Rowsell and Lowenthal, 1986; Cosgrove and Daniels, 1988; Gregory and Walford, 1989; Bender, 1993; Ingold, 1993; Fleming and Hamilakis, 1997). The landscapes of memory have always been multi-cultural and mutable intersecting landscapes. Homer, Aristotle and Pausanias, as well as the majority of ancient writers described such units (astea). Their words reflect the richness of physical and human worlds in a vibrating chorus that encompasses a variety of components, characteristics, functions and levels. The following categories are not exhaustive but rather indicative.

3.1 Natural & Human Landscapes

Urban environments include both physical and human landscapes. The physical landscapes (soil, hydrology, topography, vegetation, climate, animal communities) dictate the kind, rates and limits of human exploitation over the natural resources, by enhancing some strategies / choices against some others. In addition, the landscapes of human activities (humanscapes) play a prominent role within urban environments and are divided into three categories of human-made **'constructions' / mechanisms:** (1) hardware, (2) software and (3) heartware (Harashina, 1996).

3.2 Landscapes of Identity

a. Unfamiliar, alien or hostile landscape: it is characterized as landscape of separation. **Ancient cities hosted a variety of 'moving' or 'alien' population which had its own** particularities and experienced the depri**vation of 'home'**, e.g. slaves, metoikoi, political/economic refugees, orphans, very poor, aged or handicapped people, victims of war. The reverse procedure includes the merchants, the soldiers, people in exile or the nomads, the emigrants and the colonists. These landscapes of loss may have been originated in environmental (catastrophic phenomena such as earthquakes, soil liquefaction, volcanic eruptions, tsunami, landslides), or human-induced causes and experienced by individuals (e.g. heroes, philosophers, geographers, historians, groups of people (e.g. masters with their **pupils, artistic workshops), 'houses'/families (homeric oikos), clans & tribes, or even whole** cities. Finally, other rupturing parameters may function on a real or metaphoric level. For example the geographical distance, created the concept of borderlands, as many Greek colonies were built at the margins of the circum-Mediterranean world. Equally, alienating forces of modernity may rework a landscape, or a person may at the same time feel at home

and powerful within a local landscape but marginal in terms of a larger political and economic landscape. The case of the first years of the Peloponnesian War, when the peasants of Attica were forced to move within the Athenian Walls (Aristophanes Peace, 306-8, 551-5 & 582-600; Thucydides, II.xiii & xiv; Aristotle Ath. Pol.XXII.24.1), having as a result the disturbance of the socio-economic and sentimental equilibrium of the Athenian society, is quite indicative of the stress experienced in similar cases by people who move violently away from their **'homeland', eve**n if they still live within the larger geopolitical boundaries of the same state.

b. Landscape of return, reconciliation, unification: places of commemoration, of socio-cultural identity (e.g. cemeteries, agora, monuments), familiar paths/strategies/reactions, social bonds, myths & memories of homeland, genealogies & stories for the ancestors, the sense of self and belonging, shared language (idioms), familiar topography, familiar places within the landscape, feeling of safety. **Homesickness (homeric 'nostos') of Odysseus and the** Oath of young Athenians Ephebi (Herodotos, VIII.53; Euripides Ion, 495; Aristophanes Thesm., 533; Lykourgos Against Leocr., 76; Ploutarchos Alc., 15.4; Hesychios, s.v. Aglauros. Dumont, I, 1876: 8-15; Farnell, 1907: 19; Pelekides, 1962: 76; Der Kleine Pauly, 1967: 287-291) reflect in the best way the multi-sensory elements that forge the concept of landscape in the mind and heart of ancient people, as sight, sound, smell and touch, mind and body acted inseparably.

3.3 Functional Landscapes

Landscapes of 'power'/production/maintenance/disposal/redistribution: natural features that provide resources for humans (e.g. woods, drinkable water, mines, cereal fields), areas where production takes place (e.g. industrial zones), conflict zones, communication network (harbours, lanes of transport, coastal settlements, nodal points), places where decisions are made (e.g. oracles, temples, agora), space of information/knowledge sharing (e.g. technological achievements, education, healing).

3.4 Landscapes of human-made boundaries

Ancient poleis recognized various physical elements (e.g. shorelines, rivers, mountain heights and other natural features) as natural boundaries or characteristic points of reference within their landscapes. On the other hand, the human landscape was always segmented and shaped by the needs of daily life and the conventions of political organization (Cole, 2004: 7-8). Although the word **'extremity' (Greek esc**hatia) has not yet been found in the Mycenean Greek (Casevitz in Rousselle, 1995: 19-30), the Ionian word with its derivatives already exist in the Homeric Poems, where they belong to an agricultural terminology (i.e. Il. II, 508 & 616; IX, 84; X, 206. Od. iv, 515-6; v, 488-491; xiv, 104). Later on, they are found in the majority of Greek authors (i.e. Hesiod, Archilochos, Pindar, Plato, Xenophon, Aristotle, Suidas). Moreover, human societies are characterized by a number of human -made **'boundaries' reflect**ed to the landscape, political (citizen/foreigners or cast off), religious (people of the same or another religion), economic(rich /poor), biological (young/old, healthy/sick or crippled), social (private / public), within which the various groups have their own role and function. Three of them deserve special mention:

a. Core/periphery & geopolitical boundaries: territorial organization depended on the terrain and other geomorphological & natural features. Greek literature, which is notoriously centred on cities, recognizes 6 ecological zones (plains, cultivable hill-slopes, uncultivated hill-slopes, mountains, fens & sea). Their character varied with climate, geology and time, as did the ancient Greek cities, which varied hugely in size, territory and resources (Rackham in Murray and Price, 1990: 101-109). Most Greeks played out their roles living and working in the countryside. The archaeological evidence suggests a wide variety of settlement patterns, while many people lived in the urban centre and commuted daily to work in their fields. Especially where a family's parcel of land was located further from the urban unit, the preferred ekistic mode was living in farmsteads during seasons of high agricultural demands. Labourers who did not own their own land could hire out themselves to those who did, at least

on a seasonal basis. Even more, most social levels of society were involved in the production of food that was needed to support the population inhabiting the urban unit.

Although the population levels in the demes were constantly fluctuated, there was a standard per deme, perhaps of 65 men and of 130-1.500 inhabitants in average. In a total of 127 (+3?) demes of Classical Attica, 683 rich families and 491 members of the parliament (Boule) are registered (Osborne, 1987: 38-46 & Table 2 a, 197-200). The anatomy of Athenian society and the archaeological evidence show a powerful periphery with a high level of autonomy and various strong local profiles (Osborne in Murray and Price, 1990: 265-293). This observation is detected in the local geographical differentiation of the attic landscapes that encouraged the geopolitical system (Eliot, 1962; Langdon, 1985) and in many political/social conflicts between the members of different demes/clans (Glotz, 1953). Finally, some areas of the ancient poleis were shielded from human contact because they were sharply disputed by neighbouring states, for example the plain of Eleusis (hiera orgas) between Megara and Attica, sacred to Demeter, while others were artificially marked for communal institutions needed protection, for example the Athenian agora (Cole, 2004: 57-65).

b. Gendered landscape (Cole, 2004: 21-29): the hierarchies of divine authorities and the language used, reflected the human categorization of population (e.g. as feminine were considered the Earth, the continents, the countries & cities, the lakes & springs, many fixed locations, e.t.c., while the Sky, the oceans, most rivers & streams, the winds, the flowers, and the long-distance movement were considered as masculine).

c. Ritual space (Cole, 2004: 35-36, 136): the Greek ideology of pollution recognized three categories of existence, the dead, the living and the immortal. There was also an internal categorization of sacred space within the hieron, for example, the boundary stones (horoi), the fenced enclosure (peribolos) and the basins of water (perirrhanteria) or the temenos (a place cut off). Furthermore, differences in ritual standards for males and females reflect the existing social differentiations. On the other hand, sacred landscapes were acting as protective **shields against nature's over**-exploitation by individuals (Dillon 1997: 212-**4; Sinn in Hägg 1992:** 177-187). Political, and other kind of borders were always subject to challenge and change.

3.5 Landscapes of Perception

a. Material Landscape (modified or built environment): urban and peri-urban (transitional zones) habitats are often fragmented and disrupted reflecting human activities, roles & hierarchies. In every built environment three variables can be determined (Wilk in Kent, 1990: 34-5 & 44), the naturally fixed (by the environmental surroundings and the climatic conditions), the flexibly interrelated (from the existent resources, the technical level and the economic subsystem, meaning the time, the capital invested and the energy consumed) and the culturally fixed (by the behavioural conventions and the cultural functions of the space).

b. Symbolic landscape (belief system, worldviews, cultural configurations, habitus): landscapes are reflections of cultural identities, rather than of the natural environment. The physical environment is transformed into landscapes, and cultural groups transform it through the use of different symbols, symbols that bestow different meanings on the same physical objects (Abrahamsson, 1999): i. Imagined landscape had many forms: cosmic environments recognized by the gods themselves (Earth, Sky, river Styx), residence of fantastic/mythical creatures (e.g. Amazons, Centaurs), sinister / shadowy transitional place where weird beings were said to dwell (e.g. Sirens, Gorgons, Geryon, Cerberus), or on the contrary, places which act as shelter, nest and purgatory (e.g. caves). **There are not 'non-places' but places around** which imagination weaves itself (Bender, 2001). ii. Sacred landscape had many forms: **Mycenaean ruler's residence whi**ch integrated sacred activities within political authority and decentralized new authorities dispersed in the territory of Classical cities, where the gods were substituted for the rulers by guarding the surplus wealth and by serving as moderators of human competition (Cole, 2004: 14-15). The sanctuaries protected the landscapes and served

as 'markers', for they were placed at or near natural borders indicating the limits the community's political reach. Particular divinities were associated with certain kinds of space or land, for example Hermes was associated with caves, Hephaistos with the island of Lemnos, Demeter with hills and springs, Apollo, Artemis and Hera with the marginal landscapes of the polis outside the settlements (Cole, 2004: 16-21). iii. Educational/spiritual landscape: ordered or magical, centred or marginal, where exploration of ideas and expression of learning took place (agora as the nucleus of the socio-political life, stadium, academia, theatre). iv. Therapeutic landscape: ideal (e.g. the various 'utopias' of ancient writers), mental or religious (e.g. temple, sanctuary, oracle, physical feature with a 'healing' energy). v. Cognitive landscape: "a more or less coherent, geographically grounded frame, through which we interpret the meaning of objects and events that can be connected to a specific area". Such landscapes have an emotive charge that allows us to organize them into elements that we like and elements that we dislike.

All the afore-mentioned landscapes coexisted and merged with one another dynamically.

4. Life-cycle Analysis (LCA) of urban landscapes

4.1 City as a living organism

The holistic view of universe and all its parts and elements allowed ancient Greek scholars to conceive the analogies between the microcosm and the macrocosm. In the Homeric Iliad, metaphoric expressions echo the common perception that a city has the characteristics of a living organism (Posner, 1979: 28-46; Lévy 1983: 55-73; Γιατρομανωλάκης, 1991: 82-109). In addition, the city is treated as a whole, within the prospect of an external observer (Cole, 1976; Scully, 1990: 8-9, 103 & 105, 109). The analysis of the structure of organic nature appeared initially in the mythical narrations and gradually transformed into a scientific/ stochastic framework. Bodily-like terms and expressions in the Homeric Epics (i.e. II. , I.254, 481-2; II. 84, 159, 167, 560; XIV.36; XVI.34, 390-1) and many words that describe abstracted ideas in Greek language unify the physical, biological and intellectual worlds, humans lived in. Ionian philosophers (e.g. Anaximander, Empedocles & Heracleitos), as well as the Pythagorians tried to conceive the inner common mechanisms that underlay the natural and human world. Parmenides, first, poses the question about the function of cosmos as a living organism (DK. fr. 6,8,9). Plato, by using various linguistic schemata, establishes an integrated philosophical system, according to which myth, art and logic are three powerful intellectual expressions of the human brain. On the other hand, the perception of the universe as being created from a cosmic womb, forged the cosmogenic mentality from the Presocratic philosophers to the Stoics. Universe is a 'body' made of various wholes, it is a complex system analyzed into different autonomous subsystems (Plato Phil. 29e 1-3). In Hesiod, the phenomenon of disease is not only biological but also cosmological, as a manifestation of disequilibrium and malfunction (i.e. Works and Days, 91-2, 102-4, 189, 255, 269). Moreover, the citizen of the polis may feel that their city is sick, because the moral, intellectual and political aspect of city's life is strongly interrelated to its biological and environmental situation (Herodotos., V. 28; Thucidydes, II. 31, 49 & 53; Aristophanes Peace, 539; Euripides, Hel., 370 ff.; Demosthenes, VI. 9. 39 & XVIII. 13.45). After Plato, Aristotle uses the biological/ socio-cultural analogies in the analysis of complex living systems (i.e. Plato Theaet., 153B-C; Gorg, 524B; Phaed., 241 C; Phil., 11 D & 41C. Aristotle Eth. Nic. A6, 1097 b 22 ff., B5, 1106 a 10-14 , Γ7, 1114 a 21 ff. , E15, 1138 a 29-31; Pol. Πολ. Δ4, 1290 b 26 ff., E9, 1309, 26 ff., H1, 1145 a 30 ff.). Consequently, polis lives, transforms itself and dies like any other living organism in the Universe.

4.2 Life-cycle Analysis (LCA)

Ancient Greek thought is constantly preoccupied with the detection of a universal behaviour in cosmic, planetary, social and cultural level. Earth and humans' communities live as a global entity, for the mechanical, chemical and organic realities interrelate to each other

in 'cyclic' patterns. In fact, the word 'cycle' is used in order to describe the cycles of life in our planet, for example the hydrological, biological, of solar energy, e.t.c. (Met. A9, 346 b 16-347a 12; A13, 349b 3-19; H5, 1044b 29-1045a 5. Phys. D14, 223b 23-26.). In addition, the cycle of people effecting environment and nature limiting human continues spiralling through time, leaving its traces on the modern landscape. On the other hand, Greece is a varied country that presents opportunities for survival, subsistence and livelihood but in different ways as echo the exploitative strategies of ancient inhabitants. Many modern scholars of ecological anthropology have sought to understand the influences of landscape and energy flows on human land use and socio-political organization, although anthropologists rarely venture to compare human organization with that of other living systems (Tainter et al., 2003). Despite this fact, systems theorists (e.g. Miller, 1978), biophysical scientists (e.g. Holling, 2001) and Howard Odum (1996) were pioneering thinkers on the relationship of energy to society.Our increasingly urbanized world deals with the same major problems that ancient writers (politicians, philosophers, historians, poets) had pointed out many centuries before our era, the conversion of land to urban uses, the extraction and depletion of natural resources, the limited absorptive capacity-disposal of urban wastes, the sanitation, water supply, air pollution and cultural identity. Beyond Urban Ecology, according to which the interaction between living things and their environment in the city is studied (Douglas, 1981; Gilbert, 1989), contemporary Urban Ecosystems Analysis re-discovers the blending of socio-economic and bio-physical factors within urban dynamics (energy, materials, nutrients, genetic & non genetic information, population, labour, capital organization, beliefs & myths), by understanding the city as an ecosystem or an organism with its own metabolic processes (Wolman, 1965; Douglas, 1983; UNU/IAS report, 2003). Especially, the five main methods (UNU/IAS report, 2003) are all registered, analyzed and present in the texts of ancient Greek authors: (1) Systems Approach (detection of linkages between particular environmental phenomena and the social & natural systems + hierarchical method of clarifying the relationship of each part to the whole, (2) Biological Analysis (balance, competition, invasion, succession, dominance, hierarchies, perturbation, resilience, resistance, persistence, variability), (3) Spatial Analysis (spatial heterogeneity, scale differentiation, landscape analysis, urban land-cover models), (4) Material Flow Analyses (material flow, energy flow, metabolism, ecological footprint) and (5) Social Analysis (social morphology, social identity, socio-cultural hierarchy, access & allocation of resources such as wealth, power, status and knowledge).

5. Carrying Capacity & Ecological Footprint Analysis

The concept of sustainable development and self-sufficiency are specially highlighted by the ancient Greek authors, as they are considered 'conditio sine qua non' for the existence and survival of the poleis (i.e. Thucydides, II. 36.3 & II.41.1; Xenophon Ath. Pol., II.7 &11-12; Aristotle Pol., A2, 1253a 1ff.). The wise exploitation of the environmental resources, the assessment of the natural and human-made structures (modern managers call it SWOT analysis), the rational management of the political and socio-economic powers within the city-state define the human role, action and responsibility. On the other hand, there is a maximum potential for environmental 'productivity', apart from the Population Pressure (Pp), which is an inherent phenomenon in the communities of living organisms. Consequently, the subsystems of population dynamics, production rates, technology, strategies for survival and natural resources are in mutual interrelation. Human societies organize the annual cycle of their activities according to these parameters, in order to protect their feeding, maintaining and restoring processes (Sallares, 1991, Ch. II, par. 2: 73-84 & 100).

For non-human species, Carrying Capacity (indicated by 'K' in the logistic equation, otherwise known as Cc or Kk) is typically defined as the maximum population that can be supported indefinitely in a defined habitat without permanently damaging the habitat (Gever et al, 1991; Meadows et al., 1992). In fact, according to some scholars, human ingenuity has been so successful historically in pushing back the limits to growth that "this term has by now no useful meaning" (Simon & Kahn 1984). Plato in the Laws (E, 737 C 1- D5; 737 E-738 B)

recognizes the afore-mentioned parameters that function as a limit between human 'expansion' and environmental equilibrium. Aristotle in the Politics (B6, 1265a 39 ff.; H4, 1326a 1- b2; H6, 1327a) analyzes the population dynamics and re-defines the concept of self-sufficiency not only in terms of economic management, but of biological/ecological spectrum, too.

In reverse, Eco-footprinting is an analytic tool designed to estimate the 'load' imposed on the ecosphere by any specified human population. The metric used is the total area of productive land- and waterscape required to support that population (Rees, 1996; Wackernagel and Rees, 1996). Eco-footprinting recognizes that humans remain a part of nature and that the economic production/consumption process interrelates with the biophysical output of a finite area of terrestrial and aquatic ecosystems. It is also emphasizes biophysical (rather than monetary) measures of humankind-ecosystems relationships. Furthermore, Eco-footprint analysis has helped to reopen the controversial issue of human 'Carrying Capacity.'

But rather than asking how large population can live in a given area, eco-footprinting estimates how much area is needed to support a given population, wherever the relevant land is located. While trade enables increases in local populations, those populations are now dependent, in part, on the productivity of distant ecosystems. Thus, by shuffling resources around, trade increases total human load but does not increase total Carrying Capacity. Similarly, increasing technological sophistication has not decoupled the economy from the land. On the contrary, as history has proven, humans are more and more land-dependent. Thus, the ecological footprint of a specified population is the area of land and water ecosystems required on a continuous basis to produce the resources that the population consumes, and to assimilate the wastes that the population produces (Rees, 1992, 1995 & 1996; Rees & Wackernagel, 1994 & 1996; Wackernagel and Rees, 1996).

6. Vulnerability/Disaster/Collapse

The terms Vulnerability, Resilience and Adaptive Capacity, are relevant in the biophysical realm as well as in the social realm. In addition, they are widely used by the life sciences and social sciences with different foci and often with different meanings, blocking the communication across disciplines. Depending on the research area, Vulnerability's concept has been applied exclusively to the societal subsystem, to the ecological, natural, or biophysical subsystem, or to the coupled SES (socio-economic systems), variously referred also as target system, unit exposed, or system of reference. Vulnerability, according to Adger (2006) is most often conceptualized as being constituted by components that include exposure to multi-scaled perturbations or external stresses, sensitivity to perturbation, and the capacity to adapt. Vulnerability is also thought of as a susceptibility to harm, a potential for a change or transformation of the system when confronted with a perturbation, rather than as the outcome of this confrontation (Gallopin, 2006). A system (i.e., a city, a human community, an ecosystem) may be very vulnerable to a certain perturbation, but persist without problems insofar as it is not exposed to it. The ancient writers recognized the importance of environmental and cultural parameters in the longevity and prosperity of the cities. Vulnerable places existed within the geopolitical boundaries of the city-states, prone either to physical hazards or to socio-political structures.

Generally speaking, the 'lifecycle' of hazards includes several phases, dynamically interrelated (Prevention-Preparedness-Response-Mitigation-Recovery). Urban management is present in the works of Hesiod, Aristotle, Plato, Xenophon and other ancient authors, where a serious attempt to categorize the causes of natural and man-induced changes both in the environment and human societies, is easily recognizable (de Romilly, 1977). Moreover, ancient Greeks were fully aware of the crucial role of natural phenomena and human-induced hazards that may cause perturbations in the equilibrium of ecosystems and the life of the cities. Thucidides refers to a severe drought spell (II.47-48) and describes the notorious Athenian plague (II. 48.1-54.5, 57-58.3, 64.1; III.87.1-3). Xenophon observes that settled

areas undergo climatic changes due to the human presence and action, by using the example of snowfall ratio between unpopulated and populated areas (Cyn., IV.9). Aristotle notifies the dynamics of natural subsystems (weather, water, soil and subsoil, plant & animal communities) which exercise strong influence on human societies (On cosmos 6, 339 a 18-30. Met.A14, 351a 19-351b 8), observes the severity of several geological phenomena such as the soil liquefaction (Met. B8, 366a 23-28) and high sedimentation rates (A14, 352 a 6-18).Theophrastos writes on the various causes of soil erosion, describes the deforestation effects on the landscapes by using the example of Crete (De plant caus., I.v.ii-iii. On winds,13). Finally, Strabon (XIV.6.v cap. 684) refers to an observation made by Eratosthenes **on the irreversible results of forest's over**-exploitation in Cyprus.

Apart from studying the causes of societal and environmental collapse in the civilizations of the past (Laoupi, 2006: refers in length to relevant bibliography), modern approaches differentiate, also, the criteria of disaster analysis. When referring to ecological degradation, we speak about a number of indices, such as the catastrophe of the biotopes, the exhaustion of natural resources, excessive mass of waste, various forms of pollution, over-exploitation of **the environment, degradation of life's quality, expenses for ecological 'rehabilitation', e.t.c.** (Hern, 1979; Harris and Thomas, 1991). When referring to societal transformations, we speak about a number of parameters, such as the restriction of social differentiations, minor specialization-economic, professional, territorial-, fainter control executed by central authorities, looser administrative bonds, lesser investment on the cultural subsystems-monumental architecture, literature, artistic works-, minor **information's flow through several** human groups between the centre and the periphery, looser redistributive network of resources, minor cooperation among people, minor territorial sovereignty (Tainter, 1988; Torrence and Grattan, 2002). So, the vulnerability to natural and human-induced hazards is the first step before disaster manifestation, and includes three interdependent parameters (exposure to stress, high potential risks and limited coping capacity) referring both to the environmental and cultural status of past human ecosystems.

7. Conclusions

The parallel developments within all the modern scientific fields are hardly accidental. Not only are the disciplinary boundaries highly porous and open to question, but also, we have come to recognize that the questions posed and answers posited have a very long history within the philosophical itinerary of the ancient Greek thought. The scholars of ancient Greece, and specially the philosophers, succeeded in the working of integrated philosophical schemata that allowed the understanding, analysis and anasynthesis of the mechanisms behind the cosmos. The prolific language (terminology and linguistic flexibility), the logical argumentation and the thorough detection of common structures, functions and analogies in the planetary, physical, biological, abiotic and socio-economic systems have opened a doorway to new concepts, challenges and perspectives in Science. This huge step was reinforced also by the geographical and environmental reality of Greek landscapes. Mediterranean world is composed of scores of thousand physically differentiated microregions, the local ecologies of which have separable identities that continually interact each other. Their evolution and transformation had to take into account longer time frames, in particular intergenerational and historical dimensions, along with other socio-cultural parameters, such as the urban hierarchies and the shift of populations, ideas and products. Human existence holds centre place in the urban ecosystems of ancient Greece. The ideals of democracy, spiritual freedom and scientific progress were forged in the physical and cultural landscapes of Eastern Mediterranean, so richly varied and contradictory.

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