

Dynamic Conservation Management of Nontillable East Mediterranean Upland Ecosystems¹

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Mountainous uplands, too steep, shallow and/or rocky for profitable cultivation, make up large parts of the total area in all Mediterranean countries, especially in the Eastern Mediterranean Basin (Table 1). Whereas adjacent, arable lowlands are undergoing a rapid transformation into more intensive, irrigated agriculture, these nontillable, marginal uplands are either left to their fate of pastoral over-exploitation and uncontrolled urban-industrial-recreational encroachment or they are converted into closed, monotonous shrublands or dense, chiefly monospecies, pine afforestations. Both are highly inflammable and of low value for local populations.

There is, therefore, urgent need for new approaches in which the conservation and rehabilitation of these ecosystems can be reconciled with socio-economic advancement of the population. This is also true for all other nonarable uplands of similar nature in the Mediterranean Basin.

ECOLOGICAL CHARACTERISTICS

The greater part of these uplands is confined to coastal foothills and lower mountain regions with a typical Koeppen Cs "olive climate" -- dry, hot summers with wet, mild winters. This largely subhumid zone can be further divided into a drier xerothermo-mediterranean subzone merging into sub-desert, and into a slightly wetter, cooler, accentuated thermomediterranean subzone merging into the humid, attenuated thermomediterranean zone (UNESCO, 1963). Both are within the 400-800 millimeter isohyets, with true "Mediterranean fire bioclimes" in which acute fire hazards prevail for

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Abstract: East Mediterranean upland ecosystems are severely threatened by exponential landscape degradation and by the loss of biological diversity through monospecies afforestation and brush encroachment. Integrated landscape ecological research, planning, management and education are therefore urgently required to reconcile the need for bio-ecological conservation and restoration and for socio-economic advancement. Highest attainable diversity can be ensured by the maintenance of the dynamic flow equilibrium through controlled grazing, cutting and burning. Flexible multipurpose management for optimization of environmental protection, nature conservation, landscape and recreation amenities plus plant and animal production, should be based on ecosystem management and the creation of multi-layered fodder, fuel and/or recreation forests.

150-200 biological dry days (Naveh, 1973). Their closest ecological counterparts outside the Mediterranean are the broad sclerophyll chaparral and woodland in central and southern California, and similar bioclimatic regions in central Chile.

Table 1--Major land uses in East Mediterranean countries in 1976. (After Le Houerou, 1980).

Country	Mediter. area			Cultiv. area	
	10 ³ ha	10 ³ ha	percent	10 ³ ha	percent
Cyprus	924	855	100	432	50.3
Greece	13,080	8,102	62.0	2,331	28.8
Israel	2,033	1,367	67.2	433	31.7
Jordan	9,178	1,400	14.4	1,175	84.0
Lebanon	1,023	1,023	100	348	34.0
Syria	14,418	6,567	35.6	5,260	80.1
Turkey	77,076	77,110	22.2	8,309	48.6
Total	117,732	36,424	57.3	18,288	51.1

Country	Forest, maqui, shrub		pasture	
	10 ³ ha	percent	10 ³ ha	percent
Cyprus	330	38.5	9.3	10.9
Greece	2,618	32.3	3,153	38.9
Israel	116	8.5	818	59.8
Jordan	125	8.9	100	7.1
Lebanon	570	55.7	105	10.3
Syria	457	7.0	850	12.9
Turkey	6,051	35.4	2,750	16.6
Total	10,267	26.6	7,785.3	22.3

According to the extensive geobotanical description by Zohary (1973), both subzones belong to the Eu-Mediterranean vegetation belt of Quercetalia calliprini maquis and forests.

Great heterogeneity in macro- and micro-site conditions and a long history of active human modification have induced large floristic, faunistic, structural diversity which has contributed much to the attractiveness of these semi-natural landscapes and their complex, intricate vegetation

mosaics. These consist of dynamic regeneration-degradation patterns in sclerophyll, dwarfshrub and herbaceous plant communities. They range, according to site conditions and past and present land use pressures, from rich, productive open grasslands and woodlands to severely depleted dwarfshrub and man-made rock deserts, and from rich multi-layered semi-open shrublands and forests to one-to-two-layered, closed tall shrub maquis.

Most soils are shallow and/or rocky; many are heavily eroded, especially those which were terraced and cultivated and later on neglected. The fertile, well-structured, abundant terra rosa and brown forest soils (derived from hard limestone and dolomites of Upper Cretaceous and Tertiary rocks) and the dark rendzinas (derived from soft limestone with hard calcareous "nari" crusts), as well as the heavier basaltic soils (of volcanic origin), are conducive to vigorous growth of herbaceous plants. These include many valuable annual and perennial grasses, annual legumes and beautifully flowering geophytes, forming productive, stable shrub-free grasslands and woodlands in the xerothermic belts and their arid ecotones. However, in the more humid regions these pasture plants occur either as derived grasslands on abandoned fields, terraces and poorly drained shallow grumosols or as patchy understories of shrublands.

The highly calcareous, pale xerorendzinas (derived from soft limestone, chalk and Eocene rock marls) as well as the brown soils derived from granitic rock, sandstone and metamorphic rock, are much poorer and highly erodible. Here, herbaceous plants are much less competitive and they are presently mostly covered by low-productive and species-poor "batha" (in Hebrew) and "phrygana" (in Greek) dwarfshrub communities dominated by Sarcopoterium spinosa, Cistus and aromatic Labiatae species. Being favored by frequent burning and heavy grazing, these occupy large areas in all east Mediterranean countries. Their conversion into more valuable ecosystems should be considered therefore, as a major management challenge.

The natural potential vegetation of the cooler, wetter subzone consists of maquis dominated by Quercus calliprinos (in Greece by its western vicariant Q. coccifera) and other sclerophyll, mostly evergreen, phanerophytes. Distinguished by dual root systems, spreading both horizontally and penetrating deep into rock cracks, and by resprouting after burning, grazing and cutting, they also respond favorably to pruning and coppicing of one stem. If resprouting from suckers is prevented by recutting or browsing, they soon attain the stature of trees. Thereby, closed one-layered, very fire prone maqui thickets which have been protected from grazing and human disturbances can be converted into rich, multi-layered park-like groves and forests. This, apparently, was the way sacred oak groves were created near cemeteries, which have mistakenly been regarded as remnants of "climax oak communities". The differences between such protected maquis thickets, lacking a herba-

ceous and sub-shrub understorey, and semi-open, disturbed multi-layered shrublands, in structural, floristic and faunistic diversity, are very striking (Naveh & Whittaker, 1979). There seems, therefore, to be very little justification for complete prolonged protection as a conservation management policy aiming at reconstructing the so-called "maqui forest climax", as suggested by Tomaselli (1977).

On the contrary -- one of the oldest existing Q. ilex "climax" forests in Sardinia, with huge scattered oak trees up to 1000 years old, is maintaining its open park-like structure and reproducing itself under traditional swine and cattle grazing. Removing pastoralists would only greatly increase fire hazards and endanger the forest (Susmel and others, 1976).

In the xerothermic subzone, the natural potential vegetation consists of thermophilous park-like maquis and shrublands made up of the valuable Carob tree (Ceratonia siliqua) and Pistacia lentiscus. This evergreen shrub, combining low palatability and great drought resistance with vigorous regeneration powers after fire and cutting, is one of the last shrubs to survive over large areas of overgrazed, depleted, mosaic-like shrub-grassland with low- or non-palatable early maturing annuals. However, if these pressures are released, a striking vegetative recovery of woody plants occurs, together with a very species-rich, productive grass cover. In such a xerothermic, recovered Pistacia shrubland, on 1/10 hectare, 52 woody, 127 herbaceous, 14 reptile, 7 rodent and 31 bird species were recorded (Naveh & Warburg, 1976).

Another important formation in drier parts, consists of deciduous oak woodlands -- Quercus ithaburensis in Israel and Q. macrolepis in Turkey -- very much resembling Q. douglasii woodlands in California. Here, a very species-rich, productive grass and legume understorey is maintained under moderate grazing pressures. However, by over- or under-grazing species diversity is reduced, either to unpalatable weedy forbs or to tall aggressive grasses and perennial thistles (Naveh & Whittaker, 1979).

THE DISTORTION OF DYNAMIC FLOW EQUILIBRIUM BY MODERN LAND USES

Mediterranean land use and its impact on the landscape can be described as being cycles of multivariate anthropogenic biofunctions, corresponding to the main phases of changing land uses (Naveh & Dan, 1973). These started hundreds of thousands of years ago with the use of fire by paleolithic hunter-gatherer economies, which were replaced by agro-pastoral biofunctions lasting until recent times. In this long historical period a dynamic flow equilibrium or "homeorhesis" was maintained between the different woody and herbaceous strata by regular grazing, browsing, cutting, coppicing and/or burning cycles. As explained elsewhere in detail (Naveh, 1981) the thermo-dynamic behavior

of these highly resilient, persistent, meta-stable ecosystems is comparable to dissipative structures (Prigogine, 1976). They are stabilized by a permanent exchange of energy with their environment through climatic- and man-induced fluctuations, thereby generating conditions of renewal of higher entropy production within new regimes of order, i. e., "creating order through fluctuation".

However, in recent years this dynamic flow equilibrium has been more and more distorted by exponentially growing rural and urban populations, with their increasing demands for animal and plant products, fuel, edible plants, etc., the patch-cultivation of steep non-terraced slopes after rootgrubbing of the protective shrub canopy and, above all, by the rapid process of urbanization, road development, tourism and mass recreation, which reach even the most remote villages. At the same time, the abandonment and prolonged protection of shrublands and the expansion of highly inflammable pine forests have further depleted diversity and aggravated fire hazards. The replacement of frequent traditional pastoral fire cycles by costly and ineffective policies of complete fire protection is now causing larger, more devastating wildfires than ever.

If these threatening trends proceed unhampered, only very few spots of open unspoiled landscape will be retained in small protected parks and reserves. Surrounded by ugly man-made deserts of dereliction and despoilation, these will very soon be turned into overcrowded "outdoor recreation slums", like the shores of the Mediterranean Sea.

PASTURE UPLAND MANAGEMENT--CONSTRAINTS AND PROSPECTS

Presently, the major economic benefit derived for local populations is still through pastoral utilization of primary plant production for cattle, sheep and goats. However, due to poor animal husbandry and grazing management, livestock and pasture production are very low and their impacts are disastrous. As goats are best adapted to the rugged terrain and can make best use of lignified woody plants, they have become the major source of income from east Mediterranean shrublands (FAO, 1965). Practical ways of goat husbandry and shrub-pasture improvement--including utilization of fenced bushranges by improved Turkish Angora goats from Texas--have been discussed elsewhere in detail (Naveh, 1974). However, there is little hope for improvement and to prevent further degradation without strictly controlled grazing.

For such rational management, public and communal ownership, allowing unrestricted grazing for everybody, are major constraints. In the past, diseases, starvation in drought years and fodder shortage in early winter, prevented overgrazing during the spring flush season and seed setting. But now, the "tragedy of freedom in the commons" (Hardin, 1968) is acting as run-away feedback for accelerated pasture depletion. Adverse effects on livestock, shared by all herdsmen and now partly

eliminated by supplemental feeding, detracts only a small fraction from benefits gained by each individual keeping additional animals on common pastures. Grazing control can be achieved only as part of a new cultural, negative feedback by comprehensive over-all improvement and development of the Total Mediterranean Human Ecosystem (Naveh, 1978). The rise in livestock and pasture productivity must be combined with a rise in the socio-economic status of the pastoralist and with the elimination of ignorance and indifference at the communal, regional and national levels. This includes a change in the predatory attitudes of short-sighted exploitation and can be achieved, not merely by scientific and technological measures, but by a coordinated effort for public environmental education on all levels. In this, the short- and long-term advantages, both to the individual and the community, gained from improved livestock and conservation pasture management, should be clearly demonstrated by dramatic effects justifying these improvements and a complete change and breakthrough in perceptions and habits. Such great inputs in professional skill, human resources, education, technical and financial efforts, and investments, should serve not only the local livestock industry but should constitute an integral part of multiple-benefit landscape development and rehabilitation, as described below.

In the intensive farming systems of Israel, in Jewish collective settlements, these uplands are an integral part of highly productive beef cattle and sheep industries, based on rotational grazing, mostly in fenced, well-managed pastures. Since 1967 these methods have also been introduced into Arab villages in the Samarian and Judean Hills, with increasing success (Kamal, 1981). Many-fold rise in fodder production and quality has been achieved, even in the most shallow, dry hill sites, by reseeded with the annual legume Medicago polymorpha (hispida), in combination with controlled deferred grazing (Briegeeth, 1981).

However, even by trebling the herbaceous pasture production from less than 100 to more than 300 grams/square meter/year and obtaining 200 kilograms of meat per hectare through intensive improvements, including fertilization, not only has the great dependence on seasonal and annual climatic fluctuations not best overcome but it has even increased (Naveh, 1981). On the other hand, the deep-rooted summer green sclerophyll shrubs, capable of tapping moisture surplus from deep rock layers, can provide green fodder in the dry season and in drought years, although their nutrient value and palatability are too low to sustain high economic livestock production. Therefore, improvements have been directed towards brush conversion by controlled burning and reseeded with perennial grasses. Because of their vigorous resprouting and the need for either frequent reburning or very expensive, not always efficient, highly undesirable, chemical treatments, their ecological and economic feasibility is very doubtful. This is true even where successful early establishment of such reseeded grasses has been achieved, both in Israel (Naveh, 1960) and in Greece

(Papanastasis & Liacos, 1980).

The prospects of grass conversion of low-fertility batha and phrygana are even poorer. As shown by Papanastasis (1980), only a low productive herbaceous cover can be maintained by 3-4 year burning cycles. On the other hand, the silvo-pastoral recreational conversion of dense maqui thickets has been carried out successfully on a large scale in Israel by selective thinning, coppicing, pruning and prevention of resprouting by controlled goat grazing. Thus, in the admirable Goren Forest in the western Galilee, most of the labor expenses have been covered by wood and charcoal production and in addition, the carrying capacity has risen from less than 1 goat/hectare to more than 3 goats. Species richness of the impenetrable fire-prone maqui "climax", with less than 30 (woody) species/one-tenth hectare, has been increased to more than 70, including many highly valuable perennial pasture grasses and ornamental geophytes, together with the good landscape and recreation amenities attained³.

DEADLOCK IN ECONOMIC UPLAND FOREST PRODUCTION

Up to now, the only way of preventing further denudation of depleted uplands was by converting them into dense, chiefly monospecies pine plantations. In addition to providing labor and revenues from wood and fiber, these forests have also served, in recent years, for outdoor recreation. However, from recent data on wood production (Le Houerou, 1980) it is apparent that the annual wood increment per hectare in Cyprus is only 0.52 cubmeter and in Israel, 1.00. These also include much more productive forests on fertile lowlands and higher elevations, i.e. productivity of shallow rocky slopes is even lower. Economic benefits are further reduced by loss of many trees to wildfires and steadily increasing fire prevention and fighting expenses. The early rapid development of such hardy pioneer trees as Pinus halepensis has created the mistaken impression that we can fool nature and establish dense, stable, productive conifer forests like those in much more favorable conditions in Europe. However, even their present low productivity is now severely threatened by combined impacts of photochemical air pollutants and pest infestations. Recent field and laboratory studies (Naveh and others, 1981) showed that widespread chlorotic mottle and decline is being caused in Israel, as in California, by atmospheric ozone concentrations above 0.05 ppm, followed in P. halepensis by severe infestations of Matsucoccus josephi scales. Most recently, ozone stressed P. canariensis trees are also being attacked and killed by bark beetles in the coastal region, where ozone levels already exceed 0.1 ppm. Similar damages can be expected in all other rapidly developing Medi-

terranean countries, where the sea breeze carries photochemical oxidants from urbanized, motorized coastal regions into forested slopes, and this will increase, without doubt (as in Israel) from year to year.

In younger pine stands there is still much grazable forage but with increasing shade and accumulation of undecomposed needle litter, palatable pasture plants are diminishing, together with edible plants, flowering geophytes and wildlife. Because grazing is mostly uncontrolled, it is regarded by foresters as a menace and not an asset. On the other hand, local populations, who have been deprived of their grazing and hunting grounds without gaining any direct benefits from new forests, are mostly hostile and non-cooperative. According to Morandini (1977) much more profitable, economic, wood and fiber production could be achieved from the deeper more fertile soils in wet lowlands and abandoned fields, which are suitable for mechanized cultivation. By more rational silvo-pastoral management, described in detail by Liacos (1980), many upland pine forests could yield both more wood and more pasture and fire hazards could be greatly reduced.

ALTERNATIVE MULTIPLE LAND USE MANAGEMENT STRATEGIES

From our discussion, it is obvious that neither one-sided pastoral nor silvo-cultural crop production oriented management can provide satisfactory socio-economic solutions. Non-arable uplands also fulfill many vital bio-socio-ecological functions for which no alternative land is available; therefore their loss would be irrevocable. They are not only of great biological, scientific, aesthetic and cultural value, as the last refuge for a wide variety of plant and animal species and ecotypes, they also serve as genetic stock for future evolution and potential economic uses for food, industrial, pharmaceutical and many other purposes. These functions and further speciation cannot be ensured in botanical gardens and in the few small nature reserves, but only in natural ecosystems. These should embrace the whole range of geological, pedological, topographical and climatical variety in which the above-mentioned dynamic flow equilibrium of the traditional agro-pastoral biofunction and its defoliation pressures can be continued. Further economic benefits can thereby be derived, while at the same time these ecosystems can fulfill their protective functions as buffering zones, providing drainage basins for flood, erosion and environmental pollution control for densely populated, intensively cultivated lowlands. In view of the rapidly vanishing open wildlands, these uplands also must fulfill vital phychohygenic functions for outdoor recreation by conserving and improving their scenic value and landscape amenities. An entirely new interdisciplinary landscape-ecological approach is therefore required in which all these socio-economic, bio-socio-ecological landscape functions can be optimized by dynamic conservation management. In this, all regulatory functions operating through the vegetation canopy as negative moderating feed-

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backs of reduction of kinetic energy and abatement of adverse human impacts, ensuring self-regulation and dynamic stabilization, are combined with biotic production functions of both economic and non-economic richness, acting as positive amplifying feedbacks. For this purpose all non-arable uplands should be managed as closely interwoven networks of multiple land use patterns. In nature reserves highest priority should be given to sites with unique biological, geological and cultural value, aiming at maximum attainable ecological, biological diversity by careful, flexible, conservation management with different levels of controlled intervention, ranging from complete protection to controlled grazing, cutting and burning but with strict prevention of recreation pressures and other neotechnological interventions. For such studies, the MAB Biosphere Reserves are also most suitable. In nature parks and recreation areas optimization of landscape, wildlife and recreation amenities should enable maximum enjoyment with minimal damage to natural resources.

In the remaining open uplands, used primarily for economic benefits, landscape management and development should aim at optimization of all bio-socio-ecological, economic benefits, according to site potential, plus socio-economic and other requirements after weighing all relevant land use, environmental variables and their mutual influences. For this purpose, cybernetic, multidimensional sensitivity models, developed by Vester (1976), are most suitable. In a first approximation of such models (Naveh, 1979) environmental watershed protection, fire hazard resistance, biotic diversity, wildlife, recreation amenity, livestock production, forestry, plant production and water yields from aquifers were used as major variables. In these, highest over-all benefits were derived from flexible, multipurpose, silvo-pastoral-recreational systems, based on environmental afforestation.

On the basis of our promising introduction trials, we are now jointly realizing this with the Jewish National Fund's Forestry Division, by planting a multi-layered, semi-natural park-forest, resembling the richest semi-open maquis in structure and stability but being of much greater ornamental, recreational and economic value. Here, the local dwarf shrubs are being replaced by fast-growing, soil-protecting cover plants like Rosmarin officinalis, a highly ornamental, excellent honey plant, and the low-flammable Myoporum multiflorum. The local, low-value sclerophylls are being replaced by highly ornamental, much more palatable, productive, nutritious evergreen shrubs such as Cotoneaster franchetti and Atriplex nummularia. In the most favorable niches, slower growing but persistent and shade-spending ornamental and fodder trees Cer-tonia siliqua and Pistacia atlantica and promising Acacia introductions are being planted, while the few oak and other maqui tree remnants are being pruned.

EDUCATIONAL AND RESEARCH CHALLENGES

Such far-reaching programs can be implemented only within comprehensive regional and national masterplans, based on landscape ecological determinism in decision making on land use priorities and management strategies. As already mentioned, these require changes in the attitudes of land owners, users, planners and managers, from the top political level down to the grassroots of the village. Above all, we need to educate a new generation of interdisciplinary land managers and developers to replace one-track minded foresters, graziers, conservationists, recreationists and economists. This formidable educational challenge is closely interwoven with the research challenge, as rightly visualized in the MAB program. However, it needs much greater financial and moral support from local political and scientific authorities in order to have any immediate impact.

There is, without doubt, a great dearth of basic information on the structure and function of Mediterranean upland ecosystems. But at this crucial stage of exponential deterioration, not much can be gained from initiating pretentious, expensive and, alas, mostly very theoretical, far-fetched ecosystem studies aimed at creating the very fashionable not very realistic, mostly deterministic, "ecosystem models". In my opinion, it is much more important to continue to enlarge the "classical" down-to-earth botanical, zoological, pedological and other field studies--if these can be better coordinated and synthesized--so that their results can be applicable to practical ecosystem management. I envisage three major areas for which modern ecosystem and landscape ecological research is vital: 1) finding efficient "ecotechniques" for dynamic ecosystem management of the existing plant cover and its soil-plant-animal complex; 2) finding suitable plants and economic methods for establishing and managing multipurpose environmental afforestations; and 3) attempting to transform intangible, non-marketable landscape values into workable parameters and integrating these with economic land uses in cost-benefit analyses, computerized dynamic planning, optimization and simulation models, which are applicable to the solution of these problems.

As a first step, these challenges could best be realized by pilot research and demonstration schemes in representative sites in each country, with active cooperation of progressive communities and individuals.

LITERATURE CITED

Briegeeth, A.M. Pasture and range areas in Judea and Samaria. Proc. of Int. Symp. on pastoral sheep farming systems in intensive economic environments; 1981 March 8-14; Jerusalem, Israel: Tel Aviv Min. of Agr.; 1981.

- FAO. Report on goat-raising policies in the Mediterranean and Near East regions. Exp. prog. of tech. assistance; FAO No. 1929; 1965; Rome.
- Hardin, Garrett. The tragedy of the commons. *Sci.* 162:1243-1248; 1968 December.
- Kamal, Hatem. Recent veterinary changes to promote the economy and development of sheep and goat production in a traditional Mediterranean agriculture system. Proc. Int. Symp. on pastoral sheep farming system in intensive economic environ. 1981 March 8-14; Jerusalem, Israel; Tel Aviv Min. of Agr.; 1981.
- Le Houerou, H.N. L'impact de l'homme et de ses animaux sur la foret mediterraneenne. *Foret Mediterraneenne* 2:155-174; 1980.
- Liacos, Leonidas. Livestock grazing in Mediterranean forests. Int. Mtg. of Sci. on soil vegetation and fauna--safeguard and restoration of environmental equilibrium and regional planning in the Mediterranean regions; 1980 October; Palermo, Italy; :6-11 (mimeographed).
- Morandini, R. Problems of conservation, management and regeneration of Mediterranean forests: research priorities. In: MAB Technical Notes 2; 1977; Paris, France; UNESCO:73-79.
- Naveh, Z. Agro-ecological aspects of brush range improvement in the maqui belt of Israel. 1960; Jerusalem, Israel; Ph.D. Thesis, Hebrew University; 235 pp.
- Naveh, Z. The ecology of fire in Israel. Proc. 13th Tall Timber Fire Ecol. Conf.; 1973; Tallahassee, Florida:139-170.
- Naveh, Z. The ecological management of non-arable Mediterranean uplands. *Environ. Mgt.* 2:351-371; 1974.
- Naveh, Z. The role of landscape ecology in development. *Environ. Conserv.* 5:57-63; 1978.
- Naveh, Z. A model of multiple-use management strategies of marginal and untillable Mediterranean upland ecosystems. In: Cairns, John Jr.; Ganapati, P. Patil; Waters, William E., eds. Environmental biomonitoring, assessment, prediction and management--certain case studies and related quantitative issues. *Statistical Ecology Series* 11. Burtonsville, Maryland: Co-op. Pub. House; 1979: 269-286.
- Naveh, Z. The evolution of the Mediterranean landscape as anthropogenic biofunctions. Theoretical and practical implications. *Vegetatio*; 1981a (in press).
- Naveh, Z. The dependence of the productivity of a semi-arid Mediterranean hill pasture ecosystem on climatological fluctuations. *Agr. & Environ.* 1981b (in press).
- Naveh, Z.; Dan, J. Human degradation of Mediterranean landscapes in Israel. In: deCastri, F.; Mooney, H.A., eds. *Mediterranean type ecosystems*. Ecol. Studies. New York: Springer Verlag; 1973: 373-390.
- Naveh, Z.; Warburg, M. Plant and animal species diversity along environmental gradients in a Mediterranean landscape of Israel. Haifa. Israel: Technion-Israel Inst. of Tech., B.S.F. No. 450; 1977; 185 pp (mimeographed).
- Naveh, Z.; Whittaker, R.O. Structural and floristic diversity of shrublands in northern Israel and other Mediterranean areas. *Vegetatio* 41(3): 171-190; 1979.
- Naveh, Z.; Steinberger, E.H.; Chaim, S.; Rotmann, A. Photochemical air pollutants--a threat to Mediterranean coniferous forests and upland ecosystems. *Environ. Cons.* 74):301-309; 1980.
- Papanastasis, Vasilios P. Effects of season and frequency of burning on a phrygic rangeland in Greece. *J. Range Mgt.* 33(4):252-255; 1980.
- Papanastasis, Vasilios P.; Liacos, Leonidas G. Productivity of hermes oak brushlands for goats. Intern. symp. on browse in Africa; 1980 April 8-12; Addis Ababa, Ethiopia; Intern. Livestock Centre for Africa (mimeographed); 1980.
- Prigogine, I. Order through fluctuation: self-organization and social systems. In: Jantsch, E.; Waddington, C.H., eds. *Evolution and consciousness*. Reading, Mass.: Addison-Wesley Pub. Co.; 1976:93-126.
- Susmel, L.F.; Viola, F.; Bassato, G. *Ecologia della lecceta supramonte di Orgosolo*. Padova: Annali del Centro di Economia Montana delle Venezie X.; 1976: 1959-1970.
- Tomaselli, R. Degradation of the Mediterranean maquis. In: MAB Technical Notes 2; 1977; Paris, France; UNESCO: 33-72.
- UNESCO. Bioclimatic map of the Mediterranean zone. Explanatory notes. *Arid Zone Research* 21; Paris, France; UNESCO; 1963.
- Vester, F. Urban systems in crisis. Understanding and planning of human living space: The biocybernetic approach. Stuttgart: Pentsche Verlagsanstalt; 1976.
- Zohary, M. *Geobotanical foundations of the Middle East*. Stuttgart: G. Fischer Verlag; 1973; 5-5 pp.