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# Landscape ecology as a foundation for landscape architecture: application in Malta

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**Abstract**

Landscape ecology has the potential to contribute towards a holistic approach in landscape architecture. Such an approach can simultaneously inform, guide and inspire designers towards landscapes that are environmentally sustainable as well as being culturally and aesthetically appropriate. This paper reviews two possible ways in which landscape ecology can advance landscape architecture: (a) by providing a holistic and dynamic framework that contributes towards an alternative landscape design (e.g. ecological landscape design); and (b) by establishing the scientific knowledge (e.g. landscape heterogeneity, biological and ecological diversity and ecological networks) that can inform the design process at the local and regional levels.

Both contributions were tested at the Bahrija Project in Malta. The methodology of ecological design is applied, initially to allow for a comprehensive understanding of the local landscape, and subsequently to assist in the formulation of a preliminary landscape master plan. The paper argues that conservation policies should necessarily be complemented with a proactive approach, which can accommodate the needs of contemporary development while ensuring the protection of natural and cultural resources. 

*Keywords:* Landscape architecture; Ecological landscape design; Landscape ecology; Holistic approach; Malta; Semi-arid

## 1. Introduction: landscape ecology and landscape architecture

Ecology, in the 100 years since its inception, has increasingly provided the scientific foundation for understanding natural processes, managing environmental resources and achieving sustainable development. By the 1960s, ecology's association with the environmental movement popularised the science and introduced it to the design professions (e.g. landscape architecture, urban design and architecture). Landscape ecology's interface with these professions, however, is more recent even though its potential contribution can be just as significant for several reasons. Firstly, unlike the abstract ecosystem concept in ecology, landscape ecology embraces the 'landscape' as a concrete and tangible entity. Secondly, landscape ecology's holistic view reflects a basic philosophy in which landscape is perceived in its totality and cannot be studied by analysing its components as separate units (Zonneveld and Forman, 1990). This holistic view differs fundamentally from the fragmented and compartmentalised approach that often prevails in the design professions. Thirdly, landscape ecology's integrative perspective allows it to accommodate not only the bio-ecological sciences, but also to embrace the realm of human-centred fields of sociology, economics and the cultural sciences, all of which are connected with modern land uses (Naveh and Lieberman, 1990). As a consequence, interdisciplinary collaboration between landscape ecologists, landscape designers and planners is facilitated.

Landscape ecology has indeed contributed successfully to methods of landscape assessment and evalua-

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tion, and towards systems thinking in landscape planning (Hills, 1974; Giliomee, 1977; Steiner, 1991). In landscape architecture, however, its potential contribution towards a holistic design approach is still limited (Cook and Hirschman, 1991). This is partly the outcome of landscape architecture's close professional association with architecture, which commonly gives priority to the stylistic and formal aspects of the landscape. It is also the result of a landscape design methodology that is static, fragmentary and compartmentalised, and as such, ill-suited to the dynamic attributes of living systems (Makhzoumi, 1995). In contrast, landscape ecology's holistic approach has the potential of contributing to the search for an alternative design method in landscape architecture (McHarg, 1967; Lyle, 1985; Thompson and Steiner, 1997; Makhzoumi and Pungetti, 1999). This paper reviews this alternative approach, arguing the necessity for ecological landscape design and planning in the context of the semi-arid Mediterranean.

## 2. Ecological landscape design: an alternative methodological approach

Ecological landscape design integrates input from landscape ecology and design, both of which are seen as providing parallel and complementary, albeit different methodological approaches (Makhzoumi and Pungetti, 1999). The analytic and descriptive nature of landscape ecology, the science, provides for a holistic understanding of existing landscapes, while the intuitive and creative problem-solving capabilities of design prescribe alternative courses for future landscape development.

Ecological landscape design is based on a holistic understanding of landscape, which encourages a dynamic and responsive approach. It is holistic because it simultaneously considers past and present as well as local and regional landscape patterns and processes. It is responsive because it develops from a realisation of the constraints and opportunities of context whether natural, cultural or a combination of both. Ecological landscape design is guided by three fundamental, mutually inclusive objectives: the maintenance of landscape integrity; promoting landscape sustainability; and reinforcing the natural and cultural spirit of place (Makhzoumi and Pungetti, 1999, p. 207). The methodology of Ecological Landscape Association has been developed to achieve these objectives. It is at once 'a framework for understanding the landscape and a tool for designing it' (Makhzoumi and Pungetti, 1999, p. 211). As an interaction framework it allows the designer a holistic comprehension of landscape by investigating processes that bind one or more landscape components (e.g. abiotic, biotic and/or man-made) into associations (e.g. topography/flora, soil/geology). The framework induces a deliberate interplay across the different levels of the spatial hierarchy and along a landscape's historical development, thereby testing the validity of these associations (Fig. 1). Once validated, the association forms the building blocks of the landscape design. The process of searching for the associations not only allows a holistic, dynamic understanding of landscape, but just as significantly, allows the designer to integrate this understanding into the design process. The simplicity and spontaneity of the methodological framework encourages the intuitive and creative problem-solving potential of the landscape designer while prioritising the maintenance of landscape integrity and long-term environmental sustainability. In this paper Ecological Landscape Association refers to the methodology, while its abbreviated form (ELA) refers to an actual association that has been discerned.

## 3. Malta: defining the context

Malta, with an area of 290 $km^2$ is the largest of the three islands that comprise the Maltese archipelago (Fig. 2). With an estimated 350,000 inhabitants, Malta has the second highest population density in the world. The economy is heavily reliant on tourism, a trend that is set to increase as tourism is predicted to make an even larger contribution to GDP and foreign exchange earnings by the end of the century (Lockhart, 1997).

Increased population growth, suburban development and, to a lesser extent, tourism is fragmenting and gradually destroying the island's traditional Mediterranean landscape, which is a rich combination of semi-natural and cultural ecosystems. The consequences are environmental, ecological, cultural and aesthetic. Environmentally, contemporary development increases the consumption of natural resources, mainly water and land, both of which are in short

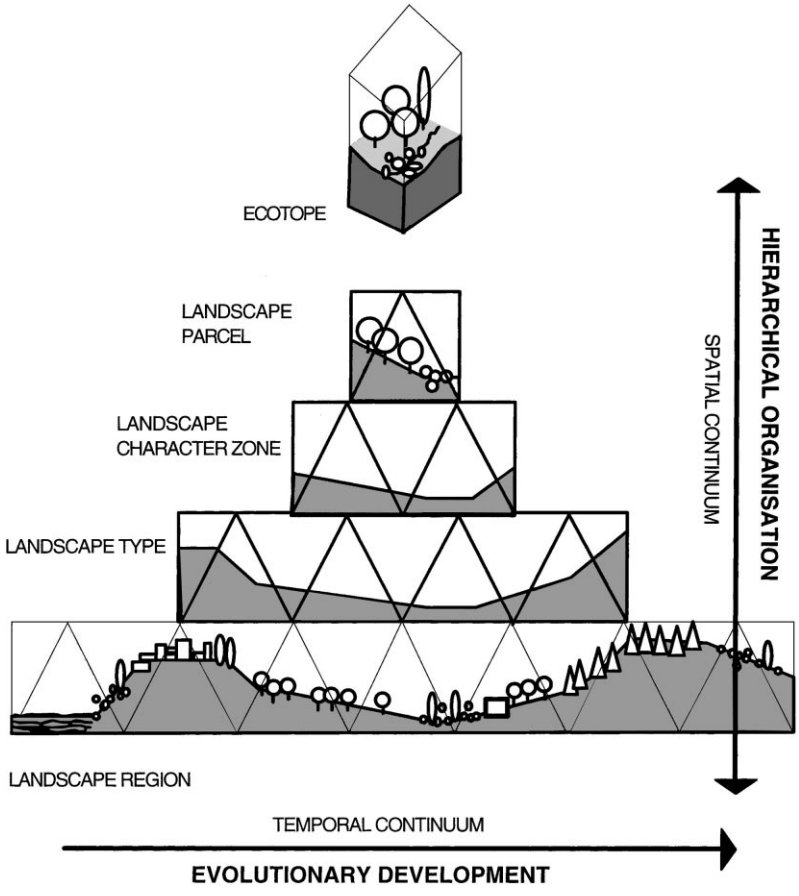


Fig. 1. The temporal/evolutionary and spatial/hierarchical understanding of landscape are central to the holistic framework of ecological landscape design.

supply. Ecologically, contemporary development is generally accompanied by a loss in biological diversity and landscape heterogeneity, as a homogeneous contemporary landscape replaces the traditional sustainable landscape. In addition, unplanned and intensive contemporary development gradually erodes the characteristically Mediterranean landscape, which is part of the island's cultural and historical heritage.

Contemporary development cannot ignore the environmental and ecological constraints of a fragile island ecosystem, and although the Planning Authority in Malta have issued a number of environmental protection directives, effective implementation can only be successful when combined with an alternative approach to design and planning, for example an ecological landscape design and planning. This alternative approach would then allow for future development while maintaining the characteristic landscape diversity and ensuring long-term environmental sustainability. The opportunity to illustrate this presented itself when the author was consulted on the Bahrija Project.

## 4. The Bahrija site

The Bahrija site is located in Malta's western region (Fig. 2). The site has an area of 130 ha and is defined on its west and north side by coast. As typical of this half of the island, the landscape is heavily faulted, dominated by scarpland and basins. True soils are generally scarce and highly calcareous. The site topo-

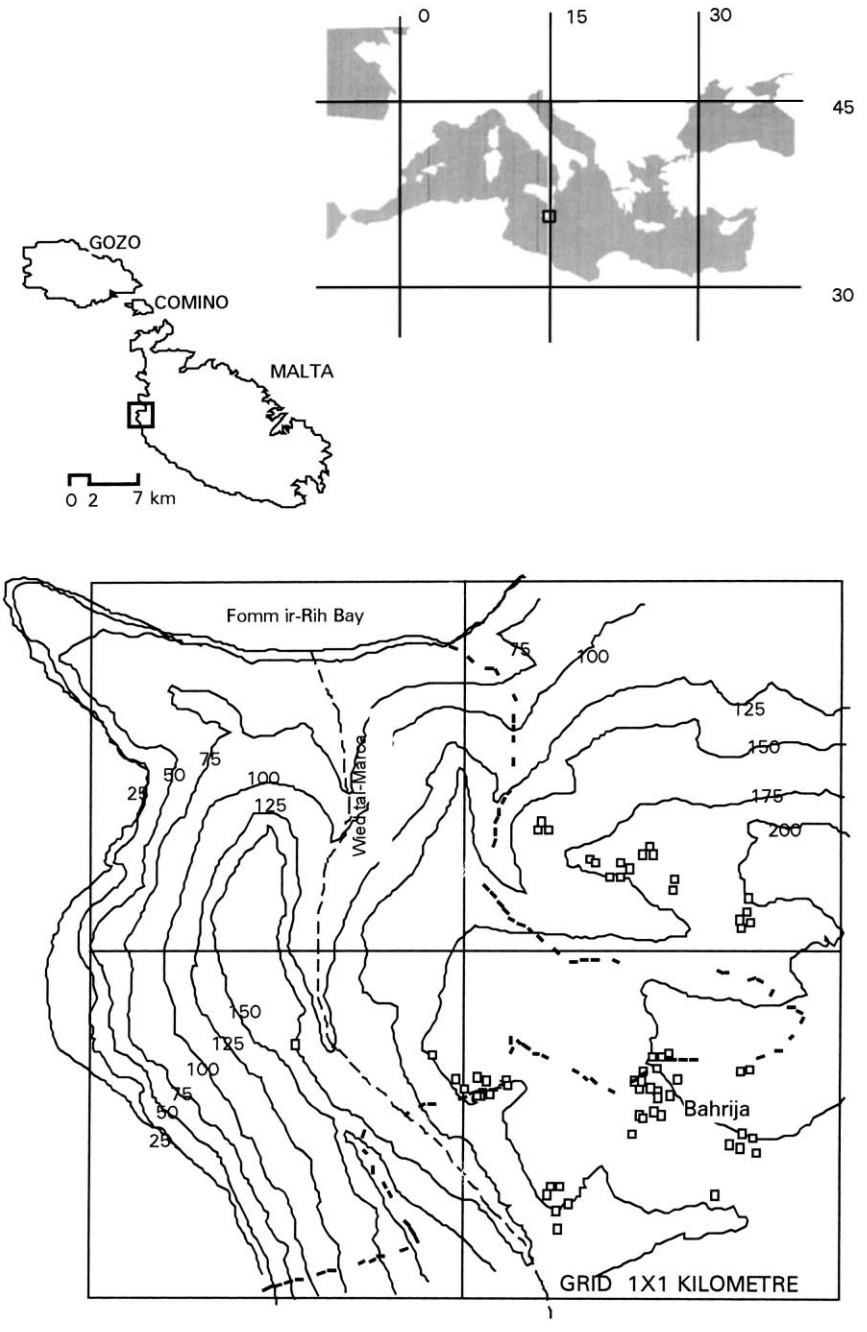


Fig. 2. Location maps of the Maltese Archipelago and the Bahrija site.

graphy and geology have evolved to form a number of distinct geomorphologic features (Bowen-Jones et al., 1961): Upper Coralline Limestone distinguishes the basin that forms the centre of the site and includes the tal-Marca ravine; a narrow linear zone of vertical scarps of Blue Clay extends in a continuous band parallel to the coast and inland at the site's eastern boundary at 150 and 180 m above sea level (m.a.s.l.),

respectively; a broad band of Globigerina Limestone slopes and Lower Coralline Limestone cliffs along the coastline with slopes in excess of 50 m.a.s.l. to the west, and gentler slopes to the north.

The small town of Bahrija (900 inhabitants) lies outside the site to the south-east at an elevation of 180 m.a.s.l. Aside from a few scattered farmsteads, the site contains no built-up areas. There are, however, several archaeological features: Punico-Roman remains and ancient quarries at the north western tip of the site; a Bronze Age settlement along the western crest; a Neolithic temple; and a large number of Cart Ruts.

The climate is characteristically Mediterranean, with 3–4 rainless months, an average annual rainfall of 500 mm occurring in the winter months and winter temperatures that remain above 0°C. Surface water is generally absent and subsurface moisture low. Bahrija, however, is one of the few sites in Malta that has year-round water in the tal-Marca ravine. Nevertheless, cultivation still depends on the seasonal rainfall.

The distribution of plant communities is closely related to topography, geology and soil availability. Furthermore, vegetation occurring on the islands must be salt-tolerant because salt spray may be blown onto most locations on the island (Haslam et al., 1977).

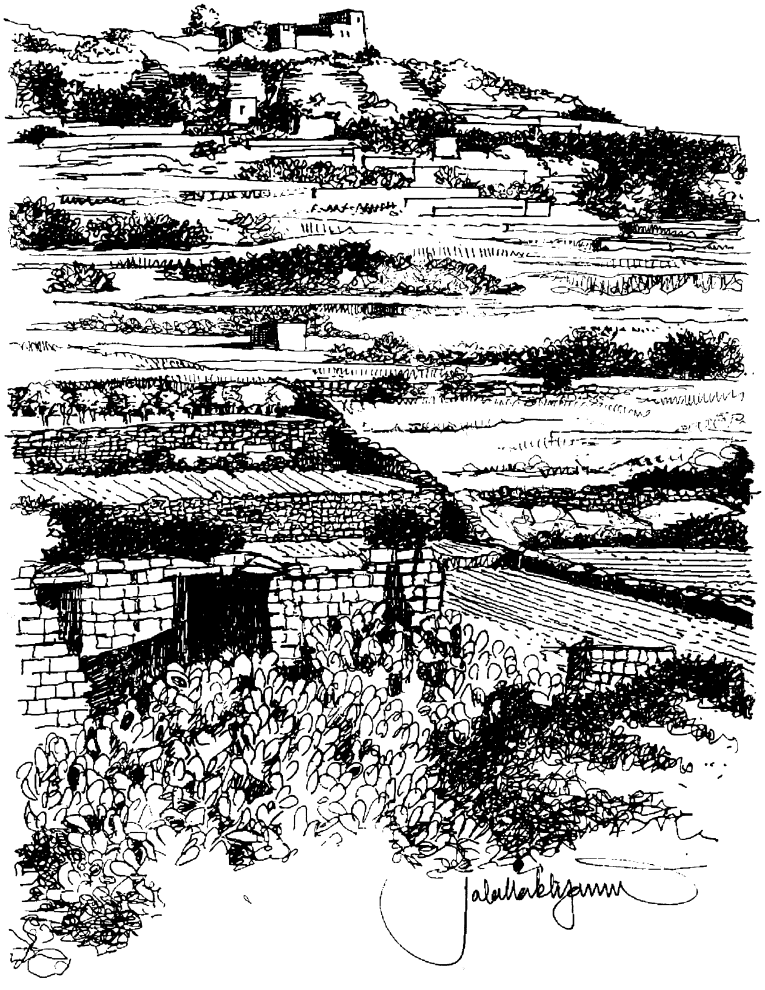

Fig. 3. View of a Maltese landscape, criss-crossed by stone walled enclosures in the flat terrain and stepping terraces along the slopes. Large clumps of opuntia, and to a lesser extent maquis, complement the sheltering effect of the walls.

Remnants of the Mediterranean Sclerophyll forest, degraded into maquis and garigue, are confined to the coastal cliffs. These marine communities constitute 14% of the Maltese flora.

The traditional rural landscape in Bahrija, as with all of Malta, is predominantly man-made and man-maintained. Having to cope with few natural resources and harsh environmental conditions, past societies have created, over millennia, an artificial landscape, building stone-walled terraces, establishing them with soil and organic matter. The result can be appreciated today as a beautiful, continuous lattice of stone walls and cultivated gardens that dominates Malta's landscape (Fig. 3).

## 5. Bahrija: landscape processes, components and pattern

The Ecological Landscape Association methodology described earlier was applied to the Bahrija site to gain an understanding of the landscape and to identify possible associations (ELA), which can then form the building blocks of the landscape design. The methodology serves as a framework for observing, recording and evaluating the landscape. Using digitised topographical survey maps (scale 1:2500), published literature, site observations and discussion with experts on the island's flora and ecology, five ELA were distinguished (Fig. 4) and are discussed herein. Minor landscape components, such tree rows and clumps, farmsteads and archaeological features are excluded here but included within the master plan in the following sections.

### *5.1. Garigue/Lower Coralline Limestone/coastal cliffs*

The coastal cliffs are extremely steep and often exposed to wind and salt spray which accumulates in the few available pockets of soil. Plants on the sheer

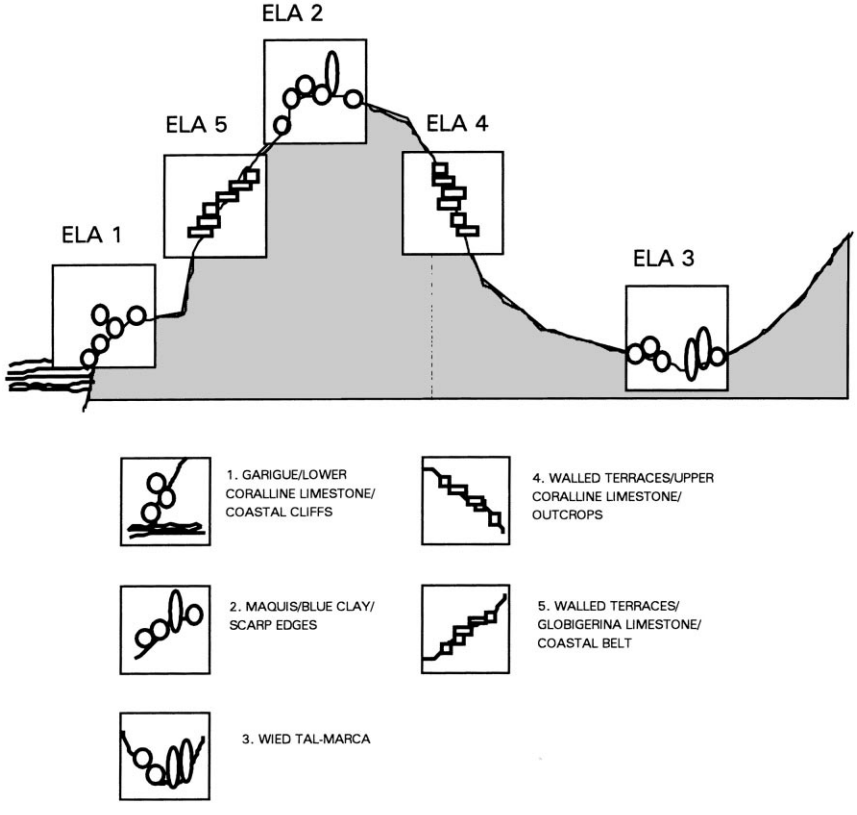


Fig. 4. The five Ecological Landscape Associations (ELA) discerned at the Bahrija site.

cliffs are sparse. Typical species include (Haslam et al., 1977): *Antirhinum* ssp., *Capparis spinosa*, *Centaurea spathulata*, *Crithmum maitimum*, *Cupularia viscosa*, *Hypericum aegypticum*, *Inula crithmoides* and *Matthiola tricuspicata*.

### 5.2. Maquis/Blue Clay scarp edges

This ELA forms a narrow zone along the scarp edges varying in degrees and exposure. It runs parallel to the site's coastal periphery and inland at the site's eastern boundary at 150 and 180 m.a.s.l., respectively. The spring line ensures that there is luxuriant vegetation, which is composed mainly of perennials, often shrubby species, similar to those of the Upper Coralline outcrops. Species include (Haslam et al., 1977): *Erica multiflora*, *Euphorbia dendroides*, *Phlomis fruticosa*, *Rhamnus lycioides*, *Rubus ulmifolius* and *Teucrium flavum*. Two tree species can also be found, *Ceratonia siliqua* (carob) and *Ficus carica*, while perennials include *Anthyllis tetraphyllua*, *Asperula cynanchica*, *Ferula communis*, *Mentha pulegium* and *Foeniculum vulgare*. These associations provide a rich habitat for birds.

### 5.3. The Wied tal-Marca

River valleys, 'wied', plural 'widien' in Maltese, are characteristic of the Maltese landscape (Haslam and Borg, 1998). They are fertile habitats that support a variety of flora and fauna and also play a significant role as catchment areas. The Wied tal-Marca enters the Bahrija site from the south, proceeds north, and terminates in the Fomm ir-Rih Bay. The river supports one of the few remaining permanent streams in the Maltese islands, with plants and animals which require year-round water supply (Haslam and Borg, 1998). Plants growing in the stream include (Haslam and Borg, 1998, p. 68): *Arundo donax*, *Polygonum salicifolium*, *Nasturtium officinale*, large clumps of *Zantedeschia aethiopica* and *Scirpoides holoschoenus*. Carob trees are found in clumps and sometimes in rows on both sides of the stream, and a few non-native trees, such as mulberry (*Morus* ssp.).

The most notable animal of the Wied tal-Marca is the freshwater crab (*Potamon fluviatilis lanbauoi*), which is an endangered species. Another, more familiar animals are the painted frog (*Discoglossus pictus*) and the trapdoor spider (*Nemesia* sp.).

### 5.4. Walled terraces/Upper Coralline Limestone/outcrops

This ELA occupies both sides of the Wied tal-Marca. As with most widien, wind protection is ensured by the valley enclosure which retains humidity in the summer. Like the previous association, this has also been extensively terraced. Eighty-nine terrace walls were recorded on the east side of the wied and 68 on the west side. Some plant species in this formation include (Haslam et al., 1977): *Anagyris foetida*, *Crataegus azarolus* and *C. monogyna*, the carob tree, *Myrtus communis*, *Olea europaea*, *Paliurus spina-christi*, *Pinus halepensis*, *Quercus ilex* and *Pistacia lentiscus*.

Over millennia, the creation of these artificial terraces has converted rocky wasteland into cultivated land. The thin, artificial pseudo-soil is not self-perpetuating and requires maintenance; the terrace walls need constant repair. During the last decades, traditional labour-intensive terrace cultivation has been increasingly rejected for alternative job opportunities in urban areas. As a result, many of the walled terraces at Bahrija are abandoned. However, these artificially created agricultural ecosystems impose certain restrictions and obligations. Adequately argued by Bowen-Jones et al. (1961, p. 351), it is as if 'the past has in fact enchained the present'. The environmental and ecological consequences of long-term neglect, therefore, are too dangerous to be permitted.

### 5.5. Walled terraces/Globigerina Limestone/coastal belt

This ELA forms a broad linear belt with gentle slopes above the coastal cliffs at 70 m.a.s.l. to the west of the site and between 35–40 m.a.s.l. along the northern coast line. Most trees and shrubs have long been removed and replaced by walled terrace cultivation, which is a prominent feature of the Maltese landscape. Over 90 stone terrace walls were recorded to the west of the site and approximately 120 longer shallower stone terraces to the north.

To summarise, the site at Bahrija has an extremely varied landscape, which combines natural, semi-

natural and cultural features. The diversity of its landscape is characteristic of the Mediterranean rural scene and reflects complex historical processes both natural (e.g. the interaction of geology, topography, climate and flora) and cultural (the construction of the walled terraced and the development of the widien). The methodological framework used to discern the five main ELA, because of its holistic perspective, steers the landscape designer away from a consideration of strictly visual features. Furthermore, its evolutionary perspective alerts the designer to the idiosyncratic nature of the landscape and allows for an appreciation of influences that ultimately account for the existing landscape patterns at different levels of the spatial hierarchy. Ultimately, the holistic understanding gained forms the basis for the Bahrija landscape master plan.

## 6. Evaluating the Bahrija landscape in the context of selected concepts of landscape ecology

The concepts of conserving biological diversity, landscape heterogeneity and overall ecological diversity form the foundation for evaluating the five ELA discerned at Bahrija. Biodiversity and landscape heterogeneity are closely related to habitat distribution and analysis with patches and corridors (Kim and Weaver, 1994; Forman, 1997). Forman (1997) concedes that of all classifications of land, the spatial arrangement of patches, corridors and matrix offer the maximum understanding of the ecology of regions and landscapes. Edge habitats, those that occur at the boundary of two different patches, i.e. ecotones, are of special significance as refuge for wildlife populations (Holland et al., 1991), provided the patches are large enough and have a clearly distinguishable community. Viewed within this context, the different ELA at Bahrija, are not only valued ecosystems in themselves and for the overall biological diversity they provide, but also, because of the ecotones created by the interface of any two ELA.

A growing understanding of the relationship between species and their habitats has prompted a broadening of conservation policies, from species and ecosystems levels to landscape levels, and from biological diversity to ecological landscape heterogeneity and diversity (Kolasa and Pickett, 1991; Farina, 1998). Within the context of the Mediterranean, Naveh (1995a) sees the aim of this total 'ecodiversity' as being the preservation and restoration of the total biological, ecological and cultural landscape diversity, and its intrinsic and instrumental values in highly valuable, semi-natural, agricultural and rural landscapes. The landscape at Bahrija is extremely heterogeneous and includes semi-natural and cultural components. The ELA, therefore, can be viewed as a mosaic of local ecosystems (Forman, 1990; Hansson et al., 1995). Above all, it is the diversity within such mosaics that allows the maintenance of ecological integrity and provides for continued landscape sustainability.

The spatial distribution of the patches, i.e. ELA, and their linkages are also significant. Linkages are realised through natural corridors and greenways (Hudson, 1991), whether singularly or as part of ecological networks (Nowicki et al., 1996), all of which contribute to biodiversity conservation. Ravines, the Maltese widien, are a living example of corridors that link the different patches and allow for the movement of species. Similarly, the coastal associations, because they form a continuous coastal belt both in the site and at a regional level, can also be seen as offering landscape connectivity.

## 7. The Bahrija landscape master plan

The landscape at Bahrija exemplifies a total biological, ecological and cultural landscape diversity that embraces beautiful and valuable semi-natural and agricultural landscapes. In addition, it is relatively unaffected by contemporary development, because suburban development has generally concentrated in and around the towns of Malta's east coast, and because protective legislation restricts the development of selected natural features (coastal ecosystems and ravines) and archaeological locations on site. The role played by Malta's Planning Authority and its statuary power is an advantage uncommon in the southern Mediterranean. Prioritising conservation and protection, however, should not come at the price of denying development. Making provisions for future development is equally necessary. The Bahrija master plan should, therefore, be formulated in the context of this discourse: the owner's desire for development and

the Planning Authority's concern to protect and conserve the island's resources.

A preliminary landscape master plan was developed to illustrate to the owner and the Planning Authority that ecological landscape design and planning has the potential to formulate an intermediary course of action. As such, it strives to incorporate contemporary uses without compromising landscape integrity and long-term environmental sustainability, and while reinforcing the landscape character of the place/region.

The master plan is not, and should not be, a finality. Rather it is simultaneously a model representing the pattern of the existing landscape and a working

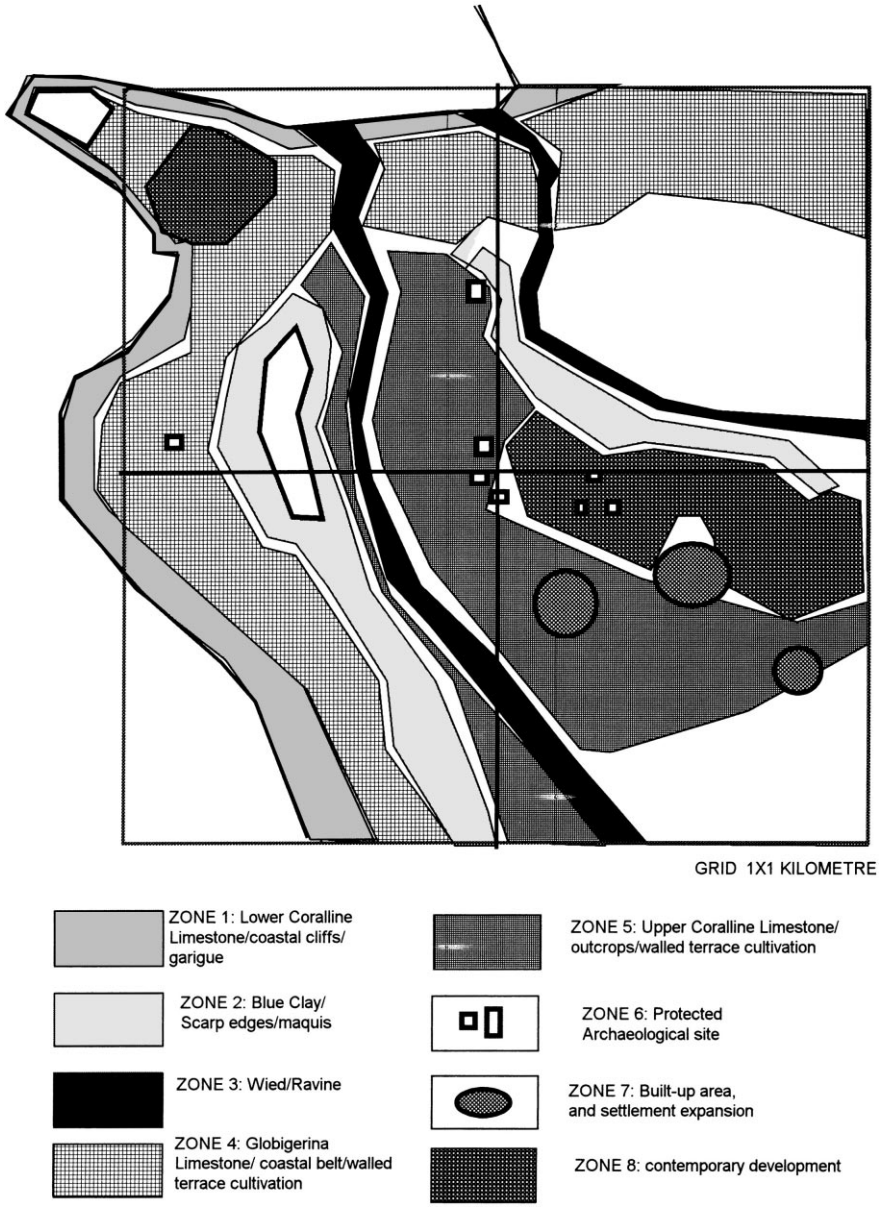


Fig. 5. The preliminary landscape masterplan for the Bahrija Project. Zones 3 and 4 have been extended beyond the site boundaries.

framework that can integrate future development. This is achieved by incorporating, where and when possible, the ELA identified for the site.

The preliminary landscape master plan consists of eight main zones (Fig. 5). Zones 1 and 2, can be regarded as nature conservation areas as they represent the two semi-natural ELA on site, the garigue/Lower Coralline Limestone/coastal cliff and the maquis/Blue Clay/scarp edge associations, respectively. Because of their linear form, extent and arrangement (along the coastline and scarp edges), their main role is to act as rich habitats and provide for landscape connectivity. The latter would be of even greater value when co-ordinated with the development of neighbouring sites. Contemporary uses in these zones should be restricted to nature trails that allow for an appreciation of the scientific and scenic value of these landscapes.

Zone 3, the Wied tal-Marca ELA, can be viewed as a natural corridor and should be similarly protected. Although wied often implies the whole valley, within the master plan this zone would be restricted to a corridor, preferably 100 m wide, which includes the watercourse itself and a broad band on each side. The width is determined by the need to prevent the leaching of nitrates and other agrochemicals into the watercourse (Haslam and Borg, 1998). The wied will provide linear connectivity in addition to its function as a habitat and watershed.

Zones 4 and 5, represent the two cultural ELA, the stone terrace walls on the Upper Coralline Limestone outcrops and on the Globigerina Limestone along the coast, respectively. These are an integral part of the Maltese cultural historical heritage as without such human intervention 'the island would have been, as it still is in some areas, largely a barren karstic waste relieved only by a few basins' (Bowen-Jones et al., 1961, p. 263). Regrettably, and for a combination of reasons, a large number of these terraces have been abandoned and are in a state of disrepair. Protection alone in this case would not be of much value. Rather their use needs to be revived through new initiatives and economic incentives. Depending on orientation and aspect, the terraces can be employed as part of an organic farming project, which is gaining popularity in Malta. They can also be used for the cultivation of vine for wine making and to re-establish olive and carob trees plantations.

Zone 6 includes the sites of archaeological significance that are presently protected by law. Six such enclaves have been designated within the master plan. Finally, Zones 7 and 8, represent areas that can accommodate future expansion of Bahrija village and for contemporary development, respectively.

This preliminary landscape master plan, although provisional, can form the framework for the future landscape design once detailed surveys of the different landscape components have been undertaken. In addition, the master plan can serve as a basis for gaining input from, on the one hand, administrators in the Planning Authority, and on the other, prospective developers and the public in general.

## 8. Conclusions

An ecological landscape design approach, guided by landscape ecology's holistic perspective and informed by its scientific knowledge base, offers three main advantages. Firstly, it moves the designer away from a viewpoint of landscape that is dominated by visual attributes towards a more dynamic and comprehensive perception. As a result, priority is given to understanding and the subsequent protection of ecosystems and ecological processes, thus conserving ecodiversity and ensuring environmental sustainability. This is especially significant in semi-arid regions, where natural resources are limited, where ecosystems are vulnerable and where environmental degradation is rapid and often irreversible. Aiming for sustainability is even more critical in island ecosystems, where the attributes of a semi-arid ecosystem are further amplified.

Secondly, as landscape ecology itself is context specific, design solutions that develop from an understanding and appreciation of the historical idiosyncracies of a specific site/region are encouraged. The Bahrija landscape is the outcome of evolutionary processes that have led to a human-maintained dynamic equilibrium between semi-natural and cultural components, which is characteristic of Mediterranean rural landscapes. The proposed master plan reflects the latter and is itself a rich mosaic of semi-natural and cultural landscapes.

Thirdly, landscape ecology has the potential to contribute to regionalism, which in landscape archi-

tecture implies a school of design that is aware of the natural, historical, social and cultural factors that have shaped a regional landscape and aims to utilise this awareness in creating future environments that are appropriate environmentally, culturally and aesthetically (Makhzoumi and Pungetti, 1999). This is supported by Forman (1997, p. 14), who argues that to accelerate the use of ecology in design, planning, conservation, management, and policy, ''we must use *regions* and landscape that balance and integrate natural processes and human activities''. Above all, a regional perspective can overcome the problems resulting from landscape planning policies and management practices that are confined to national borders.

To summarise, landscape ecology can contribute to theory and practice in landscape architecture, while interdisciplinary collaboration can benefit both disciplines. Although difficulties will arise as a result of the differences in priorities, assumptions and method, these problems can be minimised when, as Naveh (1995b) proposes, a spirit of interdisciplinary collaboration and academic tolerance is embraced.

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