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Managing Europe's Archaeological heritage

Europe's Cultural Landscape:

archaeologists and the management of change

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Cover illustration: An early medieval stronghold at Moraczewo, in the Wielkopolska region of Poland, one of c.7,000 entries on the Polish official register of scheduled sites and monuments. The stronghold is dated to between the 8th-11th century AD, and is associated with the power base of the Polanie tribe, one of the foundations of the future feudal Christian State. It sits within an agricultural landscape of much later date. Current agriculture activities on or near the site are monitored by the Service for the Protection of Monuments. The modern farm near the stronghold was built before the site was designated in 1972. Photo: W. Stępień.

15: Archaeology in the south east of the Iberian Peninsula: a bridge between past and future social spaces

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Abstract: *Archaeology has the privilege of being able to explain the long-term interaction between the social and the natural worlds. Archaeo-ecological research has made us increasingly aware that today's environmental and ecological problems are historical constructions: changing, dynamic entities that are the result of economic strategies in the past. Information about the past is crucial in the search for policies that promote the sustainable development of contemporary and future landscape. This paper, in relation to South East Spain in general and the Aguas valley in particular, considers how modern agriculture is damaging our ability to collect this information, and describes how archaeologists and palaeo-environmentalists have used archaeo-ecological surveys from the prehistoric and medieval sites of Gatas at the foot of Sierra Cabrera to establish a long-term environmental model that can inform future planning policies.*

Introduction

During recent decades archaeology has grown steadily as a social, as well as an environmental science. It has an explicit concern with the materiality which past societies have exploited, transformed and used, and this places archaeology in a privileged position to understand the interaction between the social and the natural worlds. Not surprisingly, many recent archaeo-ecological projects carried out in different parts of the world have furthered the complex dialogue between natural and social sciences, implying a move against the increasing segmentation of scientific knowledge in present day academia.

As a result of such archaeo-ecological research, we have become more aware that the environments and the ecological problems we see today are historical constructions, that they are changing, dynamic entities and, above all, that the choice of economic strategies in the past as well as in the present has had different consequences for environmental and social development. The factors causing environmental degradation are multi-dimensional and operate at different spatial and temporal scales. In our view, only the analysis of long-term trajectories of socio-natural interaction allows us to acknowledge fully the critical factors of an ecosystem, and how they behave in different social, economic or political situations. Such information is crucial in our search for policies that promote a more sustainable development of contemporary environments.

Yet economic development, especially in the form of modern agriculture, is severely damaging our ability to collect this information, by damaging both the wider environment as well as the archaeological heritage. The ecological degradation at present is twofold: on the one hand, we are faced with a progressive exploitation of all sorts of natural resources, while on the other hand, these practices destroy the empirical evidence which could help us to understand better the functioning of the ecosystems and to find new economic alternatives. One of the primary human capacities is our ability to learn from past experiences, yet this is being stifled. The currently

Fig.15.1: The lower Aguas valley in South East Spain.

dominant form of socio-natural interaction implies a cognitive as well as a material 'degradation'; imposing a new form of landscape is at the same time destroying the basis for a historical understanding of alternative trajectories. It is a responsibility of archaeology to draw attention to these problems and to argue for a more conscious use of the spaces society creates (Castro *et al.* 2000).

This paper discuss this twofold problem at landscape scale in relation to South East Spain in general, and to the Aguas valley in particular (fig.15.1), in which archaeologists and environmentalists have been working since 1985, excavating the prehistoric and medieval site of Gatas, located at the foot of Sierra Cabrera, and undertaking archaeo-ecological surveys (Castro *et al.* 1998a; 1999a; 1999b; 2000; Chapman *et al.* 1987).

Environment and historical development of the Aguas valley

The Aguas valley landscape of today is characterised by exposed soils, dry gullies or *barrancos*, extensive dry farming and irrigated areas of fruit trees. The topography varies from steep slopes in the Sierra Cabrera, a Preneogene formation, to Tertiary valleys dissected by deep gullies and leading across gentle slopes to the wide and meandering Quaternary floodplain of the Aguas river. It is situated at the heart of what today is called arid South East Spain, distinguished by a low, highly irregular and unpredictable rainfall and high constant temperatures. With a mean rainfall of 250mm it is the most arid area in Europe.

The spatial unit selected for intensive archaeo-ecological investigation covers a surface of 100km² that reaches from the northern watershed of Sierra Cabrera down to the coastline, giving a height difference of 918m in a distance of less than 10km. This gives an idea of the study area's variability in terms of geology, geomorphology, vegetation, hydrology and micro-climate which has to be taken into account when asking why an apparently arid region could at different times during the last 6,000 years become the location of some of the most important demographic and socio-economic developments of the western Mediterranean.

From the first Holocene occupation in the middle Neolithic, societies living in this region went through a slow social and economic development until the end of the Copper Age (Delibes *et al.* 1996; Fernández-Miranda 1992; Fernández-Miranda *et al.* 1993), when the Aguas valley became part of the core area of the El Argar culture (2250–1550 cal BC), the first State organisation of the western Mediterranean (Chapman 1991; Lull 1983; Lull & Risch 1996).

After a long lasting settlement crisis following this phase of over exploitation of the land, we find again a very intense occupation during the Roman and Byzantine periods (Menasanch 2000a; López Castro 1995). Once more, agricultural exploitation seems to have been the main economic activity of the region. It was promoted this time by external interests, and supported by another source of wealth from the important copper, silver and iron ores of the region, which were also extensively exploited again by the Omeyad Islamic state in the 10th and 11th centuries AD (Menasanch 2000b). In each of these periods, external economic interests played an important role in the development of the region, and led to phases of demographic and economic crisis.

The next phase of large-scale economic production started around the middle of the 19th century, when South East Spain and especially the Vera Basin became an important mining area for international companies. This was a short period that lasted until the 1920s (Sánchez Picón 1992), but its consequences were once more depopulation and massive migration to other parts of Spain and Europe.

After each of these phases of economic intensification, promoted mainly by external interests, the region became more impoverished, with less productive resources than before. Another common historical factor has been the lack of any investment in lasting economic structures that could have provided the basis for a sustainable development of the local population and which would have made this region less vulnerable to periodic crises.

Towards an archaeological theory of the investigation of social spaces

The general theoretical framework in which palaeoecological research in the Aguas region has taken place emphasises the interaction between natural and social factors and distinguishes between empirical observation and conceptual abstraction (fig.15.2). The Aguas Project attempts not only to implement different palaeoecological studies and to produce a set of particular results, but also to further the discussion between disciplines and to integrate socio-ecological research into a multicausal explanatory framework.

During the Quaternary period climatic conditions, geological material and relief provide the framework in which all natural and social dynamics take place. It allows the interdependent development of hydric regimes, drainage systems, sediment deposits, soils and vegetation. At the moment of the appearance of human societies, three objective conditions have to be fulfilled so that social life can exist: men, women and the material objects that are used by them. The reproduction of society supposes a specific form of relation between these elements that expresses itself in three types of production: basic production, the production of material objects and maintenance production (Castro *et al.* 1998b).

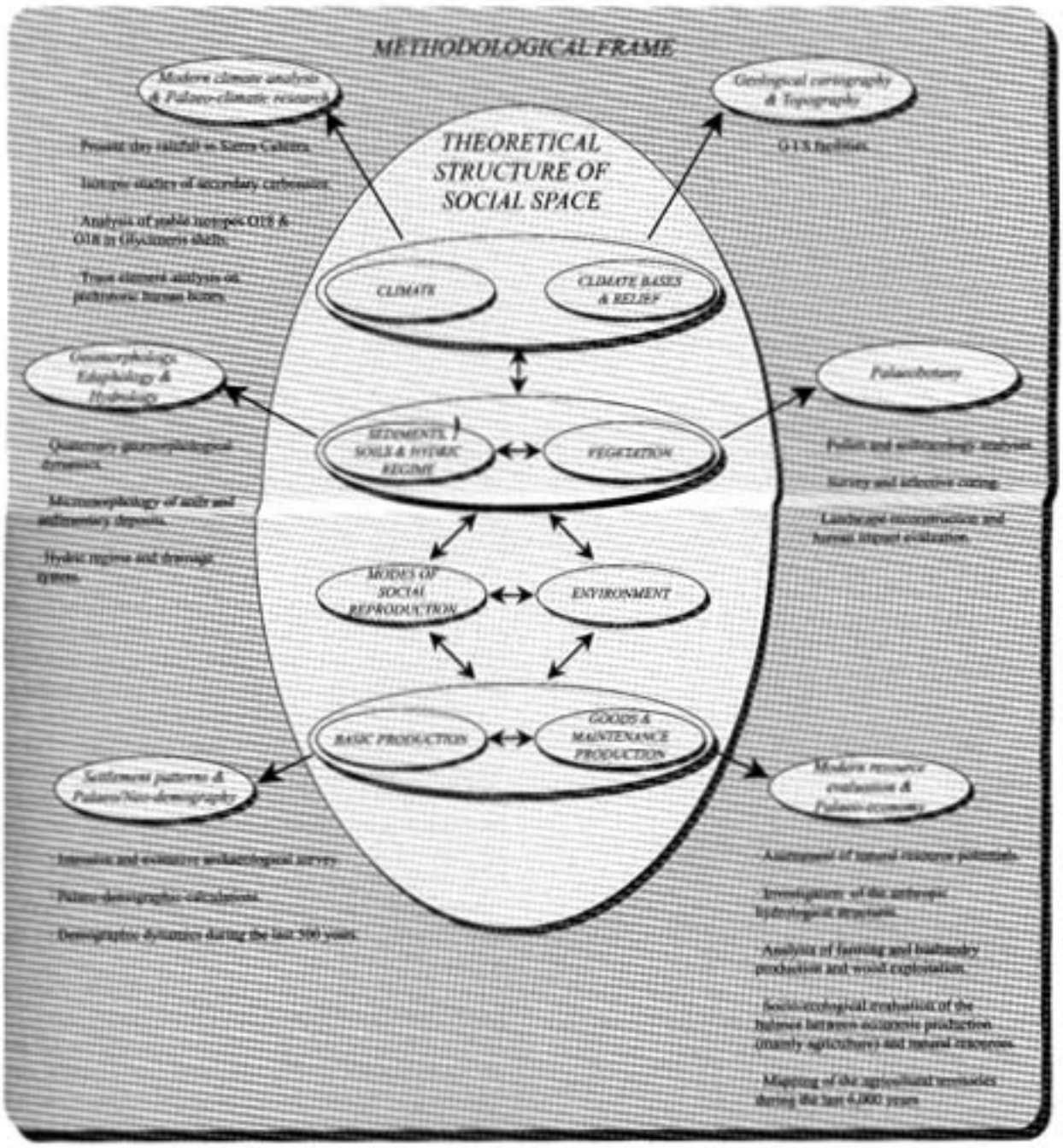

Fig.15.2: Theoretical structure and methodological framework of the Aguas Project.

- *Basic production* refers to creating the labour force that acts upon the environment and transforms it into social spaces. Taking this production into account means considering biological reproduction as a specific and socially necessary labour process.
- The *production of material objects* refers to the generation of food supplies and all other types of products designed to be used or consumed.
- *Maintenance production* conserves and maintains social objects and subjects. It increases of the social value of things without changing their use value, either artificially or through labour by improving the physical, chemical, affective and aesthetic characteristics of subjects and objects.

Natural factors and social productions interact in two spheres; the first, which is socially conditioned, formed by the *mode of social reproduction*, and the second, which is naturally conditioned, formed by the *environment*. Both are physically expressed in *social spaces*. The mode of reproduction describes and explains the relationships between men, women and the material conditions used by them through social production and specific social practices (Castro *et al.* 1996). Social space refers to the context in which social production and natural formation take place.

In an historical sense, social space defines and reflects the ecological situation in each *mode of social*

reproduction. Nature and social organisation are separate but at the same time mutually conditioned entities of our reality, so that the state and dynamic of one part reflects and affects the situation of the other. The proposed categories attempt to represent this duality in the material objects and spaces through which we perceive reality.

In this way, palaeo-ecological and archaeological objects provide all the possible information on environmental conditions, the social management of their resources and the material means of their exploitation. The complexity of the social and environmental issues we try to understand implies that the inferential framework, which allows us to gain knowledge through empirical data, can not be based on monocausal reasoning. Many of the questions we ask about the process of climatic change and/or degradation concern a whole set of environmental and social factors, which can appear to be related in apparently contradictory ways. In order to obtain this information, a complex structure of interdisciplinary research is necessary, where different methodologies proceed in independent analytical ways but are mutually related in the explanation of reality. The specific techniques applied in the Aguas Project were geomorphology, geo-hydrology, hydrology, soil micro-morphology, palynology, anthracology, carpology, isotopic analysis on shells and sediments, trace element analysis on human bones, archaeological survey, palaeodemographic analysis, palaeoeconomy, physical anthropology, historical research on modern land distribution and use, absolute dating and GIS. One of the main outcomes of the Aguas Project is the development of this theoretical and methodological structure, which can be applied to eco-historical understanding and the climatic, ecological and socio-economic assessment of the developmental possibilities of other regions.

While the multiple lines of research that have provided important results on different social and natural aspects, are presented elsewhere (Castro *et al.* 1994; 1995; 1998a; 1999a; 1999b; Risch 1998; Schulte 1999), here we want to discuss only two aspects which have often been claimed to cause environmental degradation: demography and agricultural practices.

Demographic dynamics

To test the impact of demography and human settlement on the environment has been one of the main objectives of our research in South East Spain. We consider that demographic increase or decrease is not a natural process, but the result of a socially necessary labour process, that is the *basic production*.

Systematic and selective survey and palaeo-demographic calculations have enabled us to define representative changes in the archaeological and historical record of local settlement in the Aguas valley (fig.15.3). The methods used to estimate population numbers in each period are palaeo-demographic formulae based on the extent of the settlement area (DEM-, DEM+ = minimum and maximum population estimates), the volume of cereal production as indicated by the number of grinding stones (DEM.ARQ.) and available historical documents (DEM.HIS.) (for details, see Castro *et al.* 1998a; Risch 1998).

Spatial patterns and demographic calculations show that there is no simple continuity in either settlement or population frequencies. Instead, we can observe patterns of settlement and demographic continuity and discontinuity, as well as aggregation and dispersion. Four major peaks of population can be detected in the Aguas valley: in the Argaric (*c.*2250–1550 cal BC), Roman-Later Roman (*c.*0–550 AD) and Nazari (*c.*1250–1500 AD) periods and in the 19th century AD. Comparing this situation with the rest of the Vera basin (Castro *et al.* 1995), it becomes clear how a long-term and scale-dependant perspective is a unique contribution of archaeology and one which isolates potentially critical periods for the environment of different regions.

Combining these results with other lines of research, one can observe that demography is not the direct cause of the environmental degradation in the Aguas valley. In this area, population increase has normally been linked with specific economic-political situations operating on a supra-regional scale which interrupted the self-sufficient resource organisation of the region and its inhabitants (eg the Roman Empire or the 19th century mining boom). On the other side, population decrease always followed phases of environmental degradation through overexploitation (eg Post-Argaric period) or mismanagement (eg 17th century AD after the reorganisation of the Andalusian agrarian territories and property structure).

Landuse strategies

The second line of research was to determine the environmental impact of economic processes. If we want to propose future policies of landscape management, it is important to understand which areas and resources have been exploited repeatedly in the past, and which ones are more vulnerable than others. The main aim is to define at a qualitative and quantitative level the diachronic trends of the functioning and transformation of landuse patterns. In this case we are dealing mainly with those patterns related to crop production, stock raising and the exploitation of wood resources.

In order to accomplish this task, an archaeo-ecological methodology is needed which allows us to model the development of the agricultural territories. Once the palaeo-demography has been established, the procedure used in the Aguas Project consisted of the following steps:

1. Calculation of the agricultural potential in the region: ecological characterisation, using GIS and statistical analysis, of the main traditional agricultural strategies

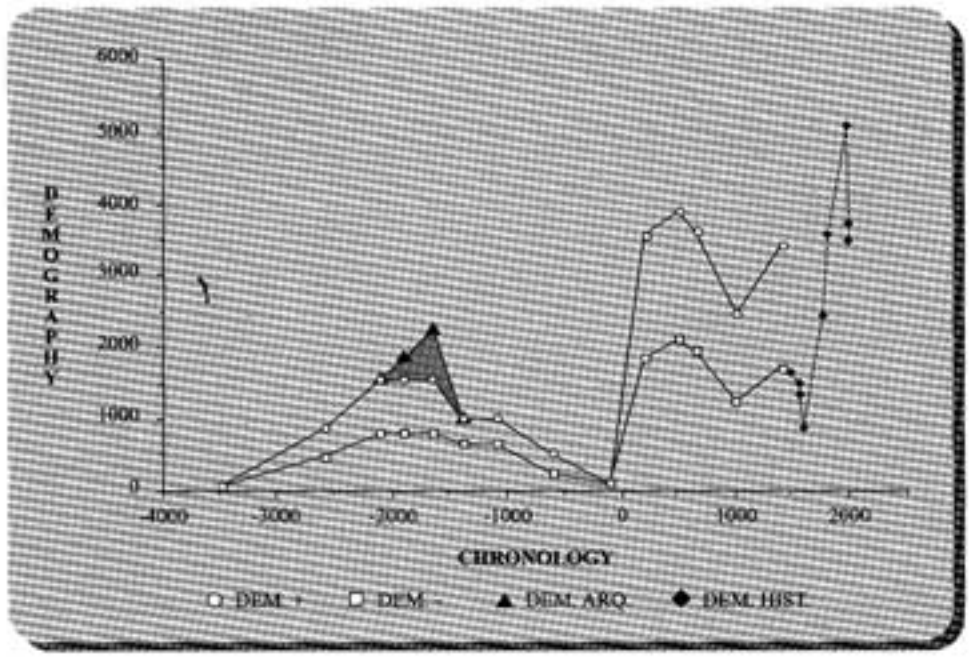

Fig.15.3: Demographic development in the Aguas valley.

(wet farming, intensive dry farming, extensive dry farming) in terms of five geo-ecological variables (height above sea level, geology, solar radiation, distance from the nearest river bed, slope) creating a map with a maximum likelihood classification of the lower Aguas in terms of the different landuse strategies.

2. Changes in the environment due to climatic and social factors have to evaluated in order to overcome a purely actualistic approach. The combined results of palynological, anthracological, soil micromorphological and geomorphological research play a crucial role.
3. Identification of the diet patterns of different societies in the past. A series of empirical parameters must be known in order to establish the types and quantities of food: identification and quantification of the carbonised seed remains from archaeological contexts in order to know which were the species consumed; isotopic and trace element analyses of human remains to evaluate the importance of different food resources in the diet, and definition of human nutritional needs (Kcal, proteins, fat, carbohydrates, etc) in order to obtain absolute figures of the crop yields necessary to feed a certain population.
4. Definition of the cultivation strategies developed in the past. The analysis of seeds and historical or ethnographic data are the main sources of information, although carbon isotope discrimination in carbonised seeds is becoming a well established technique for assessing the growing conditions and yields of crops (Araus *et al.* 1997; 2001).
5. Calculation of the agricultural territories necessary to satisfy the subsistence needs of a given population. Apart from the previous demographic calculation, information on the yields of each species can be obtained from historical information, experimental agriculture or, as just mentioned, isotopic data.
6. Spatial modelling of the agricultural territories based on the maximum likelihood classification of the ecological variables and on the accessibility of the land from the known settlements. Such a model is performed through GIS (Verhagen *et al.* 1999).

The basic empirical condition in order to carry out this methodology is excavated evidence and precise AMS dating of archaeological sequences. Thanks to the research undertaken in Gatas, but also in Fuente Alamo, Almizaraque, Villaricos and other well-known sites during the last decades, this area probably represents one of the regions with the most detailed long-term archaeological sequences of socio-natural interaction in the Mediterranean.

The extent of the land available for each type of agricultural strategy has been calculated for different probabilities, that is the degree to which a given space fulfils defined ecological conditions. At an 80% probability limit (which can be considered an acceptable degree of adjustment of land to the necessary ecological conditions and which represents a turning point in the trajectories of availability of most landuse types), there are around 3,000 hectares of available land, broadly divided as follows:

- 900 hectares of *regadío* – farming by inundation of the flood plain, produces high yields from low inputs.
- 750 hectares of *secano intensivo I* – intensive dry farming I, in the floodplain, yields can be high in certain conditions.
- 500 hectares of *secano intensivo II* – intensive dry farming II with productivity depending on rainfall and hydraulic infrastructure.

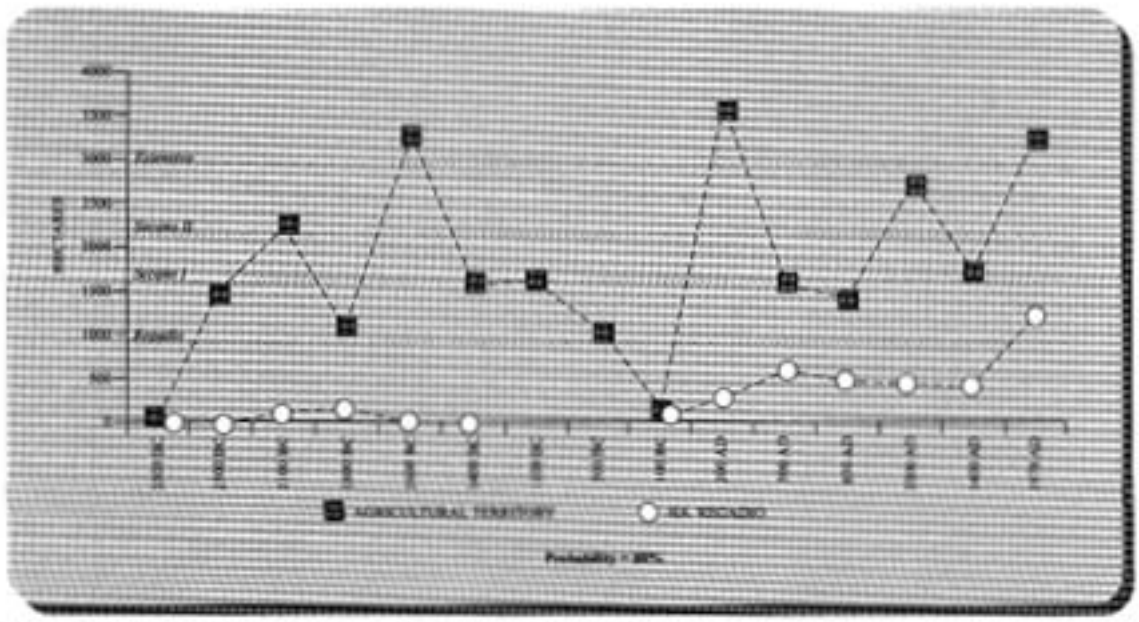

Fig.15.4: Agricultural territories and irrigated land during the last 6,000 years.

- 750 hectares of *secano extensivo* – extensive dry farming, intermediate altitude, low productivity.

Palaeo-agrarian analysis allowed us to define the landuse strategies developed in the Aguas valley during the last 6,000 years and to model, in combination with the demographic calculations, their spatial implications. Figure 15.4 shows the relationship between the agricultural territories and the different agricultural land resources of the Aguas valley at an 80% probability limit since the Neolithic period. The first human populations (4000–3000 cal BC) of the Aguas valley settled in different types of ecological situations, taking advantage of the natural diversity existing in the Aguas valley. The agricultural strategies and spaces seem to concern dry farming as well as the cultivation of the more humid river margins. Proximity to water resources or more humid areas does not seem to have been a significant factor, which agrees well with the palaeo-climatic evidence indicating more humid conditions during the early Holocene.

Higher population, more intensive agricultural practices and, probably, the tendency towards more arid conditions resulted after 3000 cal BC (Chalcolithic period) in subsistence production being mainly concentrated on the exploitation of the Quaternary valleys (pl.15.1). Distance to water resources had become a relevant factor in the selection of settlements and agrarian spaces, a strategy that allowed these populations to obtain the highest productivity with the lowest labour investment in semi-arid environments.

After 2250 cal BC (Argaric period I), agricultural territories exceeded the limits of reasonably well-suited land existing in the valley bottoms, due to demographic increase and the introduction of extensive dry farming strategies on the plains. From this moment, the beginning of extensive barley monoculture took place. That this strategy was economically and/or environmentally problematic becomes clear by the attempt made around 1900–1750 cal BC (Argar II) towards an increase in the production of legumes (*Vicia sp.*), which could only take place in the areas of higher humidity, that is, in the valleys.

With the full development of the first prehistoric State formation (Argar III: 1750–1550 cal BC) the settlement of Gatas seems to become the main centre of accumulation, transformation and redistribution of Aguas barley. Its production and an important demographic increase supported a drastic extension of the agricultural territories through the deforestation and exploitation of the Tertiary plains suited for *secano intensivo II* and *secano extensivo* (pl.15.2). The advantages of barley cultivation are its resistance to low rainfall and its adaptability to poor soils. From an economic point of view, however, the level of productivity obtained with this strategy is very low, especially if marginal *secano extensivo* soils are used (fig.15.4). Its social consequences included nutritional problems, as is indicated by the pathologies observed on human skeletons of this period (Buikstra & Hoshower 1994). Its environmental consequences continued to affect the area long after the collapse of the Argaric State around 1550 cal BC. Although the dry and hot climatic conditions detected during this period favour such an extensive agricultural strategy, other social and economic trajectories could have been possible (eg migration to other wetter regions, demographic stability, development of irrigation farming).

The landuse trajectory from 4000 cal BC to 1550 cal BC shows the maximum economic exploitation of the Aguas valley with little or no technological input. The agricultural strategy imposed during the late Argaric period has to be considered as a mistaken policy in view of its environmental

and social consequences. After the dramatic collapse of this system, human occupation of the Aguas valley experienced a continuous decrease from c.1550 cal BC until the Roman period. Agricultural production was pushed back to the most productive surfaces in the Quaternary floodplains. Other areas of southern Spain seem to have been more attractive for ecological as well as socio-economical reasons, as the archaeological record shows (Chapman 1991; Castro 1992). At the same time, low population hindered the development of more labour intensive agricultural strategies that might otherwise have obtained better yields under the already degraded environmental conditions of the lowlands.

Since prehistoric times, landuse strategies have continued to change and agricultural territories have gone through considerable fluctuations (fig.15.4). This long-term agrarian history allows us to evaluate the potentialities of the area, the consequences of anthropic impact and the possibilities for future development.

The first result is that there existed no direct correlation between food production and the extension of agrarian territories. Landuse strategies were not determined by ecological conditions; rather, by specific political decisions related to general or specific, internal or external interests. It has to be concluded that despite minor climatic fluctuations and generally speaking dry conditions, it is human policy making which plays the prime role in the conservation or degradation of these environments.

Most societies in different historical moments exploited around 1,500 hectares (fig.15.4). It is interesting that this surface is equivalent to the land available in the Quaternary valleys (*regadío* and *secano I*) at the 80% probability threshold. These soils permit an optimal relation between necessary labour input and crop output. Through the introduction of hydraulic infrastructure productivity can be further increased. The availability of sufficient amounts of water, which in this case is the main limiting factor on socio-economic development, must be linked to the high resilience and water storage capacity of the Sierra Cabrera, which has been documented at successive periods. This leads to the conclusion that any mechanisms that further water infiltration in the highlands, such as the development of a denser vegetation and/or the extension of hydraulic infrastructure, have direct consequences for the recovery of the lowland aquifers and of the vegetation existing in the valley bottoms. In general, the total water availability of the Aguas valley becomes larger.

Only in four historical moments were the agricultural territories extended to beyond 3,000 hectares, forcing agricultural territories to expand into unfavourable areas (*secano extensivo*):

- The Argaric state
- The Roman Empire
- The Omeyan caliphate
- 19th- and 20th-century Capitalism, with a clear over-exploitation of local resources caused by the mining boom.

In all these periods, the best-suited soils in the valleys were insufficient, and extensive dry farming also was also practised in areas where the agriculturally favourable factors are negative, that is where productivity is low. Only in periods when the labour force was under a high degree of exploitation did this agricultural strategy apparently become feasible. Apart from its economic implications, the exploitation of the Tertiary plains during the Argaric period probably had the most important environmental consequences, and the maquia vegetation was deforested for the first time and never seemed to recover again, giving way to more open steppe-like vegetation. The degradation caused by this state organisation could only be overcome socially and economically by large-scale investment in technology and the labour force during the period of Roman Empire.

GIS-driven modelling, based on settlement location and subsistence needs in each period, showed the number of periods during the last 6,000 years that a given space had the highest probability of being used (pl.15.3). Such a map represents the sum of the modelled agricultural territories of all periods, and allows us to distinguish those areas that were most attractive for agricultural exploitation (red), from others with low productivity and/or high labour investment requirements (green).

The conclusion is that the Quaternary valleys (*vegas*) could be cultivated successfully in all periods. On the contrary, exploitation of the Tertiary plains seems to result in a rapid fertility loss, which prevented their repeated use. Hill slopes were also used in a few periods, but in this case because of the high labour input needed for constructing the necessary terrace and irrigation systems.

This type of spatial modelling is crucial for the future development of the Aguas or similar valleys of South East Spain. It indicates which areas present the highest resilience in relation to landuse, and where anthropic impact is critical, either because of its social or of its environmental implications. Any management or development strategies for these areas should be submitted first to a detailed evaluation of its consequences.

Policy recommendations

The Aguas Project's archaeological and spatial analysis of long-term agrarian and other social productions allows us to evaluate different modes of social reproduction in terms of their ecological and social consequences. Two types of strategies, more and less aggressive, can be defined:

The *more* aggressive strategies can be characterised by:

- a high degree of exploitation of the labour force
- extensive dry-farming on the Miocene plains
- extensive sheep and goat grazing
- over-exploitation of woodland resources
- intensive pumping of Sierra Cabrera aquifers.

The *less* aggressive strategies can be characterised by:

- a low degree of exploitation of the labour force
- intensive irrigation on floodplains
- moderate cattle herding and hunting
- diverse and moderate woodland exploitation
- reduced exploitation of Sierra Cabrera.

A set of fundamental recommendations result from this analysis, that are of prime importance for the ecological regeneration of the area while at the same time allowing better socio-economic development of this and similar areas. From the theoretical framework of this project, it follows that ecological protection can not be undertaken at any cost nor consume resources that are necessary for social reproduction. It is clear that in this type of arid environment, the relevant criteria must first be water storage and water discharge capacity and second bio-mass production capacity. In principle, natural factors creating these capacities are more adequate, as they allow populations to reduce labour input and therefore the cost of the environmental policy.

In order to transform these criteria into specific environmental policies through an analytical procedure, the concept of *Natural Resource Productivity* is proposed. It implies that the possibilities of socio-economic development in arid and semi-arid areas, as well as the maintenance or improvement of the environmental conditions, are directly related to areas which present a naturally high generation of resources. These spaces need to be understood, defined and managed in the most effective way. Those areas where the Natural Resource Productivity index is highest (that is, with the highest water storage capacities and natural biomass production) should be protected or managed through specific policies, while areas with low Natural Resource Productivity indices can be submitted to economic development with the resources generated in excess by the ecologically more favourable/ productive spaces. The concept of co-responsibility would dictate that, the economic development and profits obtained from one area should not be considered as independent of the places where the consumed resources were generated. Water is one of the main factors for future development, and its social and individual consumption must imply a matching responsibility for protecting the ability to continue to produce new reserves. Furthermore, in many regions and situations such a strategy supposes much lower costs, in terms of labour or technology investment, and less social conflict than current proposals (eg long distance channeling of water resources, as proposed by the Spanish government in the new *Plan Hidrológico Nacional*).

The practical application of a Natural Resource Productivity index in the Aguas valley could mean that the degraded Tertiary plains, which do not seem to be able to recover from the environmental degradation suffered since the second millennium BC and where the Natural Resource Productivity indices are the lowest of the region, can be used for different industrial, agrarian or other purposes, as long as the mountain water storage and vegetation system is regenerated. Apparently, the high resilience capacity of the *sierra* allows the natural growth of the most adapted vegetation, as it has done repeatedly over several thousand years. The resulting water table increase in the lowlands could help to regenerate the valley bottoms, which today are under-exploited and are not well suited for modern agriculture or industries. The fact that pluviosity and soils were not significantly different 500 years ago implies that it should be possible to re-introduce tree plantations similar to those existing in the medieval period, which would contribute considerably to a decrease in the aridity and degradation of the landscape, representing a general social benefit. Precise hydrological data and continued discharge and pluviosity measurements in the area, are of prime importance for determining what volume of water would be available for this or similar development policies and which possibilities exist for increasing these resources on a local scale.

A policy based on the notion of economic-ecological co-responsibility also encourages popular concern for available natural resources and the need for their rational management. In this sense, it is obviously more convenient that its application corresponds to local democratic institutions. The introduction of regional water management institutions is probably the best help for this area. External interference in the form of the imposition of new economic strategies, as has occurred repeatedly in the history of the Aguas valley, would not contribute to sustainable and socially balanced development. The socio-natural investigation decribed in this paper provides empirical knowledge, and defines the critical factors on which a locally decided sustainable policy can be based.

Conclusion: 'plastic agriculture' – a new phase of environmental degradation

In recent years, a new phase of rapid economic development and environmental change has started in large parts of South East Spain, thanks to intensive production of vegetables, frequently under plastic covers. The possibilities offered by the European market and by climatic conditions supposes that Almería, one of the poorest regions during the last century, presents today by far the largest gross national product of all Andalusian provinces.

High profit rates now make it worth cultivating any possible area, regardless of soil quality, ecological value or the presence of archaeological remains. Given the need for horizontal surfaces, in order to construct the plastic covers and to install dribble irrigation, not only the soil surface, but also the whole topography of the landscape is changing rapidly and dramatically. While some conditions are imposed onto construction activities such as road building, 'agricultural practices' such as plastic horticulture are not required by EU or Spanish law to undertake any environmental impact assessments. The consequence is an uncontrolled economy and an irreversible loss of natural, archaeological and historical features.

Just to give some examples, it is worth mentioning that geomorphological studies of river systems, such as those carried out in the Aguas Project before 1996 (Schulte 1999), are no longer possible in many areas, given that the river courses have been altered, cemented or just filled in. The consequences for archaeological research are no less profound. Many of the sites on which the demographic and palaeo-economic analysis of the Aguas Project were based are disappearing, while the application of similar archaeological survey strategies in many other regions is no longer possible.

Parallel to this degradation of the cognitive potential of the region, the environmental impact of plastic horticulture is considerable. Apart from the surface destruction and the alteration of the natural topography, the local aquifers in South East Spain are either exhausted, contaminated or suffering salinisation processes (eg Chabart *et al.* 1996). De-salinisation machines are being employed more and more frequently, without any institutional control over their functioning or residues, which causes further degradation of the soils and aquifers. Plastic garbage caused by the removal of old greenhouses also tends to be problematic and usually remains on the surface or is just burned on the spot.

Seen from a historical perspective, this phase of economic acceleration shows the same traits as the previous ones: it is caused by external circumstances, local resources are further degraded and exhausted, and the generated capital is not invested adequately to plan future development and to evaluate alternative economic strategies. A change in the international demand for this type of agricultural products, such as lower market prices, or the transfer of this type of production to north Africa, where wages are lower, could once again trigger off social crises, and leave the area more exhausted than before. Rather depressingly, the long-term record of exploitation in this region offers a pessimistic prediction of the outcome of this short-term and unsustainable type of development. There is a salutary lesson here for those in archaeology who maintain that the record of the past has no relevance to the policies of the present and the future.

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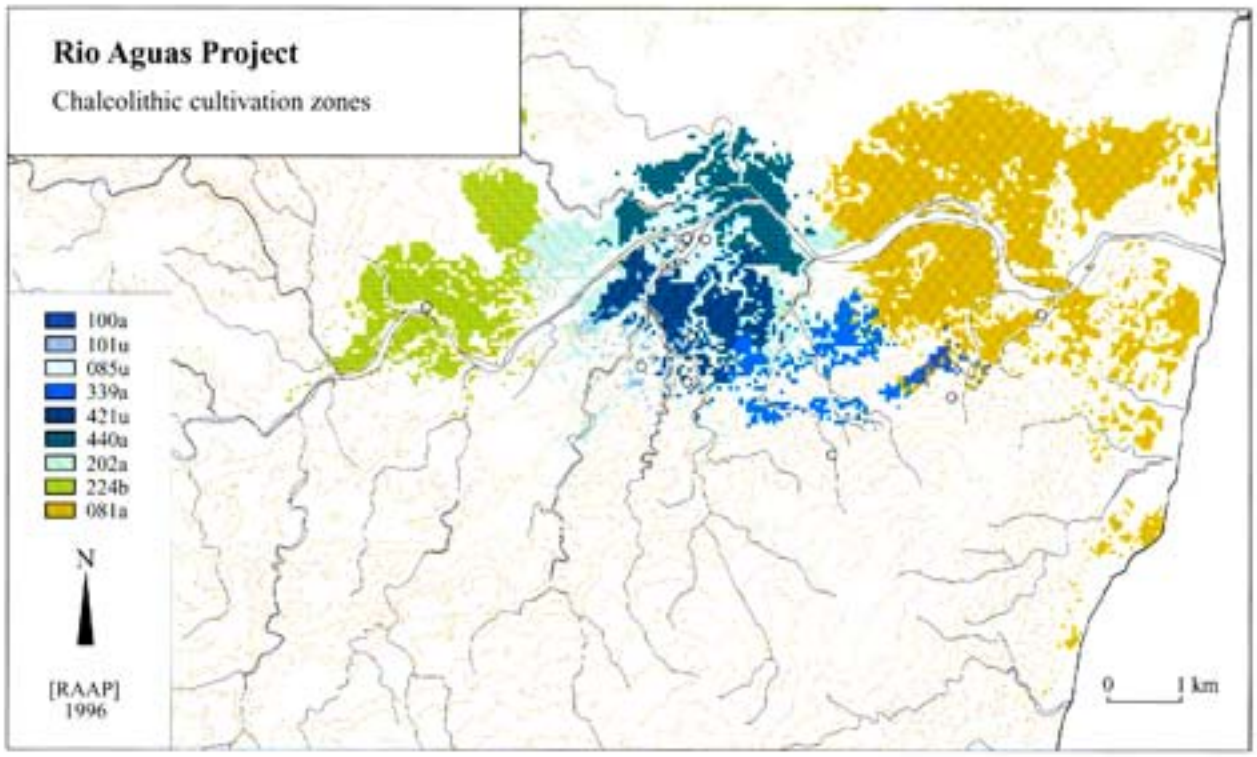
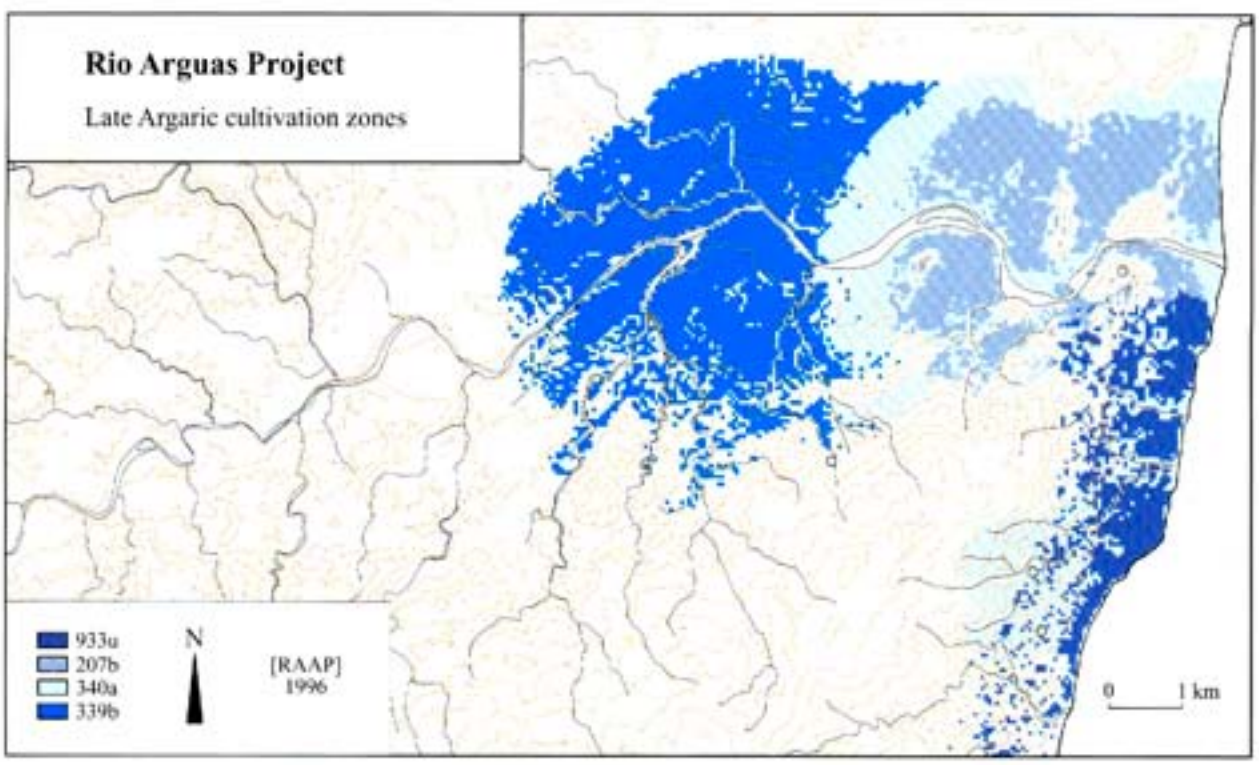
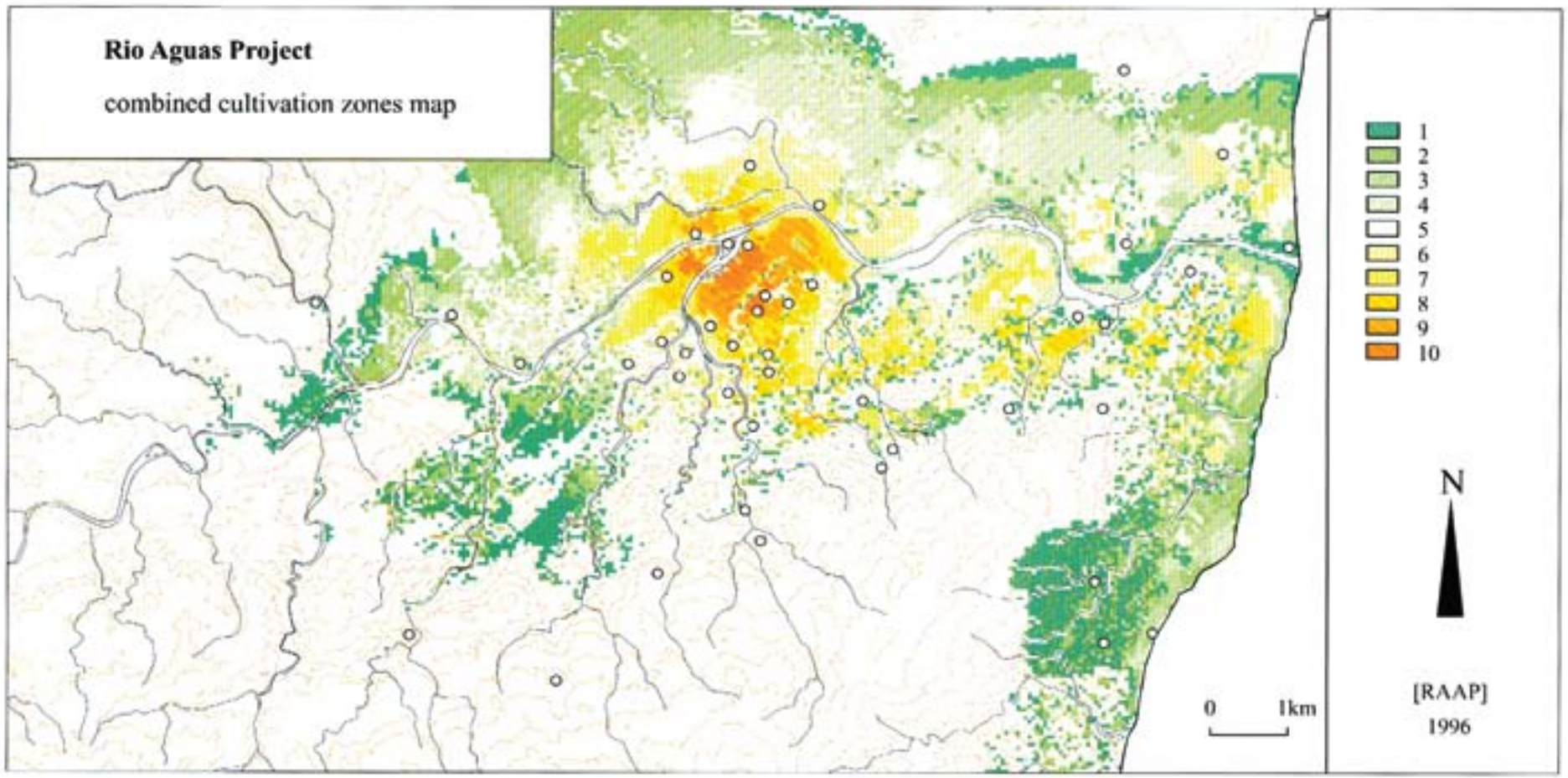


Pl.15.1: Chalcolithic settlements and their agricultural territories



Pl.15.2: Late Argaric settlements and their agricultural territories.



Pl.15.3: Settlement and agricultural territories in the Aguas valley.