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TOURISM, AGRICULTURE AND THE ENVIRONMENT. THE CASE OF THE PROVINCE OF ALICANTE, SPAIN

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Summary

Nature conservation, the development of tourist urbanisations and agriculture all compete for land. In some cases, such as that of Alicante (Spain) and above all along the coastal strip, this competition is dramatic and excluding. The three sectors have developed and grown stronger in a spectacular manner in the last two decades despite restrictions enforced by geo-environmental requirements. Ignorance of these requirements has frequently resulted in catastrophes which, although blamed on natural causes, have been provoked by human intervention.

Therefore, the province of Alicante is a real life laboratory for studying and analysing the successes and failures of conventional economic development, interaction with nature and the possibilities of achieving, or not, sustainable development.

Introduction

Tourism is a phenomenon which has characterised the second half of the 20th century. Spain, and especially the province of Alicante, is perhaps one of the places where this phenomenon has grown most spectacularly in terms of both speed – in only 30 years – and intensity – 41 million foreign tourists per year – spread mainly along the Spanish Mediterranean coastline.

Hot, yet not excessive, climate, lack of rain during the summer months (the holiday period), long beaches with fine sand and warm temperature of the sea are the physical factors which are responsible for the constant increase in people visiting the coast of Alicante. There are other factors which have influenced the growing development of this phenomenon: relatively low prices, both in terms of accommodation as well as of services; and of course long social stability which includes an exemplary political transition from an obsolete dictatorship to a dynamic democracy.

During this very same period, Rain-Fed Agriculture suffered a setback due to the abandoning of this type of crop as well as to the lack of profitability from this kind of activity. This contrasts with the increase in land devoted to Irrigated Crops – fruits and vegetables – as more water is available (transfer systems and underground water) and the increase in profitability of these crops, due to increased consumption by both the tourist population and the European Union.

The Natural Environment is the element which has suffered most during these years, especially along the coast of Alicante. Extensive areas of coastal marshes have been invaded by urbanisations or by conversion to irrigated crops. The sandy areas and coastal dunes have disappeared; the beaches have suffered erosion processes which have had to be remedied using expensive systems to reconstruct the area with artificial sand. Many of the mountainsides and cliffs have been seriously affected by the construction of residential developments and hotels. The "Wall of Cement" runs along 80% of the Mediterranean coastline. Even so, 40% of the surface of the province of Alicante is natural or semi-natural which means that there is great biodiversity. In recent years, six territories have been protected as Natural Parks (three of them are located in coastal marshes). In the same way, stricter regulations are being enforced as regards coastal development. As from 3rd March 1989, all General Plans for Urban Regulation of each municipality must carry out an Environmental Impact Study as stipulated by the Law of the Valencian Legislative Assembly passed on the said date.

Maintaining an appropriate balance between urban, agricultural and environmental development is difficult but not impossible. The development of the province of Alicante has been a combination of great successes and great mistakes, from which a lot can be learnt to the point that eventually sustainable development can be achieved. This in turn will benefit the population without mortgaging future generations. (See Auernheimer and Almenar 1987, 1990, 1991, 1992, 1996 for information on Environmental Management).

Administrative structure

Spain is reigned by a constitutional monarchy, with a parliament and senate. The Administration is divided into 17 autonomous regions and two autonomous cities (Ceuta and Melilla). The Valencian Community is one of those regions and it has a parliament which presents the King with the proposal for the nomination of the President of the Valencian Community. The President in turn names the government which is made up of regional ministers who are in charge of different areas: Agriculture, Environment, Tourism, etc…

The Valencian Community is made up of three provincial councils whose presidents are elected by representatives of each municipality. The province of Alicante has 141

municipalities. The mayors and councilors are elected by public vote as are the MPs and senators who are destined for office in the central government.

Taxes are collected by the Central Government and the Town Halls. The regional governments have little (although increasing) collecting power whilst they receive a substantial part of the taxes collected by the central government in order to carry out their functions. The Provincial Governments have no collecting power and their budgets are established by money transferred from the Central Government.

Surface and population

Spain has a surface area of 505,000 Km^2 and a population of 39,500,000 inhabitants. The Valencian Community has a surface area of 23,305 Km^2 and 3,953,000 inhabitants. The province of Alicante has a surface area of 5,863Km^2 and a population of 1,351,000 people. Alicante is rather unusual as far as the distribution of the population is concerned in so far that, to the contrary of other Spanish provinces, the population of the capital is relatively small: 238,000 inhabitants. This means that Alicante has other nuclear urban centres with a significant population (Elche, Alcoy, Elda, Orihuela, etc).

The Spanish population is divided up in a very irregular way. In general, the coast, and especially the Mediterranean, is overpopulated whilst the inland areas are underpopulated (with the exception of the "island" Madrid). It has even been calculated that 80% of the population live within ten kilometres of the coast.

The province of Alicante is a good representative of this phenomenon. During the last two decades, it has become a land of national and international immigration. Tens of thousands of foreigners, mainly from the European Union, have set up their first home here and above all those who have retired.

Alicante's coast is approximately 200 Km long and is mostly made up of cliffs and rocky coast. However, extensive areas of low sandy coast (beaches) can be found at Santa Pola, Pinet, Guardamar, Los Arenales, Playa de San Juan in Alicante, Benidorm, Calpe, Denia, etc.

Climate

August is the hottest month of the year, with temperatures in Alicante reaching 31º, maximum average, and 20º, minimum average. The coldest month is January, with temperatures reaching 17º, maximum average, and 6º, minimum average. Rainfall is scarce at 350 mm, intense and irregular and concentrated over a few days, mainly in autumn and above all in October. 80 % of the average annual rainfall can fall in just a few hours causing great floods. There are severe droughts in summer with intense evaporation, more than 3,000 hours of sunshine and a pronounced lack of water.

Thus, the province of Alicante has a semi-arid climate.

There are inland areas within the province where average annual rainfall does not reach 200 mm, whilst in the north the average along the coast is 700 mm (Denia) and the temperatures are slightly cooler in summer. In inland areas of the province (Villena and Alcoy) the continental climate and the altitude cause a reduction in temperatures with cold winters: 5º in January with frequent frosts and occasional precipitation in the form of snow.

Geology

The Province of Alicante is located on the far east of the Betic Mountain Range, where the deposits were folded during the Alpine Orogeny in the Tertiary. From South to North the Betic, Sub-Betic and Pre-Betic regions are discernible. The Betic region is made up of Permic and Triassic metamorphic materials which surface in the Sierra de Orihuela and the Sierra de Callosa. The Sub-Betic region contains Secondary and Paleocene era sedimentary rocks which make up, for example, the Sierra de Crevillente. The Pre-Betic region makes up the north of the Province: Sierra de Mariola, Aitana, Cabecó and Carrasqueta and is made up of lime sediments deposited in deep waters. All of these materials are folded and fractured to a great degree. After the Alpine Orogeny, alluvial sediments were deposited and they fill intramountainous basins such as the depression in Segura, in the south of Alicante.

Geomorphology

The landscape in Alicante is marked by contrasts. The main contrast is that of land forms and from this, a tentative division of the Province into 3 regions can be made: the southern third, the central third and the northern third. The southern third is characterised by monotonous, flat landscape where the Orihuela and Callosa del Segura mountain ranges (568m) are clearly and abruptly discernible. These flat lands are made up of the following morphological forms: alluvial plains, slopes and coastal lagoons. The open coast has long sandy beaches which, in places have the corresponding parallel belt of dunes (Guardamar del Segura). The main characteristic of the region is the Segura River which runs through it (Auernheimer et al., 1982). The central third offers a rolling landscape with mostly flatlands towards the east (Campo de Alicante) and hills and mountain ranges separated by wide valleys towards the west (Valle del Vinalopó). Salt marshes and inland lagoons (the laguna de Salinas) are produced by run-off, which can sometimes be endorheic. The coast, which is wide-open in some parts and abrupt in others, offers both sandy beaches and low cliffs. The Monnegré and the Vinalopó rivers are the two most important hydrographic accidents. Furthermore, a system of abundant oueds (dry valleys with occasional strong run-offs) runs through the whole area. Alluvial terraces and bajadas (slopes) are characteristics of the area. The northern third is frankly

mountainous. Alignment of the mountain ranges occurs in accordance with the Betic direction, that is, stretched SE-NE. Elevations crowned with sloped lime crests are separated by mainly marled narrow valleys and depressions, covered in materials carried by the gullies and rivers. Ravines, headland outcrops, and Karst process phenomena are common to this region. The Serpis river is the main drainage system of the area. The rugged coastline is made up of both coves and cliffs such as the Sierra Helada (Benidorm) and the Cabo la Nao. Some sandy beaches (Benidorm, Moraira, Javea) and some pebbly beaches (Altea, Villajoyosa) and small islands complement the landscape (Auernheimer et al., 1981).

Bajadas (Slopes)

Bajadas are surfaces which slant slightly from mountainous alignments down to flatlands. These slopes are formed by lateral coalescence alluvial fans and the lithology is based on detritus composed of different types of granules. These characteristics are typical of a semi-arid climate and they occupy a third of the surface of the province.

In some areas, such as Villena and Salinas, the following synopsis is developed: mountain-bajada-lagoon-salt pan-salt marsh. These salt pans are a form of endorheic run-off and they form pools seasonally. In the dry season, salt deposits are formed which, in the past, gave way to a mining industry that is redundant today.

Alluvial plains

Surface run-off is formed from oueds which are intermittent waterways which occasionally form immediately after precipitation during a storm. These are short waterways with marked slopes which flow into the sea having scarcely formed an alluvial plain. Some of the waterways, especially in the north of the province, could be called rivers as they transport some water, including in summer (the Serpis, Algar and Amadorio rivers).

The Segura River must be dealt with separately. It is much longer than the others and characterises the whole of the southern third of the province of Alicante where it flows into the Mediterranean after having formed a great, fertile flood plain.

Flat coastlines

Erosion from rivers and oueds provides the coast with pebbles, sand and mud which are distributed in a North-South direction, which is the way the coastal current flows in this part of the Mediterranean, and are finally deposited in the form of beaches and sandbanks. The beaches which are most commonly found in the province of Alicante are of lime sand. This sand is fine-grained and yellow-white in colour and gives a smooth profile to the beach and the shallow sea. For this reason, bathers can swim here without danger which is a decisive factor in terms of beach holidays. When the wind blows on the beach, it transfers the sand inland where it accumulates in the

form of dunes. In the north of the province, this system is more or less developed, on the beaches of Denia, Altea and Benidorm. In these places, the dunes appear to be imperfect or in an embryonic state. From the South of Santa Pola to Torre La Mata, the sandy coastline forms 20 Km of dunes which are blocked by pine trees because their advance threatens the town of Guardamar. In this area, (the mouth of the Segura River), the dunes measure 1.333 m wide. The beach-dune coastal system is completed by the development of shallow brackish coastal lagoons.

Remains of coastal lagoons can be found in Denia, Moraira, Calpe, Albufereta (Alicante) as well as in other places. However, the phenomenon can best be seen in the south of the province of Alicante until almost the provincial boundaries. The whole of this area is an arc caused by tectonic sinking and is at sea level as a result of glacial melting. Sediment silting occurs here, in what would have previously been a bay. This silting is produced by detritus carried here mainly by the Segura and Vinalopó rivers. The original bay gradually closed due to the increasing number of sandbanks (beaches and dunes). Human action also contributed to this process, drying part of the lagoons and salt marshes and leaving the Hondo de Elche and the Santa Pola Salinas lagoons as a symbol of what had once been.

Mountain ranges and coastal cliffs

The Betic area is represented by the mountain ranges in Callosa and Orihuela which are formed by quartzitic, slaty and carbonated sediments which come from the Permo-Trias. These mountain ranges stand out clear and straight on the flat horizon of quaternary sediments. The impact of the mountains on the landscape is remarkable despite the rock extractions which spoil their profile.

The Sub-Betic area is represented by the mountain ranges in Crevillente, Algallat and Reclot which are formed by lime and marled sediments from the Secondary and Cenozoic eras.

The northern area of the province is the Pre-Betic area. This is a set of mountain ranges in the Betic alignment (ENE-WSW) which are crowned by powerful lime sacks which form outcrops and are separated by valleys where marl sacks have been dug up. All the sediments are from the secondary and the Cenozoic eras. Therefore, the area is mostly tectonic where folds and faults stamp their personality onto the topography of the region. The erosion processes have shaped and even enhanced these characteristics, sharpening mountain peaks, digging out valleys, highlighting lithological differences, etc. The result is spectacular mountain ranges and deep valleys carefully terraced to be used for prosperous crops. Among the many different sets of landscapes, the Aitana mountain range is of notable interest (1,558 m).

When the foothills reach the sea, they transform into cliffs from Cape San Martín to Cape La Nao, giving way to spectacular landscape such as the Sierra Helada in Benidorm or the Peñon de Ifach (a morphological symbol of the Costa Blanca) in Calpe.

Fauna and flora

The vegetation is characteristic of the Mediterranean with little biomass and slow annual growth. All plants keep their leaves all year round and are robust and tough. The fauna found here is of Central European origin with great North African influences.

Evergreen Oak Wood, this consists of the most developed ecosystem and is formed by oak trees (Quercus ilex**)** which can grow to a height of seven metres. It is spread along mountain ranges such as the Puig Campana, Mariola and Carrascal in Alcoy in the north of the province. These areas are comparatively colder at altitudes of over 400 metres and with more rain (500 mm per year). The mountain pine (Pinus halepensis) can sometimes be found with the oak, although its presence has frequently been favoured for reforestation in a failed attempt to obtain economical productivity from the mountain. This ecosystem presents a brushwood layer with tough and thorny species such as Ulex parviflorus, Genista scorpius, Juniperus oxycedrus, Quercus coccifera and others.

Mammals are represented by the wild boar (Sus scrofa), the population of which is growing all over the province, as is the fox (Vulpes vulpes). Carnivores such as the weasel (Mustela nivalis), the ferret (Putorius putorius) and the wild cat (Felis catus) are in decline. Among birds of prey, there are increasingly less peregrine falcons (Falco peregrinus), golden eagle (Aquila chrysaetos) and somewhat more common is the buzzard (Buteo buteo).

The degradation of the oak caused by human action leads to the destruction of the tree layer and the development of the brushwood layer: Scrubland, formed by Quercus coccifera, Pistacia lentiscus, Rhamnus lycioides, Chamaerops humilis**,** etc. The fauna is equally impoverished.

The final step of ecological vegetation value is the Thyme plant. Here, the arid conditions are extreme, vegetation is disperse and not very high (30 cm), plants characteristic to this area are Thymus longiflorus, Thymus vulgaris, Teucrium polium and Helichrysum stoechas**.**

The Humid Coastal Areas are mainly formed by the salt marsh lagoons in La Mata and Torrevieja, Santa Pola and El Hondo in Elche. The latter acts as a regulating irrigation ditch where the water is fresher than in the others. All those located in the south of the province make up an invaluable ecosystem as regards rest and feeding for migratory birds. The most abundant specie is the gull (Larus ridibundus, L. argentatus). Among the many other species, the most significant is the colony of greater flamingos (Phoenicopterus ruber) and the mallard (Anas platyrhynchos).

The Sea: the waters which bathe Alicante's coastline are hot in summer, 25ºC, and warm in winter, 13ºC. The coast is not rich in biomass production as the scarcity of nutrients only allows a primary production of 9 gr. per metre squared per year

(compared with that of 100 gr. on the Atlantic coastlines). The little phytoplankton which exists has a negative effect on the development of the fauna but positive as regards tourism, the waters are transparent. Therefore, fauna is not abundant although it is very varied, as there are components from the warm waters of the North Atlantic Ocean and the hot waters of the subtropical Atlantic. The most important marine flora consists of the Posidonia oceanica bed. This slow growing phanerogam (1 cm per year) grows on soft seabeds, retaining the sediment and hardening it. This is a place where numerous species breed and grow and it protects the beach from erosion caused by waves.

Natural parks

On July 1st 1982, the statute for autonomy of the Valencian Community was passed which meant that in the following years, authority on environmental issues was transferred from the Central Government to the Generalitat Valenciana. At that time, not a single square metre of the Valencian Community was protected in terms of nature conservation.

March 1st 1984 saw the creation of the Regulating Body for Territory and the Environment and was assigned to the Ministry of Territorial Regulation, Urbanism and Transport of the Generalitat. In February 1986, the first director of the ministry was named (this nomination went to the author of this article). A policy was quickly established for the protection of natural spaces. (Auernheimer et al, 1996).

In the province of Alicante, the first territory to be protected was the Peñon del Ifach on 19th January 1987. This rocky outcrop, located in the municipality of Calpe, forms part of the rugged coast in the north of the province. It occupies a small extension of 35 hectares and measures 350 metres in height. There are more than 300 species of plants, some of which are endemic, and more than 80 species of bird. Reaching the peak is almost an obligatory excursion for tourists visiting this area. From the peak, there are great views of the coast. This park has a Nature Laboratory which students of different nationalities often visit.

On March 16th 1987, the Mongó was declared a natural park. This is a mountainous foothill which ends in the marine cliffs at Cape San Antonio. It measures 750 metres in height and there is a remarkable diversity of wildlife to be found there. Both natural parks represented historic reference points for old sailors; and they have acted as "landmarks" or "totems" throughout regional history. The hillside of both these headlands was developed residentially during the 70's and 80's, running the serious risk that their magnificent outlines would be lost among the cement. The declaring of these landmarks as natural parks caused many problems which continue today. The majority of the population has accepted the ruling very well given that it represents a great

effort – albeit symbolic – to conserve the natural conditions of the little natural habitat that can still be found along the Levante coast.

On 25th May 1987, the Carrascar in Font Rotja was declared a natural park.This has 2,450 hectares and is located in the region of Alcoy, in the inland of the province. It consists of the most important representation of vegetation communities of the Mediterranean mountains. Its exceptional conservation is owed to exceptional circumstances, among which is the interest of the locals in its conservation. The great threat to the conservation of this area comes from fires.

On 12th December 1988, three invaluable humid areas in the south of Alicante are named natural parks: el Hondo in Elche-Crevillente, the lagoons in Mata-Torrevieja and the salt marshes in Santa Pola.

El Hondo in Elche-Crevillente covers 2,387 hectares and is a shallow humid area which acts as a regulating irrigation ditch. It collects wastewater from the Segura River and from irrigation. This water is pumped up to higher lands where it is reused for irrigating the fields. It forms an integral part of the complex irrigation system of the Segura River. Under the protection of these shallow waters, an important habitat has formed for aquatic birds and hunting activities which occasionally enter into conflict with conservationists' plans. This difficult balance between farmers, conservationists and hunters is a challenge for those in charge of the natural parks.

The lagoons in la Mata and Torrevieja, located in the region of Bajo Vinalopó and the Vega Baja, take on 3,693 hectares of national park. There is a great quantity and variety of birds which co-habit with the most important salt mine exploitation in Europe (up to a million tonnes per year). Curiously, and differently to the Salt Marsh Natural Park in Santa Pola, the salt is not extracted from the sea, but rather from a diapiric fold in Pinoso (inland). This geological formation from the Triassic Period, rich in plaster and salt, provides the raw material – sodium chloride – which is extracted via test drilling and by solution in water. The brackish water is transported through channels to lagoons where solar heat evaporates the water and enables the common salt to be collected (Halite). This salt is then loaded onto ships in Torrevieja port and destined to various countries.

The Santa Pola Salt marshes cover 2,497 hectares and the wildlife population there varies greatly. The colonies of greater flamingos are of notable interest. The landscape of these salt marshes is spectacular because of the different colours from the pools where the salt is concentrated (from blue to a deep red). For naturalists, this area constitutes an example of cohabitation between human exploitation of a source (salt) and a habitat suitable for birds. The salt extracted is of premium quality and well appreciated in culinary arts. (Auernheimer, 1992).

Agriculture

In 1955, the Valencian Community was clearly a farming society. 49% of the active population worked in farming, 27% in industry and 24% in services. The agrarian sector contributed 20% of the GDP. In 1985, 15% of the active population worked in the agrarian sector with a contribution of a mere 5% to the GDP. At present, it represents little more than 3%. This remarkable evolution is similar for the province of Alicante where crops occupy half of the territory (60% rain-fed farming and 40% irrigated). Agrarian activity is by far the human activity which requires a greater area of territory which is taken at the expense of the environment. Crops replace natural vegetation, which involves a radical change for both flora and fauna. In one scrubland in Alicante, between 30 and 40 species of plants can be found, and between 5 and 6 of these can be associated with a determined crop.

Rain-fed crops include firstly, almond trees followed by vines and olive trees. These crops can be found on bajadas, on the terraces of the oueds and mountain hillsides. In all these cases, the crops are grown on terraces which are supported by gabions whose aim is to prevent soil erosion and retain the humidity from the scarce rainfall.

In the region of Alicante, the rain-fed crops; the almond tree, the carob tree and the olive tree, need to be watered at least twice a year given the extreme scarcity of water, and it is because of this that this area is paradoxically called the "La Huerta de Alicante" (The Orchard of Alicante). La Huerta de Alicante was abandoned at the beginning of the century. Gradually, the rest of the rain-fed farming regions were abandoned and this led to a series of new important environmental problems. From 1988 to 1998, the surface worked area decreased to 11% (22,000 Ha), and this affected rain-fed farming.

Irrigation farming is located in the alluvial plains of the Segura River (Vega Baja) and is dedicated to ground vegetable crops, citrus fruit and other fruit trees. Water is received from the Segura River using an old, complex system of channels. Wastage from irrigation is collected and recycled in the Elche-Crevillente reservoir. The historic lack of water has led to the creation of a system of reservoirs by which all rivers are regulated. Among these reservoirs are the ones at Beniarés, Amadorio, Guadalest and Tibi (built in the 16th century) and other reservoirs which are already filled up with sediments such as at Elda and Elche in the Vinalopó River.

Worry continues about the lack of water. In the 70's, a large transfer process (from the Tajo River to the Segura River) ended. The great amount of water brought to the lands of Alicante means that the products of the harvests in the Vega Baja are safer. In addition, activity expanded in rain-fed farming on land which had previously been abandoned or was in a semi-natural state. It is estimated that 100,000 Ha are dedicated to rain-fed farming.

Agriculture has created new styles of crops which require important investments but which yield expensive products. In many abandoned rain-fed farming areas, vegetables are being grown (especially tomatoes) using drip irrigation. Water is extracted from very deep aquifers (up to 600 metres deep) and is transferred via flexible pipes to large storage pools where water is accumulated during the whole of winter. There are hundreds of these considerably sized pools (1 million cubic metres) all over the territory. They provide a reserve of water for the summer. However, the construction of these pools involves occasional environmental risks due to the ease with which they can break and cause catastrophic floods downstream.

As of the 90's, the concept of greenhouses, that is the cultivation of crops under plastic, was added to this sophisticated system. In these greenhouses, it is possible to obtain vegetables with a perfect appearance (in fact, they seem artificial) and which are well accepted by the European Union. Personally, I think that fruit has lost much of its flavour and texture, as do many local people. However, farmers receive more profit from their crops using the new systems rather than the old ones.

Whenever there is water in Alicante, all kinds of subtropical species can be grown and in general, all kinds of species can be found. Water is a limiting factor (there is plenty of light and heat), and this is why efforts to increase the availability of water continue. At this moment, there is a great national debate in order to pass a plan for water transfer systems from North to South (water from the Ebro River) and thus increase the sources.

In summary, we can say that, although agriculture is playing an increasingly smaller part in the PIB, it is still expanding using new cultivation methods which yield higher profits.

Forestry

In Spain, all land with natural or semi-natural plant cover is called mountain or forest, whether it be tree or brushwood. 40% of the Valencian Community is forest surface compared with 23% in the European Union or 8.7% in the United Kingdom. Woodland area in Alicante is in slight expansion, due to the fact that surfaces which were previously occupied by crops or grasslands are now abandoned and woodland invades them. 56% of the aforementioned forest is low mountain (scrubland), 39% is high acicular mountain (pine forest), 5% is high sclerophyllons (gall oaks, kermes oaks). There is no significant amount of land for a high mountain deciduous forest nor for forest farming.

The function of the wood in Alicante is simply to conserve the landscape and biodiversity and prevent erosion. The slow growth of woods in this area where it rains so little means that the extraction of wood is not at all profitable. The wood has

other riches such as maintenance of biodiversity, hunting, fishing in the rivers and rural tourism.

Spain and, of course, Alicante, offer an enormous wealth of biodiversity to the rest of Europe. If someone wanted to make a collection of European butterflies, 80% of them would be found in Spain. If the collection were of plants, in Alicante, endemic species would be found and even new species.

The wood retains water and replenishes the dried up aquifers of the province. In addition, it prevents erosion, above all, in the areas where the abandoning of crops is replaced by natural plant cover.

Hunting is an important activity in this area. It is a strictly controlled activity which involves a series of services: hotels, restaurants which are also used in other kinds of rural tourism such as climbing or mountain biking. Wood maintenance is increasingly the responsibility of the civil service which has to deal with the cleaning, path maintenance, plague control (caterpillars – Theumetopoiea pityocampa – in the pine forests) and above all prevention against and extinction of fires.

Fishing

Spain is one of the three world leaders in sea fishing together with Japan and Russia. In terms of the ratio inhabitants-tonnage, Spain is the leader in terms of both catches as well as consumption.

The Mediterranean Sea is poor in terms of fish production. Even so, along Alicante's coast there are several important fishing ports: Denia, Calpe, Santa Pola and Torrevieja. Boats do not only fish this area but they also reach fishing grounds on the African Atlantic coast. The most common form of fishing is by trawler which is, at the same time, the form which most harms the seabeds. Another form of fishing is purse seining which has less impact on the environment. One threat to underwater ecosystems is uncontrolled underwater fishing which is on the increase but at the same time is becoming more and better regulated. This kind of fishing is a tourist attraction on the Mediterranean coast but as it concentrates on predators, it causes an unbalance in the food chain and endangers the stability of the ecosystem.

Geoenvironmental problems

Water sources

Water is a scarce source in Alicante. Agriculture consumes 80% of the water available. All the rivers have reservoirs which store water for the drought periods. The Vega Baja del Segura waters its fertile lands with water from the Segura River, in addition to those transported via the Tajo-Segura transfer system. The water from

this river is tightly controlled via reservoirs. In years of extreme drought, obtaining water quotas from the transfer system was a serious political and social problem. The volume of water stopped is controlled by law and the water released from the reservoirs must be authorised by the Cabinet of Ministers.

The city of Alicante is supplied by water imported from other provinces as well as underground water which comes from very deep aquifers. Surprisingly, this city, which has neither surface nor underground water, has never suffered from serious water restrictions. However, some measures have been taken to save water during some summers of the last decade. This is because of this old-age water shortage problem, this city has developed a preventative system which involves importing water from afar and supplying underground water. Thus, the water supply continues. The use of underground water sources has meant that there has been some relief from water shortage problems for some years. In the province of Alicante, there have been frequent test drillings for water at depths of between 300 and 600 metres. This source was not sufficiently controlled for some years. Thus, the aquifers were overexploited and they suffered from salination.

Other coastal towns such as Benidorm and Denia, which have extremely important tourist developments, have experienced summers with extreme water shortage and have had to take their water supplies from tankers which import water from the north of Spain. At times, this water shortage has endangered the tourist industry of these regions.

The water shortage problem is being tackled via a National Water Plan which proposes an impressive transfer system which will mainly depend on the Ebro River. This plan presupposes an agreement between the Central Government and the Autonomous Communities which has turned out to be quite difficult. In addition, and in years of emergency, de-salting plants have been established. However, the high cost of this process means that it is really only at an experimental stage.

As regards agriculture, various systems have been established with the aim of economising water, such as drip irrigation, reservoirs which accumulate underground water from low yield aquifers and greenhouse cultivation. In the same way, a large amount of the water consumed in the cities is purified and recycled for use in irrigation.

Water erosion

Most of the province of Alicante is suffering a gradual desertification process where one of the main causes is water erosion. There are many reasons why this type of erosion is especially important in this region. Rainfall is very scarce but happens a few days during the year. Rain falls during storms which last few hours (200 mm of water can fall in 2 hours). This kind of rain forms large drops which hit the ground lifting and moving the particles which form it. Secondly, the topography of the area,

with steep slopes, provides surface run-off water with great kinetic energy. Infiltration into the subsoil is scarce because the brevity of the rainfall does not give the rain enough time to go through the soil and subsoil. In addition, a large amount of the subsoil is impermeable and therefore underground run-off is not possible. It is necessary to add to this list of reasons the fact that a large area of this region has little plant cover of any importance which means that the soil is directly exposed to the impact of the large drops of water. Furthermore, most rainfall occurs once summer has ended, just at the moment when there is less vegetation and thus the soil is less protected. The abandonment of human activities in soil conservation is another of the causes of the accelerated erosion. The laborious but efficient terraces of the oueds and mountain hillsides built by man over the centuries were abandoned when farming stopped there. These terraces, which are maintained by gabions, are gradually collapsing as they are not being maintained. In most cases, natural vegetation has not been able to replace these crops and in this way, the land is exposed to water erosion. One last factor adds slow but inexorable potential energy to the erosion process. This is the tectonic movements which occur when the African plate hits the European plate. The land in Alicante rises above sea level and therefore the erosive power of run-off water is stronger.

The effects of erosion on the soil and subsoil could be qualitatively classified as sheet erosion, rill erosion, gully erosion and landslides. There are areas in Alicante such as the Monnegre river basin where all these types of erosion can be found and the advance of the gullies can be witnessed year after year.

Coastal erosion

The beaches or sedimentation areas along the coast are losing sand. That is to say, they are receding. The sedimentation-erosion balance favours the latter by breaking the old equilibrium. The phenomenon started in the 70's coinciding with the increase of tourist development in specific areas. An attempt was made to lessen these problems by building rocky dykes perpendicular to the beaches which still had sand. A few years later, the dykes failed and in general, they were destroyed by the sea. All of this work was carried out without a previous analysis of what was happening. People were trying to find a cure for an illness whose name they did not even know.

The loss of sand from Mediterranean beaches supposes a great economic problem for the areas which suffer from this problem because if there are no beaches, there is no tourism. Big hotels and urbanisations along our coast found themselves without the reason for their existence: the sand on the beach.

At the end of the 80's and beginning of the 90's, the problem was unbearable. Innumerable kilometres of beach disappeared and those that remained were increasingly narrower. The Central Government promised to and started to carry out a plan (which could be considered as an emergency plan) to stop the problem with a

budget of 540 million dollars using the Dutch technique of "nourishment" for the beaches. This technique consists of sucking up sand from the seabed, transporting it by lighters and tipping it onto the eroded beaches. This is a process which tries to follow the natural sedimentation processes (the soft technique) rather than those used previously (dykes, the hard technique). Between 1990 and 1996, more than 3 million cubic metres of sand were used.

Has the problem been solved? In order to answer this question, it is necessary to find out if the erosion-sedimentation equilibrium has been restored. For this, the causes of the accelerated erosion of our beaches have to be recognised. The diagnosis has not been confirmed for certain. Some people believe that the lack of sand is due to the large number of dams which store water from our rivers and retain sediments which, in this way, do not reach the sea. Others maintain that the partial destruction of the Posidonia bed has put the coast in danger of the erosion which the bed had lessened. The authors of this article believe that the main reason (without excluding the others) is the "wall of cement" (buildings, seafront promenades) built parallel to the coastline along the whole of the Spanish Mediterranean and especially along the coast of Alicante. All this has brought about the rupture of the subtle coastal sedimentation balance.

San Juan beach, situated within the municipality of Alicante, is fed by sediments transported by the Monnegre River, which flows into the north of this beach. The north-south coastal current creates a beach of 6 Km and is responsible for the increasing (and almost saturated) tourism. This river operates seasonally and has a reservoir, the Tibi, which was built in the 16th century. This reservoir has been saturated with sediments for decades, which is why it has been impossible to modify the sediment contributions to this beach for years. The accelerated erosion of this basin (which has been referred to in a previous section) would in any case provide more sediment. So, the beach began to recede at the beginning of 1975, although it was one of the last ones to do so along Alicante's coastline.

In 1980, there was an exceptional storm. The sea level rose because of atmospheric conditions (in the Mediterranean there is hardly any form of tide) and the waves reached the maritime promenade and had an impact on the ground floors of the buildings which were situated on the seafront. Great material loss was suffered all along the coast of Alicante. The presence of these buildings prevented the waves from using up their energy by rebounding fiercely out to sea (eroding the sand). When the storm had ended, 75% of the beach had disappeared. Alicante was left with no beach and …no tourists! The storms of consequent years managed to replace a small part of the sand but not enough. Finally, at a cost of 4 million dollars, the beach was rebuilt using the "nourishment technique". But how long?

Having taken into account these events, a clear conclusion can be drawn as to why the beaches are eroded. Buildings are constructed too close to the sea and, indeed,

within the area of impact from it whenever a big storm occurs. The coastal ecosystem and the way it works have been ignored, the beaches have been invaded, the system of breezes has been cut off, dunes and coastal marshes have disappeared. In other words, the erosion-sedimentation system has been broken in favour of the former.

Floods

There are two kinds of flood in Alicante. The first is the quiet and foreseeable flood. This type of flood is produced in the alluvial plain of the Segura River in the south of the province. The second type of flood is violent and unforeseeable. It caused by intense localised storms over relatively small areas which suddenly activate oueds which have remained dry for years.

1. The Segura river floods

The Segura River flows into the Mediterranean in the municipality of Guardamar del Segura. The sediments which are dragged by the river have generated a fertile plain which spreads across the provinces of Murcia and Alicante. Fruit and vegetables are grown on this plain and are irrigated periodically via a complex system of irrigation ditches, drainage channels and reservoirs. This is an agriculturally rich area where the main problem is lack of water.

The Segura River has a sloping basin of 18,630 Km^2. When a storm of significant size breaks over the river basin, the river bursts its banks and the water invades the alluvial plain and hits, above all, the vegetable plantations, whereas the bush-like crops are only slightly affected. In the last half of this century, various important floods have occurred. In 1946, the area covered by water was 23,600 Ha, in 1948: 6,141 Ha, in 1972: 2,873, in 1973: 2,730 Ha and in 1987: 12,000 Ha. Losses in farming in 1987 amounted to 108 million dollars. Work on the regulation structure (dams and reservoirs) of the drainage basin began in the 18^{th} century. In 1945, the area controlled was 4,454 Km^2 and in 1987, 7,103 Km^2. Even so, these measures were not enough to prevent the last great flood. Since that year, the central and autonomous governments have been developing an impressive plan to regulate the basin. Very high investments have been made in the construction of new reservoirs, silt clearance, meandering suppression, canalisation of river waterways, etc. All this work is almost finished and the civil service assures us that the Segura River will not flood the Vega Baja region again. Investment amounted to 600 million dollars. The work has been justified as a way of avoiding the loss of crops. Thus, it is supposed that this is a beneficial investment with fast profits. However, only the positive effects of these developments have been analysed and not the possible negative ones.

Suppressing the floods will cause some undesirable consequences which include an increase in the use of fertilisers and pesticides. Several processes caused by the flood will no longer take place, for example, nutrient enriching from the mud carried by the water, leaching or wastewater disposal.

The ground-water table of the alluvial plains in the Vega Baja is very close to the ground surface. Underground water contains several grams of salt due to the accumulation of salt in irrigation water and the intrusion of seawater. The floods provided a layer of fresh water which pushed the salt water downwards and thus the danger of the plant roots reaching this salt water was lessened. If the plants come into contact with the salt water, they die.

The floods in the Vega Baja formed part of the environmental system (somewhat similar to what was happening in the Nile before the Assuan dam was built). Water levels rose slowly, the inhabitants were warned several hours beforehand, agriculture certainly suffered damage although very rarely was people's safety in danger.

2. Oueds floods

There are three reasons why floods caused by oueds are catastrophic in Alicante in terms of both property and human lives. The first is due to the very configuration of the gullies in Alicante. These are intermittent waterways which have been dry for many years and are short and steeply sloping. The waterway cannot be seen very clearly on a topography of the land and at times it is impossible to see it at a simple glance. The second reason is the wet weather flow which, here, involves little rainfall but concentrated in a few days and even a few hours. This happens in Autumn, usually in October. The third reason is due exclusively to human irresponsibility. In Spain, a waterway or river is that which is named by the Hydrographic Confederation (the official administration). Many of these oueds are not recognised as waterways and because of this, have traditionally been used for rain-fed farming as their beds are formed by more fertile alluvions than the nearby land.

From the 60's onwards, the great urban development invaded these beds. The main street in Alicante is called "la Rambla" (the Oued). In this case, buildings were constructed on the edges. That is to say, the natural water flow route was respected. However, in many other more modern residential districts in Alicante, streets cross the natural direction of the water flow at a perpendicular angle. From 1949 to 1979, there were 87 occasions when rainfall reached more than 30 mm in one day. On 22 occasions, floods were produced which caused damage to some areas of Alicante. Catastrophic floods were recently produced in 1982 and 1997.

Between 18.00h, 19th October and 06.00h, 20th October 1982, a downpour released 217 litres per square metre. That is, more than half the annual average (350 l/m^2). 136 litres per square metre of the aforementioned quantity fell in two hours. The maximum intensity of rainfall reached 180 litres per square metre per hour. The water ran through the streets of Alicante, dragging vehicles, flooding underground garages and businesses, ruining industries and totally paralysing the city. As a result of this disaster, the Administration elaborated a plan for work which would channel future storm rain. This ("once and for all") anti-flood campaign was budgeted at 43 million dollars and aims to channel rain water via outlet channels (underground

pipes). In this way, the water would be carried to the sea thus saving Alicante and the surrounding areas from new catastrophes. The plan began slowly, so much so that on the 30th September 1997 it was still not operative.

In 1983, the authors of this article wrote about the catastrophe of 1982 for a University of Alicante publication:

> *"Flood precautions"*
>
> The recent catastrophe of October 1982 has made this subject very topical. Unfortunately, the collective memory is usually short and as time passes with no further incident, confidence is restored and the risk is run that people will forget. It is important to emphasise that these storms did not provoke a flood in the strictest sense of the word. That is, it was not a question of a river bursting its banks, but rather damage was caused within the waterway itself as the water found various buildings within it. The flooded area of the Barranco de las Ovejas and that of the Agua Amarga, is the mouth of the gully which has been occupied in part by residential buildings, factories, roads, railway tracks, etc…"
>
> (Auernheimer 1983)

On 30th September 1997, the city of Alicante and the surrounding areas received 270 litres per square metre in 6 hours (80% of the average annual rainfall). There were 8 fatal victims. Material damage was in the order of thousands of millions (although never really quantified). The newspapers named the event as TOTAL CHAOS. The other headline directed at those in charge of Adminstration was INDIGNATION. Now, work is progressing although the system is still not operative. On the other hand, it has been admitted, even by the authorities, that if there are exceptional storms, the measures taken may not be enough.

Landslides

Land and rock movements along the mountain hillsides in Alicante are relatively frequent. In part, they are a natural phenomenon but the majority are caused by human action. Many of the new urbanisations built from the 60's onwards sit on steep hillsides formed by detritus (at the foot of a mountain), materials deposited in meta-stable equilibrium. Changes in this equilibrium caused by the building of roads and homes cause landslides which in turn destroy the constructions (Sierra de la Carrasqueta, El Palomaret in the town of Petrel). In other cases, and with the aim of building on the seafront, vertical slopes were carved into the mountains in order to obtain flat platforms on which to build. These mountains are made of extremely fractured limestone which is why they fall from the slope and onto residential homes (La Albufereta de Alicante).

Special mention should be made of the historic parts of many towns and cities of the province such as Alicante, Sax and Petrel which were built on mountain hillsides and topped with lime outcrops. The lime scarp was used to build defending castles and this was the reason why the population took the opportunity to build their homes on the hillside which surrounded the castle. In these places, there is a double risk. On one hand, large pieces of rock from the cracked scarp break away and roll down the hillside. On the other, the hillsides are formed by detritus which are subject to creeping or by expansive soils.

Seismicity

Between 1818 and 1819 a series of earthquakes devastated the Vega Baja (epicentre in Torrevieja) and in 1829 the tragedy was repeated in a year when there were more than 100 earthquakes. The destruction was practically total. An intensity X (10) was calculated on the Mercalli scale for this earthquake, taking into consideration the damage done. Since then, several earthquakes have been recorded but of very low intensities which have produced hardly any damage. The last reason for this frequent seismicity lies in the pushing movement of the African plate on the European plate which causes great multiple faults in Alicante.

The seismic risk in this area is greater than in other areas, not only because of the faults where epicentres can be located, but also because the sedimented detritus in the alluvial plain (sand, silt and clay) are relatively inappropriate for supporting constructions. Furthermore, the population has increased remarkably as a result of the appearance of extensive coastal urbanisations as second homes or tourist residences. Fortunately, most buildings are no higher than two floors and many houses have been built on gentle slopes where the materials are more consistent than those which form the alluvial plain.

In Spain, there has been an Earthquake-Resistant Standard since 1974 which obliges builders to calculate the structures capable of withstanding the vibrations produced by earthquakes. However, this ruling was not widely adhered to until the beginning of the 90's when, and after an up-dating of these standards, the ruling authorities demanded the application of the norms (Auernheimer, 1992, Delgado et al 1993).

Domestic and industrial waste management

Industrial waste dumped into the atmosphere is not a problem in the province of Alicante as the industries installed here are light and do not produce air pollution. Urban construction and therefore the high concentration of motor vehicles are located along the coast where the sea breeze disperses the pollutants.

Wastewater dumping represents a problem for the river waters because the lack of water in these rivers, such as the Segura River, does not allow sufficient solution of the wastewater. In many cases, coastal cities dumped wastewater into the sea via

short distance off-shore sewage outfalls. The situation has changed radically over the last 15 years thanks to an ambitious plan to install a purifying plant. At this time, approximately 80% of wastewater is purified and it is hoped that by the year 2002 the 95% mark will be reached. A good proportion of the water purified is recycled and used in order to increase water irrigation sources. As a result of this plan, the beaches are clean. A weekly analytical control of these waters guarantees the quality of them.

Urban domestic waste (rubbish) represents an only partially resolved problem. The increase in population and the increase in waste produced per person (1,5 Kg per day) means the traditional tips have exceeded the saturation point. The task of finding new sites to place tips is extremely difficult because of opposition from towns where proposals are made to install regional tips. It could be said that a third of domestic waste is disposed of correctly, another third is disposed of in places which could cause environmental problems. Finally, the third third is uncontrolled and has varying impacts on the environment (Auernheimer and Martínez de la Vallina, 1987; Auernheimer and La Orden, 1992).

Tourist development in Alicante

Tourism is currently one of the most important economic activities of previous decades, because of both full capacity and its relative growth. For example, in 1996 production related directly to tourism represented 6% of the Gross World Product and if the activity generated by tourism itself is considered, then the figure rises to 10% of the GWP. During that year, there were 595 million international tourists, 5% more than the previous year. In contrast, in 1950 there were only about 25 million.

In 1996, Spain – the third most popular tourist destination after the USA and France – received 41 million tourists, who brought in a total of 23,300 million dollars and the sector as a whole contributed about 10% to the GDP, providing work for 8% of the active Spanish population. As for the province of Alicante, it welcomed 7.2 million international tourists in 1998 as well as 5.8 million tourists from various points in Spain. This made it possible to provide 9% of the active population of Alicante with work and generated, directly or indirectly, more than 12% of the provincial Gross Added Value. In the last five years, the total number of tourists has increased at an average annual rate of 4%. These tourists occupy more than 50,000 places in hotels, 25,000 places in campsites and more than 500,000 places in apartments located within the Province.

Tourism in Alicante is, for the main part, a typical example of the 3 S's (sun, sand and sea). This is because the people who come here demand precisely and explicitly these three elements at the same time. The coastline of Alicante is especially gifted in these three areas, as mentioned previously. Alicante offers plenty of sunshine, many

sandy beaches, with a great capacity to welcome the visitors, and blue sea – poor in plankton – and a temperature which makes it possible to bathe almost all year round. These natural conditions, as well as other extremely important factors from the past, such as the cheap land and labour force, explain the particular tourist development of Alicante, which is superior to that of Spain as a whole. The town with by far the most tourist activity is Benidorm, which concentrates 80% of overnight stays of the province in its hotels and 60% of the total of those staying within the Valencian Community.

Tourism versus agriculture

Farming and tourist activities compete for two basic resources within the Mediterranean Basin: land and water. Therefore, it can be understood why the Mediterranean countries are worried about the expansion of tourism which demands part of these two relatively scarce and, in some places, almost depleted resources. From the specific case of the province of Alicante, it is possible to draw some useful conclusions in order to place this obvious confrontation within the context of the Mediterranean world.

Firstly, and as regards to the competition between agriculture and tourism for land, it is important to point out that this is not established in identical terms. Agriculture needs land for production; it is an ecological system which is vital to agrarian production. On the other hand, tourism needs the land as a support system where residences, facilities and leisure activities can be installed. The productive capacity of the land is not important but rather its suitability for construction or its visual or scenic quality. For the specific reason that agriculture is much more sensitive to the productive capacity of the land and tourism is indifferent, competition between the two in this field is only partial. Tourist activity tends to move towards lands of little agricultural import. However, the land is especially attractive as it is close to the seafront or in areas of particular scenic interest such as the humid areas (on low coasts) or coastal land and headlands (on high coasts). This is different to urban expansion in non-tourist cities which do tend to occupy special quality land precisely because most of these cities developed in areas with important agricultural production, which produced surpluses more easily. Expansion of traditional cities and agriculture tend to be more confrontational than the growth of the tourist industry and agrarian activity.

Secondly, and in relation to competition between agriculture and tourism for water, certain factors should be considered. Obviously, competition in this domain is more direct and easy to see. This is due to the clash between agrarian demand, especially irrigated fruit and vegetable, growing which is the most common farming activity within the Mediterranean region, and the clearly seasonal tourist demand, such as sun and beach tourism. Both activities require great water resources. This demand

reaches a peak just when the offer is at a minimum. That is to say, during the summer period which is extremely dry in the Mediterranean climatic context, and especially on semi-arid lands where most of Alicante is situated, competition can become very intense.

What can be said to rationalise this underlying conflict between tourism and agriculture? The figures extracted from the environmental input-output table for the Valencian Community (Almenar et al, 1998), the region where Alicante is located, can be taken as a point of departure for the discussion. At the beginning of this decade, a modernised and competitive Mediterranean agriculture, such as that of this region, required 1,290 litres of water for each dollar of agrarian produce. On the other hand, the hotel and catering trade, the heart of the tourist industry, only needed 22.5 litres per dollar of product which was almost sixty times less. While regional farming requires approximately 2,650 Hm^3/year, the hotel and catering trade as a whole only needs 77. Water inefficiency in agriculture can obviously be blamed on the much lower prices paid by this industry for water, on average less than three cents/m^3. Meanwhile, the service industry pays 20 cents/m^3 and households (domestic consumption) 22 cents/m^3 (Almenar, 1998). It is obvious that in a situation where there are difficulties with the water supply, as is frequent in the Mediterranean Basin, it is unquestionably preferable to encourage economic growth which centres on the lodging and feeding of tourists rather than on farming, fruit trees or vegetable growing. If Alicante's economic growth had been centred on farming instead of tourism, in the same proportions both for produce as for income, demand for water would have been higher and entirely unsustainable. Tourism wastes no more on water than agriculture, in fact it is totally the opposite.

Conclusions

The province of Alicante, being a typical Mediterranean coastal territory, runs a number of geo-environmental risks. If these are not taken into account, the country's economic activity and human habitability is threatened. Cases such as the phenomena of floods and coastal erosion, with the resulting loss of such a vital resource as sand to tourism, are some particularly noticeable consequences which could be caused as a result of ignorance of the physical reality in territory planning.

Tourism is an important growing economic activity all over the world, with great future prospects for the short as well as long term. For both Northern and Southern Mediterranean countries, tourism is an economic and social modernisation option which should be encouraged because of the possibilities it offers in this field. It must certainly be adapted to the geo-environmental limitations mentioned in the previous paragraph.

The development of tourism may compete with the farming industry for resources such as land and water. However, if tourism exerts the slightest pressure on these resources, it is more profitable, in terms of produce and income, than farming. Furthermore it has less impact on the environment.

In relation to this, it is fundamental to be aware of the physical surroundings and the different anthropic problems which occur here. Therefore, tourism is a good option for the economic development of the Mediterranean countries both in the present and in the future. It is imperative that the conservation and restoration of the natural wealth are seriously and decisively considered. Natural wealth refers to the quality of the water, the suitability of the sand, the beauty of the landscape, etc and the maintenance of these factors is crucial in order to be able to continue with the tourist industry in the long term.

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