Land system dynamics in the Mediterranean basin across scales as relevant indicator for species diversity and local food systems

Deliverable 2.2: Identification of local case studies for land system analysis downscaling

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Introduction

The main objective of the DIVERCROP project is to analyse the land system dynamics in the Mediterranean Basin and to identify their main drivers at different scales. Working with a multiscale approach implies to connect a global analysis with some local case studies. The study area sampling was proposed already on the project proposal, and it is based on the previous land system characterization at the whole Mediterranean scale. The idea was to collect various case studies representing some of the main dynamics occurring at the Mediterranean level. For this reason, the first part of the project (land system characterization and dynamics) was developed at the global scale (see Deliverable 2.1) and allows to identify some possible dynamics to be deeply analyzed at local level. The choice was based on the following criteria:

- the case study borders must correspond to that of an administrative unit according to EUROSTAT nomenclature: NUTS3 (department), LAU1 (commune) or LAU1 group;
- the case study must involve several land systems or alternatively several trajectories of land systems;
- the case study must be representative of other situations in the Mediterranean basin (representativeness to be identified in the framework of WP2 activities from the bottom up);
- Presence of databases on the territory, accessibility for interviews.

Considering these criteria, each local partners proposed a possible case study, which was discussed and approved by the WP coordinators. In this document, we present the main characteristics of all the local case study.

Portugal

Localization of the case study and their topographic/geographic characteristics

The case study will comprise the municipalities of Serpa and Mértola (part of the NUTS III - Baixo Alentejo) and the municipality of Alcoutim (NUTS III – Algarve). The city of Serpa village of Mértola and village of Alcoutim are the municipal capitals with a population of 6 233, 2 824 and 921 respectively (INE 2011). The three municipalities are crossed by the Guadiana River, through a gentle valley. Following east, there is a progressive transition from peneplain to a hillier landscape. The Alqueva dam (the largest artificial lake in the Iberian Peninsula) follows the Guadiana River along 83 km of the its main course and is located 30 km above Serpa, irrigating part of the municipality.
The climate is Mediterranean, with mild winters and xeric summers, with a strong seasonal effect (Delgado et al. 2009), and an average annual rainfall of 452.01 mm. The area includes Parque Nacional do Vale do Guadiana, a Natura Network site, under the birds directive. The park has 69.773 ha, being the vegetation dominated by holm oak woods, with extensive cistus areas and rained plantations (ICNF 2018).

Main land system dynamics included and analysed

Main dynamics in the region are afforestation, abandonment of arable land and intensification of agriculture, namely in livestock production (Bakker & van Doorn 2009; Costa et al. 2011). We will be focusing in silvo-pastoral system Montado, which is known to be susceptible to the three threats aforementioned.
Table 1 – Changes to land cover between 1995 and 2010. Δ represents the variation in area relative to its 1995 value

<table>
<thead>
<tr>
<th></th>
<th>Δ (%) [1995-2010]</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban fabric/</td>
<td>Agriculture</td>
<td>Pastures</td>
<td>Agroforestry</td>
<td>Forest</td>
<td>Shrubs</td>
<td>Open spaces</td>
</tr>
<tr>
<td>transport/industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mértola</td>
<td>7</td>
<td>13</td>
<td>-42</td>
<td>2</td>
<td>79</td>
<td>-37</td>
</tr>
<tr>
<td>Serpa</td>
<td>24</td>
<td>3</td>
<td>-28</td>
<td>-10</td>
<td>16</td>
<td>-14</td>
</tr>
<tr>
<td>Alcoutim</td>
<td>33</td>
<td>-8</td>
<td>-45</td>
<td>-13</td>
<td>66</td>
<td>-39</td>
</tr>
</tbody>
</table>

Main characteristics in terms of land/farming systems obtained from the WP2 but also from the local knowledge/existing documents

The area has a Mediterranean climate, an undulating relief with poor and shallow soils and is located in a peripheral part of the country. Due to these conditions the area can be considered marginal in terms of agricultural production, although agriculture is a relatively important source of income (Bakker & van Doorn 2009). The region was strongly shaped by the protectionist campaign for the improvement of cereal production in Portugal. A rural exodus has taken place and still continues, mainly because of the poor conditions for agriculture (Pinto-Correia et al. 2004).

Nowadays, the landscape is dominated by extensive non-irrigated crops, and recent tree plantations due to public support to promote forest cover and soil restoration to prevent desertification of the region. This resulted in the increase of stone pine plantations (with low productivity levels) but also of olive yards and oak woods. Subsidies and regulations of CAP have also led to an intensification of livestock production (Carolino 2010, Costa et al. 2011). Most of the land is privately owned, with large properties in Mértola, and smaller in Serpa and Alcoutim. Serpa covers an area known for its wine industry (Pias) and has been distinguishing itself through D.O.P cheese. In Alcoutim, tourism has an important and growing importance (Rota do Guadiana 2018).

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Figure 2- Land systems and its changes as described by WP2
Figure 3 – Land use and land cover of the study area in 2015

The food production that will be analyzed for the WP5 - Cattle
Algeria

En ce qui concerne l’Algérie, nous avons estimé, à partir d’investigations accrues, qu’il serait pertinent de définir les cas d’étude en fonction d’une coupe Nord-Sud à travers laquelle apparaît une dégradation écologique. Car Ce pays apparaît à la fois comme une zone de transition entre les climats tempéré et tropical et un contact entre les guirlandes montagneuses méditerranéennes et les surfaces tabulaires africaines. La marque, dans le paysage morphologique, des empreintes climatiques du Quaternaire, signes d’un balancement répété entre phases pluviales et arides, donne encore plus de valeur à cette observation. Ainsi, le jeu des influences naturelles est à l’origine d’une véritable marqueterie où se juxtaposent plaines, plateaux et montagnes, régions sèches et régions humides. Les conditions du milieu sont souvent difficiles, mais pour mieux en tirer partie, les populations ont mis en place un ou plusieurs systèmes de production en fonction de la dégradation écologique Nord-Sud à travers laquelle le climat méditerranéen, en Algérie et pour l’ensemble du Maghreb, a été subdivisé en plusieurs zones bioclimatiques.

Ainsi, et à partir de ce qui a été énoncé, nous avons fait le choix de quatre secteurs de l’Est algérien pour la mise en œuvre du projet DIVERCROP en Algérie, des endroits suffisamment représentatifs de la dégradation écologique Nord-Sud et eu égard à la diversité des situations, mais des situations qui ont ensemble deux points communs : des activités agricoles prenant différentes modalités et des zones rurales qui sont devenues des espaces d’interférence urbaines et rurales. Les terrains choisis présentent des contextes se résumant de la façon suivante :

- Une plaine littorale, celle d’Annaba, qui constitue une zone agro-écologique assez particulière, elle a toujours été fertile. Toutes les cultures maraîchères y sont pratiquées grâce à un climat relativement favorable, et l’élevage bovin est également de mise. Cependant, la plaine est menacée par l’urbanisation et par la mise en place d’infrastructures industrielles, celles-ci constituant un facteur de dégradation de l’environnement et l’une des manifestations les plus fortes de la pollution.
L’axe El Eulma-Sétif-Aïn Arnat, dans les Hautes Plaines orientales, où se concentrent 400.000 habitants et où prédominent la céréaliculture, l’élevage intensif et l’aviculture. Dans cette zone, l’agriculture est mise à mal par une explosion urbaine dont les retombées sont fort inquiétantes, notamment celles qui ont trait à sa pérennité et aux enjeux relatifs au foncier.

Deux secteurs sahariens : une oasis, dans les Ziban, constituée par la palmeraie de Tolga, près de Biskra, et une zone limitrophe, El Ghrous où les jardins de serriculture sont minutieusement cultivés en polyculture pour constituer l’une des régions les plus importantes en produits maraîchers de l’Algérie, ainsi qu’un autre secteur, celui du Souf, devenu lui aussi une zone nourricière par excellence et exportatrice de produits agricoles,
mais dont le développement porte atteinte à l’écosystème traditionnel oasien. Ici et là, les problèmes environnementaux se posent avec acuité, ils sont liés aux dynamiques actuelles des pratiques agricoles (tarissement de la nappe phréatique dans les Ziban et remontée des eaux dans le Souf).

Fig. 3 - Une palmeraie à Tolga

Nous sommes dans la première année du projet et nous n’avons donc pas encore abouti aux résultats de la recherche, mais dores-et-déjà nous sommes en mesure de donner un aperçu de la dynamique des agro-systèmes dans les Ziban et dans le Souf, deux secteurs situés au Nord du Sahara algérien où les organisations humaines ont pris forme à travers un système socio-hydraulique qui, depuis des siècles, a su s’accommoder des conditions difficiles du milieu. L’agriculture se limitait, autrefois, au système oasien traditionnel où, à l’ombre du palmier dattier, évoluent plusieurs strates de cultures. Aujourd’hui, ce système a des difficultés pour subsister, du fait de plusieurs facteurs. Dans l’oasis de Tolga, cette situation est la conséquence d’une urbanisation rapide et massive des abords des vieilles palmeraies, qui tend à faire émerger une véritable conurbation. Elle est d’autre part liée aux retombées socio-économiques générées par les mises en valeur agricoles récentes des espaces environnants, qui se traduisent par un renouveau de la phœniciculture et un essor spectaculaire de la plasticulture.

Les Ziban sont une vieille région phœnicole, irriguée autrefois par des sources jaillissant du piémont de la chaîne montagneuse du Zab, relayées aujourd’hui par des forages puisant dans des nappes semi profondes et abondantes. L’agriculture y a été relancée depuis les années
1980 par un renouveau de la phœniciculture grâce à de nouvelles plantations autour des anciennes palmeraies et également par la mise en valeur d’autres terrains. 
Le secteur d’El Ghrouss, comme tant d’autres, constitue un exemple parfait de l’essor particulier de l’agriculture dans la région des Ziban. Ici, le renouveau phœnicicole a été très vite supplanté par un développement spectaculaire de la plasticulture : culture maraîchère sous serres à perte de vue, soit plus de 20.000 tunnels en modules standardisés (50 X 8 m) pour ce secteur en 2018. On y cultive une grande variété de cultures (tomates, poivrons, courgettes, concombres, artichauts, melons, pastèques...). Ces produits sont écoulés sur le marché de gros d’El Ghrouss qui, chaque jour, draine vers lui, plusieurs centaines de négociants venus aussi bien de l’Est que du Centre et de l’Ouest du pays.

Le développement de la plasticulture a été impulsé par deux apports successifs, l’APFA qui assure, depuis les années 1980, l’accession à la propriété foncière à ceux qui mettent en valeur des terres et le PNDA\(^2\) qui finance ceux qui développent l’agriculture. Les terres ont été attribuées sur des fourchettes allant de 2 à 10 hectares selon les potentialités avec une irrigation au goutte-à-goutte, un système non gaspilleur et moins dépensier. Or, dans un grand nombre de cas, ces deux facteurs n’ont pas été suffisamment coercitifs pour empêcher certains comportements concernant les modes de faire-valoir, dans la mesure où des bénéficiaires de terres n’ont pas manqué de se dérober de leurs engagements envers l’État pourvoyeur de la terre et du financement. Car, la pratique de la plasticulture étant une œuvre fastidieuse, ces attributaires préfèrent confier la serre à un tenancier ou procéder à sa

\(^2\) Programme Nationale du Développement de l’Agriculture.
location. Globalement, un tenancier reçoit le ¼ de la récolte, alors qu’une serre est louée, courant 2009, à environ 300.000 Dinars l’année. Locataires et tenanciers ont une origine variée, ils viennent principalement de secteurs maraîchers à la réputation ancienne, la Mitidja ou le Sahel algérois entre-autres.

Selon nos calculs, une serre produisant, en moyenne, 11 quintaux de tomates ou 7 quintaux de poivrons, assure des revenus équivalent ceux de 20 palmiers *deglet nour* avec des rendements de 100 à 150 kg/arbre. Mais les investissements sont plus élevés dans le premier cas que dans le second. Pourtant, les exploitants ont tendance à investir, au départ et en même temps, dans les deux types de culture, tout en songeant à réduire graduellement le nombre de serres dans le temps. Car malgré un volume de travail très lourd et des charges plus élevées, la serriculture permet des revenus immédiats, alors que les jeunes plantations de palmier n’entrent en production qu’après une dizaine d’années. Le palmier exige moins d’efforts, il est plus rentable et le cours de son produit moins fluctuant. Ainsi, pense-t-on, de la sorte, répondre à tous besoins monétaires urgents, en attendant que soit mise sur pied la palmeraie qui, plus tard, constituera le capital sécurisant de l’exploitation.

Le secteur d’El Ghrouss et les Ziban, dans l’ensemble, sont l’archétype d’une paysannerie dynamique. L’essor de la plasticulture, grâce aux apports de l’État et au climat saharien, en a fait la première région productrice de primeurs. Cependant, la multiplication des forages ne va pas sans peser sur les potentialités hydriques, car les nappes sont soumises, aujourd’hui, à un rabattement inquiétant. Mais c’est dans le Souf, et plus qu’ailleurs, que le phénomène est mieux ressenti. Dans cette région, l’irrigation se fait à partir de la nappe phréatique. Le système de culture traditionnel consiste en la plantation de palmiers aux fonds de vastes cratères, appelés, en terme vernaculaire, *ghouts*, l’eau étant puisée directement de la nappe phréatique. Cette méthode permet aux agriculteurs d’éviter toutes les charges d’irrigation, auxquelles l’on fait face dans les autres régions arides.
Ce système d’irrigation original et unique est adapté aux conditions sévères du milieu naturel du Souf. Cependant, et parce qu’il est complètement dépendant du niveau de la nappe, il est considéré comme précaire. En s’élevant ou en s’abaissant, cette nappe menace les palmiers, soit par ennoiement, soit par sécheresse. Ainsi se pose le problème d’une catastrophe agro-écologique probable, à la suite d’une surexploitation des eaux souterraines par une urbanisation très forte ou par les nouvelles formes de mise en valeur des terres qui misent sur une intensification intense de l’agriculture par un développement accru des cultures maraîchères et fruitières qui demandent une consommation sans cesse croissante de la ressource en eau.
Fig. 6 – Localisation des cas d’étude en Algérie
Italy

Localization of the case study and their topographic/geographic characteristics

We decided to choose the Pisa plain for our case study which is composed, on an administrative level, of the six municipalities Pisa, Calci, Cascina, San Giuliano Terme, Vecchiano and Vicopisano, extending for an area of 475 km² and including 195,000 inhabitants.

The Pisa plain is an alluvial plain of the Arno river, characterized by low land level and gentle slopes on the margins. The area is surrounded by the Pisan Mounts to the north-east, the Livornesi-Pisano hills to the south-west and the Tyrrenian Sea to the west. It is representative/illustriative of coastal plains located in Mediterranean regions.

The plain is crossed by Arno and Serchio rivers and the western part, adjacent to the seaside, comprises a regional nature reserve/park, Migliarino-San Rossore-Massaciuccoli Park. Additionally, the park is part of the bigger MAB-Biosphere Reserve that extends also to the Pisan Mounts in the north-eastern part of the study area.
The plain has been peatland ever since and has been reclaimed in the early years of last century. The climate is typically Mediterranean, with warm and dry summers, mild and rainy spring and autumn and winter with temperatures rarely below 0 degrees C. The average annual rainfall is ca. 900 mm. Soils range from sandy in the coastal parts to silty and loamy. One problem of the area is flooding in wet winters, especially on silty and loamy soils. Drainage systems are installed in the whole plain area. Usually, irrigation is not used in agriculture, just for very limited vegetable productions.

The plain area is dominated by the urban system of Pisa, which is the most important city in the area (ca. 90,300 inhabitants), and that develops compactly its centre and extends as a radial system to the surrounding agricultural area. The demographic and economic growth has resulted in a significant urban expansion especially since the ’70s; however, over the last decade Pisa area has tended to a low population growth and urban growth concentrated in the surrounding areas.
Main land system dynamics included and analysed

The land use of the Area Pisana is characterized by nearly half of the surface with agricultural use, while 17% are artificial or urbanized surfaces, and 31% woodland and semi-natural habitats. Only 3% of the surface is covered by water bodies, and 1% by wetlands.
Due to these characteristics, the Pisa plain is an emblematic example of peri-urban agriculture in an area of the Mediterranean. In the Pisa plain, agriculture is characterized by two macro types, one of which is olive-growing, mainly on the Pisan Mounts, which is typified by small and very small farms, often on hobby basis. In the second macro type, the farms are larger-sized and consist mainly of arable land with cereal-forage and cereal-industrial production. In the last decades in the study area there has been a reduction in farms and agricultural land and consequently an increase, besides the urban areas, also in natural and wooded areas.

The recent dynamics in the farming systems, as resulted from WP2 analyses, are insignificant. Local studies of the dynamics in the last twenty years reveal a simplification of the farming system, as livestock and vegetable farms have decreased. Abandoned areas have increased significantly.

The food production that will be analysed for the WP5

The food productions that will be analysed for WP5 will be on the one hand olive production and on the other hand livestock for meat production. The productions were selected because they represent the local agriculture considering both the geographic organisation of the space and the local identity and culture of urban and rural people living and working in the area. Moreover, in both cases it is possible to map the spatial and social organisation of the food chain, since local processors, cooperatives, groceries and other stakeholders of the food chains are still active economic actors in the area. This is not guaranteed for other crops, such as cereals or vegetables. At the same time, several projects of local valorisation are organised for both olive and meat productions in the area to sustain the production, the consumption and the valorisation of local resources and networks. For all these reasons, these productions are suitable to design the complex socio-economical system of the local food chain that may sustains the periurban farming system.
Malta

Localisation of the case study and their topographic/geographic characteristics

The Maltese archipelago is a group of low-lying small islands situated in the Central Mediterranean Sea at 96 km south of Sicily, almost 300 km east of Tunisia and some 350 km north of the Libyan coast. The land area of Malta is made up of three inhabited islands (Malta, Gozo and Comino) and several uninhabited islets, with a total land area of 316km\(^2\).

The climate of the Maltese Islands is typically Mediterranean, with a 30 year average temperature of 18.6 (±0.4)\(^\circ\)C, and average monthly temperatures varying between 12.4\(^\circ\)C during the winter period to 26.3\(^\circ\)C during the summer period. Average annual precipitation is 553.1 (±157) mm. Precipitation is normally associated with defined wet periods, which are then followed by rainless summers. The Islands also have a windy climate, with average mean wind speeds at 16.3 kmhr\(^{-1}\), with the predominant wind being the North-westerly which blows on an average of 20.7% of the days in a year (Galdies, 2011).

Geologically, the Maltese Islands are composed almost entirely of sedimentary rocks, i.e. mainly limestones from the Oligo-Miocene age but there are also some minor quaternary deposits of terrestrial origins. The Maltese soils are relatively young, characterised by low soil horizon development, and show close similarity to the parent rock material. The soil is calcareous, ranging from mild to moderately alkaline. These soils have however also been modified substantially through human influence over time, including mixing or addition of rock debris during reclamation. The major terrestrial ecosystems, which form part of the ecological succession sequence toward the climatic climax ecosystem, are steppe, garrigue, maquis and woodland ecosystems. Woodland ecosystems are generally scarce, with remnants remaining in few localities in the form of small copses of Holm Oak. Coastal ecosystems include a saline marshlands, sand dune systems and beaches, and areas dominated by cliff habitats or gently sloping rocky shores characterised by halophytic vegetation in small saline soil pockets (Schembri, 1993).
Malta has a long cultural history, with the first evidence of settlements being from more than 7000 years BP (Patton, 1996). The first settlements modified the landscapes for agricultural practices, including grazing activities. Human activities have since then had a significant impact on the landscapes and the ecology of the islands, with the clearing of woodland and maquis habitats for agriculture, grazing and wood procurement. Whilst more recently, agricultural abandonment and afforestation activities have been associated with increase land cover of these ecosystems.

Main land system dynamics included and analysed

In 2014, Malta had a population density of 1,346 persons per km$^2$ (NSO, 2016a), the highest in the European Union. Malta also has a booming tourism industry, which in 2017 exceeded 2.2 million inbound trips with an increase of 15.7% over the previous year$^3$. Agricultural land cover today occupies around 51% of the territory whilst urban and industrial areas occupy more than 30% of the surface area of the Maltese Islands (MEPA, 2010; Table 1).

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Table 2 – Percentage and area of land cover by type for Corine Land Cover 2006 (MEPA, 2010)

<table>
<thead>
<tr>
<th>Land cover type</th>
<th>Area (km$^2$)</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural areas</td>
<td>161.5</td>
<td>51.2</td>
</tr>
<tr>
<td>Urban areas</td>
<td>70.4</td>
<td>22.3</td>
</tr>
<tr>
<td>Forested areas</td>
<td>2.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Coastal wetlands</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Natural vegetation</td>
<td>57.8</td>
<td>18.3</td>
</tr>
<tr>
<td>Industrial and commercial units, mineral extraction, airports, port areas, dump sites, green urban areas and sports and recreational facilities</td>
<td>23.31</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Main characteristics in terms of land/farming systems

The Maltese farming systems comprise land farmers and livestock breeders. Most livestock production is based on imported feed concentrate and fodder together with fodder. Land farmers practice two forms of farming: 1) dry arable farming and 2) irrigated farmland. The first category relies on rain to grow mostly fodder, onions, garlic, broad beans, potatoes and some permanent crops such as vines, olive trees and fruit trees. Irrigated farmland in greenhouses and open fields where they grow a wider range of vegetables (Atriga, 2018).

The average land holding size in Malta is small compared to the European average, and 75.6% of the agricultural holdings have a utilised agricultural area of less than 1 ha each, 22% are between 1 to 5 ha, and 2.4% exceed 5 ha (NSO, 2016b).
Figure 6 – Number of agricultural holdings according to the size of the utilised agricultural area (ha) in 2013 (NSO, 2016b)

Figure 7 below illustrates trends in agricultural production from Malta for the main crops, i.e. fodder, vegetables, potatoes, grapes and olives, based on data provided by the National Statistics Office during the DIVERCROP project. Land cultivated for fodder production covered the largest surface area followed by land for vegetable production. The data indicates an overall increase in areas of land cultivated for fodder production and also in the area of vineyards and olive orchards. A reduction in the overall surface area cultivated with potatoes has been observed, leading to lower potato production overall. Contrastingly, an increase in olive and grape production has been observed between 2000 and 2017. Interestingly, yield data (Kg/ha\(^{-1}\)) also suggests a general increase in the yield of vegetables and grapes but diminishing potato yield during this timeframe.
Figure 7 – (a) Area cultivated (ha) and (b) production (kg) and (c) yield (kg/ha) data for annual and perennial crops from Malta (source: NSO). The area for each crop is not collected for each year and for intermediate years it is assumed to remain the same as the data collected in the previous survey.
The food production that will be analysed for the WP5

Two crops will be analysed in WP5, namely potato and olives. Potato is a traditional crop in Malta, introduced whilst part of the British colony. There is a strong tradition of cultivation of potato for to the northern European markets. Olive production also historical roots, as demonstrated by considerable historical evidence that shows ancient olive presence on the island and from Maltese endemic varieties of the olive tree (e.g. the tal-Bidni and Malti cultivars).
Spain

Fig 1. Localization of the case study

<table>
<thead>
<tr>
<th>Spain-Comunidad de Madrid</th>
<th>Comarca de las Vegas</th>
<th>Municipalities analyzed</th>
</tr>
</thead>
</table>

Localization of the case study and their topographic/geographic characteristics

Fig 2. Area of study
The area of study (165,47 km$^2$) comprises three municipalities which are part of the “Comarca de las Vegas”: San Martín de la Vega, Titulcia and Ciemposuezuelos. The territory is vertebrated and organized around the main river Jarama, and in the case of Titulcia, the river Tajuña, both afluents of river Tajo. In the vegas, predominant soils are sedimentary, mix of sand, clays and limes, whereas the moors are characterized by gypsum, loam and limestones (Comunidad de Madrid, n.d). (Fig 3.)

By 2017 San Martin had over 18.8000 inhabitants and has experienced a considerable (77%) demographic growth since 2000. Ciemposuezuelos’ population raised from 13.554 in 2000 to 23.737 in 2017 (75% growth). Titulcia remains as a small town of 1.234 habitants in 2017, 36% more than in 2000 (data from INE, 2018).

The climate is continental Mediterranean, with dry and hot summers, cold winters, and large annual and daily thermal oscillation. The maximum average temperature comes in July (23.7ºC), with a maximum diurnal temperature of about 40ºC and minimum nocturnal temperature of about 18–20ºC. (Barbero et al, 2013). The area has the lowest rates of precipitation in the Comunidad of Madrid.

The area considered has high environmental values, as reflected by the fact that % of it was included in the Southeast Regional Park (Parque Regional del Sureste), where San Martin de la Vega stands out for the gypsumiferous high slopes (cortados), pine trees and a natural reserve area with lagoons and wetlands, (Red2red 2015) next to the banks of the Jarama River (fig 4).
Main land system dynamics included and analysed

Agrarian Utilized Surface (SAU) has decreased considerably in San Martin de la Vega, and increased in Titulcia (Table 2). There is also a general process of concentration of land in a reduced number of farms, whose amount decreases over years. Permanent pastures have been lost, probably evolved into shrubs after abandonment of it use (Table 1).

Fig 5. Land use Changes. Aerial photos 2007-2017

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Ciempozuelos</td>
<td>2188</td>
<td>-1%</td>
<td>188</td>
<td>-47%</td>
<td>141</td>
<td>-55%</td>
</tr>
<tr>
<td>San Martin Vega</td>
<td>3338</td>
<td>-4%</td>
<td>687</td>
<td>-93%</td>
<td>2176</td>
<td>-12%</td>
</tr>
<tr>
<td>Titulcia</td>
<td>409</td>
<td>33%</td>
<td>9</td>
<td>-56%</td>
<td>277</td>
<td>-98%</td>
</tr>
</tbody>
</table>

Source of data: INE Censo Agrario 1999, 2009
Table 1. Evolution of SAU and number of exploitations

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Ciempozuelos</td>
<td>2375</td>
<td>233</td>
<td>1648</td>
<td>-31%</td>
<td>10</td>
<td>13</td>
<td>+30%</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>San Martin Vega</td>
<td>4025</td>
<td>522</td>
<td>3237</td>
<td>-20%</td>
<td>8</td>
<td>23</td>
<td>+94%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Titulcia</td>
<td>418</td>
<td>32</td>
<td>547</td>
<td>+31%</td>
<td>13</td>
<td>34</td>
<td>+62%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source of data: INE Censo Agrario 1999, 2009

Figure 5. Land Cover changes 2006-2012. Source: Project CLC

In terms of land cover, the main changes observed correspond to the expansion of artificial uses: 64% of changes in land cover between 2000 and 2012, which were concentrated in the period 2000-06. Between 2006 and 2016 the trend was ralentized, areas under construction by 2006 were completed, but there were no more large urban developments (view Figure 4 and 5). There was also a process of re-naturalization of mineral and extraction areas, including flooded gravel pits, which have been restored to sclerophyllous vegetation and transitional shrubs. Besides that, not significant changes are recognisable.
Main characteristics in terms of land/farming systems
(Based on information obtained from the WP2 but also from the local knowledge/existing documents)

According to WP2, most of the area correspond to (7) “High slopes characterized by olive groves and vineyards associated to natural vegetation (trees and shrubs)”. (Fig 6)

Table 1. Importance of cereal production

<table>
<thead>
<tr>
<th></th>
<th>SAU cereals (Ha)</th>
<th>% SAU mais and barley/SAU cereals</th>
<th>% SAU cereals/total SAU in the municipality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barley</td>
<td>Mais grain</td>
<td>Other cereals</td>
</tr>
<tr>
<td>Ciempozuelos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Martin de la Vega</td>
<td>681</td>
<td>1064</td>
<td>136</td>
</tr>
<tr>
<td>Titulcia</td>
<td>152</td>
<td>23</td>
<td>12</td>
</tr>
</tbody>
</table>

Source of data: INE. Censo Agrario 2009

Fig 6. Land systems and changes 05-15. Results from WP2

Source: WP2 DIVERCROP
The “Comarca de las Vegas” was traditional the main area of horticultural food supply for the capital city Madrid. Agriculture was the main driver of the region until the last decades of the twentieth century. Then, horticultural cultivations were partly abandoned, partly urbanized and partly substituted by industrial cultures like maíz to feed cattle. Nowadays the main cultures in the region are barely, olive trees and maíz (Red2Red, 2015).

In Titulcia, which is much a rural municipality than the other two, agriculture stands for over 8% of the municipal GDP, whereas in the rest it barely accounts for the 1% in Ciempozuelos (the one with a lower rate in the region) or 2% in San Martin.

Titulcia is included in the Protected designation of origin for its wine “Vinos de Madrid”.

The food production that will be analysed for the WP5 Aspargus, a traditional culture which is being promoted through the local quality label “Vega de Ciempozuelos”, applied to the horticultural production in the municipality of Ciempozuelos. It is also cultivated in San Martin and has expanded considerably.

The second representative product to be analyzed might be oil (or wine), which has a notable presence in the area.
Tunisia

Localization of the case study and their topographic/geographic characteristics

The study will focus on the plain of Haouaria, located in the Cap Bon in north-eastern Tunisia (Fig. 1). The plain is surrounded by the forest of Dar Chichou and Djebel Haouaria, and the Mediterranean Sea on both sides. The climate is Mediterranean upper sub-humid, with irregular precipitation and wind 300 days per year on average. The annual rainfall is about 568 mm/year (1972-2007) with erratic rains mainly between September and April. Summers are very dry as rain during this season contributes only 2% of the annual total precipitation. Monthly evaporation average is 104 mm, ranging from 176 mm in July to 35 mm in December. Dominant sandy soils and a rather flat topography favor direct rain infiltration, explaining why the hydrographic network is almost nonexistent in the plain of Haouaria (Mekki et al. 2017).

Fig. 1. Localization and key characteristics of the study area. Garaet is a natural wetland. (from Mekki et al., 2017).
Main land system dynamics included and analyzed

The introduction of shallow and tube wells along with industrial agriculture made intensive and diversified agriculture possible. In Haouaria, the main crops are cash crops (e.g. tomato, red pepper, potato), which increased dramatically at the expense of economically less profitable crops such as caraway and groundnuts. Cash crops were later associated with the introduction of drip irrigation in the 1990s and the increase in the number of wells. Presently, very few smallholder farmers cultivate tomato, which is mainly produced by large agroindustrial farmers relying on informal contract farming (generally made without written contracts), with a diversity of arrangements. The differences among these arrangements depend on the sharing of production fees and profits (Ghazouani and Mekki, 2016; Mekki et al., 2017).

Main characteristics in terms of land/farming systems obtained from the WP2 but also from the local knowledge/existing documents.

Agriculture remains the main economic activity in the Haouaria region, with almost 70% of its population involved in this activity (INS, 2010). In Haouaria, land ownership is highly fragmented due to population increase and landowners processing. The number of farmers is about 6000 (CTV Haouaria, 2015). The large number of small agricultural plots has increased well density (between 1 and 2 wells per hectare on average). Large landowners are more likely to own tube wells. The average land plot size is about 0.75 ha (AFA, 2010). Small farms (< 5 ha) constitute about 78% of the total holdings (CTV Haouaria, 2015), while there are 20 medium farms 20-100 ha) and only 9 farms larger than 100 ha. The mechanization of agriculture and the development of the tomato and pepper agroindustry have shaped socioeconomic conditions in the area.

The socio-economic development of the Haouaria plain relies on groundwater resources and is suffering from depletion and quality deterioration of the shallow and deep aquifers. The resulting fivefold exploitation increase between 1970 and 2006 for the shallow aquifer and twofold for the deep aquifer shallow aquifer, respectively (CRDA, 2011), has led to the qualitative and quantitative degradation of water resources in the plain.
Cropping patterns in the Haouaria plain have long consisted of traditional irrigated crops such as groundnuts and caraway in rotation with fodder crops for livestock (Sethom, 1977). Agriculture consisted of extensive production systems with low inputs and with flooding as the main irrigation technique. Rainfed food grains (mainly wheat) were also cultivated. With the introduction of cash crops and the intensification of phreatic and then deep groundwater pumping in the 1970s and 1980s, farmers gradually shifted towards high value vegetables (e.g. tomatoes, red peppers, potatoes) (Ghazouani and Mekki, 2016).

The food production that will be analyzed for the WP5: tomato, pepper.
DELIVERABLE 2.2: IDENTIFICATION OF LOCAL CASE STUDIES FOR LAND SYSTEM ANALYSIS DOWNSCALING

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