Briefing notes

on the CIRCE rural case studies: Tuscany

Summary

▶ *Tuscany is an extremely rural area, with a landscape that has high economic value for culture, heritage, agriculture and tourism.*

▶ *Climate hazards such as severe floods and heat waves have affected the region in recent years.*

▶ *The rural economy is heavily dependent on agriculture, a sector that is particularly sensitive to climate change.*

▶ *Key research issues include the impact of climate change on agriculture, forest fires, and tourism; adaptation strategies for agriculture and natural ecosystems; and the role of agriculture and forestry in climate change mitigation.*

1. Physical and socio-economic characteristics

Geography:
Tuscany (22,990 km^2) is the widest administrative region in central Italy and is located between 9° and 12° East and 42° and 44° North (Figure 1). The geological structure is represented by the Dominio Umbro-Marchigiano (flysch sand-marl stone) and the Dominio Toscano. The latter is a two-layer

Figure 1: Location map for Tuscany (modified from http://www.roadtoitaly. com/info/italy_ tuscany_map.htm accessed 04-01-08)

1

metamorphic series; the lower-layer comprises sandstone, limestone, dolomite and Triassic to late Palaeozoic rock, the upper-layer comprises flysch, claystone, marl, limestone and dolomite. From an environmental point of view, Tuscany is peculiar for its extremely heterogeneous morphological and climatolgicial features. The topography ranges from flat areas along the coastline and principal river valleys, to hilly and mountainous zones towards the Apennines chain. Approximately two-thirds of the region is covered by hilly areas, one-fifth by mountains and only one-tenth by plains and valleys. The complex orographic structure influences the climate of Tuscany that ranges from typically Mediterranean to temperate warm or cool depending on altitude, latitude and distance from the sea. Almost 96% of the territory is rural with woodlands covering 50% of the region (Figure 2). The land use is predominantly agricultural where the land is flat and mixed agricultural and forestry in the hilly and mountain areas. Tuscany has a population of 3,566,071 inhabitants (6.2% of the Italian population), predominantly located in flat areas (361 inhabitants km^{-2}), whilst in hilly and mountainous areas the population density is respectively, 152 and 87 inhabitants km^{-2}. Tuscany has a high archaeological, historical, cultural heritage value and contains six international UN-ESCO sites (*Patrimony of Humanity*).

Climate:
The annual average temperature ranges from 12°C in the northern mountainous region, to 15°C in the southern coastal region. The coldest month is January, whilst the warmest are July and August. Annual rainfall ranges from 600

Figure 2:
Land use in Tuscany
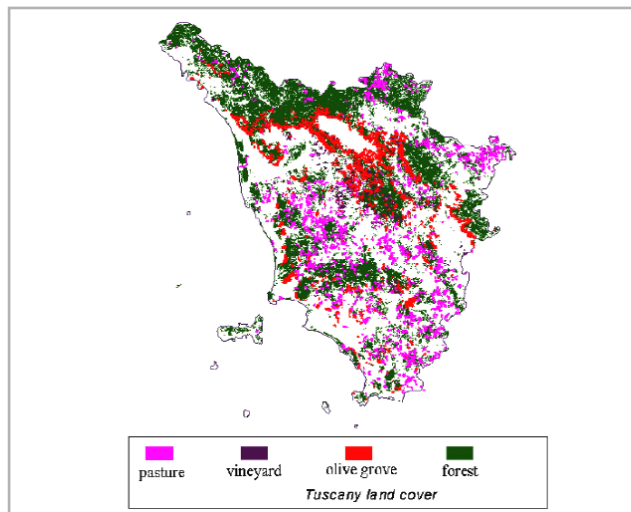
to 2400 mm. The prevailing wind direction is from the west / northwest. In the past few years, the region has experienced several extreme climate events. In particular, extreme flood events in Versilia (1996), Elba Island (2002) and Carrara province (2003) and heat waves in June 2002 (maximum temperature > 34°C for nine consecutive days) and May 2003 (maximum temperature > 30°C for five consecutive days) in Florence.

Economy:
In Italy the estimated GDP (PPP) per capita was US $30.2 thousand in 2006. The GDP of Tuscany represents 6.8 % of the national GDP. Relative to 2005, the regional GDP of the agricultural sector increased by 1.7 %, and more specifically, the agro-food and agro-tourism sectors increased by 4.8% and 2.7 % respectively. In addition, exports for the whole agricultural sector rose by 7.3%, while the contribution from the agro-food industry rose by 11.8%. The main crops in Tuscany are:

▶ grapevine (63,460 ha)

▶ olive (91,500 ha)

▶ durum wheat (884,716 ha)

▶ bread wheat (2,929,440 ha)

▶ maize (1,665,082 ha)

▶ sunflower (521,779 ha)

The total value of agricultural production was estimated to be €2,367 million in 2006, of which forestry contributed €49 million and fisheries €74 million.

2. Justification for choosing this case study region

Vulnerability to climate change:
Rural areas of Tuscany are characterised by agricultural and tourist activities that may be very vulnerable to climate change. In particular, grapevine and olive are two of the main agricultural crops in Tuscany. The former is very important for the economic role that wine producers play at national and international levels; whilst the latter is important not only for the income that it generates but also for its contribution to landscape. Both crops are perennial, so the selection of the most appropriate crop management techniques is fundamental and may be considerably affected by changes in climate. Rural tourism has increased exponentially over the last 15 years in Tuscany, so that now it represents the main income for many farmers. The expected changes in temperature and precipitation may have negative effects such as increasing management costs (water supply, electricity for air conditioning, etc.) and reducing the production of traditional local crops and livestock.

Availability of appropriate data
Complete datasets have been collected as part of previous EU-funded projects, CLAIRE, CLI-VARA, MICE. In particular, the following data are available in the Facoltà Agraria database (University of Florence): climate, geo-morphology, land use and vegetation cover, forest fire, agricultural crops (see Section 6). Moreover, in two other ongoing EU-Projects (AG2020 and PICCMAT) research activities are focusing on Tuscany as a case-study area, and information collected during these two projects will available for the CIRCE rural case study.

Access to stakeholders, including decision and policy makers
Contacts have been established with a variety of local stakeholders, including: Farmer Consortia, agencies and departments of the local government of Tuscany (see Section 5).

Brief summary of previous / ongoing work in this region
Several previous EU-funded projects have conducted regional scale analyses for agricultural crops and forestry. Recently, a fellowship was funded by the Agency for the Development of Agriculture (ARSIA) to study the impact of cli-

mate change on grapevine, and a regional programme on the impact of climate on agriculture and forestry was launched in 2007. The local government in Tuscany is actively considering the role of climate change in the planning of different economic sectors. For example, the *Observatory of the Kyoto Protocol* has just been established to quantify different sources or sinks of greenhouse gases.

3. Key research issues

▶ Impacts of climate change on crop production, forest fire risk, etc.

▶ Evaluation of possible adaptation strategies to overcome the negative impacts of climate change on agricultural and natural ecosystems

▶ Role of agriculture and forestry in the mitigation of climate change (e.g., as carbon sinks)

▶ Rural tourism as a
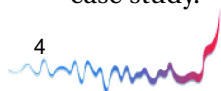
main driving force in s o c i o - e c o n o m i c change in the agricultural sector

4. Key areas of integration

Key links will be established with other CIRCE research lines, including the terrestrial ecosystems of the Mediterranean, and relevant societal dynamics. Output from these research lines fits in well with the Tuscany case study. Work carried out in this case study will contribute to the development of new environmental policies for the Tuscany region and will be used to adjust agronomic and cultural management strategies for farmers.

5. Regional stakeholders, policy makers, institutions

▶ Farmer Consortia and wine producers (e.g., Chianti Classico Consortia, Frescobaldi, Antinori and Folonari wine producers)

▶ Agency for the Development of Agriculture (ARSIA)

▶ Local government departments (Forestry, Agriculture, Tourism, Environment, Energy, Health, etc.)

▶ Rural Communities.

6. Data availability

▶ Climate data:
• 73 stations (covering the period 1951-1997; source: Istitituto Idrografico; parameters: daily maximum temperature, minimum temperature, precipitation).
• 51 stations (covering the period 1987-2000; source: ARSIA; parameters: daily maximum temperature, minimum temperature, precipitation, wind speed and direction, air humidity, solar radiation).

▶ Typography:
• A digital elevation model (75 x 75 m) to provide spatially gridded data (2.5 x 2.5 km) on longitude, latitude, altitude, distance from the sea, etc. (for downscaling purposes).

▶Land use and Vegetation databases:
• The Corine Land Cover database is available for determining land use.
• A vegetation database *La vegetazione forestale* Arrigoni, 1998 is available for determining characteristics of the natural vegetation.

▶Forest fire:
• Fire data records (cover the period 1984 to 2002; source: local / regional government; data available: date and hour of forest fire starting, geographical coordinates, morphological characteristics of the burned area (aspect, slope, etc.), cause of fire, area burn, vegetation status, access restrictions).

▶Agricultural crops:
• Statistical data is available at the provincial level for: yield, cultivated area, and production.
• Experimental data is available at the local level for: phenology, biomass production, pest and disease.

Other datasets on rural

Further reading
▶Arrigoni, P.V., M. Raffaelli, M. Rizzotto, F. Selvi, D. Vicini, L. Lombardi, B. Foggi, C. Melillo, R.Benesperi, G. Ferretti, S. Benucci, S. Turrini, P.L. di Tommaso, M. Signorini, E. Bargelli, U. Miniati, C. Farioli, V. de Dominicis, S. Casini, A. Chiarucci, P.E. Tomei, M. Ansaldi, S. Maccioni, E. Guazzi, L. Zocco Pisana, A. Cenerini, L. Dell'Olmo, E. Menicagli, (1998) *La vegetazione forestale. Serie Boschi e Macchie di Toscana. Regione Toscana*, Giunta regionale, 215 pp.
▶Bindi M., Fibbi L., Maselli F., Miglietta F. 2000. Modelling climate change impacts on grapevine in Tuscany, In, Downing TE, Harrison PA, Butterfield RE and Lonsdale KG (Eds.), *Climate Change, Climatic Variability and Agriculture in Europe. An Integrated Assessment, Research Report No. 21*, Brussels, Belgium: Commission of the European Union, Contract ENV4-CT95-0154, pp. 191-216.
▶Moriondo M., Good P., Durao R., Bindi M., Giannakopoulos C., Corte Real J. 2006 Potential impact of climate change on forest fire risk in Mediterranean area. *Climate Research* 31:85-95.
▶Moriondo M., Bindi M. 2006. Comparison of temperatures simulated by GCMs, RCMs and statistical downscaling: potential application in studies of future crop development. *Climate Research*, 30: 149-160.
▶Olesen J.E. and Bindi M. 2004. Agricultural impacts and adaptations to climate change in Europe. *Farm Policy Journal*, 1: 36-46.
▶Portoghese, I., Uricchio, V.F., and Vurro, M. 2005. A GIS tool for hydrogeological water balance evaluation on a regional scale in semi-arid environments. *Computer and Geosciences*, 31(1): 15-27. http://dx.doi.org/10.1016/j.cageo.2004.09.001
▶Steinberger, E. H. and Gazit-Yaari, N. 1996. Recent changes in the spatial distribution of annual precipitation in Israel. *Journal of Climate,* 9(12): 3328-3336. doi: 10.1175/1520-0442(1996)009<3328:RCITSD>2.0.CO;2
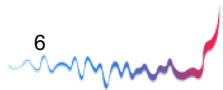
activities are also available, but are not yet included in the digital database.

Acknowledgements

▶ Final version, January 2008

Links

▶ *Kyoto Observatory- http://www.osservatoriokyoto.it/*
▶ *Tuscany region information (in Italian)- http://www.regione.toscana.it/prehome_1024.htm*
▶ *Agency for the Development of Agriculture – http://www.arsia.toscana.it/*
▶ *Marchesi de' Frescobaldi wine producer (in Italian / German)- http://www.frescobaldi.it/*
▶ *Marchese Antinori wine producer- http://www.antinori.it/*
▶ *EU Project PICCMAT: Agriculture and Climate Change: mitigation, adaptation, policy changes http://www.climatechangeintelligence.baastel.be/piccmat/index.php*
▶ *EU Project AG2020:* Foresight Analysis for World Agricultural Markets (2020) *http://www.risoe.dk/Research/sustainable_energy/energy_systems/projects/AG2020.aspx*

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