BRIEFING NOTES ON THE CIRCE RURAL CASE STUDIES: APULIA

Summary

Agriculture is an important economic sector in the Apulia region of Italy, water availability is irregular and scarce (especially in summer), and there are indications of the harmful effects of climate change.
The following are key issues:

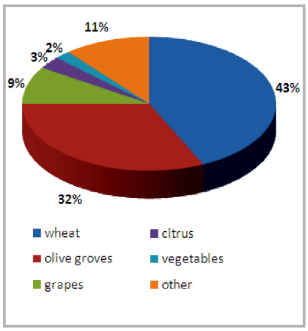
- *Understanding the close interactions between climate, soil and vegetation, which collectively regulate water balance at all scales*
- *Downscaling climate parameters to the regional level on the basis of existing information*
- *Simulation of the impacts of climate change on water resources and agriculture*
- *Assessing for dangerous shifts in seasons at the regional scale*

1. Physical and socio-economic characteristics

Geography:
Apulia (Italian: Puglia) is a region in southeast Italy (located between 41°53'N - 39°48'N and 14°49'E - 18°35'E) bordering the Adriatic Sea to the east, the Ionian Sea to the southeast, and the Strait of Òtranto and the Gulf of Taranto in the south (Figure 1). Its southern part, known as Salento, forms a peninsula - the heel of the Italian "boot". The region comprises an area of 19,345 km^2 and has a population of about 4 million (density of 210 inhabitants / km^2).
Apulia comprises diverse morphological zones with clearly defined characteristics. The substrate comprises of large extensions of limestone rock arranged in vast horizontal or sub-horizontal strata. The structure of the underlying rock confers smoothness to the landscape, and the gentle contours make mountains appear like hills even at high altitudes. Due to high substrate permeability and infiltration of rainwater, there are few rivers and a lack of surface water. In the past, most of Apulia was probably covered with Mediterranean scrub composed of evergreen bushes and trees, but today only 67,000 hectares remain wooded, 5% of the entire territory of the region.

Dried up river bed

Economy:
Apulia has an agricultural area of about 14,700 km² partitioned as follows:



Farming used to be the main occupation, but industry has expanded rapidly. Farm products include olives, grapes, cereals, almonds, figs, tobacco, and livestock (sheep, pigs, cattle, and goats). Manufactured products include refined petroleum, chemicals, cement, iron and steel, processed food, plastics, and wine. Fishing is active in the Adriatic and in the Gulf of Taranto. Apulia contributes 4.7% to the national GDP. The scarcity of water is an acute and long-standing problem in Apulia, and drinking water is transported by aqueduct across the Apennines from the Sele River in Campania.

Climate:
The climate is entirely Mediterranean (Figure 2), with mild wet winters and hot dry summers (the coldest month is January and the warmest is July). Precipitation falls mainly in winter.

2. Justification

Agriculture, water supply and tourism are sectors vulnerable to climate change in the region. As in many other Mediterranean, the combination of gentle topography and high population density has led to an intensification of agricultural farming and the replacement of existing natural vegetation with agricultural crops and pasture. A progressive expansion in irrigation (and consequential increase in

Figure 1: Map showing the Apulia case-study location

productivity) has extended cultivation from vegetables to tree crops. Intensive irrigation is now used to grow table grapes and citrus fruits, and emergency irrigation is used to grow olive crops by an unplanned process with little regard for the long-term sustainability of water resources. An understanding of the variability and decline in water resources, in the context of social impacts and social and vegetation adaptation, is of paramount importance for the sustainable management of water resources in the future. The availability of water resources has economic implications, affecting the regional workforce and the uninterrupted supply of water to the population. Tourism is a developing industry in the region whose growth could be limited by climate change and coastal management including the protection of small harbours.

3. Key Research Issues

An integrated assessment of cross-sector impacts of climate change for Apulia will be undertaken focusing on agriculture (in particular grapevine, olive and wheat), fire risk, water resources, biodiversity and tourism.
Water resource allocation for agriculture / industry / domestic purposes will be evaluated in conjunction with relevant regional policies.
Practical and specific measures of adaptation will be explored in consultation with stakeholders (e.g., farmers' consortia, wine producers, local and regional agencies, rural communities and non-governmental organisations).

4. Key areas of integration

- climate change
- water resources
- terrestrial ecosystems

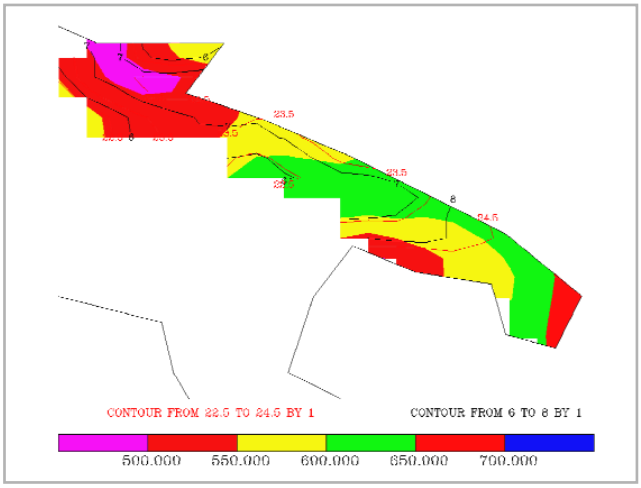


Figure 2: Mean temperature (July = red lines; January = black lines) and precipitation for Apulia

- agricultural / forestry activities
- rural economy
- policy response

5. Regional stakeholders, policy makers, institutions

- National Hydrographic Service, Department of Bari
- Department for the Natural Resources of Puglia
- Provinces and authorities for environment and tourism (Bari, Foggia, Brindisi, Lecce, Taranto)
- ARPA (regional agency for the protection of the environment)
- Local agencies and consortia for agriculture
- Insurance companies
- National Agency for environmental Protection of ITALY (APAT)
- Ministry of Environment

6. Data availability

The Water Research Institute (IRSA) and the University of Lecce have systematically collected a number of important time series. In particular:

- River discharge for four main river basins (around 40 years of data).
- Rainfall, recorded at 124 monitoring stations managed by the Regional Hydrograph Service and temperature measured at about 50 monitoring stations managed by the Regional Hydrograph Service, for the last 50 years.
- Other data are available for shorter periods such as solar radiation (since 1980) and a set of meteorological variables (temperature, humidity, precipitation, wind) since 1990.
- Wave data are available at one station in the Adriatic Sea (since 1989), and historical sea-level data at three coastal stations.
- Complimentary data include the piezometric head (the pressure that exists in a confined borehole/aquifer) continuously measured in six wells, and digital maps of land use, and hydrological and geological parameters.

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Further reading

- Manfreda, S., Di Santo G., Lacobellis V., and Fiorentino M. 2002. A Regional Analysis of Rainfall Pattern in Southern Italy, Proc. of the 4rd EGS Plinius Conference on *Mediterranean Storms,* October 2-4, 2002, Mallorca, Spain. Abstract available from: http://www.cosis.net/abstracts/PLC04/00076/PLC04-A-00076.pdf
- 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. doi:10.1016/j.cageo.2004.09.001
- Refsgaard, J.C., Nilsson, B., Brown, J., Klauer, B., Moore, R., Bech, T., Vurro, M., Blind, M., Castilla, G., Tsanis, I., and Biza, P. 2005. Harmonised techniques and representative river basin data for assessment and use of uncertainty information in integrated water management (HarmoniRiB), *Environmental Science & Policy*, 8, 267–277. doi:10.1016/j.envsci.2005.02.001
- Talamo P., Di Sabatino S. and Ruggiero L. 2004. The influence of the Appennine on precipitation along the Adriatic coast of Puglia, In *Abstracts of the 6th Plinius Conference on Mediterranean Storms*. 17-24 October, 2004. p 38 http://www.cosis.net/abstracts/PLC6/00052/PLC6-A-00052.pdf
- Veneziano D. and Iacobellis V. 2002. Multiscaling pulse representation of temporal rainfall, *Water Resources Research,* 38(8), 1-13, doi:10.1029/2001WR000522. Abstract available from: http://www.agu.org/pubs/crossref/2002/2001WR000522.shtml

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