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ANALYSIS

Regional convergence of environmental variables: Empirical evidences from land degradation

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ABSTRACT

Studies on regional convergence in environmental variables may provide useful information to drive policies regarding complex processes featured by the interaction of ecological and economic factors. In order to provide empirically observed evidences on regional convergence in environmental phenomena, we chose Land Degradation (LD) as the study variable because it represents a key topic in both environmental projections and policy strategies. This paper explores the temporal variation (1990–2000) of a synthetic index of vulnerability to LD, called ESAI (Environmental Sensitive Area Index), calculated on the whole Italian territory. Convergence in land vulnerability was analysed on three different geographical scales: NUTS-2 regions, NUTS-3 provinces, and local labour systems (LLSs). Different convergence patterns were identified and discussed according to the level of LD estimated over the national territory and the economic characteristics of these areas.

1. Introduction

A key property of the neoclassical growth model is its prediction of economic convergence (Barro and Sala-i-Martin, 2004). This means that there is a negative relationship between the change in the studied variable over time and the level of the same variable at the initial time (Quah, 1997). The notion of convergence in a certain variable across countries or regions is a useful concept and, in the case of per capita income, a well studied area (e.g. Sala-i-Martin, 2002).

In the last years assessment has taken place and evidences found in convergence of economic variables (Sala-i-Martin, 1996), population and social factors, life quality indicators (e.g. Giannias et al., 1999), as well as in environmental governance and policy strategies (Neumayer, 2001). Notably, convergence in pressure on the environment has less frequently assessed in developed countries (see Neumayer, 2001; Aldy, 2006; Ezcurra, 2007 and references therein).

Studies on regional convergence in environmental variables are meaningful as they provide effective information to drive policies regarding complex processes featured by the interaction of ecological and economic processes (e.g. Quaas et al., 2007). Decreasing pressure on the environment may depend on a combination of policy and economic factors (Stern et al., 1996). Higher income levels strengthen preferences for environmental protection among the population, increasing pressure on policy-makers to enact strong environmental policies (e.g. Stern et al., 1996). Moreover, technological improvements and sectoral changes towards less polluting services should have further reduced pressures (Neumayer, 2001).

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Analysing the dynamics of many environmental pressures — especially air and water pollutants — in the European Union, Neumayer (2001) found evidences for convergence of only some of the studied variables. This puzzle needs to be further studied especially in other areas of pressure on the environment. If there is empirical evidence of convergence of the studied variables , then our ability to predict their differences between countries or regions in the future is enhanced (Castles and Henderson, 2003).

In fact, a crucial aspect of future projections of environmental variables is the role of economic, demographic, and social growth, and the sources of that growth across countries or regions (e.g. Kok et al., 2004; Aldy, 2006; Ezcurra, 2007). As an example, the most recent IPCC analyses include long run projections of key variables that are based on the assumption of convergence. Unfortunately, assumptions rather than sound empirical evidence tends to drive much of the debate in the climate change literature (Castles and Henderson, 2003).

In order to provide empirically observed evidences on regional convergence in environmental phenomena, we chose Land Degradation (LD) as the study variable because this is a process linked to both ecological and economic driving forces and represents a key topic in environmental projections as well as in policy strategies (e.g. Thornes, 2004; Salvati et al., 2008a). LD reduce the soil fertility and it was generally associated to geophysical conditions (e.g. climate, soil characteristics, slope, vegetation cover) coupled with drought features (e.g. Thornes and Brandt, 1995; Basso et al., 2000; Iosifides and Politidis, 2005; Incerti et al., 2007). In complex ecosystems of Mediterranean basin pressure on the environment causing extended LD increased in the last years (Montanarella, 2007).

This paper explores the temporal variation (1990–2000) of a composite index of land vulnerability to degradation estimated on the whole Italian territory at different geographical scales. Moving from cross-country to single-country studies represents a relatively new line for convergence research (Arbia and Paelinck, 2003) and reduces the problems associated with data comparison from different countries (Vincent, 1997). The analysis in this paper has been designed to provide a statistical examination of the tendency, if any, towards convergence at a regional scale (Aldy, 2006; Ezcurra, 2007). Such an analysis is not strictly based on a theoretical model of regional convergence (Neumayer, 2001). In fact, it would be difficult to derive a theoretical model in which land vulnerability converge. However, if vulnerability to LD resulted primarily from the impact of agriculture, industry, and tourism activities (Salvati and Zitti, 2005), linked to worsen climatic conditions (Puigdefabregas and Mendizabal, 1998), then convergence in land vulnerability could be affected by economic development. Moreover, vulnerability to LD could depend on the availability of physical capital as described by ecological conditions (e.g. climate, vegetation, and soil quality), which could affect themselves the convergence process (e.g. Thornes, 2004).

2. Materials and methods

2.1. Study area

The Italian peninsula extends from latitude 47°05′29″ to 35°47′05″ N and longitude 6°32′52″ to 18°31′13″ E. It is surrounded by the Thyrrenian sea to the west, the Adriatic to the east, the Ionian in the south and is bounded by the Alps to the north. A second chain of mountains, the Apennines, runs down the centre of the country from north to south. Its coastline (including the islands) extends for Ca. 7375 km. Italy has a surface area of Ca. 301,338 km^2, much of the land being either hilly or mountainous. Its mountainous topography, latitudinal extension, and proximity to the sea account for a great deal of variation in Italy's climate (Venezian Scarascia et al., 2006).

2.2. Estimating vulnerability to LD

The establishment of an information system is necessary to assess the processes that lead to LD (Rubio and Bochet, 1998). The general framework used here is the standard ESA (Environmental Sensitivity Areas) procedure (Basso et al., 2000; Brandt et al., 2003; Salvati and Zitti, 2005). In this model, different dimensions (climate, soil, vegetation) described by some key indicators (rainfall, slope, soil depth, etc.) produce a synthetic index of land vulnerability (Brandt, 2005). By using Geographic Information Systems, it is possible to produce high-resolution maps depicting vulnerable areas (Brandt et al., 2003; Brandt, 2005; Ferrara, 2005; Salvati and Zitti, 2005).

In this study, the selected indicators were chosen according to a number of requirements influencing the reliability of the outcome (Rubio and Bochet, 1998). They include the (i) availability and regularity of time series, (ii) quality of data sources, (iii) easy computing of spatial data. According to Brandt (2005) and Ferrara (2005), the variables chosen mainly refer to climate, soil quality, and land use/cover. No economic variables were considered in such a procedure.

Each indicator was transformed into a score indicating sensitivity to LD by way of a weighting system (Basso et al., 2000). Weights were attributed to each indicator (Brandt, 2005; Ferrara, 2005) according to the relation with LD phenomena suggested by previous research (Rubio and Bochet, 1998; Basso et al., 2000; Brandt et al., 2003; Ferrara, 2005; Salvati and Zitti, 2005 and references therein). Sensitivity scores of all the indicators were finally aggregated *via* geometric mean into a composite index of land vulnerability (ESAI, Basso et al., 2000).

2.3. Indicators of LD

Climate and soil quality represent the most important factors affecting land vulnerability to degradation (Le Houerou, 1993; Puigdefabregas and Mendizabal, 1998; Basso et al., 2000; Salvati et al., 2005). In this paper, climate characteristics were described by the following variables: rainfall, temperature, evapotranspiration, and aspect (see Basso et al., 2000). Climatic values of such variables for the period 1961–2000 were calculated using daily data measured at about 500 long time series stations belonging to the national meteorological networks (Salvati et al., 2005; Venezian Scarascia et al., 2006). To obtain a regional distribution and spatial coverage of the two meteorological variables over the periods chosen (1961–1990, 1971–2000) kriging and co-kriging (with elevation, latitude, and distance to the sea as ancillary variables) procedures were applied (Libertà and Girolamo, 1991, 1992), respectively to precipitation and temperature (see Salvati et al., 2005, 2008b and references therein). The average annual reference