Climate data for political areas

Timothy D Mitchell*, Mike Hulme* and Mark New**

*Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich NR4 7BL

Email: t.mitchell@uea.ac.uk

**School of Geography and the Environment, Mansfield Road, University of Oxford, Oxford OX1 3TB

Email: mark.new@geography.oxford.ac.uk

Revised manuscript received 5 December 2001

The context of climate change impact studies

The origins of the idea that humans might be enhancing the natural greenhouse effect through emissions of carbon dioxide (and other greenhouse gases) stretch back into the nineteenth century (Tyndall 1863; Arrhenius 1896a 1896b), but it did not 'fire the imagination of the scientific community' until the 1970s (Kellogg 1987, 113). Now the annual total of climate-related publications is doubling every decade (Stanhill 2001).

As the scope of the challenge to societies posed by climate change has become apparent, policy-makers have sought a better understanding of the possible consequences of climate change on all spatial scales. In recent years, much emphasis has been placed on the *regional* variations in climate change, climate impacts, vulnerability and adaptation. In particular, the Inter-governmental Panel on Climate Change (IPCC) has specifically provided:

- reviews explicitly of *regional* climate change information (Giorgi and Hewitson 2001);
- *regional* reviews of the impacts of, adaptation to and vulnerability to, climate change (Watson *et al.* 1998; McCarthy *et al.* 2001).

Although these IPCC reviews attempt to draw generalized conclusions that apply to entire continents – McCarthy *et al.* (2001) divide the world into only eight major regions – the reviewers are hindered by the lack of cohesion between individual studies:

> Because available studies have not employed a common set of climate scenarios and methods and because of uncertainties . . . assessment of regional vulnerabilities is necessarily qualitative. (White *et al.* 2001, 44)

Therefore an increasing number of researchers are attempting to combine data-sets that span a number of countries in order to draw robust conclusions that apply to entire continents, or to the world (e.g. Barnett and Adger 2001). Such attempts usually rely on pre-existing data-sets that often have only coarse spatial and temporal resolutions; the added value they provide lies in the bringing together of information from disparate sources and separate disciplines.

It is in this context that researchers require climatic information for spatial domains that are governed by non-climatic boundaries, rather than the domains traditionally favoured by climatologists (coherent climatic zones) or modellers (grids). This requirement arises because the climatic information must be combined with demographic, cultural and socio-economic information, which typically has a patchy spatial coverage, varies widely in quality and is available only for countries or sub-regions. Since harmonizing such data-sets is one of the more difficult problems to overcome, these authors have personally received (in the two months prior to writing) a number of requests from around the world for climate data averaged by country. These researchers have a wide range of subjects in mind, including:

- water resources in Africa;
- links between growing season length, biodiversity and cultural diversity;
- adaptive capacity to climate change.

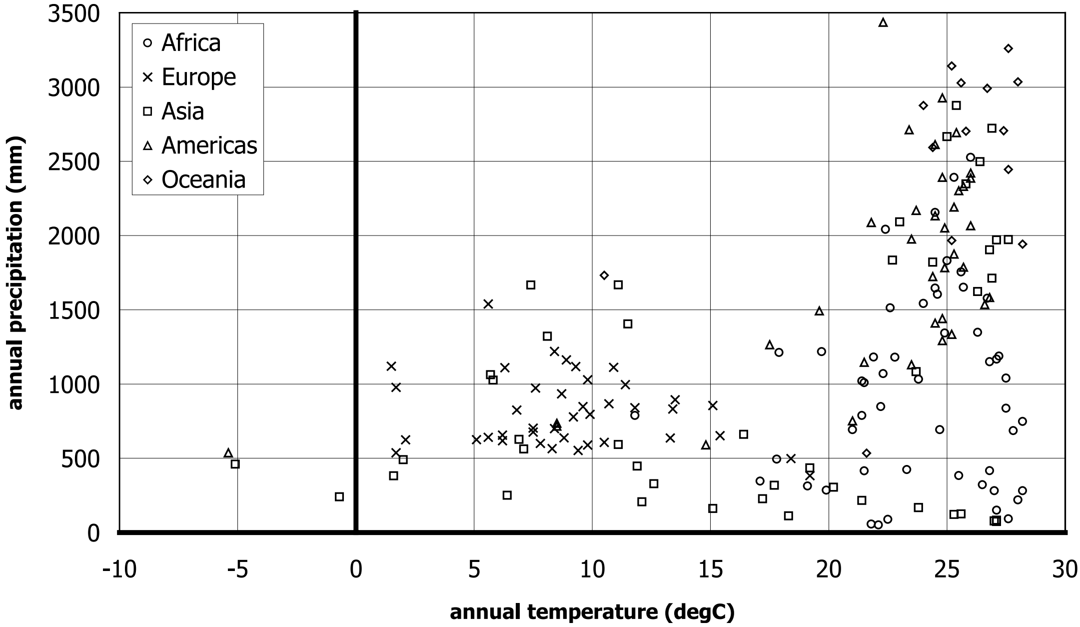

Figure 1 The annual mean climatology for each of the 188 UN countries. The climatology is defined by the 1961–1990 mean annual temperature (°C) and precipitation (mm). The set of countries is sub-divided by continent

The provision of country-by-country climate data

This need has been met by building upon previous work, in which observations from meteorological stations were assimilated onto a 0.5° latitude by 0.5° longitude grid covering the land surface of the earth (New *et al.* 1999 2000). In this new data-set, the gridded data were transformed into 'country' averages by allocating each 0.5° grid-box to a single 'country', and calculating the weighted mean of the constituent grid-boxes of each 'country'. The weights were necessary because the spatial area represented by a grid-box varies with latitude; the weight of each grid-box was the cosine of its latitude.

We place 'country' in inverted commas because in many cases the spatial aggregation is based on a territory or island. The set of 'countries' employed here is the product of a compromise between a definition derived from United Nations (UN) membership, and a definition based on climatic coherence. For example, strict UN membership would require the 'United Kingdom' to include grid-boxes representing Gibraltar and the Falklands, whereas climatic coherence requires geographically distinct territories or islands to be treated separately. The compromise adopted here is to use United Nations (UN) boundaries wherever possible (e.g. the Danish archipelago was included within 'Denmark'), but to treat any overseas possessions as separate 'countries' (e.g. 'Greenland'). Thus a set of 289 'countries' was developed, comprising 188 states recognized by the UN, and a further 101 islands and territories. These statistics highlight the large number of small island states that are individually represented.

Each land grid-box was allocated to an individual 'country' by visual inspection. Where more than one country had land within a grid-box, the box was allocated to the country with the single largest stake within that grid-box, except where a UN country would otherwise be unrepresented (e.g. San Marino). Where the ownership of a territory is under dispute, the recognition of ownership made by the UN was used.

Thus a data-set has been developed which contains month-by-month variations for each of 289 'countries' and for seven surface climate variables: daily mean temperature and precipitation

(1901–1998); daily minimum and maximum temperature, daily temperature range, vapour pressure and cloud cover (1901–1995). It is anticipated that these variables will be updated to 2000 in the near future. The average from 1961 to 1990 has been obtained for a further two variables: frost day frequency and wet day frequency.

We illustrate this new data-set in Figure 1, where we plot the recent climate for each of the UN member states, grouping the states by continent. It is not only the states that have distinctive climates; there are also differences at the continental scale: for example, few European countries are warmer than 15°C, but few African countries are cooler than 20°C. It is worth noting that no state exceeds an apparent temperature threshold of 18°C; yet the projections from global climate models suggest that many countries will warm to temperatures greater than 18°C over the course of the twenty-first century (Giorgi and Hewitson 2001).

The accuracy of this new data-set depends on the accuracy of the gridded data-sets of New *et al.* (1999 2000), since the former is derived from the latter, and the reader is referred to those publications for the full details of the methods used and the quality of the original observed data. It should be noted that the accuracy varies in time and space, and from one variable to the next. The most accurate period is likely to be 1961–1990, the period for which the climatological normals were calculated; therefore every time-series was first calculated as anomalies relative to 1961–1990, and the anomaly time-series is then made absolute using the 1961–1990 normal. Although the time-series of precipitation and temperature were obtained directly from observations, the time-series of the other variables rely on a combination of observed data and synthetic data estimated using predictive relationships with temperature and precipitation. Where insufficient data were available to obtain a value early in the twentieth century – a problem most notable in the developing world – the value was 'relaxed' towards the 1961–1990 mean.

It should also be noted that although the size of each 'country' may not necessarily affect the accuracy, it may have an impact on how meaningful the climatic data are for a particular purpose. For example, although the values for 'Luxembourg' may be representative of climate throughout this city-state, the values for 'Russia' are certainly not simultaneously representative of climatic conditions in both Siberia and the Volga catchment.

The use of country-by-country climate data

This data-set is publicly available (http://ipcc-ddc.cru.uea.ac.uk/) in the form of ASCII files. It is *not* the intention that this data-set be used to represent climate at a point, or in sub-regions of a country; the intended use is in research that spans many countries, and where it is necessary to average climatic behaviour over politically defined areas. This data-set may be particularly relevant when considering the vulnerability of human and natural systems to present climate variability, and to future climate change. Research examining vulnerability and adaptation to climate impacts might employ comparable data from a wide range of sources; we note a few possible sources below:

- population on a 2.5 minute grid (http://sedac.ciesin.columbia.edu/data.html);
- world development indicators (http://www.worldbank.org/data/dataquery.html);
- water and climate atlas (http://www.cgiar.org/iwmi/WAtlas/atlas.htm).

This is the first time such a country-oriented global climate data-set has been made available spanning such a long period of time and representing such a selection of climatic variables. The authors encourage researchers to make appropriate use of this data-set, and to engage the authors in dialogue about its relevance for their research.

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