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The world by latitudes: A global analysis of human population, development level and environment across the north–south axis over the past half century

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A B S T R A C T

Development and environmental issues are commonly analysed by using administrative divisions. In this paper, instead, we analysed how the human population and various economic, social and environmental indicators are distributed across the north–south axis by using latitudinal approach. This was done because many of the factors forming the natural living conditions of human societies, such as climate, are largely depending on the distance to the equator. The analysis was done with the spatial resolution of five latitudinal degrees while the temporal scale of the study includes the last 50 years.

We found that only less than 1/8 of the human population lives south of the equator while around 50% of the population dwell within the area between 20°N and 40°N, where also most of the world's development and poverty related problems are located. Majority of the economic and social indicators are low on both sides of the equator, but go up with the distance from the equator. For environmental indicators, however, the pattern is more heterogenic and is often correlated with the population density. Most populated latitudes are the scarcest on water, and land in there has been taken to agricultural use more than in other parts of the globe.

The latitudinal approach allowed us to see geography based development patterns that might not have been visible with more conventional methods such as cross-country analyses on development. The approach was developed substantially beyond the previous studies. Four development directions of using spatial data-based approaches in development studies were identified.

Introduction

The world population has more than doubled over the last 50 years (UN, 2009; Klein Goldewijk, Beusen, & Janssen, 2010). At the same time, the volume of the world economy has grown 20 fold (as measured with Gross Domestic Product (GDP) per capita) (World Bank, 2010). Also many social development indicators have shown considerable progress in most locations of the world; for example the global life expectancy at birth has grown from 52.5 to 68.9 years in the past half century (UNDP, 2009b; World Bank, 2010). Apart from that, the number of people living under poverty line keeps growing, and so does the stress for the environment (World Bank, 2009b; WWF, 2010). For instance the growth of freshwater shortage has been very dramatic in various parts of the globe (Kummu, Ward, De Moel, & Varis, 2010).

It is common to investigate the progress and status of the indicators for population, social and economic development, as well as natural resources and the environment on an administrative basis, most importantly by countries or regions. This is typical to the analyses and statistics of United Nations Organizations, development banks and most other international organizations and actors that produce policy relevant statistics and research (e.g. UN, 2009; UNDP, 2009b; World Bank, 2009b; World Water Assessment Programme, 2009; WWF, 2010). This is an understandable and pragmatic approach because for such reports, national (often government) organizations are the data sources and policy makers. Nations are typically further grouped according to geographic regions, income levels (high, middle, low) etc. (e.g. World Bank, 2009b; WWF, 2010).

In this paper, however, we investigate these issues from a merely scientific viewpoint by looking at selected indicators across the north–south axis by using latitudinal approach, and in particular their evolvement over the past half-century. The latitudinal approach was chosen due to the fundamental geographic importance of the distance from the equator to almost any conceivable entity in the nature. For example, the terrestrial temperatures and precipitation patterns are depending strongly on the latitudes (**see** Fig. 1A) although, naturally, other factors such as altitude, distance to the sea, wind patterns, etc. have much influence, too. Consequently, the climatic zones, such as the Köppen

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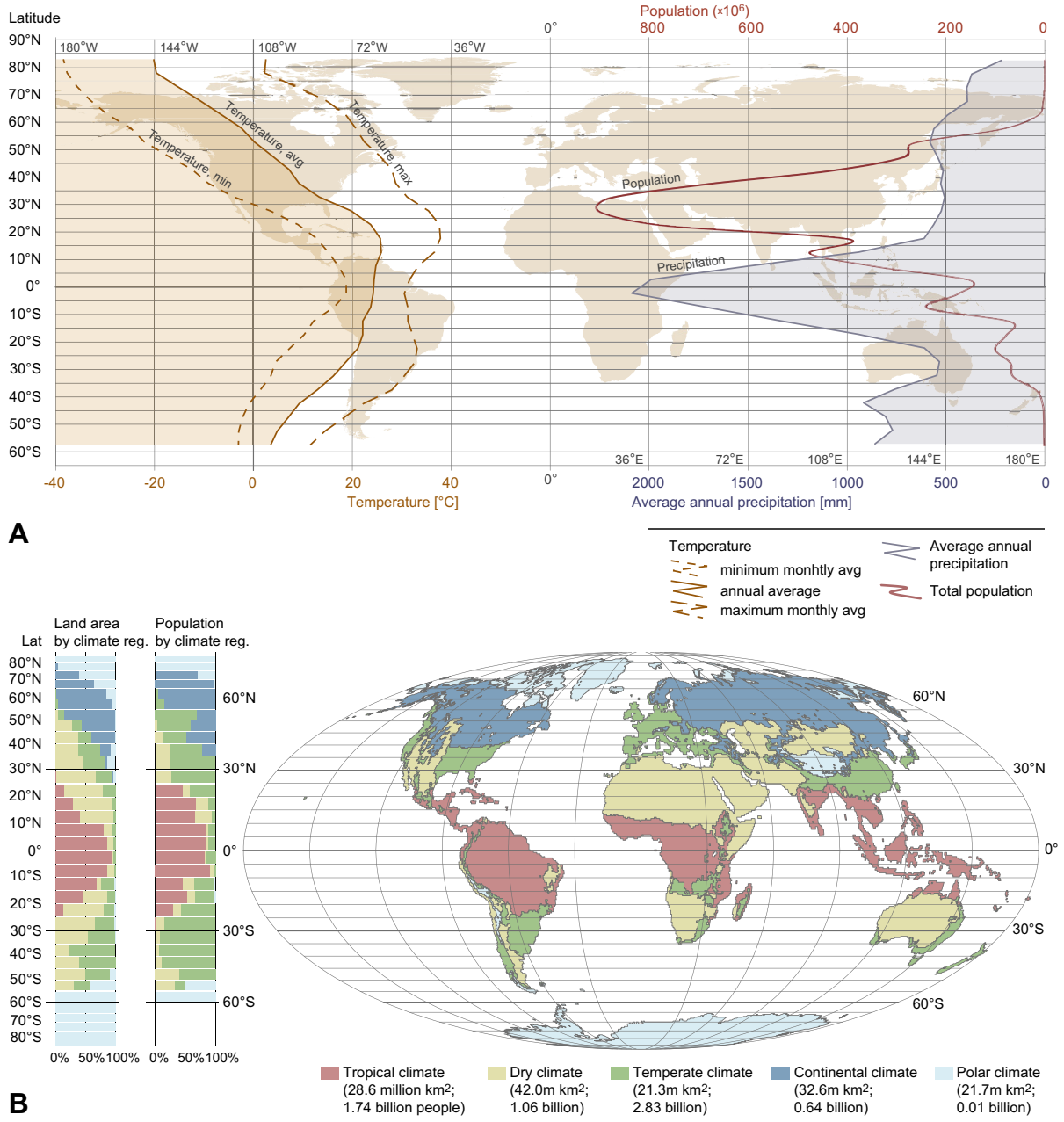

Fig. 1. Climate patterns and population by latitudes. A: Latitudinal distribution of the average temperature with monthly minimum and maximum temperatures (left) and the average precipitation with the total population (source: Klein Goldewijk et al., 2010) (right). Source for the climate data: WorldClim v1.4 (2005); B: The Köppen climate regions (source: Rubel & Kottek, 2010) mapped together with the latitudinal distribution of the percentage of the total land area and population (source: Klein Goldewijk et al., 2010) within each five degree of latitudes.

climate regions (see e.g. Rubel & Kottek, 2010), show a clear pattern across the latitudes (Fig. 1 B). Accordingly, vegetation zones, seasons, and so forth also depend on latitude. It can, thus, be argued that the distance from the equator is among the main factors framing the living conditions for human societies.

A division based on natural conditions is in many cases more justified than a division based on administrative boundaries. For example, the issues related to water resources are often looked by river basins rather than administrative boundaries (e.g. GWP, 2000). Even though the latitudinal approach is not strictly a natural division, we believe that it provides a useful division to analyse the global datasets as the latitude has large impact on the environment and living conditions. Further, the approach is easy to repeat, and results to illustrate, for any kind of global analysis.

The latitudes or climate regions are not used widely in the global development analyses. Nevertheless, some studies do exist. Gallup, Sachs, and Mellinger (1999) map the global population and economic development across the latitudes while Mellinger, Sachs, and Gallup (2000) analyse the associations of development with climate and distance to the sea coasts. Sachs (2001) points out the dramatic social and economic development gap of tropical areas, in low latitudes. Easterly and Levine (2003) argue, however, that the institutional deficiencies in tropical countries rather than the climate, agricultural systems and health-related challenges determine the tropical development gap. Sachs, Mellinger, and Gallup (2001) provide an analysis of the geography of poverty and wealth, including the latitudinal aspect. Brown, Meeks, Ghile, and Hunu (2010) concentrate on the impact of climate and