

Towards a GIS-based analysis of mountain environments and populations



**Environment and Natural Resources Service
Sustainable Development Department**

in collaboration with
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Service
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Towards a GIS-based analysis of mountain environments and populations

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Preface

The value of spatial information for understanding development issues and improving decision-making is increasingly recognized. With this publication, FAO seeks to apply GIS-based analysis techniques to deepen understanding of conditions underlying poverty and hunger in the world, with special reference to mountain environments and populations. This focus is especially appropriate in 2003, as we begin the follow-up activities to the International Year of Mountains 2002 and consider ways in which the international community can respond more effectively to the special needs and concerns of mountain people.

Environmental constraints limit the prospects for agricultural development in many mountain areas, yet about 70 percent of the world's mountain population of 719 million remain rural and continue to depend on the natural resource base of land, water and forests for their livelihood. The spatial information about mountain environments and livelihood systems presented in this report provides new specificity about important aspects of the conditions that determine their sustainability.

The techniques used to prepare this report are applicable on a global scale, and will be extended later to other environments where poverty affects significant numbers of people. The work is being developed as a contribution to international initiatives for reducing poverty and hunger and achieving sustainable development. It is expected that the results will aid, *inter alia*, in the formulation and implementation of poverty reduction, food security and sustainable development strategies, and in the monitoring of progress towards the achievement of various international commitments and goals within the framework of Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS) and the Millennium Assessment Programme.

FAO is grateful to the Government of Norway for the encouragement and funding it has provided for this work, and to its collaborating partners for the constructive dialogue on substantive issues of common interest that has begun to emerge. We are committed to our common task and confident that this first set of preliminary results will not only demonstrate the potential usefulness of the method, but also prove to be of immediate use to those concerned with improving living conditions in mountain environments in a sustainable manner.



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Abstract

Towards a GIS-based analysis of mountain environments and populations

by Barbara Huddleston, ESAF; Ergin Ataman, SDRN with FAO GIS specialists Paola de Salvo, SDRN, Marina Zanetti, AGLL, Mario Bloise, SDRN, Judith Bel, SDRN and Gianluca Franceschini, SDRN; and Luca Fè d'Ostiani, INRM

32 pages, 6 maps, 9 tables, 8 graphs; Environment and Natural Resources Working Paper No. 10, FAO, Rome 2003

This report presents the results of work in progress. It applies GIS techniques and newly available geo-referenced data to understand conditions underlying poverty and hunger in the world, with special reference to mountain environments and populations. Following the system developed by the United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC) in 2000 for classifying mountain areas, hilly as well as high mountain areas are covered by the analysis. New data about global population density from the LandScan 2000 map has made it possible to estimate population figures for each mountain area class, as well as for other parameters about agricultural land use, farming systems, environmental constraints and yields per person that contribute to the estimation of the number of vulnerable rural mountain people. The report notes that, although vulnerable people represent a far greater proportion of the total population in high mountain areas, their absolute numbers are far greater at lower elevations. In all, around 245 million rural mountain people in developing and transition countries are estimated to be vulnerable to food insecurity. Of these, 87 percent live below 2 500 m where population pressure and increasing demand for grazing land are creating serious sustainability problems for mountain environments and the livelihood systems of the inhabitants. This report concludes with a brief summary of five areas of opportunity for developing more sustainable livelihood options for mountain people, namely, water, agriculture, conservation and tourism, forests and rangelands, and mountain industry and services.

Keywords: mountains, poverty, hunger, food security, environments, populations, GIS, mapping

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Section one

INTRODUCTION

Mountain water, forests, flora and fauna constitute a rich global resource. Yet, in many places, the people living in mountain environments are exposed to harsh climatic conditions and soil and terrain constraints that make sustainable agricultural production difficult. In many locations, their relative isolation also limits non-agricultural options.

This report uses newly available geo-referenced data to explore the distribution and characteristics of mountain populations by region, type of mountain environment, and for rural mountain people, the type of farming system practised. The results contained in this report represent a first set of findings from work in progress. In subsequent work it is proposed to deepen the analysis for mountain areas by considering a larger number of variables that might help explain the extent of livelihood vulnerability, and its causes. At the same time, because much of the analysis is based on global GIS data, it is also envisaged to extend the work to non-mountain areas, eventually encompassing other locations where the nexus between environment, poverty and food insecurity is of particular concern.

The analysis in this report has been developed from GIS databases produced by FAO's Environment and Natural Resources Service from sources cited at the end of the paper. The reference map for all the analysis contained in this report has been the mountain map produced in 2000 by the United Nations Environment Programme-World Conservation Monitoring Centre (UNEP-WCMC). At that time, UNEP-WCMC defined six mountain area classes on the basis of slope and elevation. The UNEP-WCMC has recently added a seventh mountain area class, referring to isolated inner basins and plateaus and using a 7 km instead of 5 km radius for local elevation range, but the significance of these changes has yet to be fully investigated.

The procedure used for this report was first to create a geo-referenced map showing the six mountain area classes, as defined by UNEP-WCMC in 2000, and then to overlay the boundaries for the mountain area classes onto geo-referenced maps for each of the other pertinent variables. In this way the values for each of the other variables within the boundaries of each mountain area class, or other defined zone, could be obtained.

With the exception of the information on prevalence of malnutrition in mountainous countries, which was provided by the multi-donor-supported Micronutrient Initiative, all the data analysed here have been derived from maps developed by FAO's GIS Unit. The objective was to investigate the usefulness of GIS to generate data that would permit insights into location-specific characteristics of mountain environments and livelihood systems considered pertinent to guide action.

Variables examined in this study include the distribution of mountain area across regions and mountain area classes, distribution of mountain people across regions and mountain area classes, population density and extent of urbanization in mountain areas, rural land cover and agricultural land use in mountain areas, main farming systems, incidence of environmental constraints, degree of isolation as measured by distance of mountain areas and people from roads, productivity of rainfed agriculture based on estimates of livestock density and amount of cereals produced per person per year, and prevalence of selected micronutrient deficiencies.

The data were calculated using the best global maps available. Although most maps used as sources for this report were prepared with a 30 arc-second grid of the world, in one or two instances it has been necessary to use maps that were prepared with a 5-minute grid. Adjustments in the data have been made to bring the results obtained from these lower-resolution maps into line with those obtained at the 30 arc-second resolution. Due to the rather small-scale resolution of these maps, some variables such as area and population in some small and/or island countries could not be calculated with sufficient accuracy. Furthermore, for a few countries, there may be up to a 10 percent difference in the variables compared to other available international statistical data, as some of the maps originated from different sources and have slightly different topographic features, such as coast lines and/or water bodies. When overlaid, that is, when analysed together, such differences can cause small errors. However, the magnitude of these errors was deemed acceptable for the purposes of this document.

The results reported here differ in some respects from those in the *Special feature in The state of food insecurity in the world 2002, (SOFI)*, mainly in the calculation of population data and urban and rural shares in total mountain population, for which more accurate data were obtained after SOFI went to print.

In general, this first set of results highlights a number of features of mountain environments that differ markedly from one part of the globe to another. It also provides some initial insights into the livelihood systems of mountain people.

We look forward to continuing the collaboration with other partners in efforts to further improve the knowledge and understanding of vulnerable environments and livelihood systems. For further information, or to comment on the method or preliminary results, please consult the Web site of the FAO GIS Unit at www.fao.org/sd/eidirect/gis/Elgis000.htm, or send an e-mail to GIS-Manager@fao.org.