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EVALUATING THE FEASIBILITY OF MINI-IRRIGATION PROJECTS FOR COLOMBIAN ANDEAN WATERSHEDS

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1. INTRODUCTION

In lesser developed countries, there is a general need to identify data efficient, objective and comprehensible regional land use planning tools to support multi-party negotiation and consensus building. This study tested the AEGIS+ v2.0 modeling software for its appropriateness in assessing the potential effects of small irrigation projects on the regional water balance within a small mountain catchment in southwestern Colombia (Fig. 1). Conflicting goals of within watershed and off-site water demand are likely to become increasingly contentious issues as societies attempt to keep pace with the food and water demands of ever increasing populations.

2. ASSUMPTIONS AND ANALYSIS

The specific region chosen for this proof-of-concept analysis is the 3,200 ha Río Cabuyal sub-catchment nested within the 100,000 ha Río Ovejas watershed. Certain critical assumptions were made which affect the reliability and acceptance of the analysis. A common problem in developing countries is the paucity of reliable, long term climate data. No climate station exists within the Río Cabuyal sub-catchment although several stations lie within a close radius. Consequently, long term daily weather sequences were generated using the Weatherman routine available with DSSAT v.3 and AEGIS (Pickering, et al. 1994), and interpolated using an inverse square function. Soil properties are important parameters in all production-based simulation models. Model parameters for the four soil mapping units in the sub-catchment, all classified as Typic Dystrandepts, were taken from previously published soil surveys, an historical database of more than 1,000 samples made available from the state agricultural department, and corroborating field measurements. Hillside environments are characterized by variable topography which may severely limit crop management decisions like machinery use and irrigation options. A digital terrain model was created from existing 1:10000 topographic maps using ARCINFO which allowed for the interactive selection of slope class intervals. For the analyses presented, three class intervals were chosen: 0<7%, 7<30% and >30% slopes. The potential for irrigation was restricted to the 0<7% slope class within the watershed. Sub-catchments within the Río Ovejas watershed, e.g., Río Cabuyal, are ungaged so no systematic data are available. Field estimates at an upper, mid, and lower location in the Río Cabuyal were made using accepted, empirical, cost-effective field procedures.For this study, production estimates and economic yield predictions were of secondary importance to water balance calculations. As such, drybean (*Phaseolus vulgaris*) was chosen as a proxy for a variety of higher value, short season, shallow rooted, row crops. Assumptions of lesser importance for the conclusions of the study relate to choice of variety, seeding and fertilization rates, residue management and non-limiting pest and disease control. In a typical environment of negotiation and consensus building, the analysis could be broadened by taking full advantage of the capacity of AEGIS to simulate an enormous range of crops and management practices including irrigation method and automatic irrigation scheduling strategies which are relevant to this analysis.

An important advantage of the GIS link provided by AEGIS is the capability to accurately and interactively define geographic space and access data directly from maps and images. Overlaying climate, soil and slope coverages resulted in the creation and definition of 993 polygons or «fields» within the 3,200 ha Rio Cabuyal sub-catchment. The area of noncontiguous «fields» varied from less than 500 m^2 to several hectares. Some of this area, however, is roadway, homestead and watercourse and can be «deselected» as never being available for agriculture. During an interactive, compromise planning exercise, stakeholders can define conditions and select fields for inclusion in one or more planned irrigation projects. The tradeoffs in terms of water partitioning for domestic reserves, irrigation demand and downstream use and concomitant temporal variability can then be assessed using AEGIS. Fig. 1 presents the thematic map of one of many possible initial plans which calls for irrigation for all fields that meet the 0<7% slope condition and are at an elevation less than 1,700 masl. This last condition is imposed as an example where operational costs are important and irrigation would have to be gravity fed rather than pumped to the farmgate.

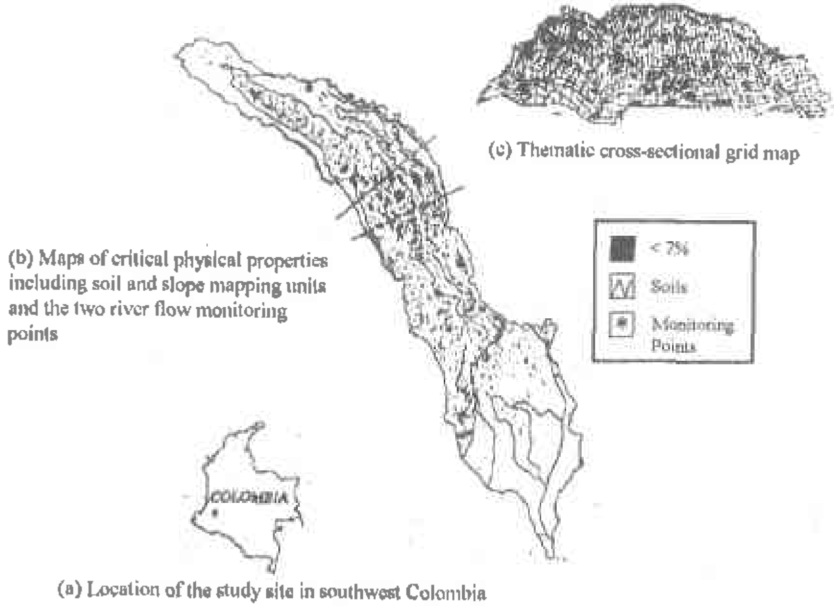

Figure 1. Thematic maps of critical physical properties including soil and slope mapping units and the two river flow monitoring points. Also shown is a thematic cross-sectional grid map highlighting the typical spatial complexity regional planning analysis for hillside environments must deal with.

3. RESULTS AND CONCLUSIONS

Fig. 2 presents summary output of seasonal demand for irrigation by month of seeding for the predominant soil mapping unit. The box plots are a slight modification of the AEGIS+ tabular output which summarizes seasonal minimum, average and maximum demand by «field» and by cropping strategy. Fig. 3 shows the expected percent reduction in flow at two points in the river (Fig. 1) for the one year in ten of greatest demand assuming a benchmark of 100 ha total area under irrigation. The analysis quantifies the risk and tradeoffs vis-a-vis multiple uses of water. In general, initial positions about resource planning can be quantified and presented for discussion. During discussions, new positions can be formulated and simulated in an iterative manner until a consensus is reached. AEGIS has been demonstrated to stakeholders in the region and they agree that data collection requirements are well within the capabilities of government agencies in most Latin American countries, and that the software might usefully and economically be applied for ex ante impact analysis and compromise planning addressing multiple objectives of land and water use.

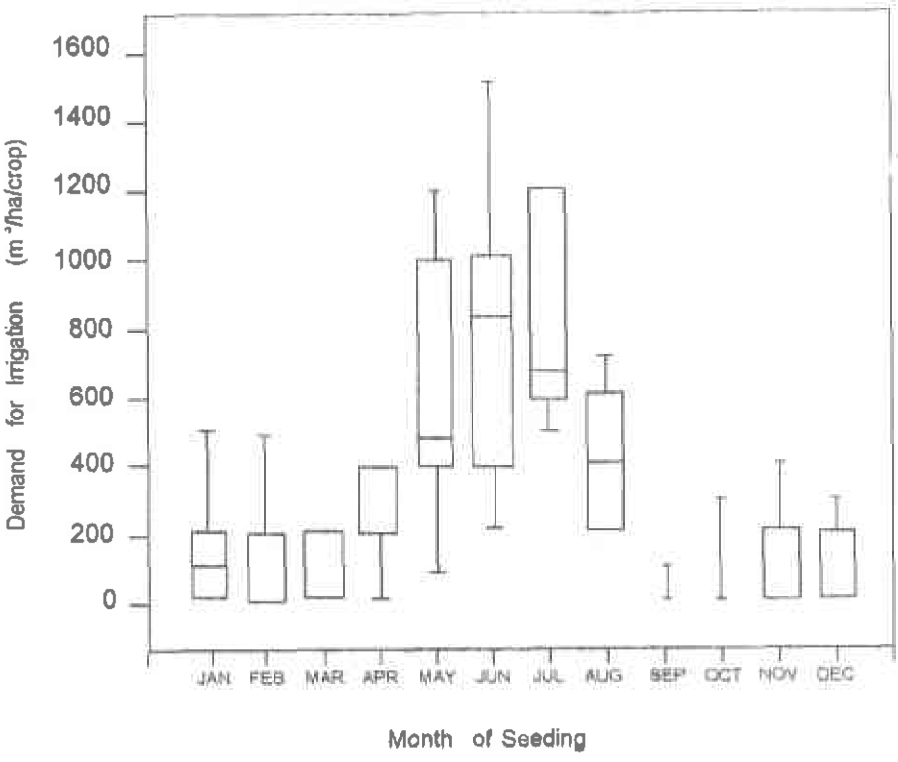

Figure 2. Frequency distributions and percentiles (10,25,50, mean, 75 and 90) for total crop demand per hectare for irrigation water. Seeding was on the firs day of the month shown.

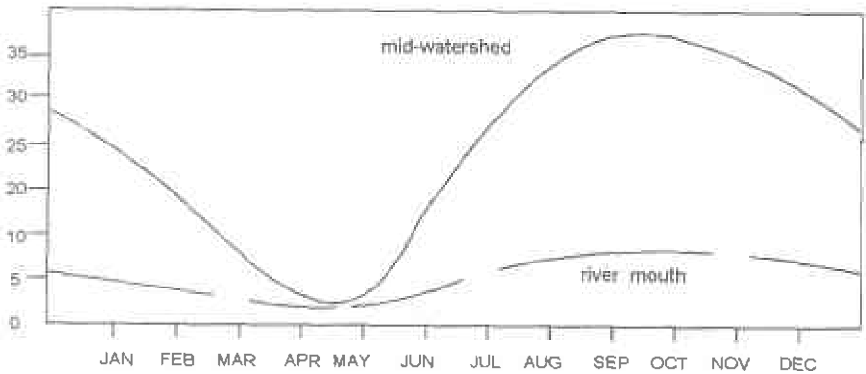

Figure 3. The expected percent reduction in river flow at two points in the watershed for the one year in ten of greatest demand for a benchmark of 100ha total area under irrigated crops.

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