LANDSAT IMAGE AND SAMPLE DESIGN FOR WATER RESERVOIRS (RAPEL DAM CENTRAL CHILE)

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Abstract. Spatial heterogeneity of the Rapel reservoir surface waters is analyzed through Landsat images. The image digital counts are used with the aim or developing an aprioristic quantitative sample design.

Natural horizontal stratification of the Rapel Reservoir (Central Chile) is produced mainly by suspended solids. The spatial heterogeneity conditions of the reservoir for the Spring 86 – Summer 87 period were determined by qualitative analysis and image processing of the MSS Landsat, bands 1 and 3. The space-time variations of the different observed strata obtained with multitemporal image analysis.

A random stratified sample design (r.s.s.d) was developed, based on the digital counts statistical analysis. Strata population size as well as the average, variance and sampling size of the digital counts were obtained by the r.s.s.d method.

Stratification determined by analysis of satellite images were later correlated with ground data. Though the stratification of the reservoir is constant over time, the shape and size of the strata varys.

Introduction

To be meaningful, the sampling design for evaluation of aquatic resources must incorporate the spatial configuration of the system elements.

The multispectral information of the Landsat image has been shown to be a very useful tool in monitoring processes of environmental phenomena related to water quality in natural lakes and reservoirs. Several authors (Verdin, 1985; Khorram *et al.*, 1985; Lindell *et al.*, 1986; Bartholdy and Folving, 1986) have succeeded in designing maps of water quality by means of the development of empirical equations for reflectance bands 1, 2, and 3 of the MSS Landsat and for variables such as: biomass (chlorophyll-a), transparency associated Secchi disk and suspended solids derived from field measurement.

In most cases the researcher lacks the basic information about the spatial temporal variability of the most common parameters. One of the possible consequences of this difficulty is that the distribution and size of samples in the system studied are not always the most appropriate. In general, the field measurements design is a random simple sampling design (r.s.s.d) using the morphometric features of the water body.

One unexplored possibility of the Landsat information applied to the study of lakes and reservoirs, is the use of the image digital counts in such a way that through the analysis of the variability of the sets of the digital values of the images (Landsat)

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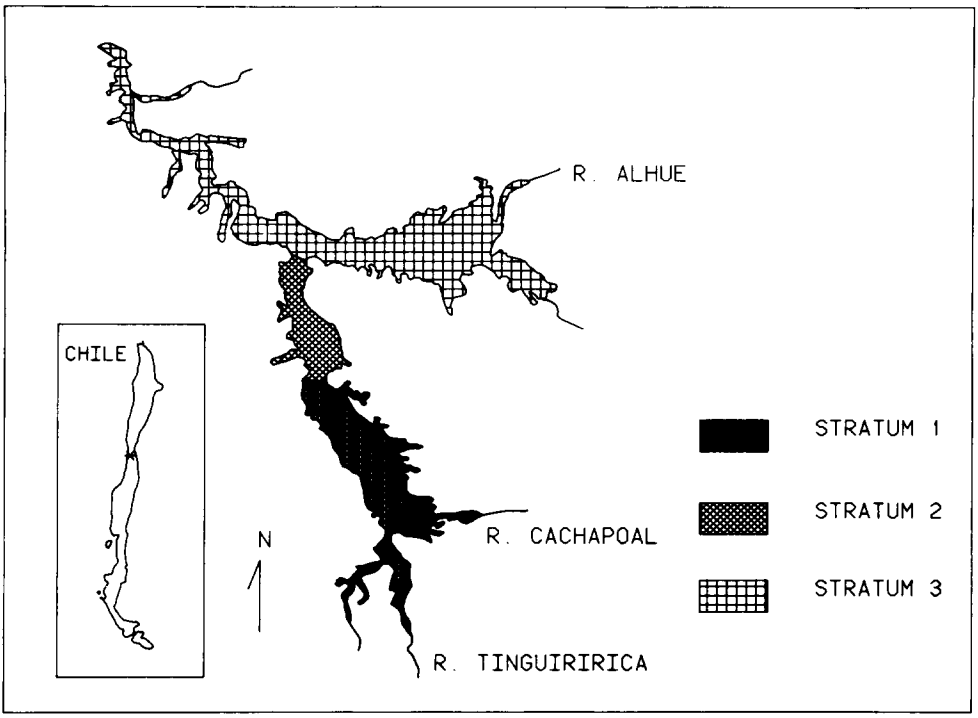

Fig. 1. Stratification of Rapel reservoir.

one can develop aprioristic statistical criteria to optimize the sampling design to obtain quantitative field information. The use of the pixel as the smallest unit of observation and information will facilitate the development of the optimum sampling design to significantly improve data acquisition and confidence. In addition to a quantitative analysis, the qualitative analysis of the image allows discrimination between structures and their limits (borders), increasing the amount of information about the space occupied by defined variables.

For Rapel Reservoir, the MSS Landsat information allows an efficient discrimination for areas of different concentrations of suspended materials (Lavanderos, 1987). This gradient of sediment concentration results in a natural stratification of the reservoir waters. Assuming that pixel mean reflectance into visible spectra in the reservoir is produced mainly by the presence of solids in suspension, changes in the pixel values result of the spatial and temporal variations of the solids.

In this paper we show how the statistical analysis of the digital cound associated with the mean reflectance of the pixel images allows development of a aprioristic random stratified sample design for Rapel Reservoir suggested by the same image.

Characterization of the Study Area

The Rapel Reservoir is located in the Central zone of Chile (34° 02′ 30″ Lat. s., 71° 35′