Choosing Optimal Spatial Resolution – Study of Two Agriculture Dominated Areas

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ABSTRACT

The optimal selection of spatial resolution for a remote sensing based study is very important. Two methods, one based on local variance and the other based on semi-variance at lag 1, available for arriving at a solution of this problem are tried out in this study. The areas covered are agriculture-dominated regions of North Gujarat and Western Uttar Pradesh. SPOT-1 HRV multispectral data were analysed. It was found that the optimal spatial resolution is about 60-80 m.

Introduction

Users of remotely sensed data have access to data of many types from various satellite sensors. The data vary in temporal resolution, spectral resolution, spatial resolution and quantization levels. These quantities are not entirely unrelated. However, the concern of the present study is the choice of spatial resolution (hereafter SR).

SR has been defined from essentially four considerations, viz. 1) geometric properties, 2) ability to distinguish between point targets, 3) ability to distinguish the periodicity of repetitive targets, and 4) ability to measure the spectral properties of small finite targets. The first is described in terms of IFOV whereas in second definition Rayleigh criterion is used. Modulation transfer function forms the basis of third definition. The definition considered here is based on spectral properties of the target. This measure of SR is of interest as it defines the size of an area for which a single radiance value can be assigned with reasonable assurance (Colwell, 1983, Chapter 1).

Presently available satellite sensor data vary considerably in SR from fine resolution
of 10 m and 20 m in SPOT-HRV panchromatic and multispectral mode, to medium resolution of around 80 m in Landsat MSS, to coarser resolution of 1.1 km and 4 km in NOAA-AVHRR in local area coverage and global area coverage mode. The future IRS missions, besides many other missions, will provide data of higher SR (ISRO, 1991). Thus, many options shall be available with a user. One of the first problems facing users will be the choice of an appropriate SR based on his study aim.

Two methods that have been commonly reported in literature for choosing optimal SR are: one based on local variance (Harrison and Jupp, 1990) and the other on semi-variogram (Atkinson and Danson, 1988). In the present study, these two methods were tried out over agriculturedominated areas and the results are compared.

Study Area and Data Used

Two sets of satellite sensor data were used.

1. SPOT-1 HRV multispectral data of October 9, 1986, path-row K 201 – J 303 over North Gujarat; and


The areas were dominantly covered with standing crops at the time of satellite pass. The area covered in data set 1 is dominated by oilseeds and fodder crop. The dominant crops in area covered in data set 2 is wheat and sugarcane.

Methodology

Before proceeding to describe methods used in the present study, it may be appropriate to define the meaning of optimal SR. If the SR is too fine then the information will be repeated and if the SR is too coarse then there will be loss of information. Between these two extremes of information replication and information loss, there is a SR at which the spatial information in the scene is maximized without duplication. The local variance statistics and the semi-variance are defined and explained in the context of choice of optimum SR here below.

a) Local variance

Local variance is defined as (Harrison and Jupp, 1990):

Local variance = .5 Σ(x_ij - x_kl)^2/n,

where x_ij is the gray value of central pixel of a small window; x_kl is the gray value of neighbouring pixels in the window; and n is the number of neighbouring pixels considered. Notice that the deviations are taken from the gray value of central pixel and not from the local mean gray value. The results of local variance can be summarised graphically by plotting pixel resolution versus local variance.

b) Semi-variance

The semi-variogram is a function that relates the semi-variance at a particular lag to that lag. Semi-variance at lag h for a regular (equispaced) series of observations x_i of n points is defined as:

Semi-variance (h) = {2(n – n)}^{-1} Σ(x_i – x_{i+h})^2