LAND EVALUATION FOR SUSTAINABLE LAND USE BY REMOTE SENSING AND GIS CASE STUDY: ASSESSMENT OF SOIL EROSION IN PAKISTAN

Y. Yamamoto[1], S. Uchida[2], T. Suyama[1] and A. Shoji[1]
[1]National Grassland Research Institute, Senbonmatsu 768,
Nishinasuno, Nasu, Tochigi 329-27, Japan
[2]Japan International Research Center for Agricultural Sciences, 1-2 Owashi, Tsukuba, Ibaragi 305, Japan

ABSTRACT
In the northern part of Punjab in Pakistan, severe soil erosion has caused land degradation and has disturbed sustainable land use systems. Since much of this erosion has been marked near rivers, watersheds and topography are considered to be related to soil erosion. We applied the Geographic Information System (GIS) and Remote Sensing to the assessment of an erodible area. GIS is very useful for conducting spatial data analysis using map data. Remotely sensed data provides the information about land surfaces. In this study, the distance from the river, weighted by the slope estimated by GIS, and the standard deviations (SD) of LANDSAT/TM4 were closely related. The SD was believed to show the homogeneity of land surfaces affected by soil erosion. Based on these results, a land evaluation map of soil erosion was produced.

KEYWORDS
Geographic Information System (GIS), Remote Sensing, Erosion, Land, Evaluation, Pakistan

INTRODUCTION
The Pothwar plateau in the northern part of Punjab province has a lot of agricultural land. However, the area consists mostly of loose soil, which is easily erodible. Severe erosion seriously hindered sustainable agriculture.

The objective of this study is to construct spatial data sets for suitable land use systems to prevent land degradation, and to assess the hazards of soil erosion caused by geographic factors, using the Geographic Information System (GIS) and Remote Sensing.

METHODS
The test site, located near the town of Fatehjang, measured 28.8 km from east to west and 25.5 km from south to north. ILWIS (Ver.1.4) *, which was developed by ITC**, was adopted as the GIS software.

At this test site, since soil erosion has been especially marked beside rivers, it was suggested that distance from a river might be one of the factors of erosion. Hence, the river lines were extracted from a map (scale 1:50,000) and input to GIS through the use of a digitizer. Furthermore, topographic factors might also be related to land degradation. In a GIS, topography is expressed by the Digital Elevation Model (DEM) produced by interpolation with contours. Therefore, contours were extracted from the same map above, and input into the GIS in the same way. The mesh size of the constructed DEM was 30 meters. Then, the slope of each mesh was estimated using the DEM. Next, the distance from the river was calculated by the buffering with weight which has been assigned by slope to reflect topographic features.

With a view to grasping present land conditions at the test site, the standard deviations (SD) of 3X3 windows were calculated using LANDSAT/TM4 data observed on February 9, 1992. This calculation is performed by neighboring operations with GIS to shows the homogeneity within the specific area determined by window size. Comparing the SD with the results of the buffering from the river, the relation between soil erosion and topographic factors was discussed.

*ILWIS: The Integrated Land and Water Information System
**ITC: International Institute for Aerospace Survey and Earth Sciences, Netherlands

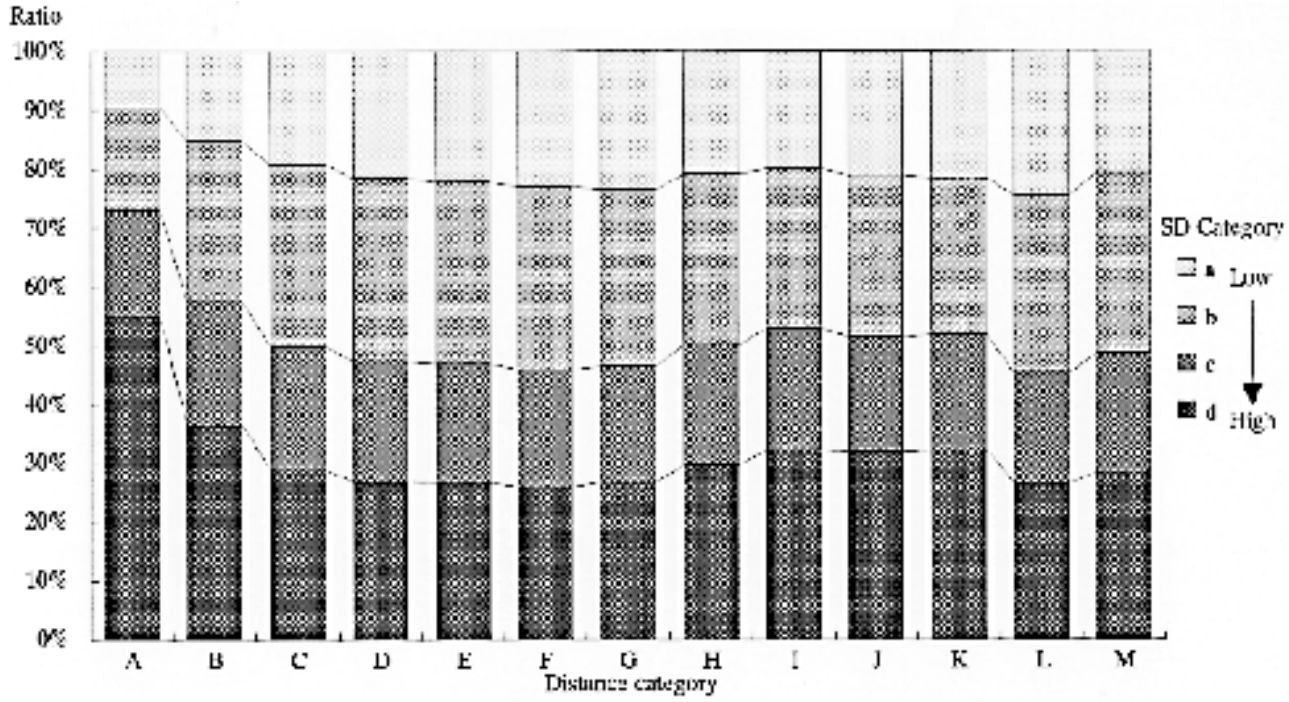
RESULTS AND DISCUSSION
Figure 1 shows the ratio of each SD category(a to d) in the distance category(A to M). Category-d, which was the highest SD category, got a 55.0% share of distance category-A which was the area nearest to the river. In distance category-B, category-d of SD accounted for a 36.5% share.

The SD of 3X3 windows shows the homogeneity of the land surface. In the area where large-scale soil erosion had occurred, the reflectance pattern observed by satellite would be nonhomogeneous and dispersive because of the bare land created by erosion and the shadow of complicated figures. In this study, since the share of the high SD category was large in distance category-A and category-B, soil erosion near rivers might be very noticeable in these categories. As a result, they were considered as a potentially hazardous zone of soil erosion or land degradation related to river networks.

Figure 2 is a land assessment map of soil erosion at the test site. It was produced by overlaying the SD category on the distance category.

ACKNOWLEDGEMENTS
This study was carried out with the collaboration of the National Agricultural Research Center in Pakistan. The authors would like to express their gratitude.

Figure 1
Ratio of the SD category in each distance category.



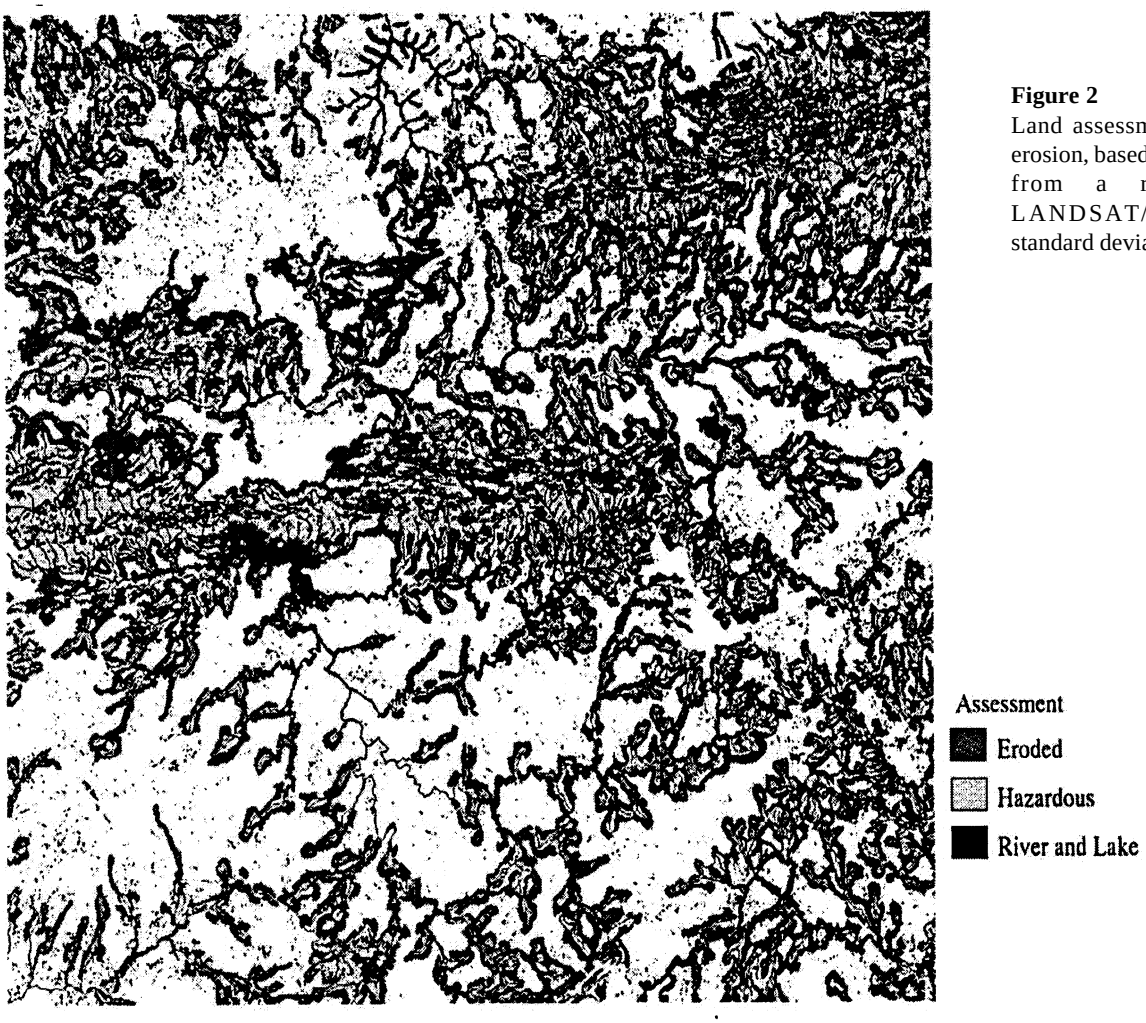


Figure 2
Land assessment of soil erosion, based on distance from a river and LANDSAT/SAT/TM4 standard deviations.