

USDA-ARS Hydrology Laboratory
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The USDA-ARS Hydrology Laboratory is investigating remote sensing techniques for measuring hydrologic parameters and variables. Current research deals with runoff Curve Numbers (CN), evapotranspiration (ET), and soil moisture. CN and ET research utilizes visible and infrared measurements and soil moisture investigations focus on the microwave region of the electromagnetic spectrum. Previous studies have involved visible and near infrared data in estimating the percent of impervious area.

CN research is aimed at developing and evaluating methods for using remote sensing for the USDA-SCS. The role of remote sensing in the SCS procedures is shown in Figure 1. It is essentially an alternative source of land cover information. However, sources such as Landsat also have the advantage of a computer compatible format.

Whether or not remote sensing will eventually play an operational role will depend upon its cost-effectiveness. Improved spectral and spatial measurements will influence the effectiveness side of these tradeoffs.

Curve number accuracy is limited by the number of land cover categories that can be reliably defined, which in turn depends upon the available spectral bands and the spatial resolution. In this application, the accuracy can be evaluated by the expected error in estimating the CN of the basic modeling unit, a subwatershed. Conventional methods are assumed to have a small constant error as shown in Figure 2. Investigations have shown that when using Landsat data the error depends upon the subwatershed size and decays as it increases. Figure 2 shows that if the decision criterion was error the user would not choose Landsat for areas less than S in size.

Improved spectral and spatial measurements should shift the error-subwatershed size relationship down as illustrated in Figure 2. Under these conditions, remote sensing is advantageous at a smaller subwatershed size S'.

Our research has not considered the questions of what spectral information could improve the procedure and how improved spatial resolution would affect accuracy. The reason for this is that we are focusing on making the best use of existing data sources. However, these problems are important and could be studied using laboratory and/or small scale experiments. Research on these subjects would be similar to the problems involved in crop discrimination and urban land cover studies. At this state it is not possible to say whether spectral or spatial measurement improvement is more valuable.

Aside from the question of the best spectral bands, studies are needed to evaluate the temporal features of remotely sensed data. Classification and analysis for CN depends upon the time of year. However, studies to identify optimal conditions have not been conducted. Also, the use of multi-date data has not been adequately investigated.

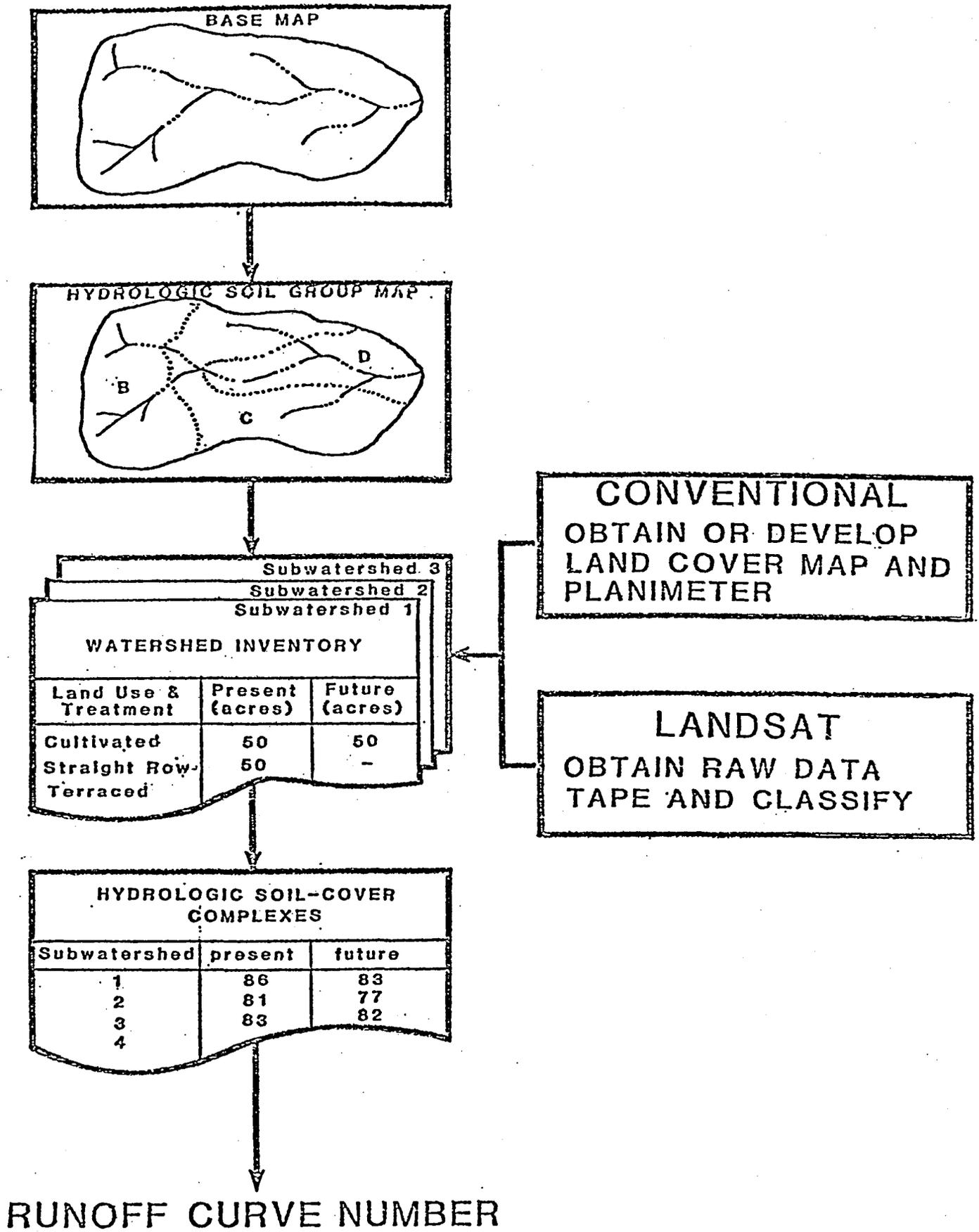


Figure 1. - Comparison of Conventional and Remote Sensing Approaches to Curve Number Estimation.

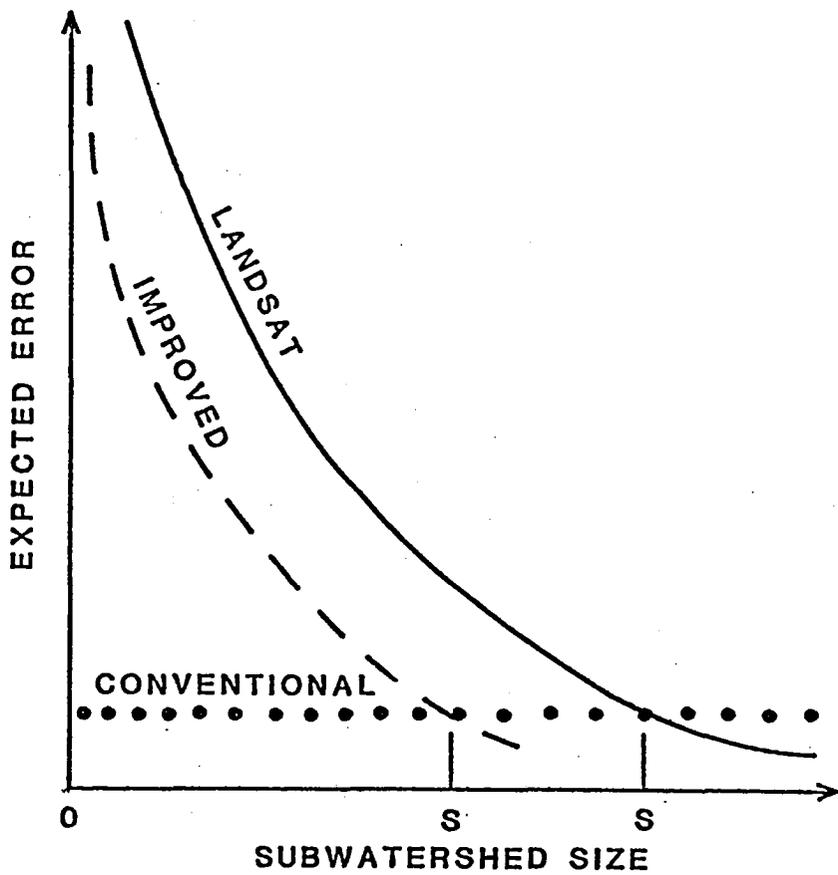


Figure 2. - General Relationship Between the Expected Error in Estimating the CN and Subwatershed Size.

Other problems that should be considered which significantly affect the utility of remotely sensed data in quasi-operational applications, such as CN estimation, are data calibration and registration. Information extraction will always be limited by calibration. It seems that procedures could be developed to make this more quantitative. CN estimation, as illustrated in Figure 1, involves the combination of several data bases, remotely sensed land cover being one. Accuracy and reliability depend upon registering these. Reliable and easy to implement procedures for ground registration would be useful. Also, since all data bases are ultimately referenced to the USGS topographic maps, why not obtain the data at a matching 1:24,000 spatial scale?

Another topic of interest is the estimation of the percent of impervious area directly from remotely sensed data without intermediate land cover classification. Based upon available Landsat bands, procedures for doing this have been developed. One example is shown in Figure 3. Studies to determine the optimal spectral bands have not been conducted and would be useful. Relationships between the expected error and the size of the study area have been developed based upon Landsat data bases, however, the effect of spatial resolution has not been investigated.

Current research in ET estimation employs an energy and moisture budget approach for the interpretation of thermal infrared data as acquired by the NOAA operational satellites. The 1.1 kilometer spatial resolution of the Advanced Very High Resolution Radiometer prevents field by field evaluation of moisture characteristics and thus has potential utility only for regional scale ET assessment. Aircraft data should be acquired and analyzed to ascertain the significance of improved spatial resolution in the analysis of thermal infrared data.

REFERENCES

- Bondelid, T. R., Jackson, T. J., and McCuen, R. H., 1980, Comparison of Conventional and Remotely Sensed Estimates of Runoff Curve Numbers in Southeastern Pennsylvania, Proceedings of the ACSM-ASP Annual Meeting, St. Louis, Mo.
- Bondelid, T. R., Jackson, T. J., and McCuen, R. H., 1981, A Computer Based Approach to Estimating Runoff Curve Numbers Using Landsat Data, AgRISTARS Technical Report, CR-R1-04040.
- Carlson, T. N., Dodd, J. K., Benjamin, S. G., and Cooper, J. N., 1982, Satellite Estimation of Surface Energy Balance, Moisture Availability and Thermal Inertia, Journal of Applied Meteorology 20, pp. 67-87.
- Jackson, T. J., 1975, Computer Aided Techniques for Estimating the Percent of Impervious Area from Landsat Data, Proceedings of the Workshop on Environmental Applications of Multispectral Imagery, Ft. Belvoir, Va.
- Jackson, T. J., and McCuen, R. H., 1979, Accuracy of Impervious Area Values Estimated Using Remotely Sensed Data, Water Resources Bulletin, Vol. 15, No. 2, pp. 436-446.

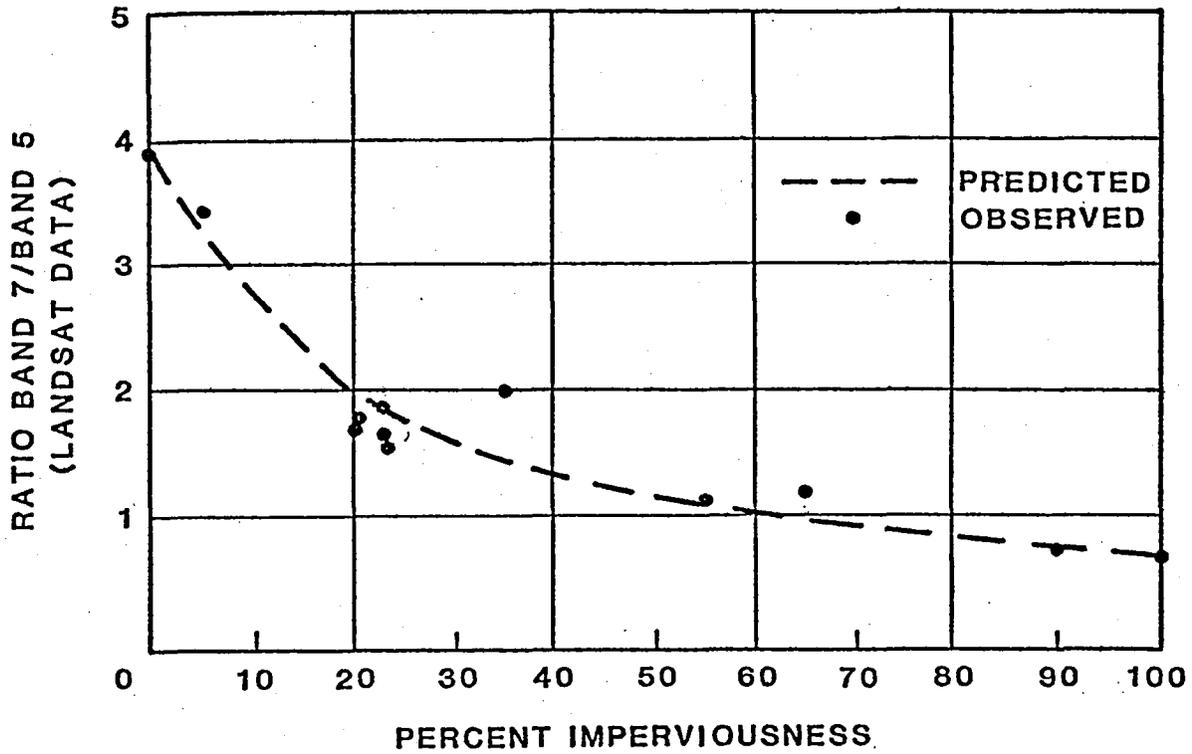


Figure 3. - Relationship Between the Percent of Impervious Area and the Ratio of Two Landsat Bands (McKeon, et al., 1979).