USE OF IMAGE PROCESSING TECHNOLOGY IN HYDROLOGY

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ABSTRACT

A challenge facing the hydrologist in the 1980's is how to keep informed about the rapid advances being made in computer technology and to update the hydrological tools in the light of these advances. The science of image processing has developed with the advances in computers, and as such needs to be examined to assess the use of this new technology in hydrology.

The aim of this paper is to stimulate interest and discussion, and as such is not intended to be a comprehensive review of the topic. Three applications in hydrology will be discussed namely:

1. The use of remotely sensed data in hydrological modelling.
2. The use of the data base to manage large volumes of raster data and
3. The use of image processing software.

1. THE USE OF REMOTELY SENSED DATA IN HYDROLOGICAL MODELLING

Remotely sensed data has been used to estimate both the input data needed to drive the model and the parameters in the model. For example, satellite data have been used to estimate the rainfall data needed to run hydro-electric power operating models in Canada (Bellon and Austin, 1985). There are many well known remote sensing techniques to estimate model parameters such as land cover and irrigated areas.

The model state variables like soil moisture have also been updated by means of remote sensing, Peak, Johnson and Keefer (1983) modified the National Weather Service River Forecast System rainfall/runoff and snow melt models so that the variables of soil mositure, snow water equivalent and snow extent could be updated as the model was being run.

2. THE USE OF THE IMAGE PROCESSING DATA BASE TO MANAGE RASTER DATA

A typical Landsat scene contains four images of about 7 million pixels each. Therefore, the image processing systems have efficient techniques for storing and retrieving large quantities of raster data. Rainfall, soil and temperature data could be stored as digital maps and output in several formats by means of an image display subsystem. Some of the larger image processing systems also support geographic information to produce thematic maps.

Seed, Dent and Piper (1985) used the locally developed image processing system P.I.P.S. to store elevation data as a geodetic grid. This grid was accessed by means of the P.I.P.S. utility subroutines and was used to generate a rainfall map which was also stored in P.I.P.S. format.

A major constraint on the use of distributed hydrological models in the past, has been the volume of data to be processed at each time step.

3. THE USE OF IMAGE PROCESSING SOFTWARE

If the data are stored as an image data base then the software features (image manipulation) for classification can be used. There are many routines for general image manipulation that are of use for any data set. For example, enhancing the data base by means of smoothing, changing the pixel size and specifying an area of interest by means of a bit map to name just three applications.

The many powerful classification procedures supported by an image processor are also of considerable interest to the hydrologist. For example, these routines could be used to objectively identify homogeneous regions, for example, of areas of sediment or salt yield.

As a first attempt, the Mfolozi catchment was classified into seven physiographic regions using height, maximum slope at a point and the de Villiers, 1968 soil maps. The slopes were calculated using the height data, and both images were scaled to have a range of 256 levels. It was found that the numbering system used by de Villiers was somewhat arbitrary for example, the class 2 had in fact similar properties to class 14 as both were sandy soils. The classes were grouped into five broad classes and ranked according to texture. New class numbers were assigned to each class and then rescaled to the same range as the other images. The modified numbering system is shown in Table 1.

TABLE 1: RENAMED SOILS CLASSES FOR PHYSIOGRAPHIC REGIONALISATION

de Villiers class	14	11	2	1	3	4	5	8	9	6	7
New class	1	1	11	21	33	34	35	41	42	51	52
	12	13	10								
	53	54	55								

The iterative clustering routine in P.I.P.S. was used to identify seven clusters in the feature space. These regions are shown in Plate 1.

As the intention was simply to demonstrate by way of an example the usefulness of the iterative clustering routine, one is able to conclude from these preliminary results that the technique is able to produce interpretable regions.

4. CONCLUSION

Image processing technology can not only provide data to be used by hydrological models, but also a convenient data base structure together with powerful software mapping and regionalisation. It is the author's opinion that image processing may well provide the basis for the next generation of hydrological models.

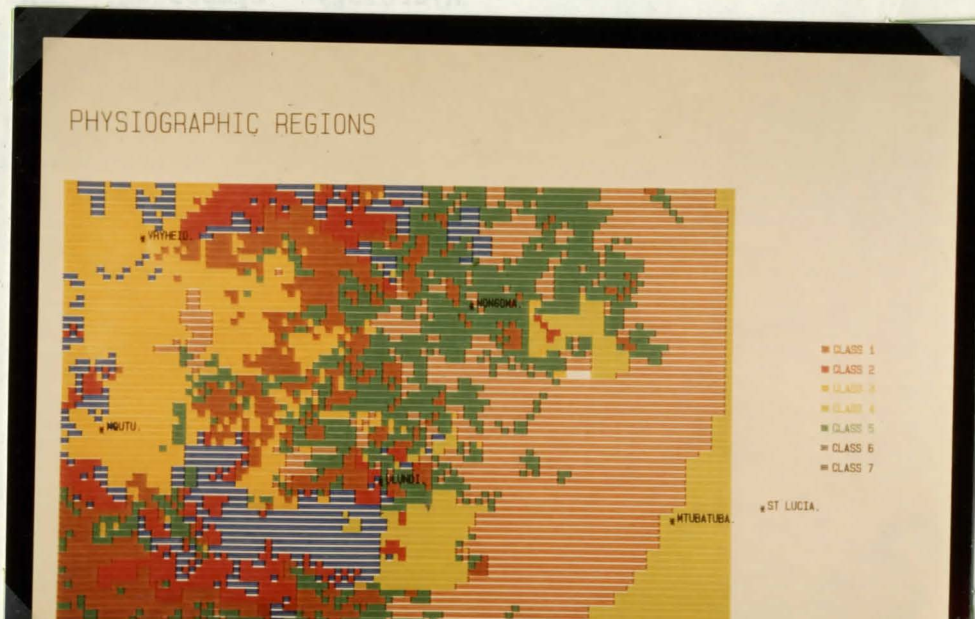

PLATE 1: PHYSIOGRAPHIC REGIONS FOR THE MFOLOZI CATCHMENT USING HEIGHT, SLOPE AND SOIL TYPE.

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