THE APPLICATION OF LOW COST REMOTE SENSING TECHNIQUES TO DRAINAGE AREA STUDIES

by

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In drainage area studies, one element is the construction and verification of a hydraulic model of the sewer system using WALLRUS. One of the more fallible sets of data to be input to the model is the percentage impervious area in each sub-catchment. Frequently this value is arrived at by measuring the impervious areas from OS maps for typical areas and then assigning similar impermeabilities to similar looking areas. This is supplemented by impermeability surveys. This approach is somewhat subjective and any errors in assessing percentage impermeabilities will result in corresponding errors in the predicted flows.

Clearly a more scientific and objective method is desirable and after consulting our remote sensing division we decided that we could improve on the manual method by using airborne video cameras and then manipulating and analysing the data so acquired.

At this time SWK has been commissioned to carry out a D A S at Callington by South West Water Services. The construction of a verified WALLRUS model was required and SWWS agreed that we should compare the results using manually derived impermeabilities and remotely sensed impermeabilities.

Two video cameras were used, one recording true colour and one infra-red. Two cameras were considered necessary since the infra-red camera only records vegetation and may miss permeable non-vegetated areas. The cameras were fitted on a single vibration damped mounting to a Jet Ranger Helicopter.

Images were obtained in overlapping stripes at three different altitudes to allow later determination of the optimum altitude for further survey work. Recording was monitored within the aircraft. The total survey time was approximately 30 minutes and covered an area of approximately 24 square kilometres.

A number of computer processes had to be developed to convert the raw imagery which was in analogue form (video pictures) to a format useable by the computer, i.e. digital format, which could then produce a raster image (made up of a grid of pixels) for display.

By selecting sample areas we could teach the computer to classify permeable and impermeable areas across the whole image.

Catchment boundaries were identified from the WALLRUS model of the drainage network backed up by site work where necessary. Identification of non-contributing areas was undertaken using traditional site inspection and dye-test methods.

Catchment boundaries and non-contributing areas were drawn onto the computer image catchment.

Having taught the computer to differentiate between permeable and impermeable surfaces, assigned permeabilities to various colours and defined boundaries, it was a straightforward process to obtain impermeable areas for each catchment by counting the number of pixels for each surface type. Each pixel was converted to an area in accordance with scales obtained by reference to the ordnance survey maps as the pixel size varies due to variations in ground level and the height of the helicopter's flight path.

Alternative methods of classifying permeable and impermeable areas were investigated. One method used the 'supervised classification' method which involved the use of colour and infra-red imagery to identify the surface types (multi-band classification) and in the other method we classified the infra-red images alone using the density slice technique.

Generally the results obtained using manually derived impermeable areas give acceptable flow predictions compared to the flows actually observed. (An agreement of within +25% and -10% is considered acceptable for hydraulic model verification).

In our first attempts using computer based methods, with multi-band classification, poor correlation was achieved. Using density slicing to assess impermeable/permeable areas the results improved considerably. The results still are not as good as the manual method, but most of the predicted flows are higher than actually measured. This may be due to patios, greenhouses etc being included as impermeable areas whereas they generally would drain to soakaways. This can be accounted for by applying a correction factor throughout.

The table below compares volumes of flow for the different methods for one particular storm.

COMPARISON OF VOLUME OF FLOW (m^3)

DATE OF STORM. 13th November 1990						
Flow Monitor	Multi-Band Classification	Density Slicing	D.S Area Reduced By 25%	Manual	Actual	Verification Limit
F2	-	644	622	600	702	631*
F4	209	156	123	143	120	150
F5	327	267	204	159	164	205
F6	493	431	330	327	346	432
+ F7	188	180	139	102	88	110
F8	1052	874	675	658	614	767
+ F9	419	365	278	119	75	94
F10	-	326	255	251	277	346
F11	392	298	233	240	199	248

* Lower Limit
\+ Small Catchment

The results of the development of this technique of assessing impermeable areas are very encouraging. Further development to eliminate some stages in the computer manipulation of the imagery and in the aquisition of the imagery will substantially reduce the cost of this method of determining impermeable areas, thus making the process competitive with the manual methods.

David Searby, Wessex Water : How could the method could be applied to partially separate areas?

Answer : Groundwork would have to be carried out to determine which parts of the catchment connected to the system and which did not. Once these had been determined the method could be applied to the connected areas only.

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Brian Sharman, North West Water : I note that shadows cast by the low sun in the winter when the photographs had been taken had interfered with the infrared imagery. How could the problem of foliage of trees overhanging impermeable surfaces be overcome in summer?

Answer : It had been necessary to apply a calibration factor to the results from tests to achieve agreement. Presumably this approach could be adopted to the problem of foliage.

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David Beale, D H V Burrow Crocker : Had sample areas been used which had been thoroughly checked on the ground to achieve calibration?

Answer : The purpose of developing the method was to avoid ground checks. The costs of ground checks on sample areas might make the method uneconomical.

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Wapug Spring Meeting 1992 - Discussion

Dave Walters, M Barber & Co : The influence of trees is very important, since over 50% of impermeable area can be covered by trees. Were there problems identifying bodies of water? Cost?

Answer : Tests were carried in December, when there was no foliage. No bodies of water in our test site. The Canadian 8-band system ought to be able to differentiate. £16,500 spent on hardware/software development.

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Peter Myerscough, Yorkshire Water : Problems with steep catchments?

Answer : None envisaged

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