Use of image classification in urban drainage modelling



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Surface runoff – runoff coefficients

Methods traditionally used for determining impervious areas:

- Calculations based on aerial photos, technical maps etc.
- Type values based on the characteristics of the catchment



Catchments



 $\alpha = \frac{F_1 \cdot \alpha_1 + F_2 \cdot \alpha_2 + \dots + F_N \cdot \alpha_N}{\sum_{n=1}^{N} F_n}$ n=1



Model setup - drawbacks

- Time consuming
- Difficult to update
- Not well documented and image interpretation is subjective
- Model parameters are static difficult to test changes in runoff based on e.g. rain intensity or allocation of water



Objective

- Find a new method that would improve the flexibility of surface runoff modelling
- Use methods from remote sensing to describe surface types based on aerial photos and image classification
- Adapt to the level of detail that is required in urban drainage modelling
- Make the method as automated as possible



File Edit View Project Processor Options Window Help



Text Output

Classification of Training Fields

TRAINING CLASS PERFORMANCE (Resubstitution Method)

Project Class Name	Class Number	Reference Accuracy+ (%)	Number Samples	Number of Sam 1 Pervious are	nples in Cla 2 Impervious	ass 3 Shadows
Pervious area Impervious Shadows	1 2 3	93.7 99.6 97.6	27762 24852 2778	26015 94 65	55 24758 2	1692 0 2711
	TOTAL		55392	26174	24815	4403
	Reliabili	ty Accuracy	y (%)*	99.4	99.8	61.6

OVERALL CLASS PERFORMANCE (53484 × 55392) = 96.6% Kappa Statistic (X100) = 93.8%. Kappa Variance = 0.000002.

+ (100 - percent omission error); also called producer's accuracy.

* (100 - percent commission error); also called user's accuracy.

Area classification not saved to disk. Classification of Selected Area Lines 1 to 16000 by 1. Columns 1 to 32000 by 1

CLASS DISTRIBUTION FOR SELECTED AREA

		Number		
	Class	Samples	Percent	Area (Hectares)
1	Pervious area	389,280,644	76.0	608.251
2	Impervious	102,169,421	20.0	159.640
3	Shadows	20,549,935	4.0	32.109
	Total	512,000,000	100.0	800.000
End	maximum likeli	ihood classif	ication	

38 CPU seconds for classification. 09-03-2012 12:41:15



6148_526_528.tif (chs. 1,2,3)

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MultiSpec Windows Application - 6148_526_528.tif (chs. 1,2,3)







NDVI – normal differential vegetation index



$$\begin{split} \text{NDVI} &= \frac{\rho_{\text{IR}} - \rho_{\text{R}}}{\rho_{\text{IR}} + \rho_{\text{R}}} \\ \text{Where:} \\ \rho_{\text{IR}} &= \text{pixel reflectance values in the near infrared spectrum} \end{split}$$

 ρ_{R} = pixel reflectance values in the red spectrum

NDVI – normal differential vegetation index



NVEI – non vegetation elimination index



NVEI = $\frac{\rho_{\rm B} - \rho_{\rm R}}{\rho_{\rm IR} - \rho_{\rm R}}$ Where:

$$\label{eq:rho_IR} \begin{split} \rho_{IR} &= pixel \ reflectance \ values \ in \ the \ near \ infrared \ spectrum \\ \rho_{R} &= pixel \ reflectance \ values \ in \ the \ red \ spectrum \\ \rho_{B} &= pixel \ reflectance \ values \ in \ the \ blue \ spectrum \end{split}$$

Spectral analysis, vegetation/non vegetation index, tech. maps and manual inspection

Database with runoff coefficients

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Testing the method

- Tested the fully automated method against best manual fit
- Validated surface runoff against measured water levels/flow compared to calculated
- Mouse was used as the sewage model
- Used rain gauges operated by the Danish Water Pollution Control Committee (T<2 yrs.)

Manual versus automated



Measured and calculated water levels







Measured and calculated flows



Discussion

Screwed images will introduce errors



Conclusions

- It is possible to use image classification as a tool for describing surface types for use in urban drainage modelling
- Surface types are stored in a database and give full flexibility and documentation in relation to modelling surface runoff
- Reliable result can be achieved by a fully automated method
- Implement satellite images in the future