

Projektering van watervraag in stedelike gebiede (Deel 3): Die meervoudige regressiemodel as makro-projeksiemodel

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Extended summary

The purpose of this article is to research the value of multiple regression models for forecasting the demand for water in urban areas. On the one hand the extent to which meaningful regression models for calculating the demand for water in specific areas can be developed is determined, and on the other hand the extent to which a regression model developed for one area can be utilised to forecast the demand for water in another area.

Firstly various linear regression models for forecasting the demand for water in the Bloemfontein municipal area were developed. The model which has the best reliability coefficient (R^2), namely 0.8638, or 86.38 % reliability, and which includes rainfall, temperature, population figures and water restrictions as independent variables and water consumption as dependent variable, was employed in the forecasting model.

In order to test the transferability of a regression model developed for one area to other areas, two approaches were adopted. Firstly regression models were also developed for Pretoria and Kimberley on the basis of the same independent variables included in the Bloemfontein model. Thus it was possible to test whether the model structure is transferable or not. The reliability coefficients (R^2) obtained in this way were relatively high ($R^2 = 0.7107$ in the case of Pretoria and $R^2 = 0.6915$ in the case of Kimberley), which implies that the models respectively explain 71.07 and 69.15% of the variation in water consumption figures. The real water consumption of these two areas, peak demand excluded, can therefore be calculated relatively satisfactorily with the regression models.

Next the complete Bloemfontein model was applied to the data of Pretoria and Kimberley. In addition to testing the transferability of the model structure, the transferability of the regression coefficients of the Bloemfontein model to other areas could now be determined. Large differences were found between calculations on the basis of the Bloemfontein model and real water consumption figures for Pretoria and Kimberley, which serves to indicate that regression coefficients are location-bound and can therefore not be transferred to other areas.

It can therefore be concluded that regression models are location-bound, but that this approach and the identified independent variables (the model structure) can be extrapolated to other areas successfully.

Samevatting

Die doel van hierdie artikel is om die waarde van meervoudige regressiemodelle vir die projektering van die vraag na water in stedelike gebiede te ondersoek. Enersyds word bepaal in watter mate sinvolle regressiemodelle ontwikkel kan word om die vraag na water binne bepaalde gebiede te beraam, en andersyds in watter mate 'n regressiemodel wat in een gebied ontwikkel is, aangewend kan word om watervraag in 'n ander gebied te projekteer.

Eerstens is verskillende lineêre regressiemodelle om die vraag na water in die Bloemfontein munisipale gebied te projekteer, ontwikkel. Die model wat die beste betroubaarheidskoeffisient (R^2), naamlik 0.8638, of 86.38% betroubaarheid, gelewer het, en reënval, temperatuur, bevolkingsgetalle en waterbeperkings as onafhanklike veranderlikes en waterverbruik as afhanklike veranderlike insluit, is as vooruitskattingmodel gebruik.

Ten einde die oordraagbaarheid van 'n regressiemodel wat in een gebied ontwikkel is op ander gebiede te toets, is twee benaderings gevolg. Eerstens is daar ook vir Pretoria en Kimberley regressiemodelle ontwikkel aan die hand van dieselfde onafhanklike veranderlikes wat in die Bloemfontein-model ingesluit is. Sodoende kon getoets word of die modelstruktuur oordraagbaar is. Die betroubaarheidskoeffisiente (R^2) van die regressiemodelle wat so verkry is, was relatief hoog ($R^2 = 0.7107$ vir Pretoria en $R^2 = 0.6915$ vir Kimberley), wat beteken dat die modelle onderskeidelik 71.07% en 69.15% van die variasie in waterverbruiksfers verklaar. Die werklike waterverbruik van die twee gebiede word, met die uitsondering van spitsverbruik, redelik bevredigend deur die regressiemodelle verreken.

Vervolgens is die volledige Bloemfontein-model op die data van Pretoria en Kimberley gepas. Benewens die oordraagbaarheid van die modelstruktuur kon die oordraagbaarheid van die regressiekoeffisiente van die Bloemfontein-model na ander gebiede nou bepaal word. Groot verskille tussen beraamings aan die hand van die Bloemfontein-model en die werklike waterverbruik van Pretoria en Kimberley het voorgekom, wat daarop dui dat regressiekoeffisiente plekgebonde is en dus nie na ander gebiede oorgedra kan word nie.

Die gevolgtrekking wat gemaak kan word, is dat regressiemodelle plekgebonde is, maar dat die benadering, en die geïdentifiseerde onafhanklike veranderlikes (die modelstruktuur), met sukses na ander gebiede geëstrapoleer kan word.