Data-driven analysis used to find human influences on groundwater heads – physics-based modelling needed for verification

EGU2020-7659: Separating groundwater response to climate and anthropogenic changes using long-term groundwater head time series in the Netherlands

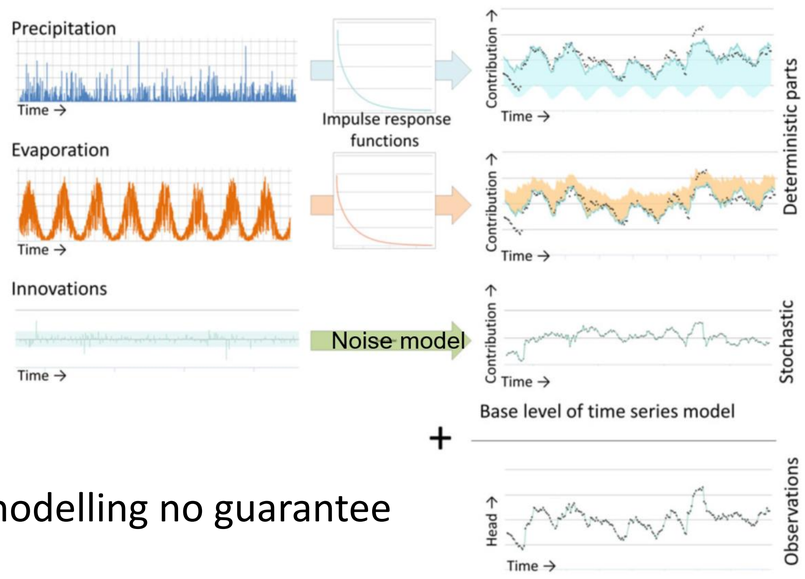
Willem J. Zaadnoordijk
TNO Geological Survey of the Netherlands
willem_jan.zaadnoordijk@tno.nl

Introduction

We consider the groundwater system with precipitation and reference evapotranspiration as natural boundary conditions. Our reference is the Netherlands with its moderate climate, mostly controlled surface water levels, and mainly public water supply with regulated (ground)water abstractions and documented drawdowns.

Method

Assume precipitation and evapo-transpiration are only natural influences on ground water heads, separating response to these meteorological factors from the variation of groundwater heads using transfer-noise modelling gives the change due to human activities. Zaadnoordijk et al. (2019)



Results

Precipitation and evaporation response; optionally response to other variables; and residuals.

Discussion

Success in transfer-noise modelling no guarantee for causal relation.

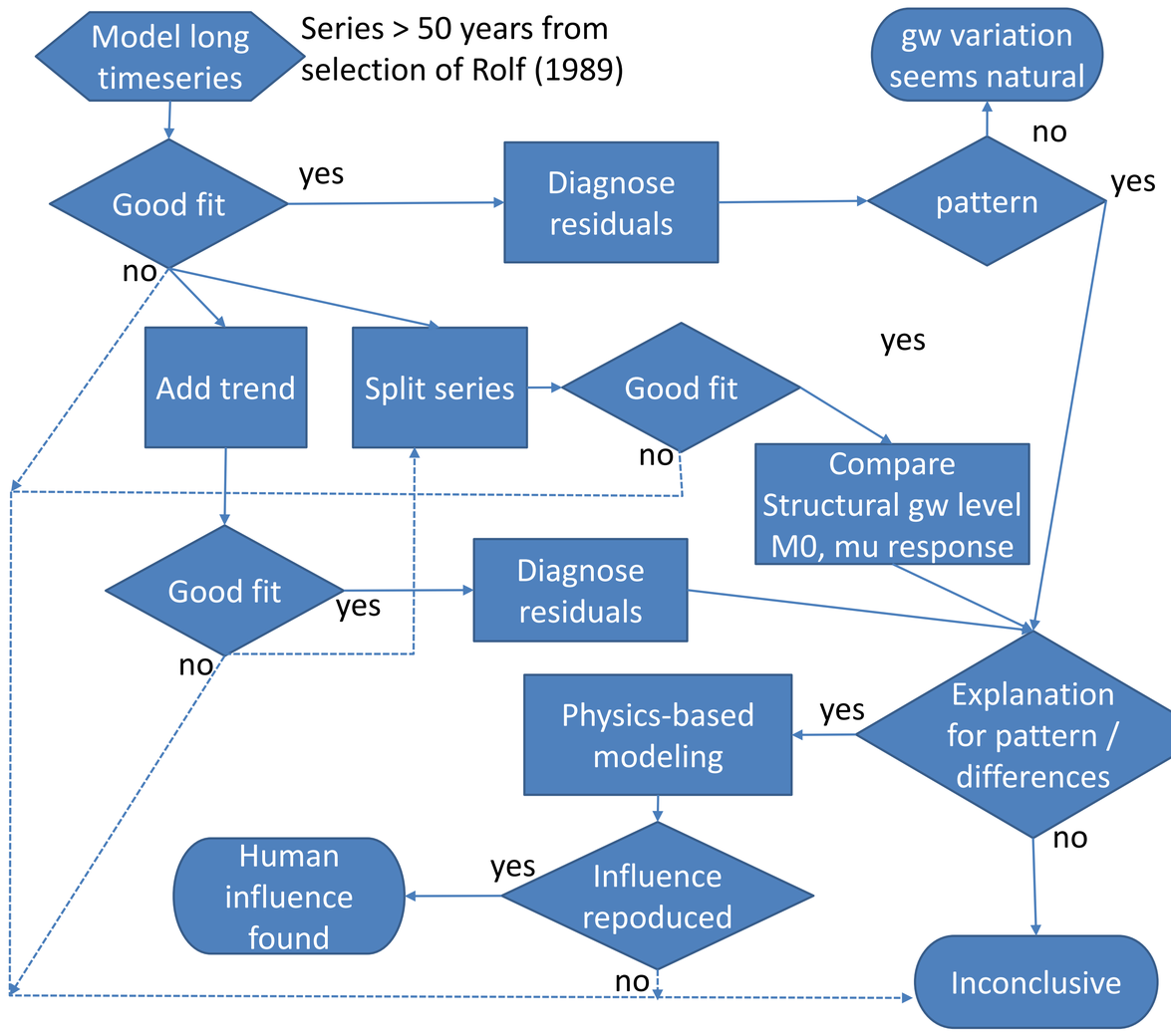
E.g. Maas (2012) showed mismatch drawdown from extraction between data driven and physics based models due to water and land management changes having regional effect similar to abstraction. Witte et al. (2019) verified influence from urbanisation and increasing agricultural crop yields as causes of regional groundwater head trend.

Conclusions

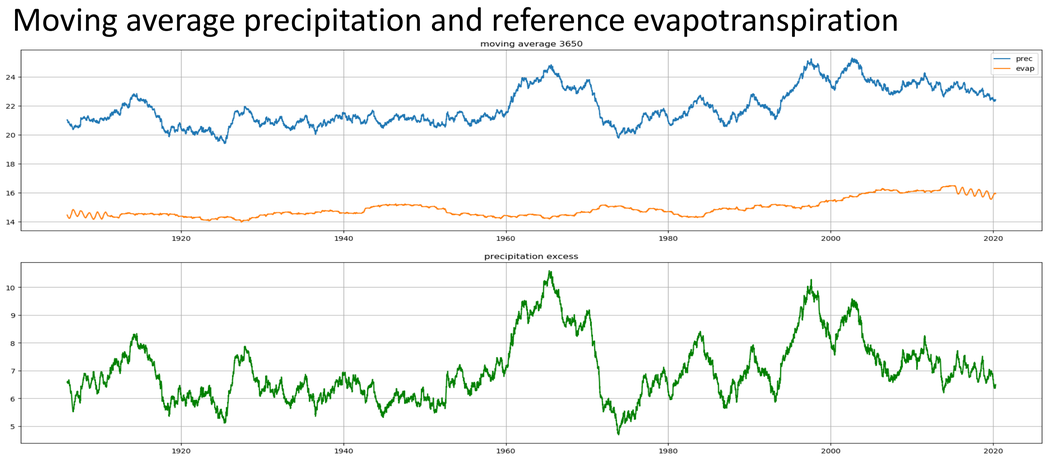
Correlation not necessarily indication of causal relationship.
Physics-based model needed to understand relation

References

Maas (2012) Caveats time series analysis - Terwisscha (in Dutch) Stromingen, 18,#2, 43-75
Obergfell (2020) PhD thesis TU Delft
https://doi.org/10.4233/uuid:40454512-e67c-41c5-963b-5862a1b94ac3
Rolf (1989) downward trend gw levels NL (in Dutch) TNO report
Witte et al. (2019) Water, doi:10.3390/w11030478
Zaadnoordijk et al. (2019) Groundwater doi: 10.1111/gwat.12819



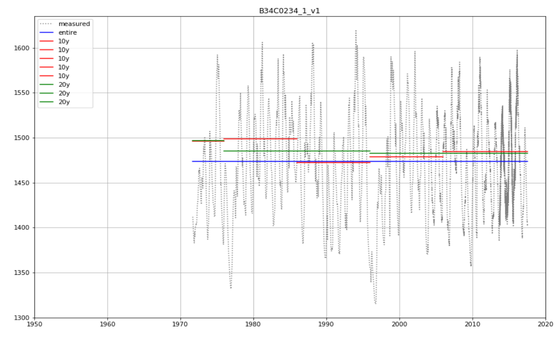
Moving average precipitation and reference evapotranspiration

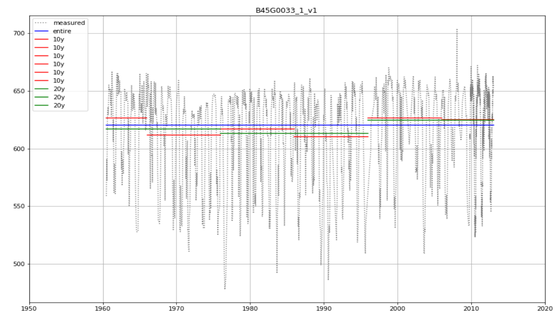


Examples of splitting series with structural level and response parameters

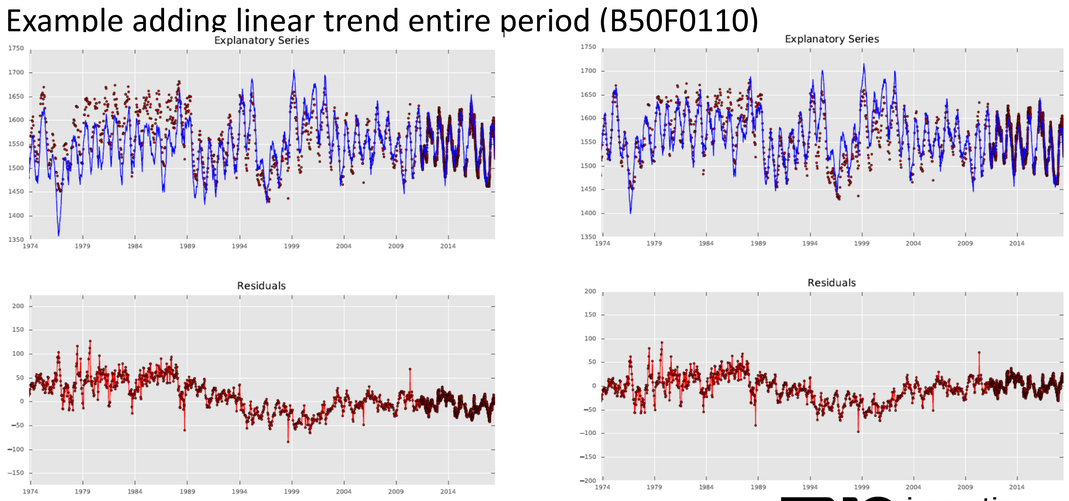
B34C0234_1_v1	out	out1966-1975	out1976-1985	out1986-1995	out1996-2005	out2006-	o2_-1975	o2_1976-1995	o2_1996-
regimeok	1	1	1	1	1	1	1	1	1
RMSE	20.13	20.23	19.07	23.80	16.74	20.23	20.25	25.18	20.42
base	1401	1389	1421	1354	1384	1415	1389	1391	1402
M0prec	88733	102034	115991	109987	110241	93536	102870	109905	97334
mu_pr	149	158	224	165	167	144	159	187	147
sigma_pr	122	127	203	144	139	114	129	166	117
evFactM0	1.01	0.85	1.11	0.83	0.98	1.06	0.86	0.98	1.00
strucniv	1473	1496	1499	1472	1479	1484	1497	1485	1483

B45G0033_1_v1	out	out1966-1965	out1966-1975	out1976-1985	out1986-1995	out1996-2005	out2006-	o2_-1975	o2_1976-1995	o2_1996-
regimeok	1	1	1	1	1	1	1	1	1	1
RMSE	16.7	21.6	17.9	17.3	16.0	13.9	13.0	21.4	17.1	13.5
base	620	639	616	621	606	636	613	626	614	621
M0prec	33005	25835	36830	39866	34106	29394	35215	32033	35601	28290
mu_pr	73	79	82	100	70	88	75	80	83	60
sigma_pr	79	82	87	109	76	110	81	85	90	65
evFactM0	1.55	1.87	1.63	1.63	1.46	1.78	1.33	1.75	1.57	1.47
strucniv	621	627	612	617	610	626	625	617	613	624





Example adding linear trend entire period (B50F0110)



TNO-GSN groundwater tools with more time series models

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TACTIC GROUNDWATER

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