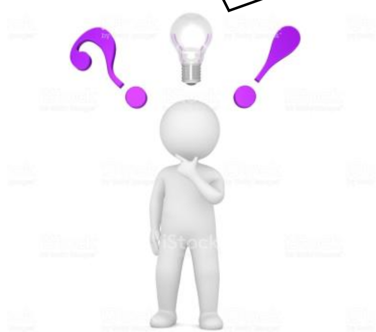
University of Stuttgart
Germany

Lumped hydrogeological model (LHgM)??

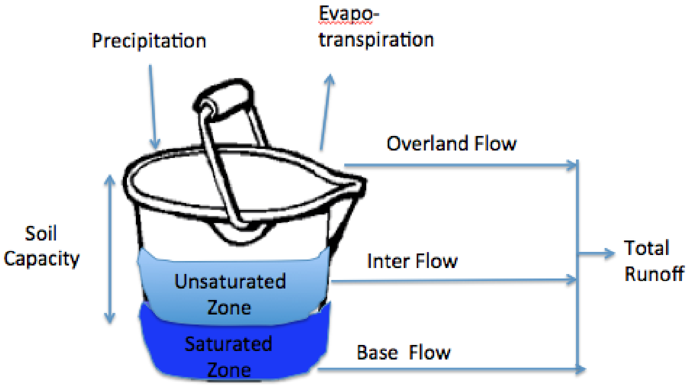


Source: https://istockphoto.com

Lumped hydrogeological model (LHgM) for reasonable, long- term predictions of groundwater storage and depletion

Fahad Ejaz

Can a conceptually lumped hydrological models (LHM) compete PDE based model?



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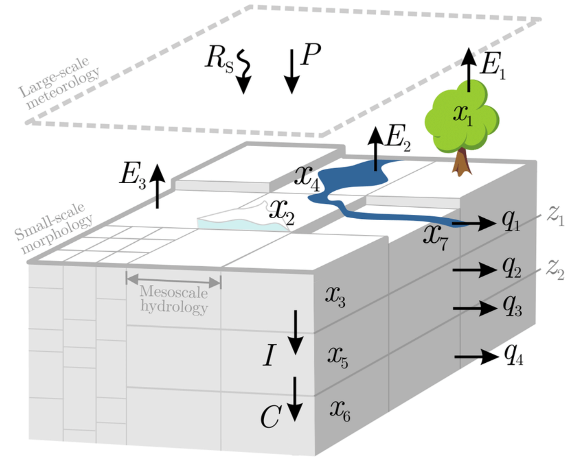
VS



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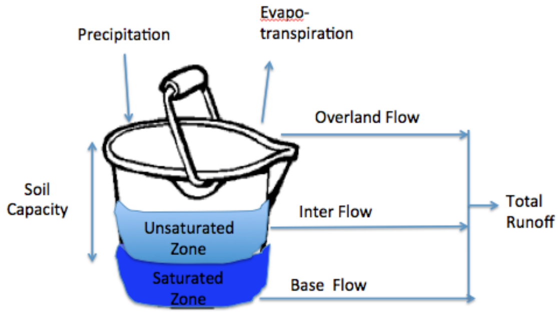
Only 12 Parameters

207 Parameters

2) Do current LHM close water balance during calibration?



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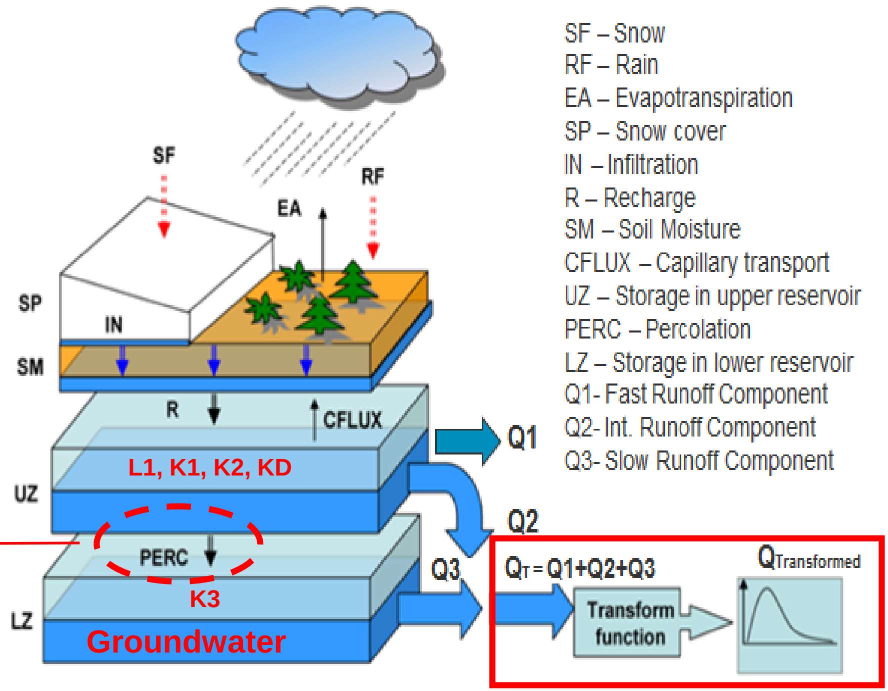
Gap in Water Balance

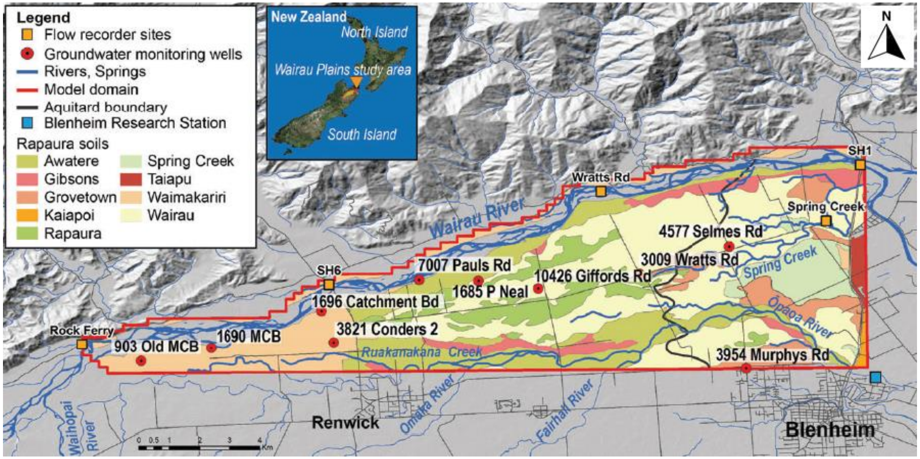


Outlet Discharge

- ✓ LHM: Calibration at only discharge outlet,
- ✓ LHbM: Calibration at only discharge outlet and groundwater storage.

Study Area

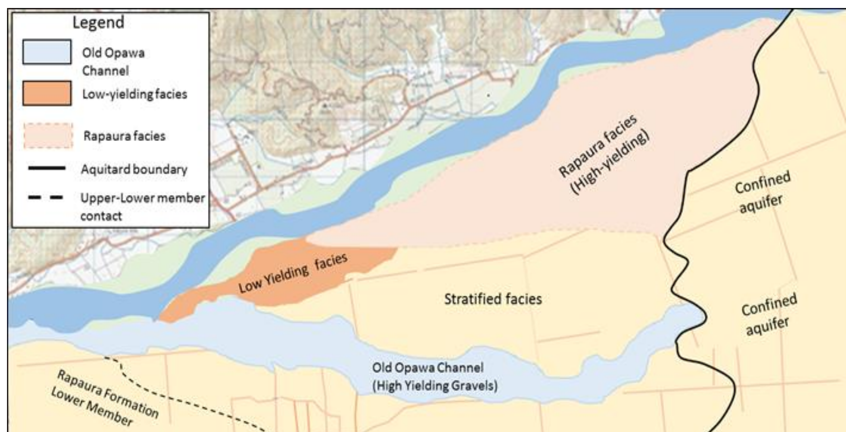
Model domain and geology



Source: Wöhling et al., 2018

- Wairau River as main driving force,
- A = 85 Km^2
- Highly transmissive coarse gravels,
- Outlet discharge as emerging streams or springs,

- Three lithological layers,
- Confined Aquifer close to the coast,

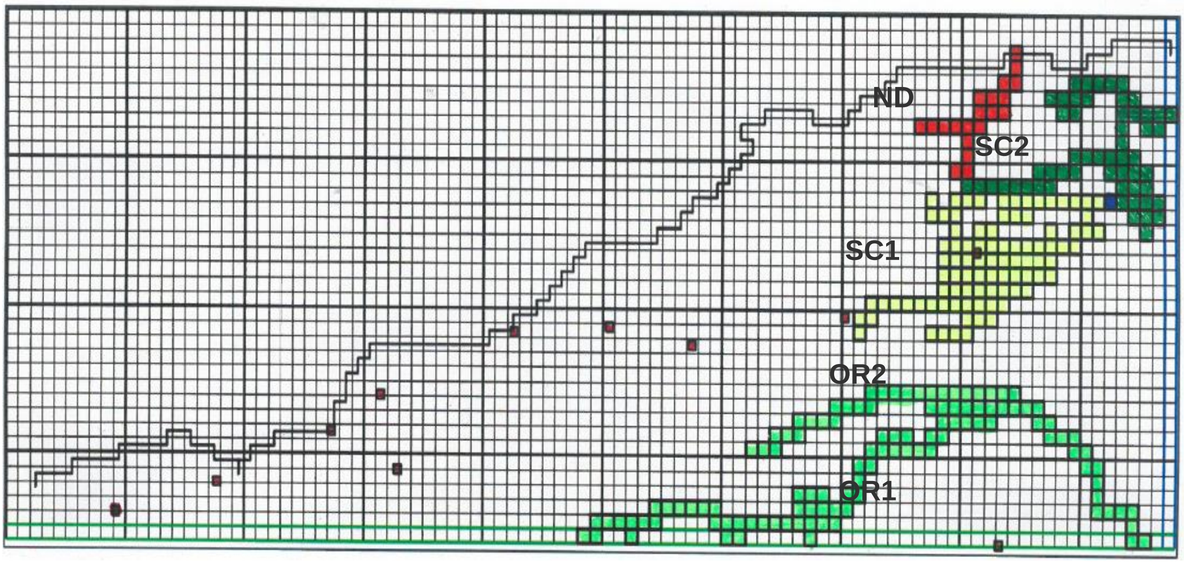


Source: Wilson., 2016

Study Area

Emerging Springs and Streams

- SC1 being close to Wairau River and directly linked to it

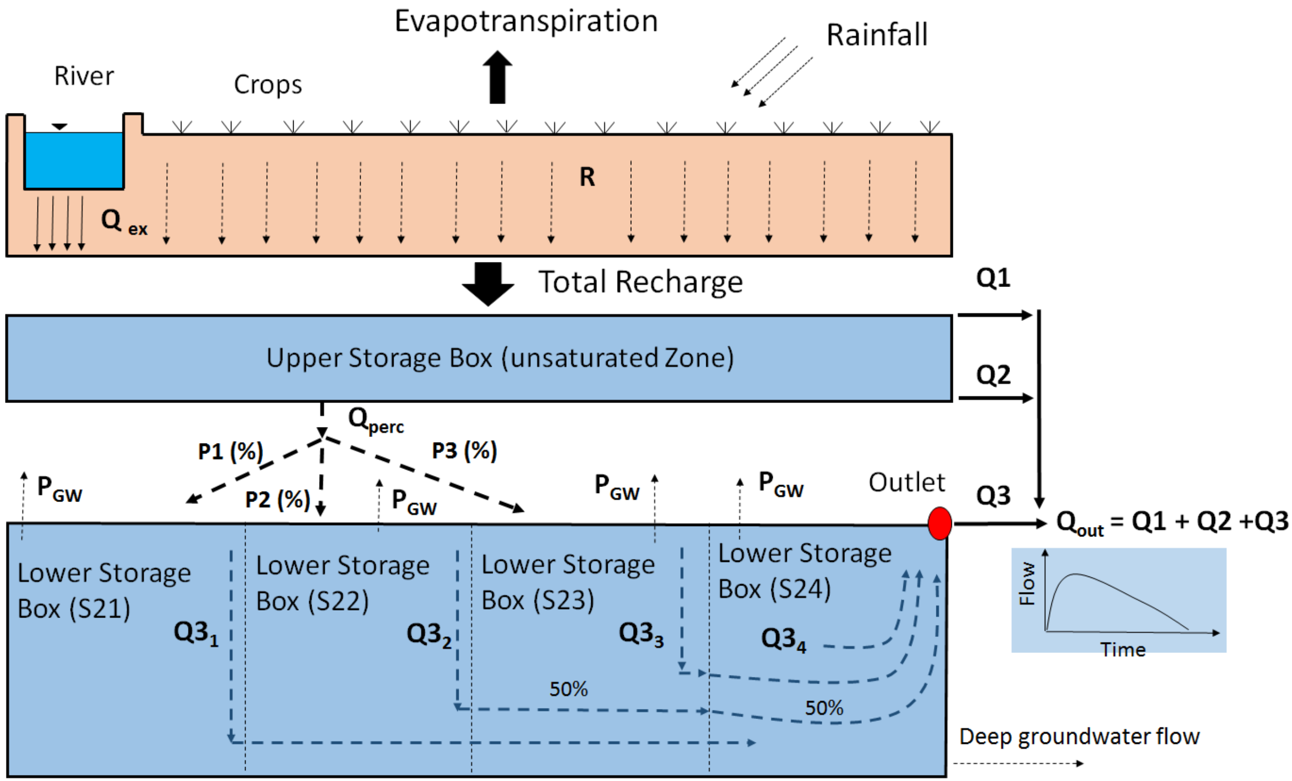


Legend

- Northern Drain (ND)
- Spring Creek 2 (SC2)
- Southern Streams (OR2, OR1)
- Spring Creek 1 (SC1)

LHgM schematic diagram

Outlet discharge, groundwater storage and flow paths



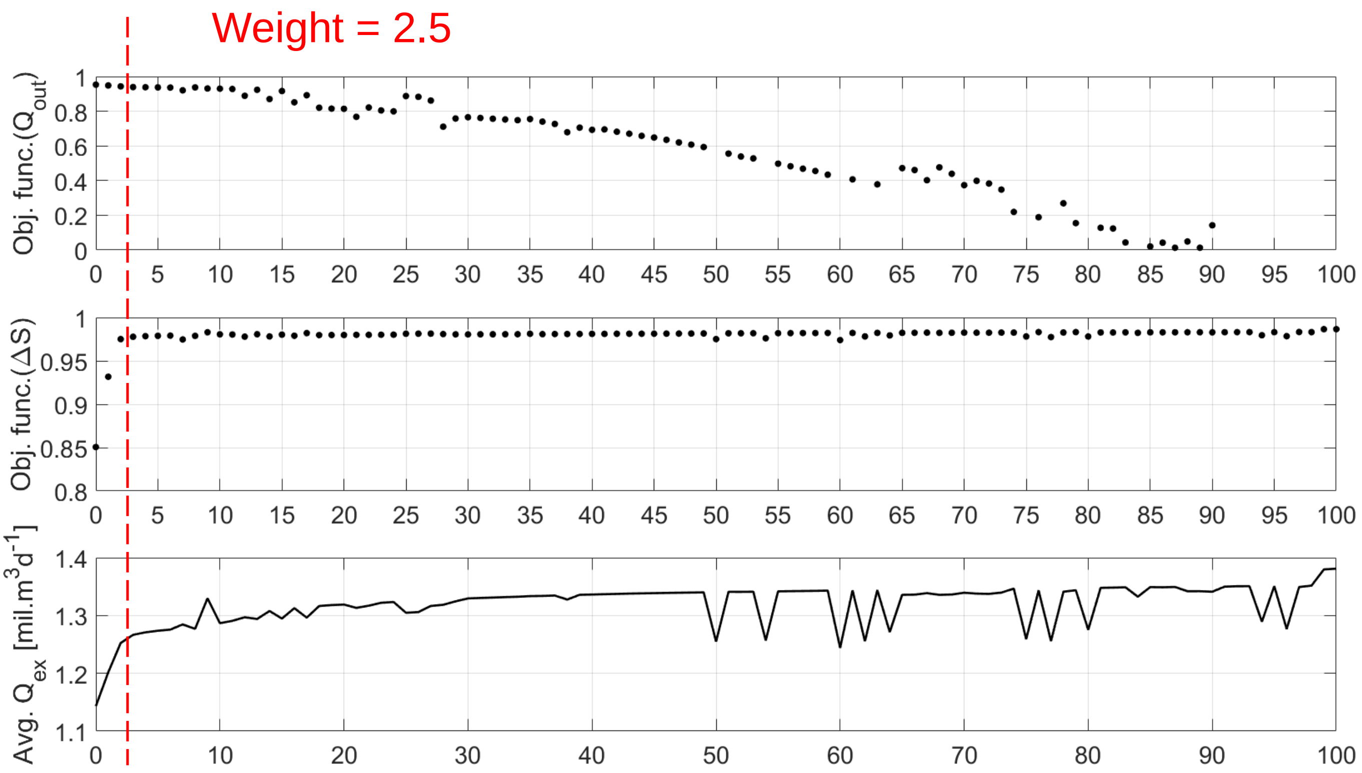
Model Results

Optimized parameters and ranges

Par.	Description	Unit	LB	UB	Opt.
UZL	Upper Reservoir Threshold	$mil.m^3$	0	100	1.82
$K1$	Recession Coeff. (Surface Flow)	(−)	0	1	0.05
$K2$	Recession Coeff. (Inter Flow)	(−)	0	1	2.91×10^{-10}
$K3_1$	Recession Coeff. (Base Flow 1)	(−)	0	1	0.18
$K3_2$	Recession Coeff. (Base Flow 2)	(−)	0	1	0.04
$K3_3$	Recession Coeff. (Base Flow 3)	(−)	0	1	0.17
$K3_4$	Recession Coeff. (Base Flow 4)	(−)	0	1	0.08
$\alpha1$	Coeff. of power function	(−)	0	7.7	0.15
$\alpha2$	Coeff. of power function	(−)	0	1	0.11
$P1$	Percent. of Base Flow 1	%	0.01	0.5	0.52
$P2$	Percent. of Base Flow 2	%	0.01	1-P1-P3	0.46
$P3$	Percent. of Base Flow 3	%	0.01	0.5	0.02

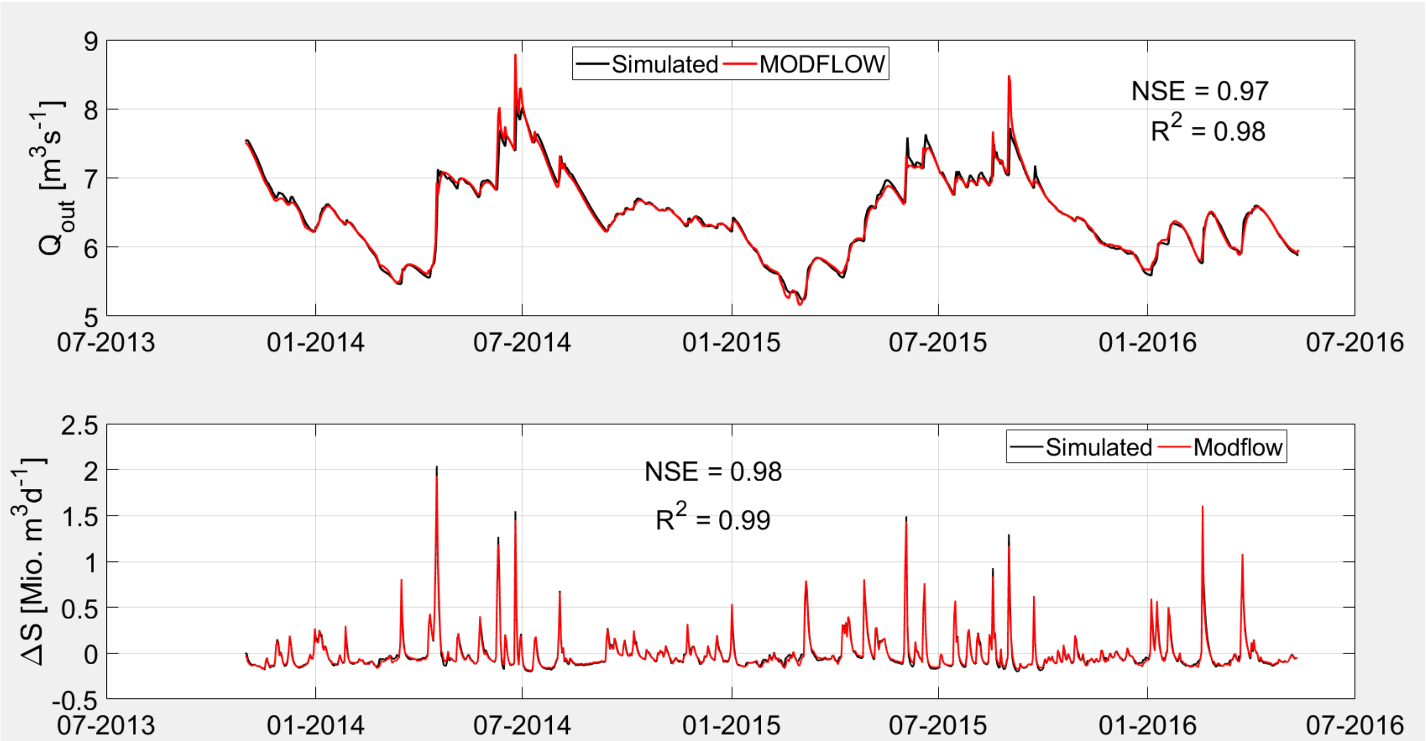
Model Results

Calibration



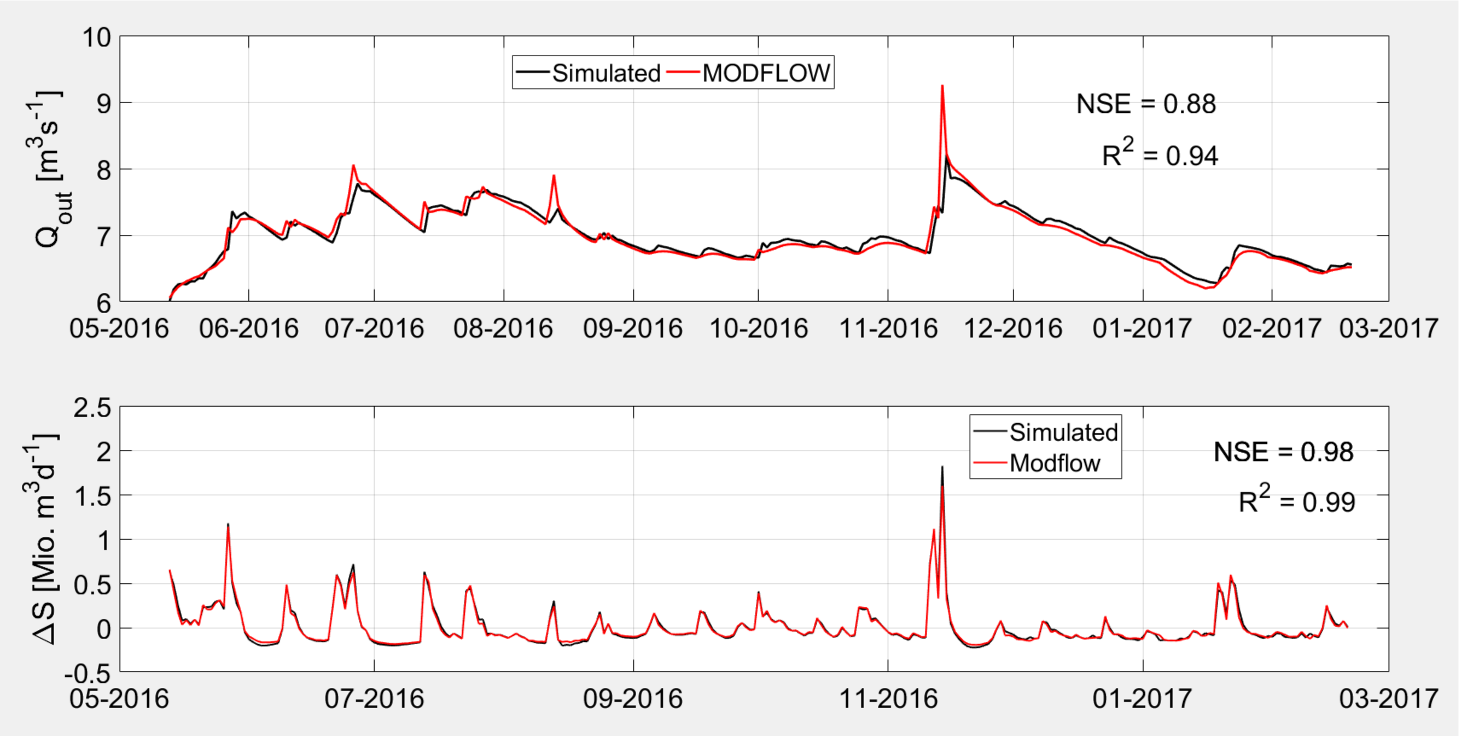
Model Results

Calibration



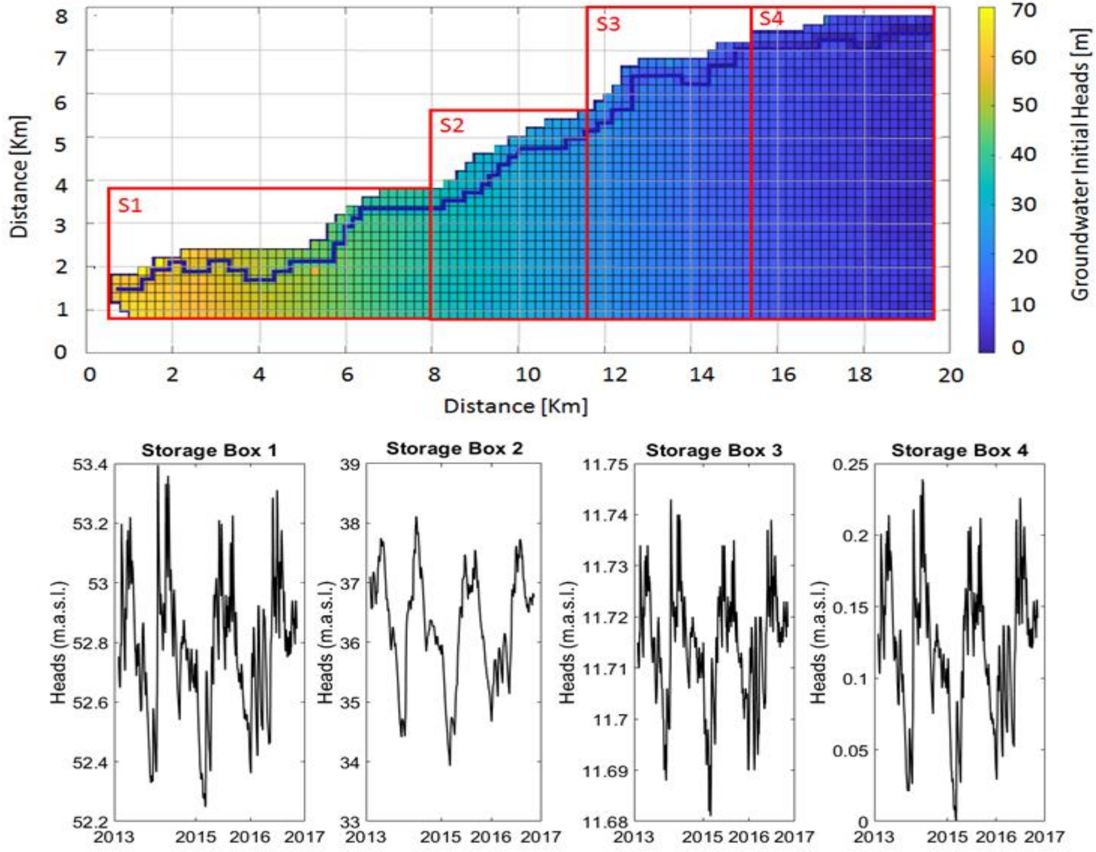
Model Results

Validation



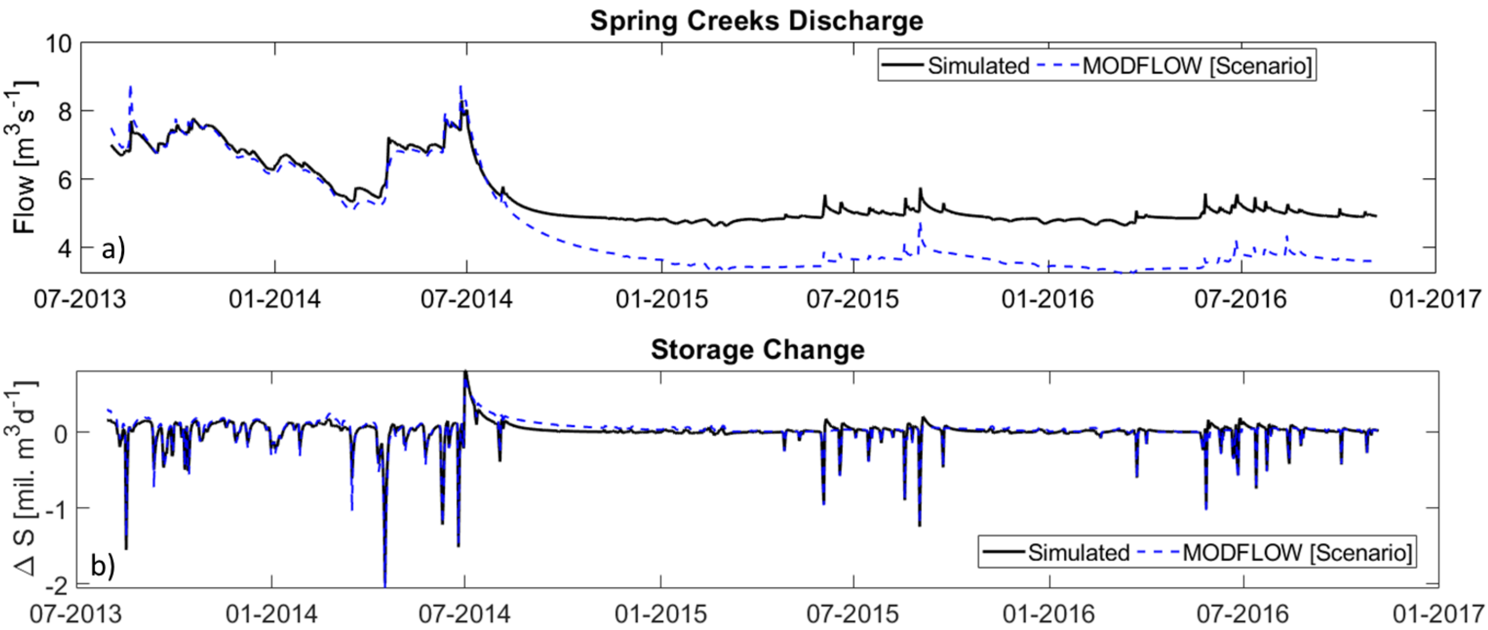
Model Results

Validation: Natural behaviour of groundwater levels



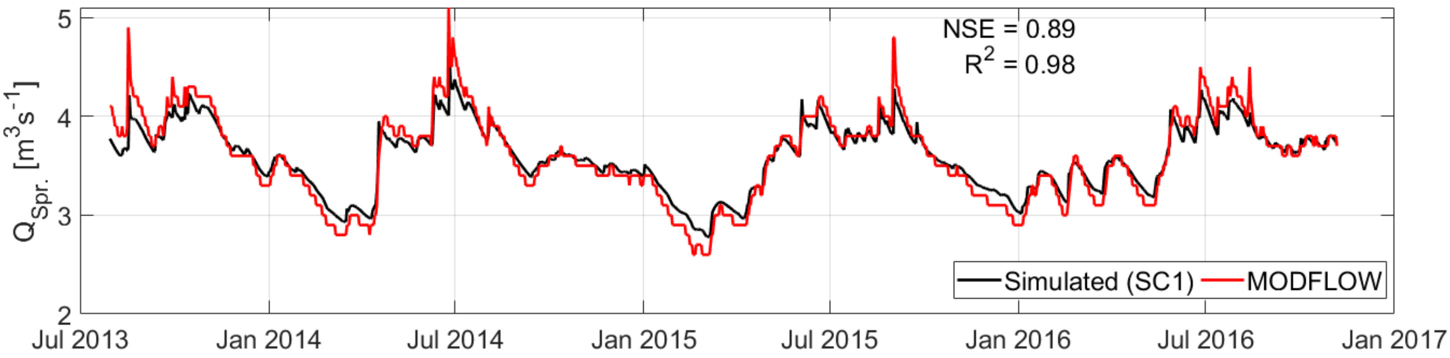
Model Results

Validation: Extreme case

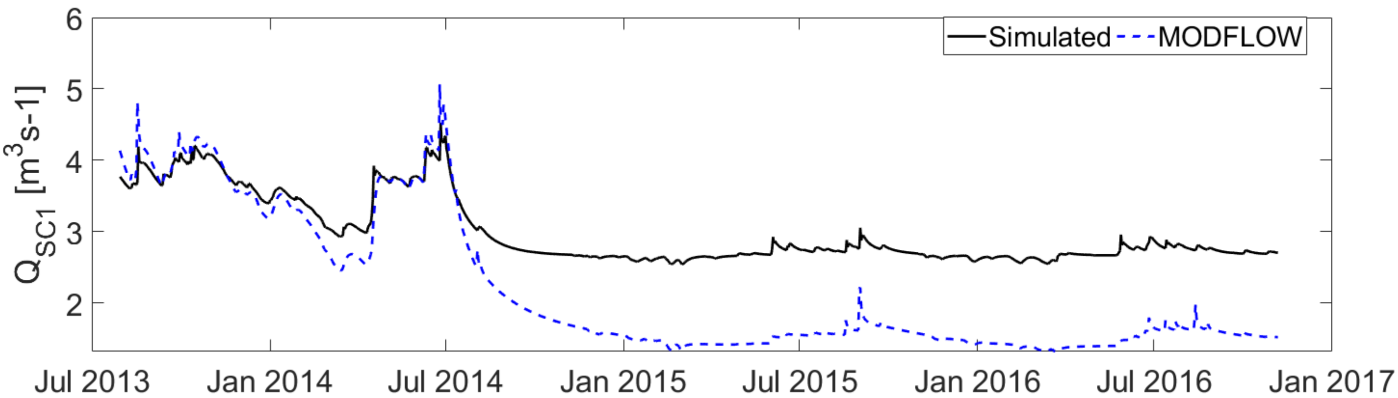


Model Results

SC1 under Extreme Scenario (dynamic)



Limitation of competually lumped models



Conclusions

- LHgM really helps to solve problems without going into too much complexity,
- Water budget closure during calibration is necessary,
- Consideration of geological information helps to characterize natural behaviour,
- Limitations compared to pde based models,
- Useful specially in data scarce regions.

Reference

- https://dashboard.wikiedu.org/courses/University_of_Georgia/Hydrologic_Modeling_(Spring_2017)/uploads accessed on 30-04-2020
- Thomas Wo• hling, Moritz J. Gosses, Quantifying river621 groundwater interactions of new zealand's gravel-bed rivers: The Wairau plain, Groundwater (2018).
- S. Wilson, Wairau aquifer stratigraphy review. Technical Report 1053- 670 1-R1., Technical Report, Chistchurch, New Zealand: Lincoln Agritech 671 Ltd., 2016.