Modelleren is mensenwerk

Lieke Melsen
Universitair Hoofddocent
Computational Hydrology

WAGENINGEN
UNIVERSITY & RESEARCH

WND-Conferentie Model-leren, 15 december 2023

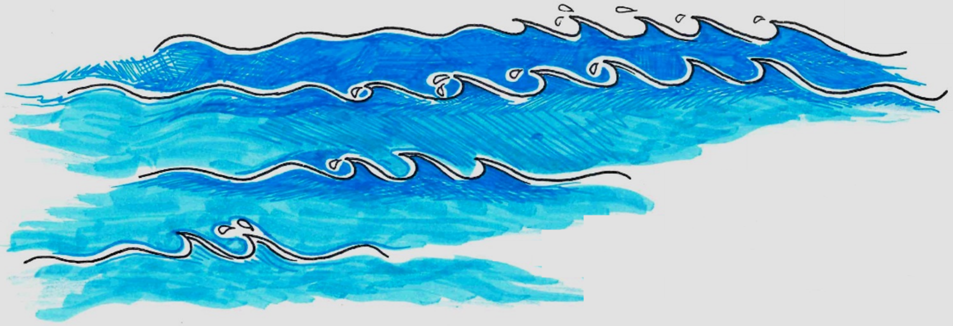
“Een hypothese van hoe een systeem werkt, gecodificeerd in kwantitatieve termen”

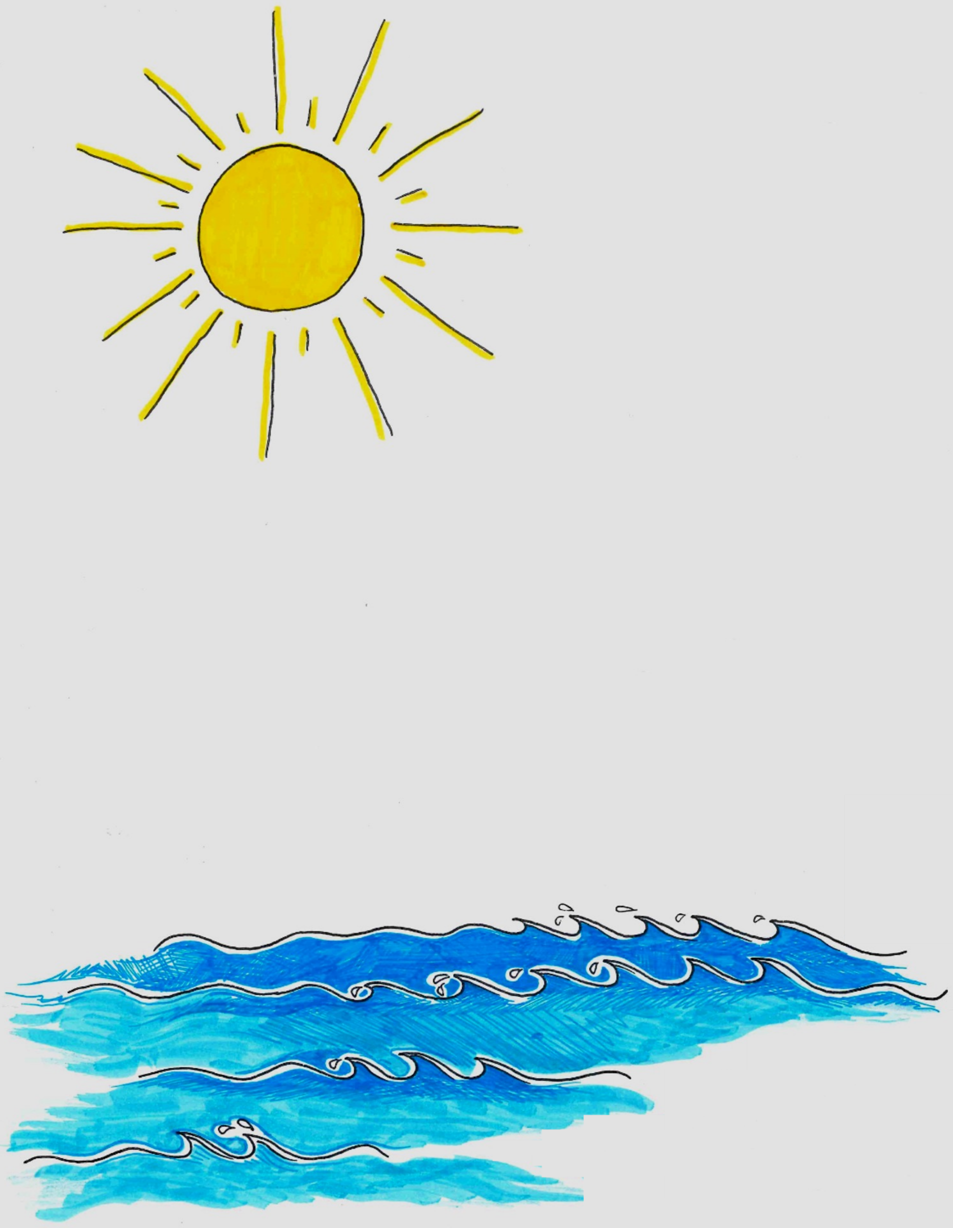
Savenije, H. (2009), HESS Opinions: The Art of Hydrology, HESS 13, 157-161.

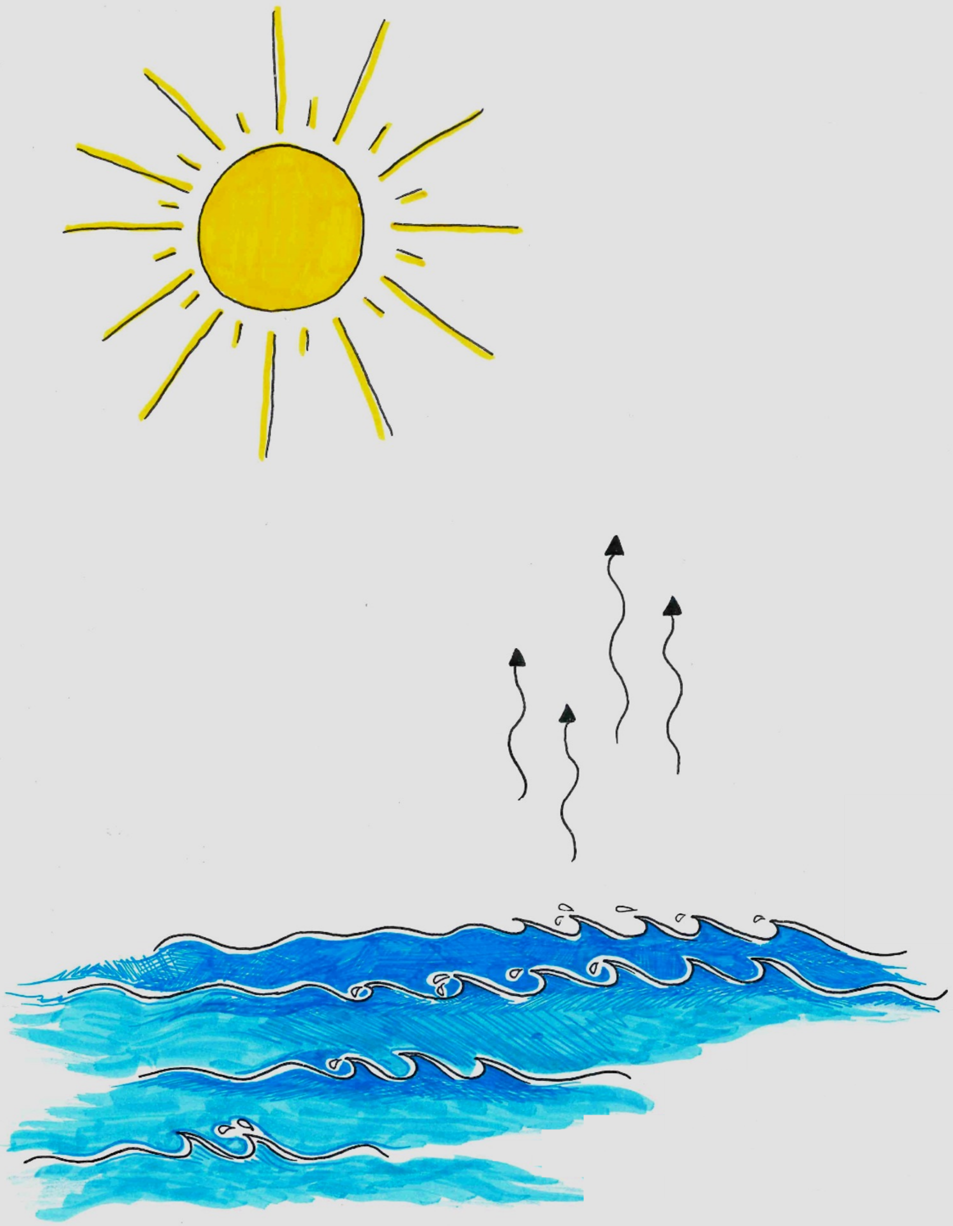

Perceptueel model:
Het bepalen van de relevante processen
Mathematisch model:
Beslissen welke vergelijkingen het proces omschrijven
Procedureel model:
De code runnen op een computer
IJking, gevoeligheidsanalyse, onzekerheidsanalyse
Evaluatie:
Vergelijk modelresultaten met observaties

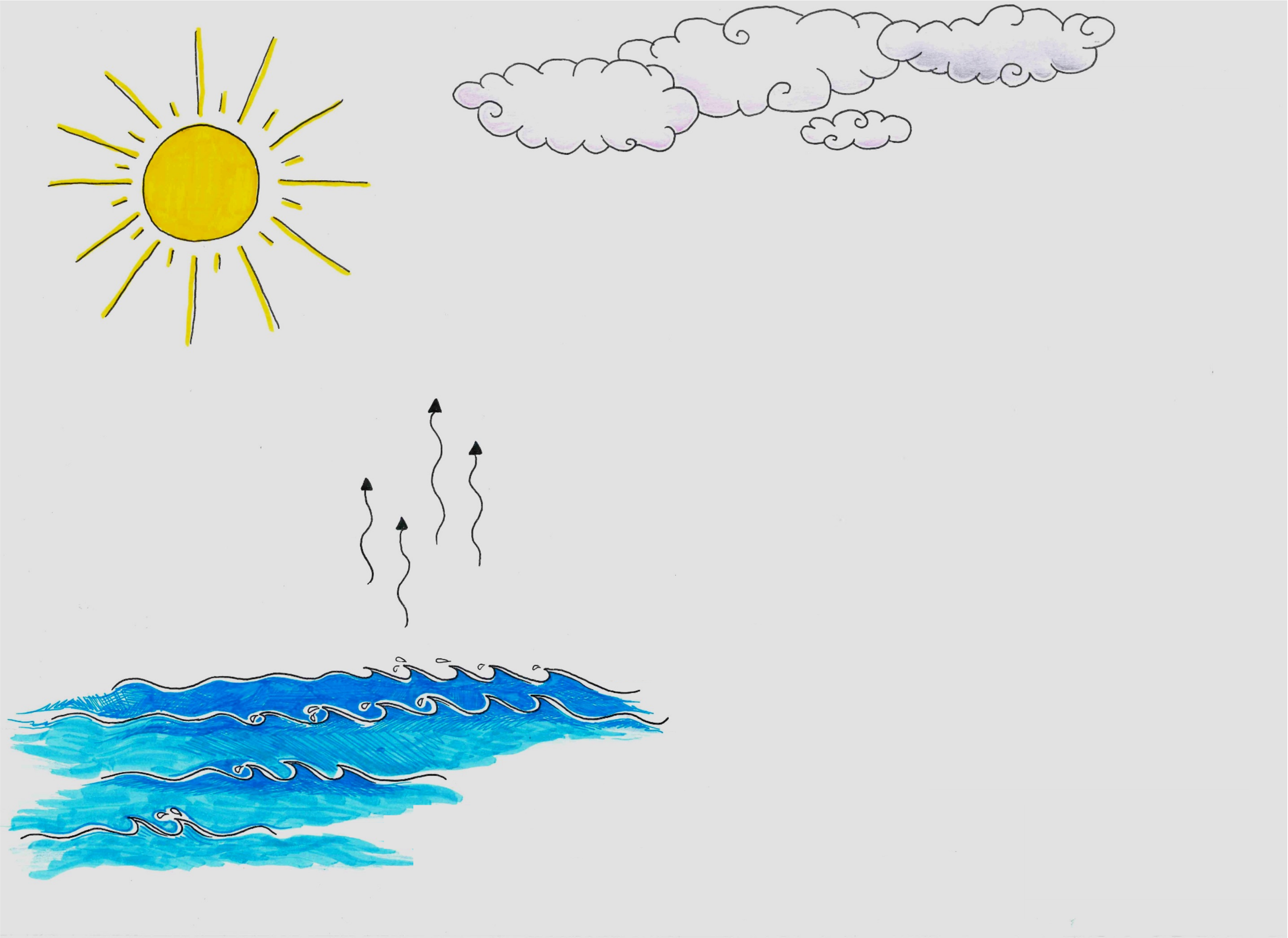
Modellen zijn inherent onzeker…

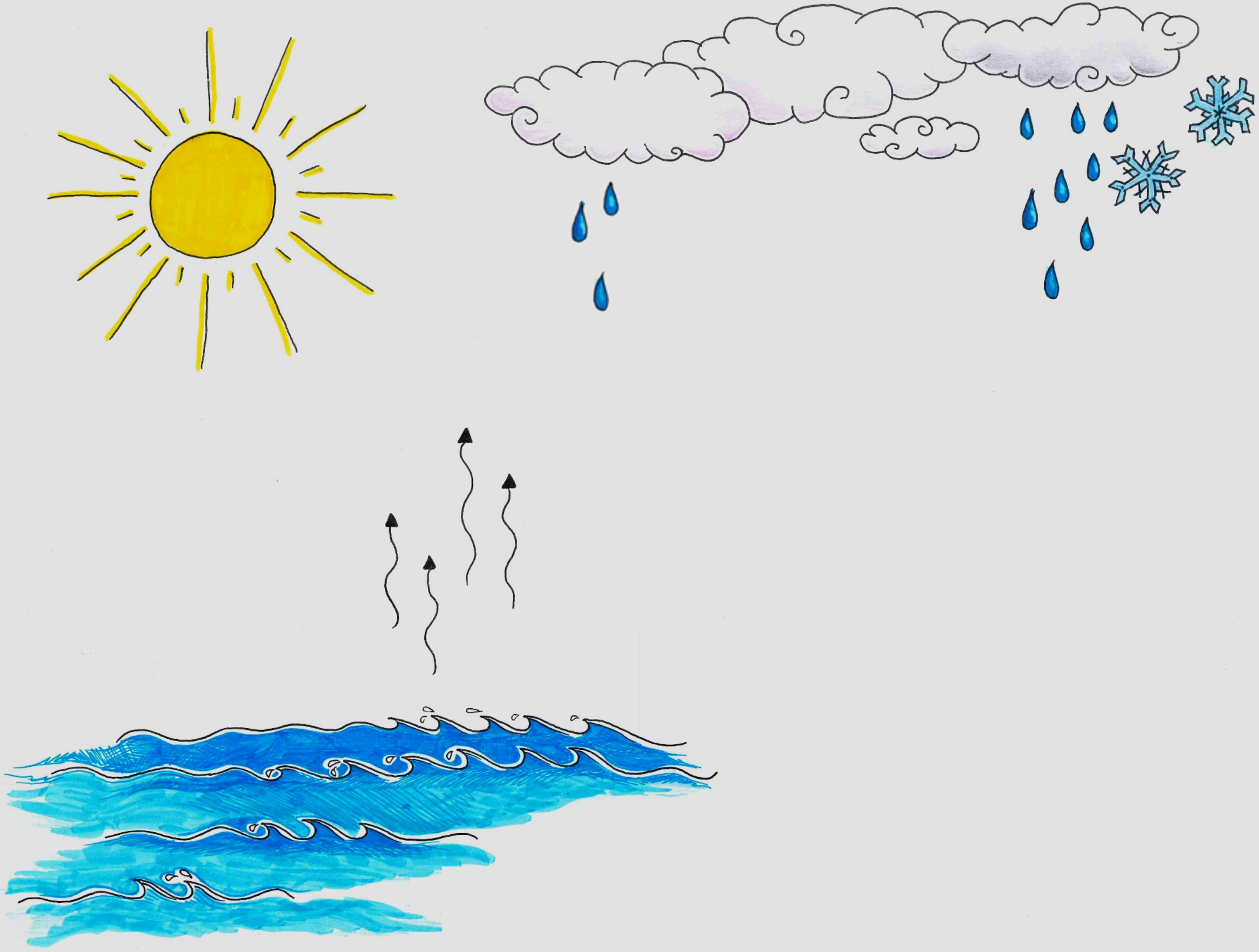
- Data
- Parameters
- Model structuur

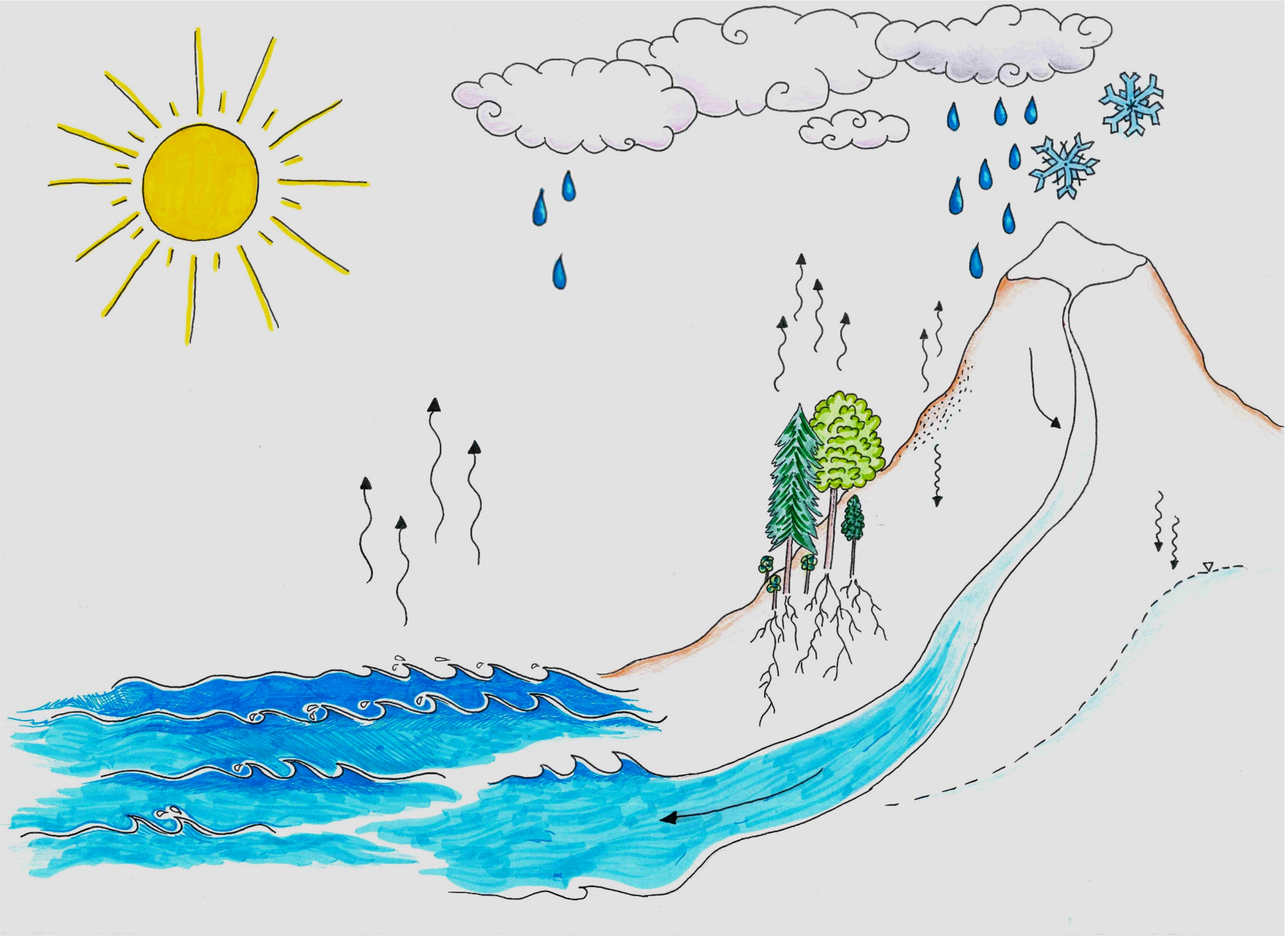


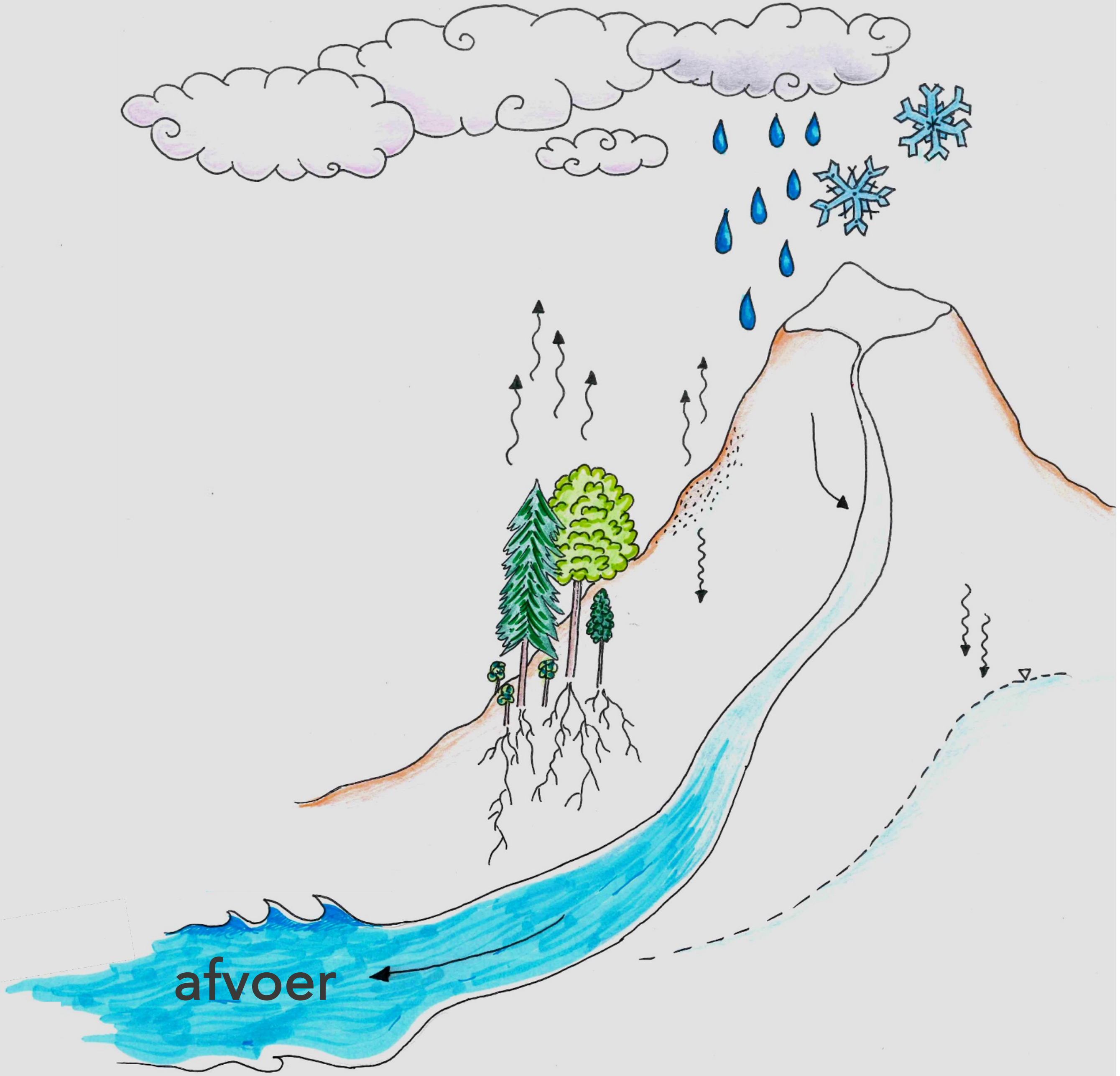








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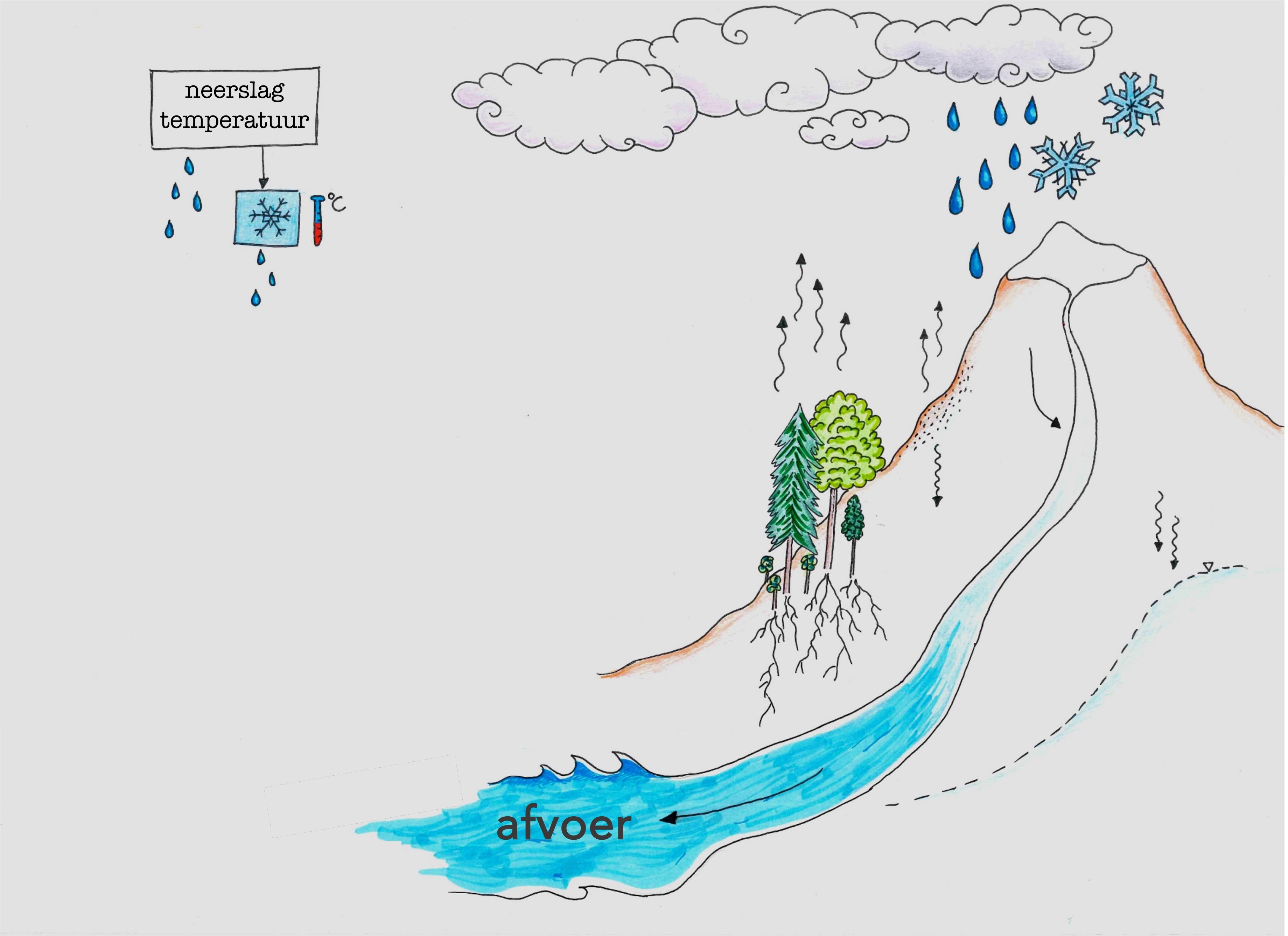
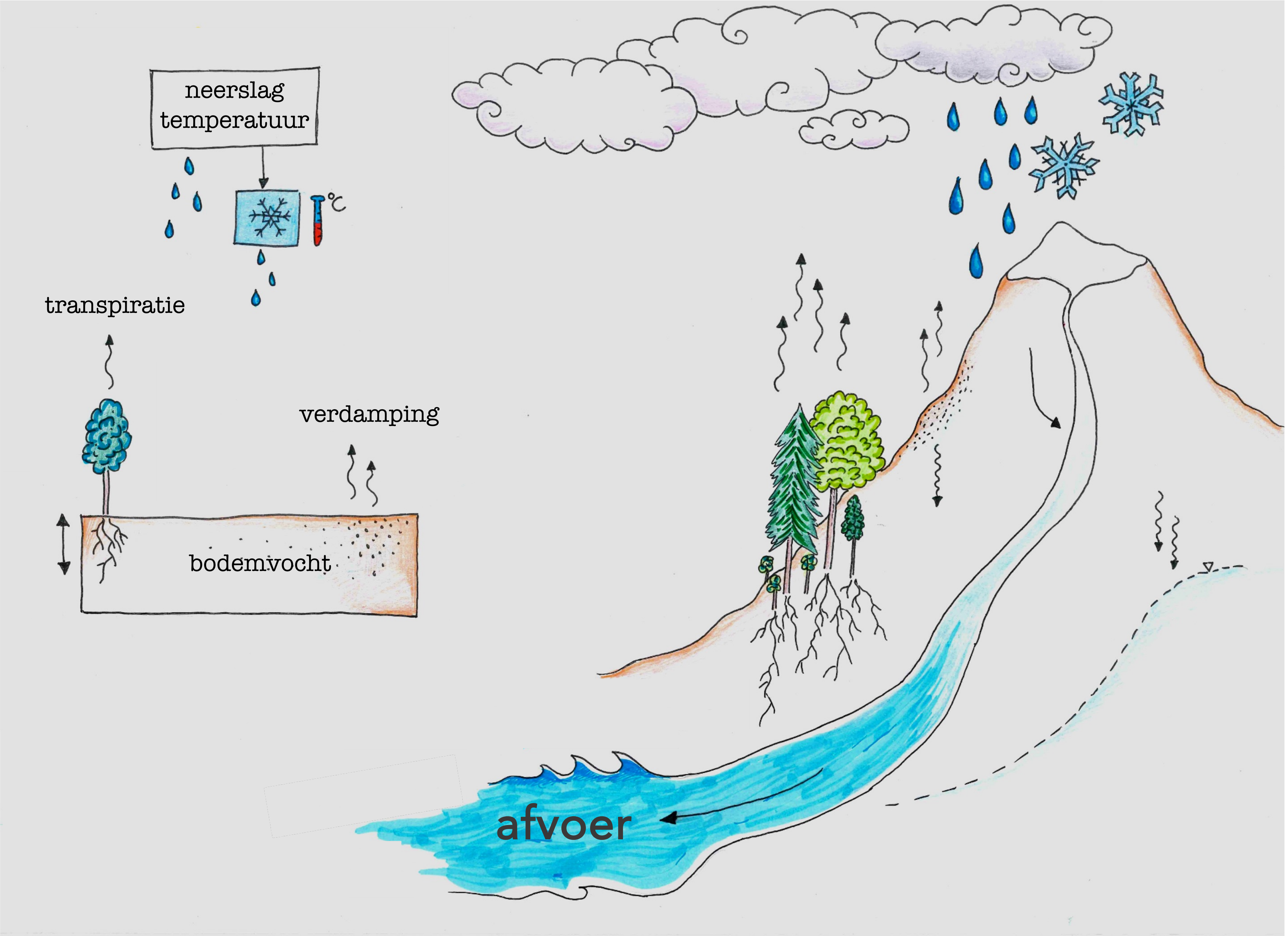

neerslag
temperatuur
°C
afvoer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temperatuur
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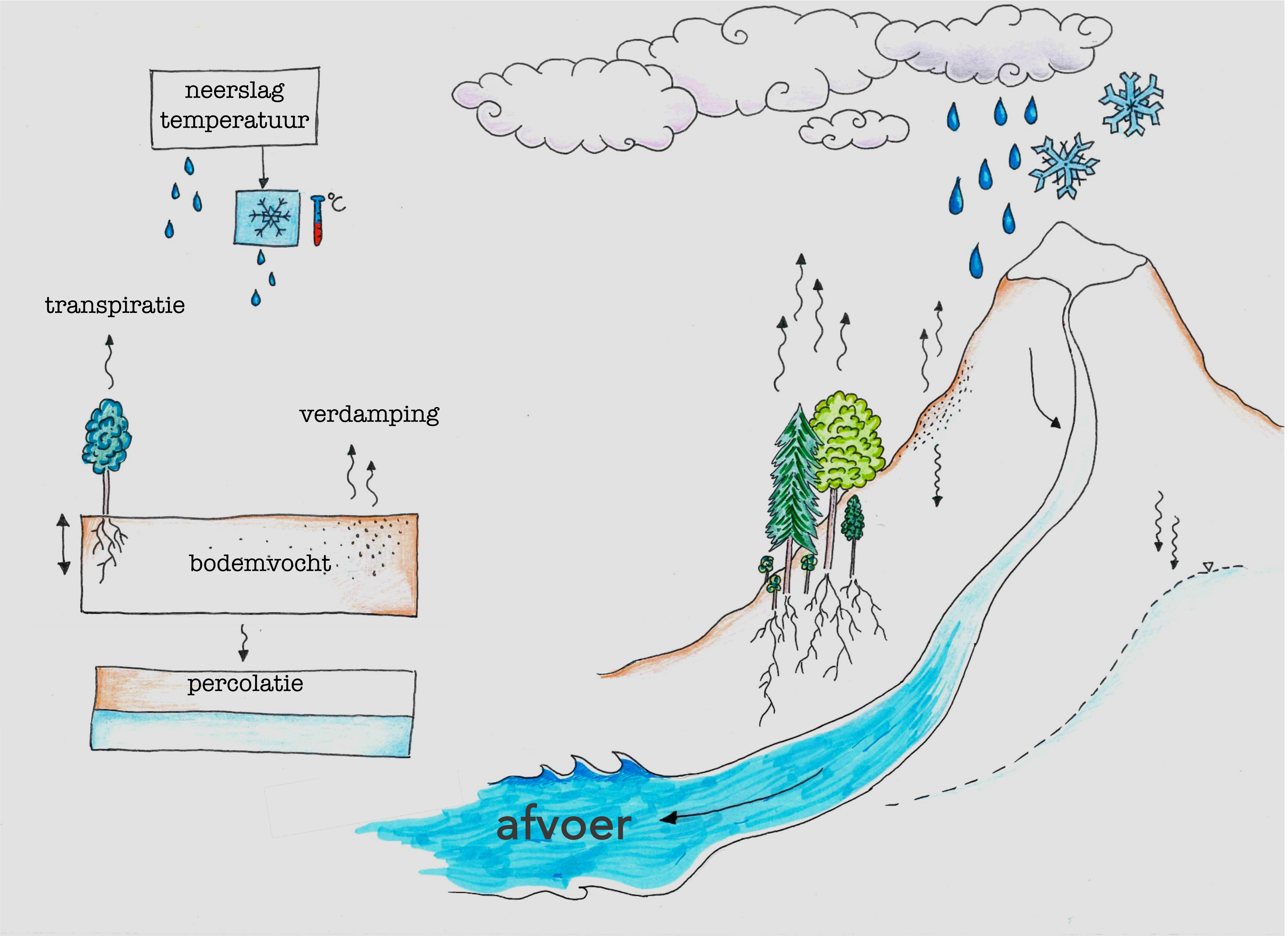
transpiratie
verdamping
bodemvocht
afvoer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percolatie
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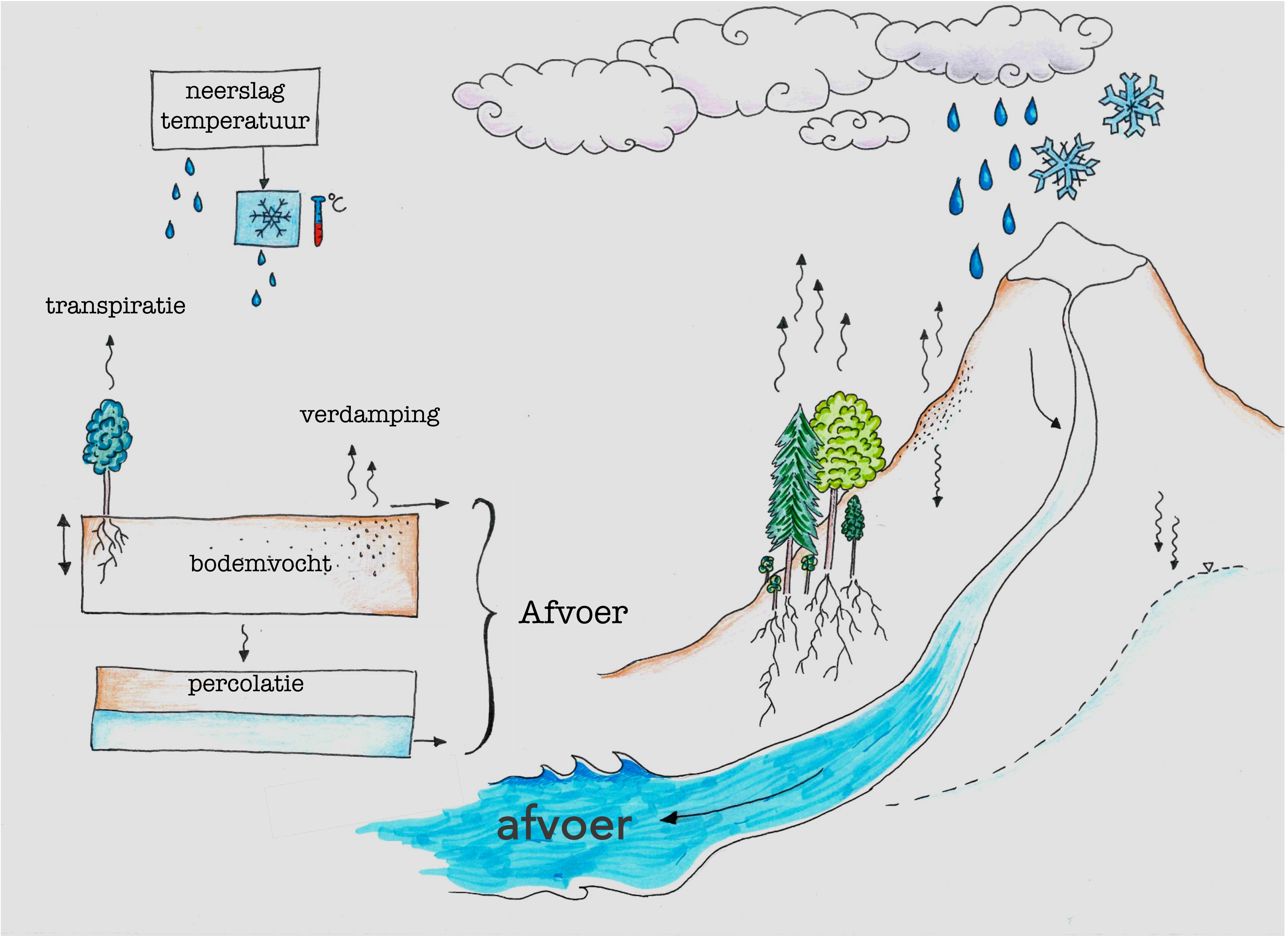
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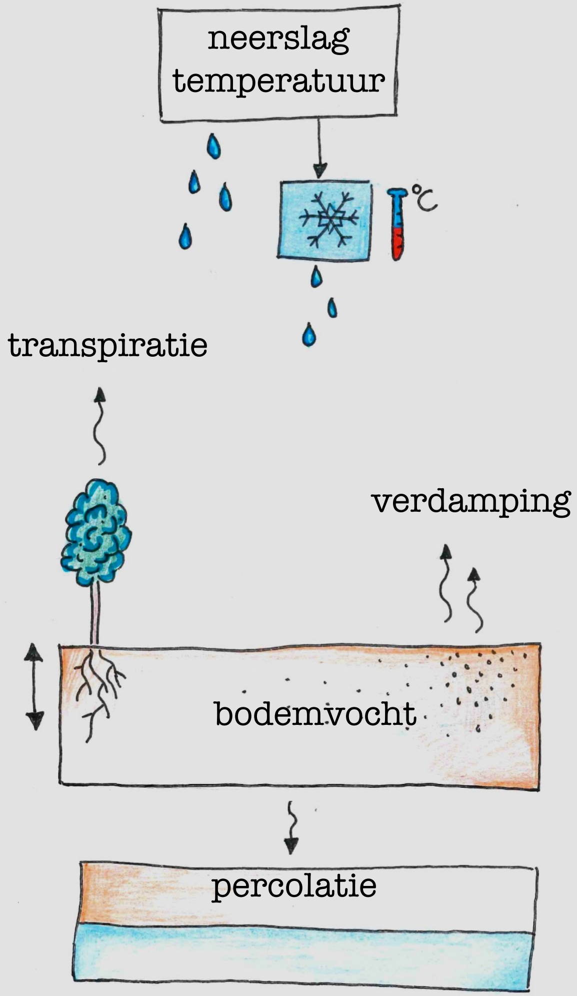
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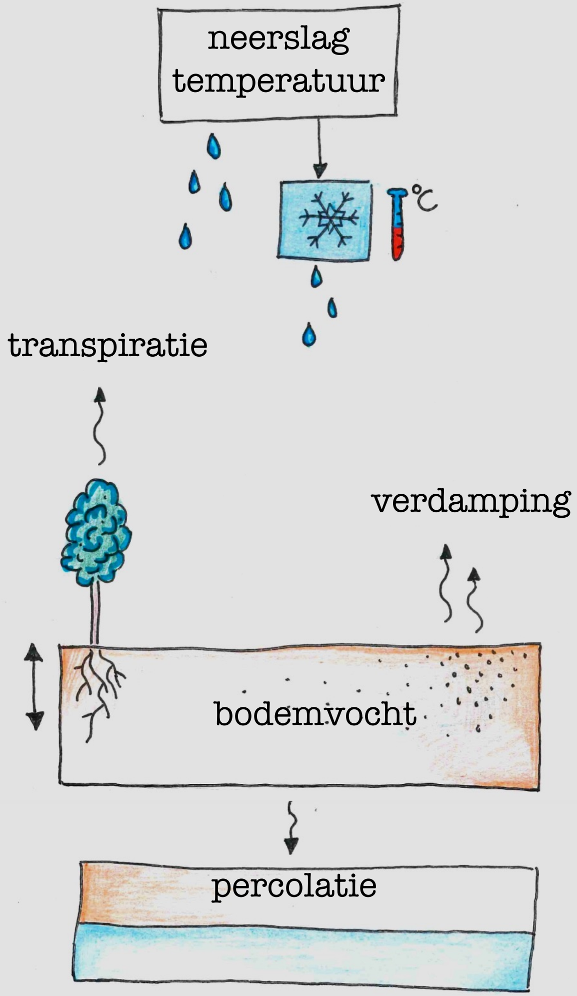
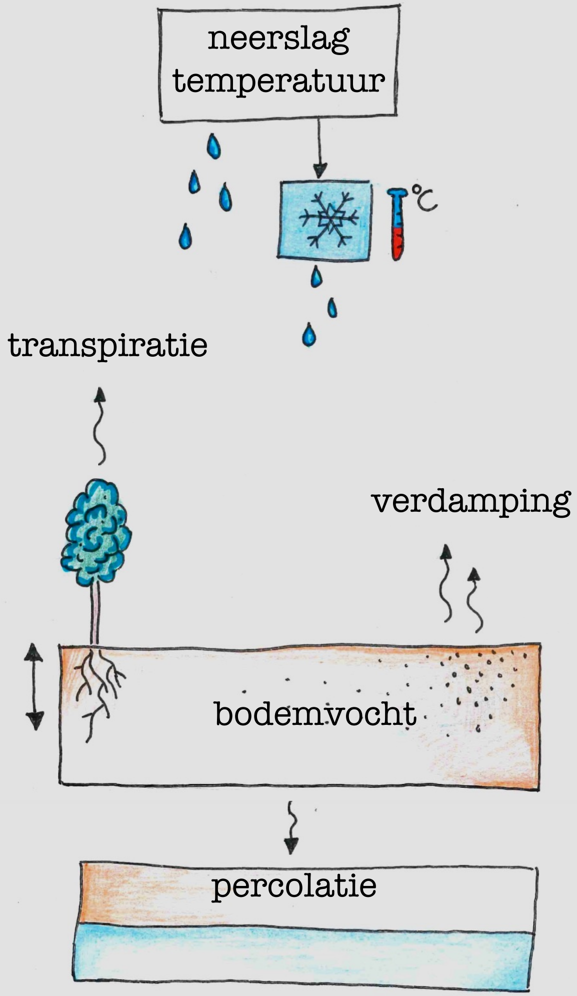


$$Q_b = \begin{cases} \frac{d_s d_m}{w_s W_2^c} \cdot W_2 & \text{if} \quad 0 \leq W_2 < w_s W_2^c \\ \frac{d_s d_m}{w_s W_2^c} \cdot W_2 + \left(d_m - \frac{d_s d_m}{w_s}\right)\left(\frac{W_2 - w_s W_2^c}{W_2^c - w_s W_2^c}\right)^g & \\ \qquad \text{if} \quad W_2 \geq w_s W_2^c & \end{cases}$$



$$ET_o = \frac{0.408\Delta\left(R_n - G\right) + \gamma \dfrac{900}{T+273} u_2 \left(e_s - e_a\right)}{\Delta + \gamma\left(1 + 0.34 u_2\right)}$$

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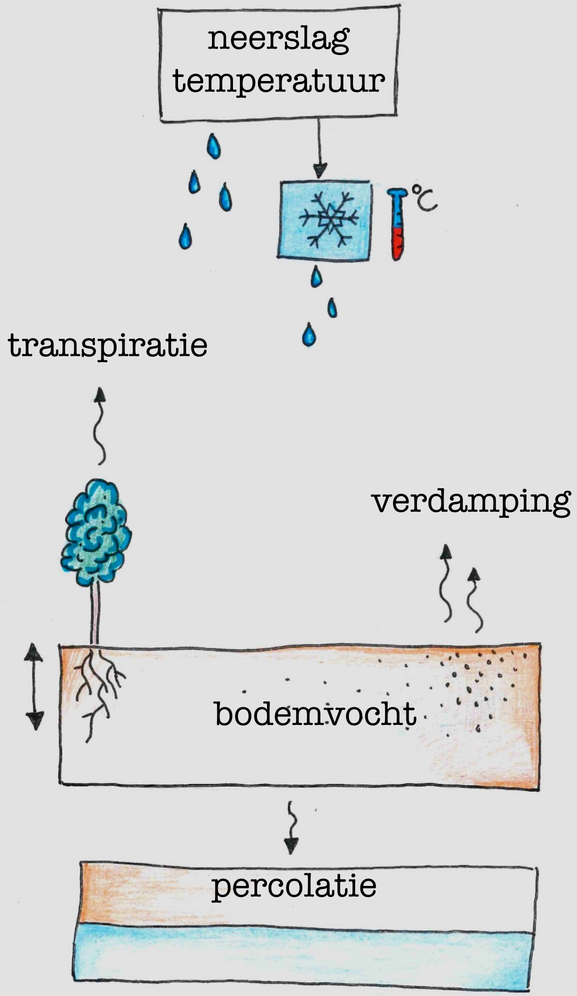

$$M = a\,(T_a - T_b)$$

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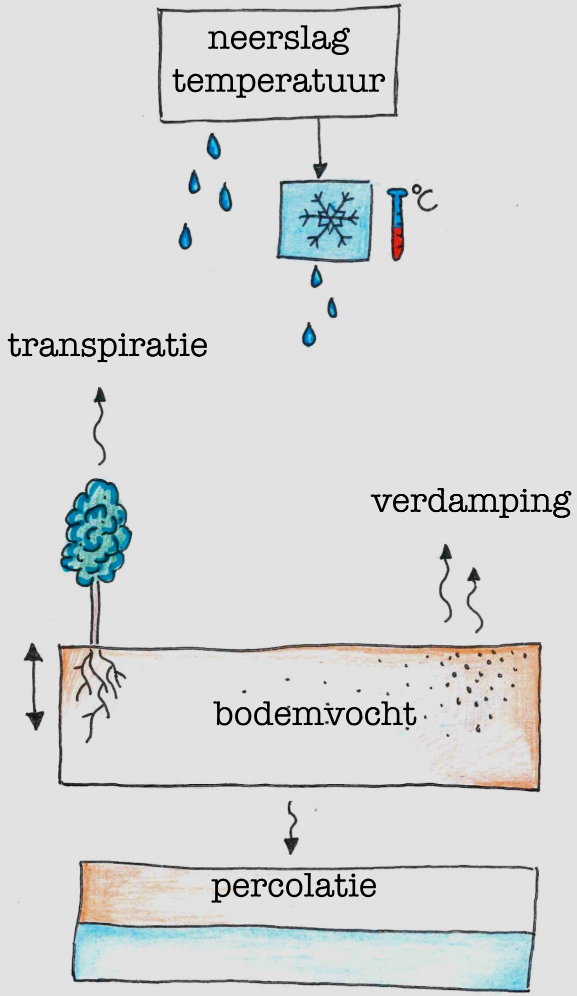
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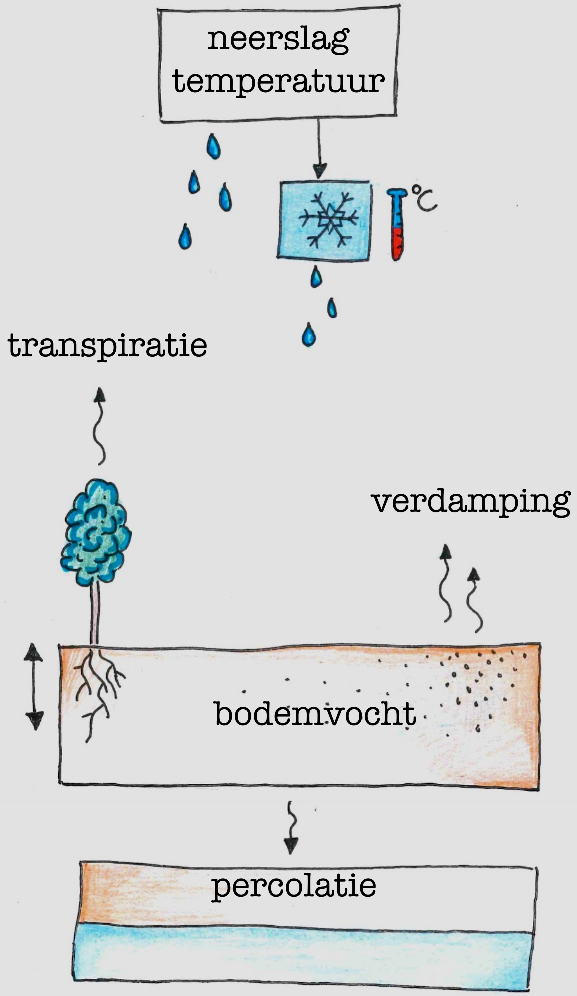
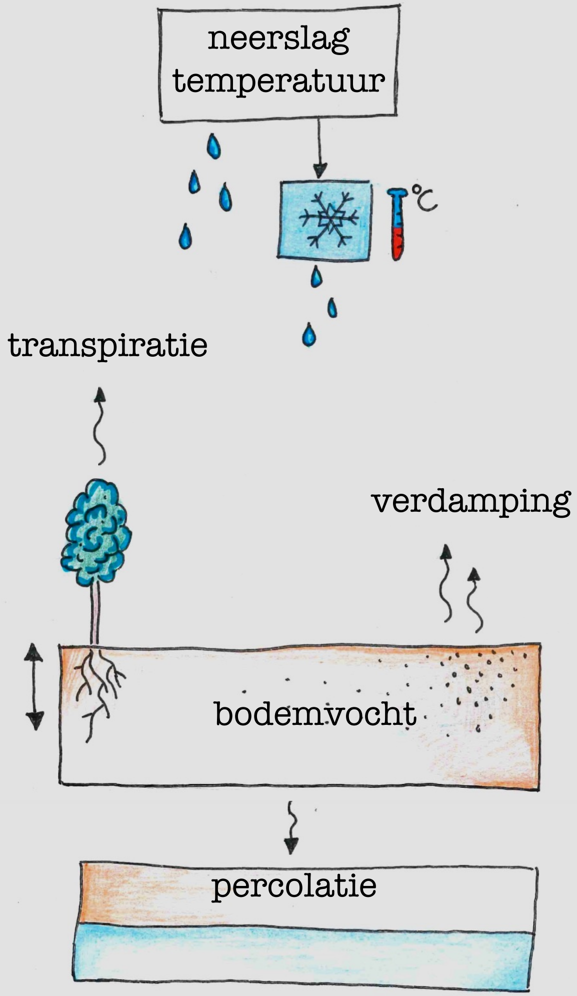


$$M = a\,(T_a - \mathrm{T_b})$$

M = sneeuwsmelt
a = factor
T_a = waargenomen temperatuur
$\mathrm{T_b}$ = temperatuur waarbij sneeuw begint te smelten



parameters

$$M = a\,(T_a - T_b)$$

variabele

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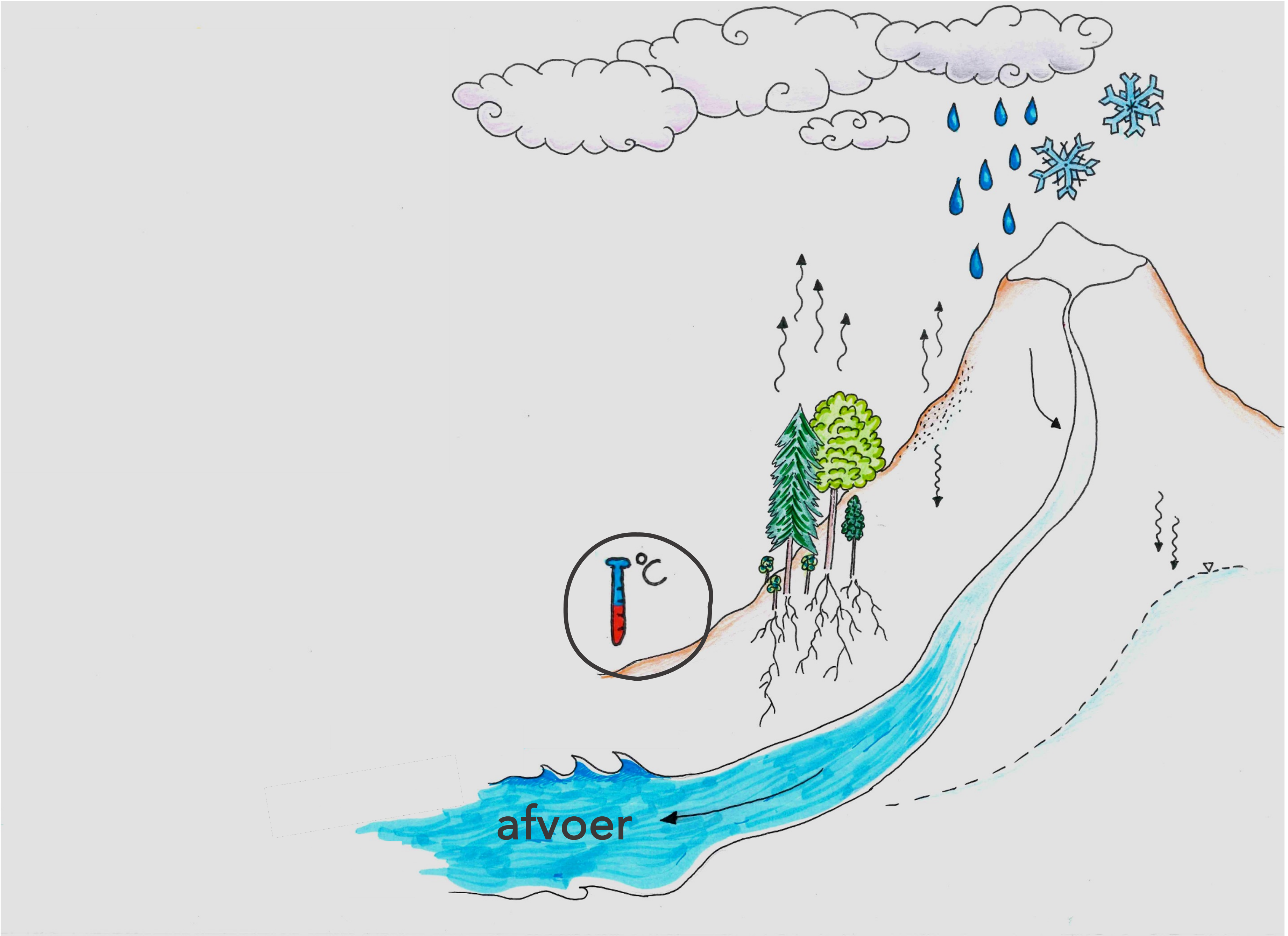
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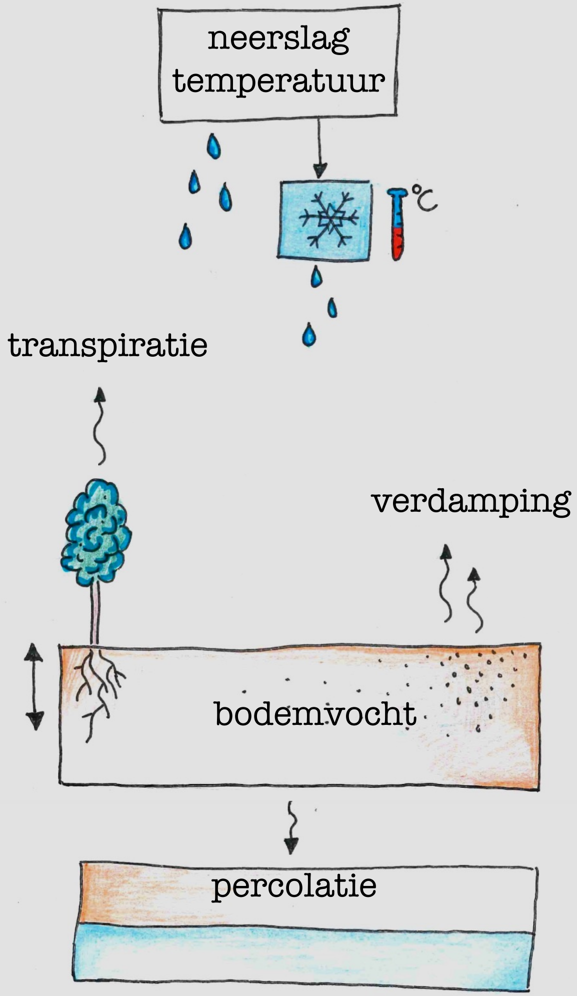

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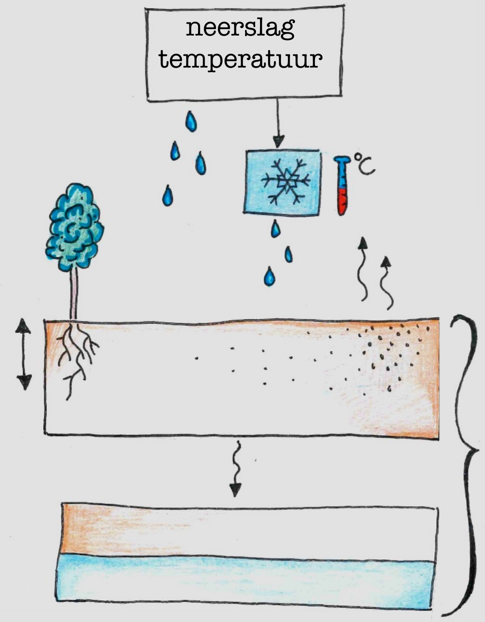
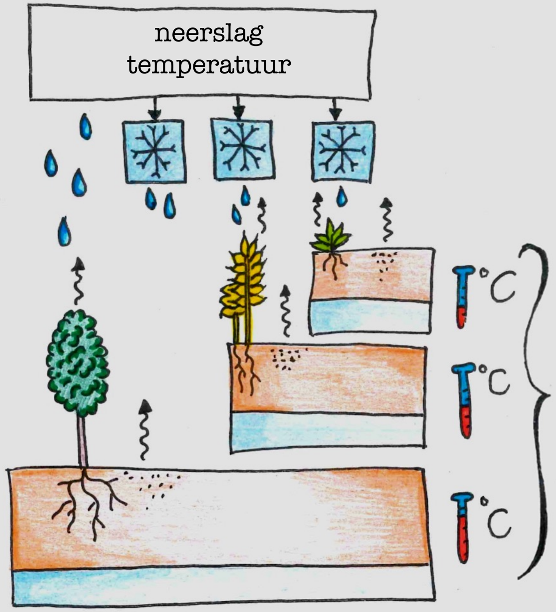
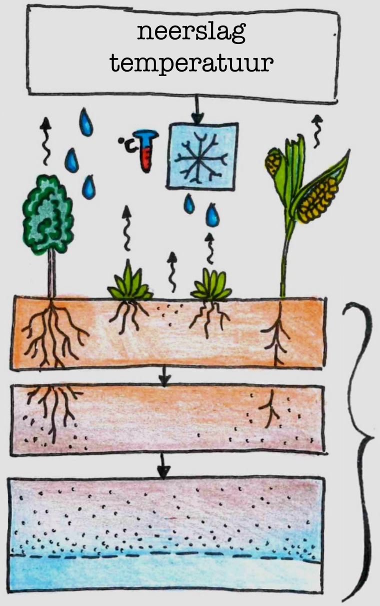


Model 2



Model 3



Modellen zijn inherent onzeker…

- Data
- Parameters
- Model structuur

Modellen zijn inherent onzeker…

meetonzekerheid

- Data
- Parameters
- Model structuur

Modellen zijn inherent onzeker…

- Data
- Parameters
- Model structuur

meetonzekerheid

afhankelijkheid andere modellen

Modellen zijn inherent onzeker…

- Data
  - meetonzekerheid
  - afhankelijkheid andere modellen
- Parameters
  - schaalverschillen
  - versimpelde processen
- Model structuur

Modellen zijn inherent onzeker…

- Data
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meetonzekerheid

afhankelijkheid andere modellen

schaalverschillen

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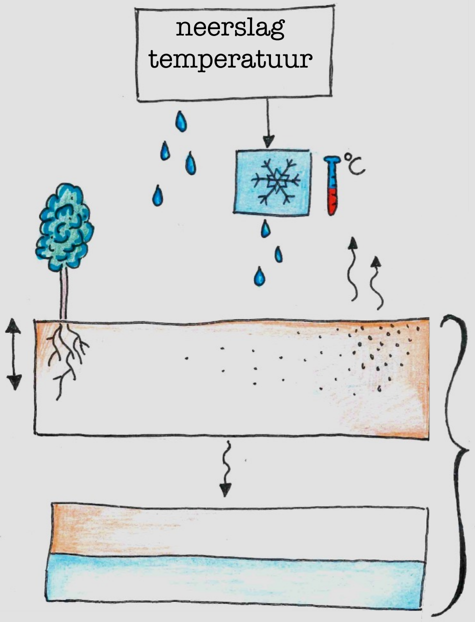
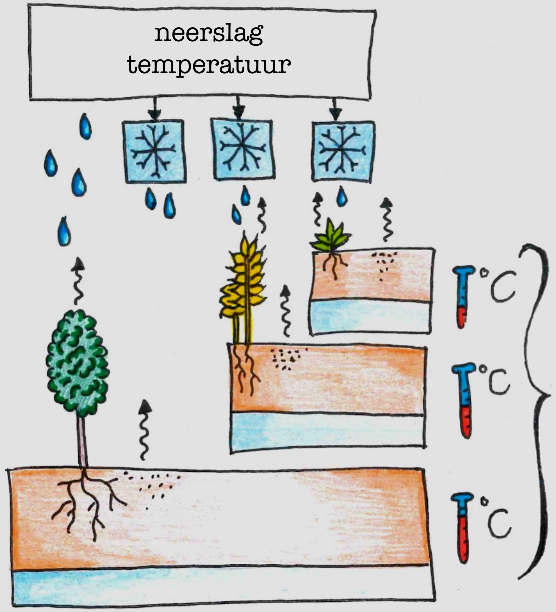
Modellen zijn inherent onzeker…

- Data
  - meetonzekerheid
  - afhankelijkheid andere modellen
- Parameters
  - schaalverschillen
  - versimpelde processen
- Model structuur
  - versimpelde processen
  - verkeerde proces-beschrijving
  - onbekend(e) proces / interactie

Model 1



Model 2



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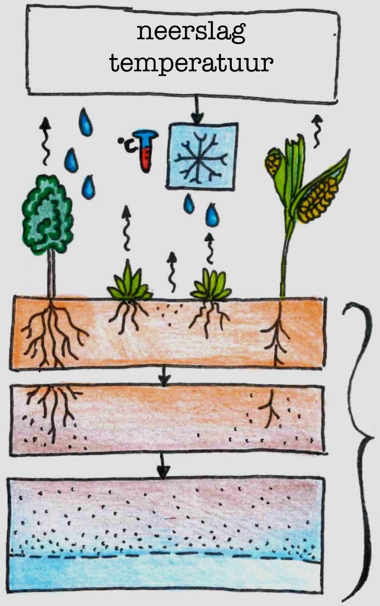


Kies een bestaand model
IJking, gevoeligheidsanalyse, onzekerheidsanalyse
Evaluatie:
Vergelijk modelresultaten met observaties

1529 wetenschappelijke studies (1990-2018)

Affiliatie van
de eerste auteur

Land waar het model
is toegepast

Onderzoeksvariabele

Ruimtelijke schaal

Temporele schaal

Landschaps-
karakteristieken

Importance of soil moisture measurements for inferring parameters in hydrologic models of low-yielding ephemeral catchments

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Received 21 March 2001; received in revised form 17 February 2002; accepted 16 April 2002

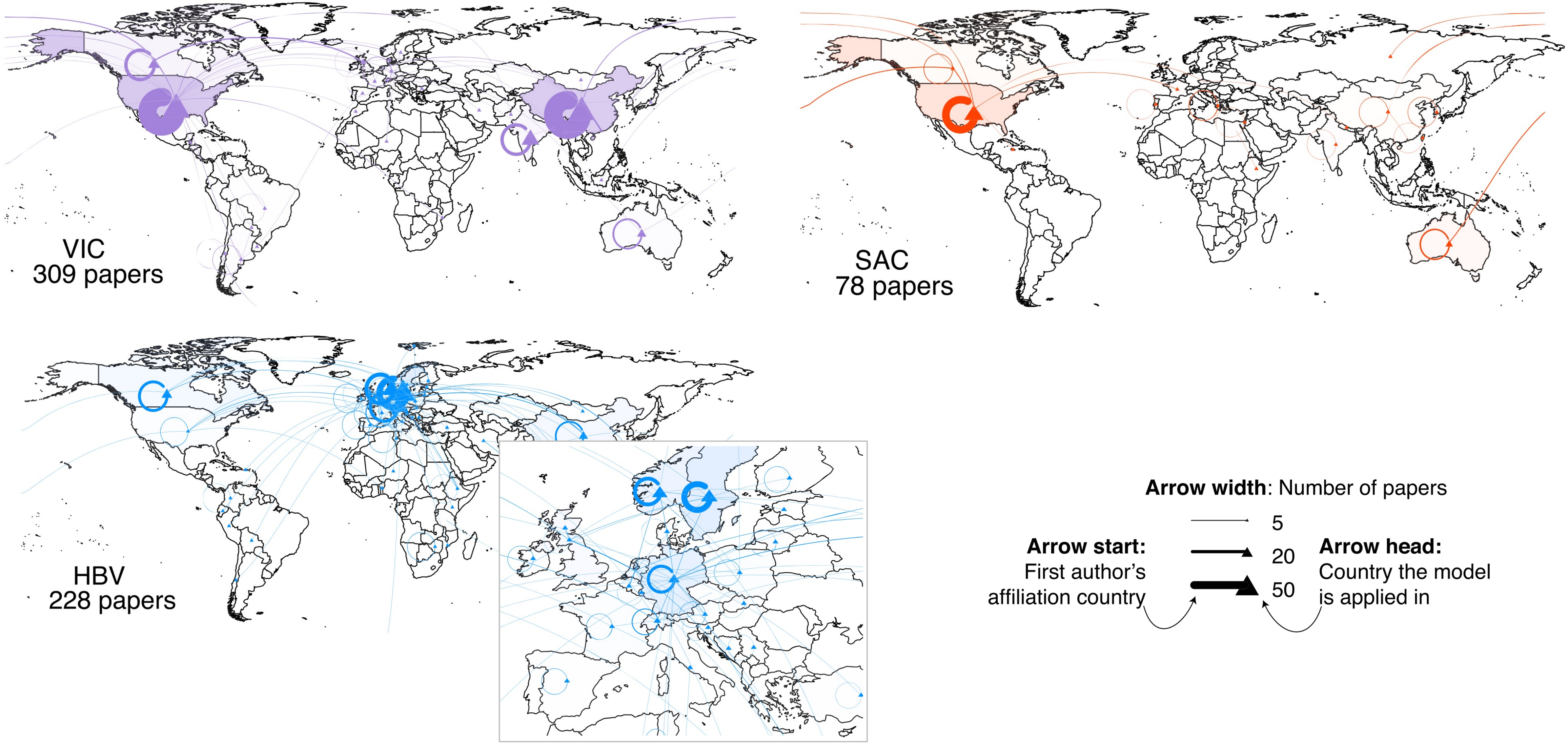
Abstract

Low-yielding catchments with ephemeral streams provide a stern test of the capability of conceptual catchment models for predicting the hydrologic response of the natural landscape. Sustained periods of little or no flow mean that the information content of the streamflow time-series for parameter estimation is limited. During periods with no streamflow, such ephemeral catchments also offer no information on a catchment's soil moisture status. As a result, parameters estimated solely from streamflow data are often poorly identified and span a wide range of the feasible parameter space. These general observations were confirmed by an application of the conceptual VIC model in a 6 ha experimental catchment in eastern Australia. Using a Monte Carlo style assessment of parameter uncertainty, it was shown that the simple three-parameter model was ill-posed when calibrated solely to the streamflow response. Failure of the calibration procedure to distinguish unique antecedent moisture storage conditions prior to large rainfall events meant that the observed streamflow response could be replicated from a large envelope of potential parameter combinations. The inclusion of an estimated time-series index of *areal* soil moisture status into the calibration procedure, however, significantly reduced the number of feasible parameter combinations, and resulted in predictions that confirmed Bowen ratio measurements of actual evapotranspiration. Attempts to further reduce parameter uncertainty by including the measured evapotranspiration data into the joint calibration procedure were unsuccessful. The shortness of the measurement record was seen as a major factor inhibiting improvement. The results of this study highlight the critical importance of antecedent moisture conditions on streamflow yields in ephemeral catchments and point to the desirability of spatio-temporal soil moisture accounting. Future research efforts are discussed in terms of establishing the appropriate spatial and temporal resolution of soil moisture measurements needed to extend the results observed for this small experimental study to larger catchments.

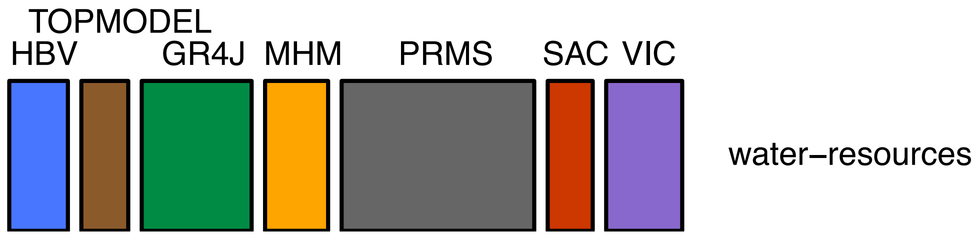
Keywords: Ephemeral catchments; Conceptual catchment models; Soil moisture; Evapotranspiration; Joint calibration; Parameter uncertainty; Monte Carlo sampling

Addor & Melsen, 2019. Legacy, rather than adequacy, drives the selection of hydrological models, WRR

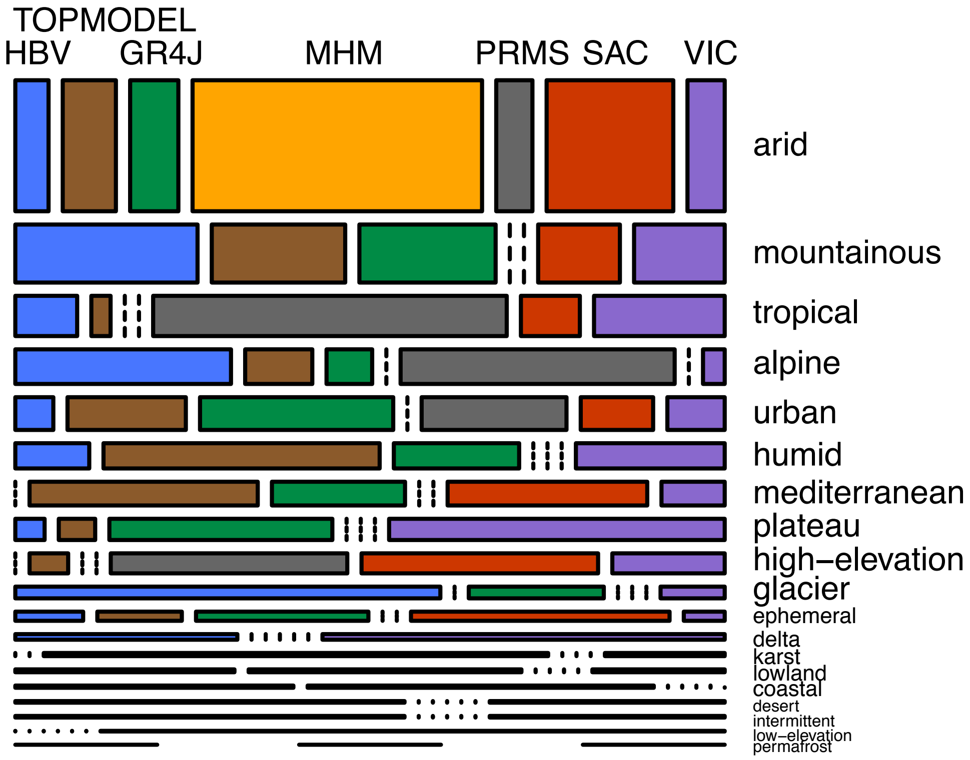
Geografische voorkeur in modelgebruik



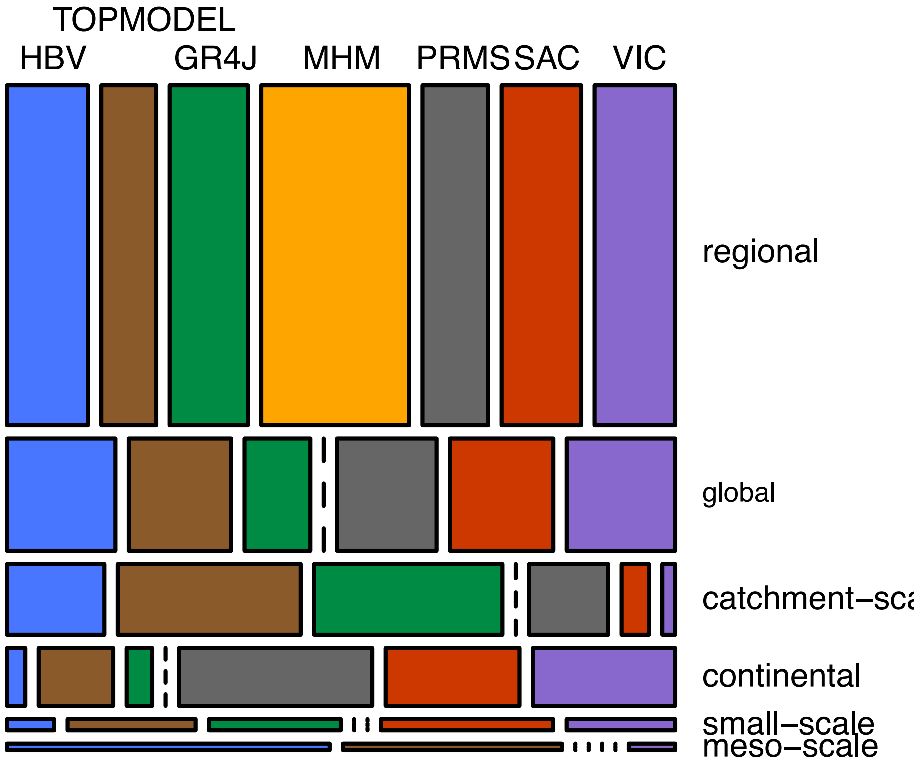
onderzoeksvariabele - 478 papers

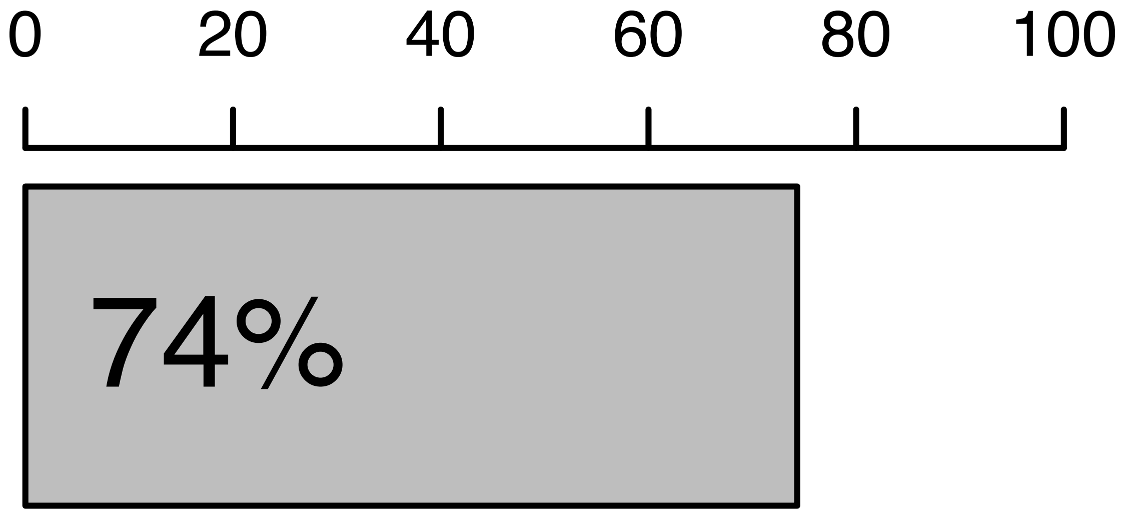


landschaps karakteristieken **- 260 papers**



ruimtelijke schaal **- 368 papers**





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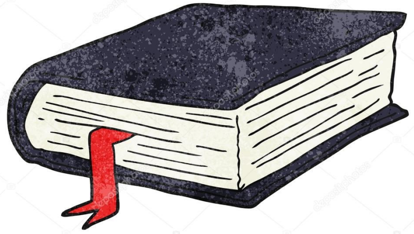


Ervaring

Model-
ecosysteem

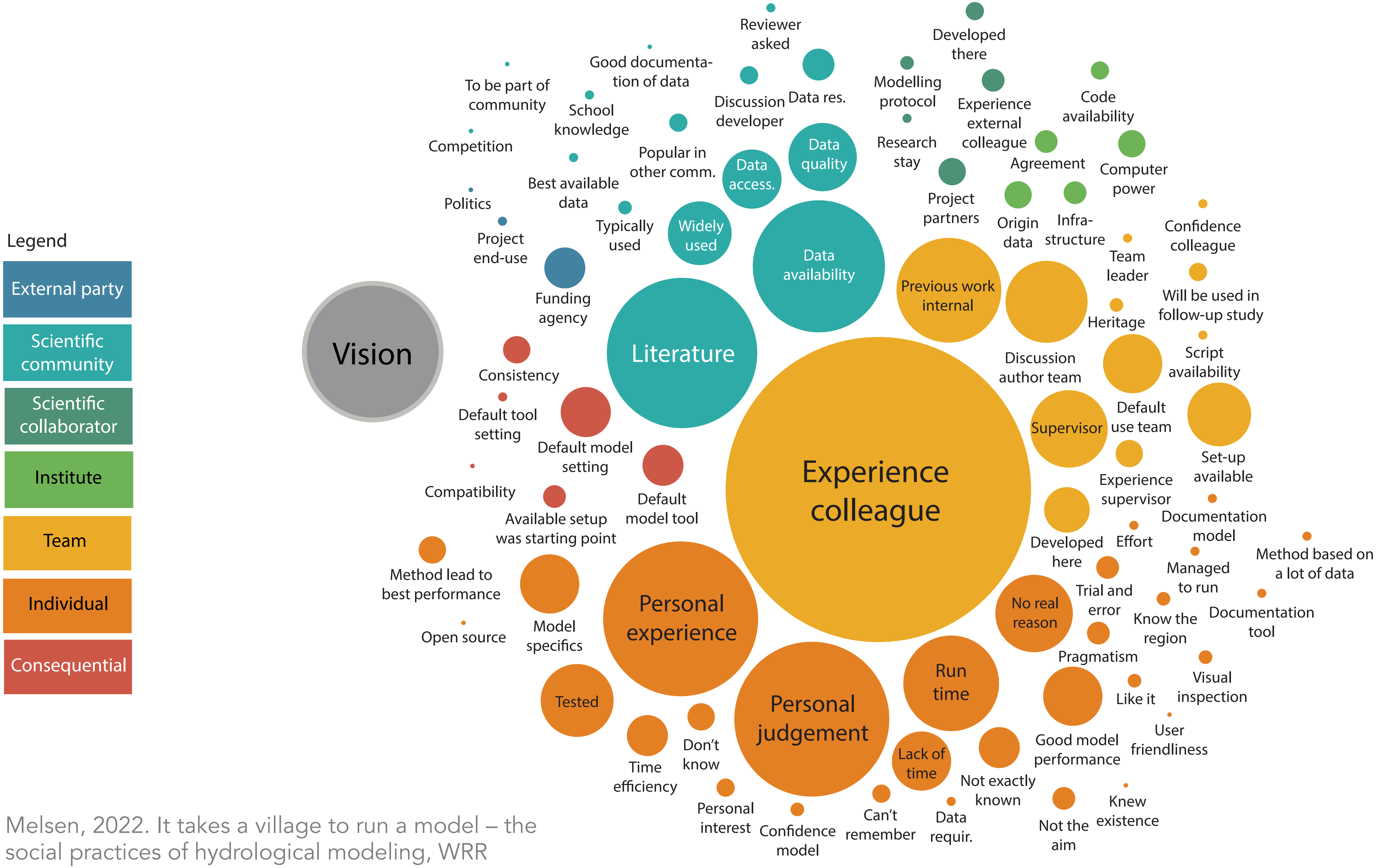
Voorkeur voor
conventionele
benaderingen

"Legacy":
gemak, ervaring, gewoonte

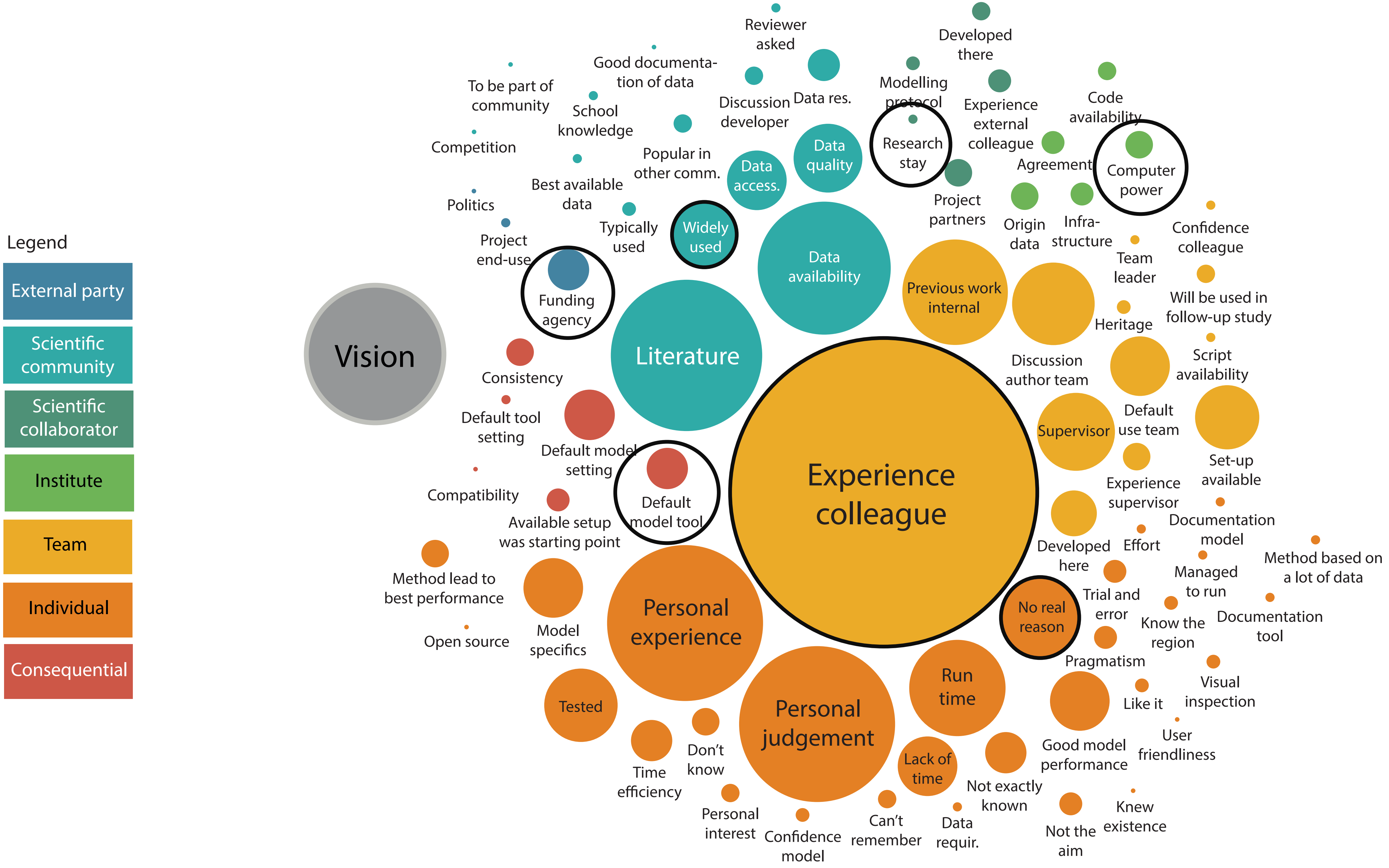
De modelleur onderzocht

14 diepte-interviews
3 verschillende onderzoeks-instituten (Frankrijk, België, Duitsland)
Februari – Juni 2020

3 onderzoeksleiders
4 senior onderzoekers
4 medior onderzoekers
3 junior onderzoekers



Melsen, 2022. It takes a village to run a model – the social practices of hydrological modeling, WRR


Legend
External party
Scientific community
Scientific collaborator
Institute
Team
Individual
Consequential
Vision
Reviewer asked
Developed there
Good documenta-tion of data
To be part of community
School knowledge
Discussion developer
Data res.
Modelling protocol
Experience external colleague
Code availability
Competition
Popular in other comm.
Data access.
Data quality
Research stay
Agreement
Computer power
Best available data
Project partners
Politics
Typically used
Widely used
Origin data
Infra-structure
Confidence colleague
Project end-use
Data availability
Team leader
Funding agency
Previous work internal
Will be used in follow-up study
Heritage
Literature
Discussion author team
Script availability
Consistency
Default use team
Default tool setting
Supervisor
Set-up available
Default model setting
Experience colleague
Experience supervisor
Compatibility
Default model tool
Documentation model
Available setup was starting point
Developed here
Effort
Method based on a lot of data
Method lead to best performance
Managed to run
Trial and error
No real reason
Personal experience
Know the region
Documentation tool
Model specifics
Open source
Pragmatism
Run time
Visual inspection
Tested
Like it
Personal judgement
User friendliness
Don't know
Good model performance
Time efficiency
Lack of time
Not exactly known
Personal interest
Knew existence
Can't remember
Data requir.
Confidence model
Not the aim

Epistemisch

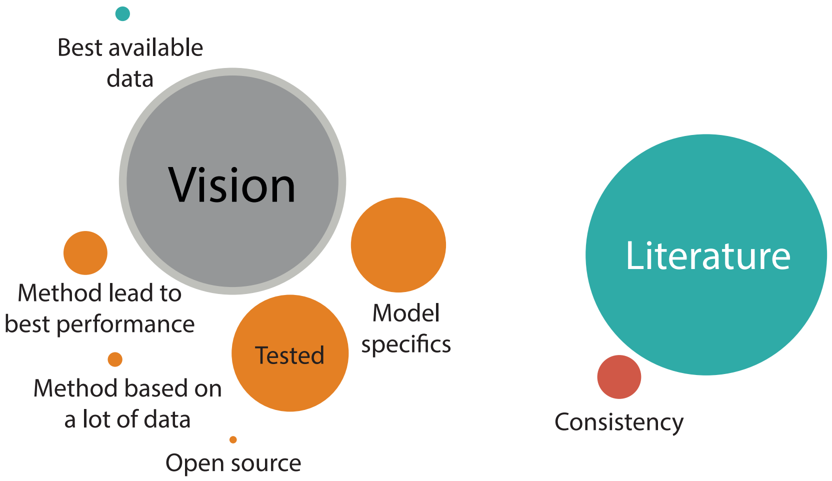
gebaseerd op kennis – met de intentie om de waarheid te achterhalen

Contextueel

Persoonlijk, sociaal, politiek, cultureel, pragmatisch

Epistemisch

gebaseerd op kennis – met de intentie om de waarheid te achterhalen



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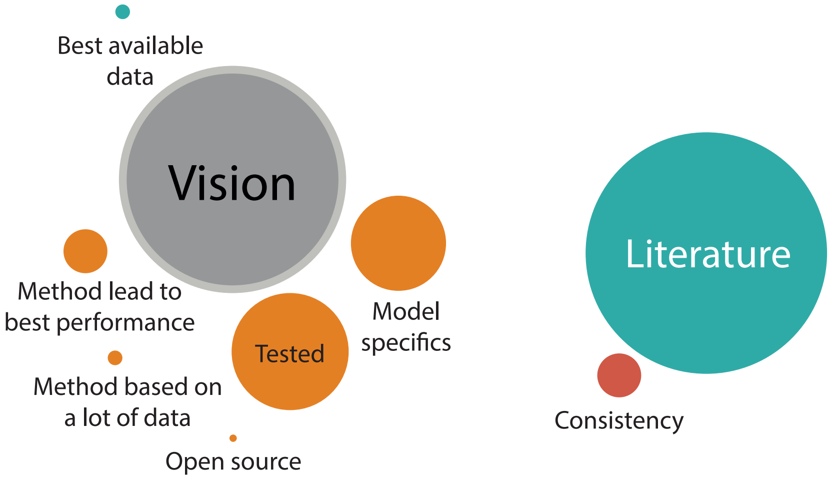

Contextueel

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Kies een bestaand model

IJking,
gevoeligheidsanalyse,
onzekerheidsanalyse

Evaluatie:
Vergelijk
modelresultaten met
observaties

Verschillende methoden leiden tot
verschillende resultaten

"Legacy":
gemak, ervaring, gewoonte

Verschillende modellen leiden tot
verschillende resultaten

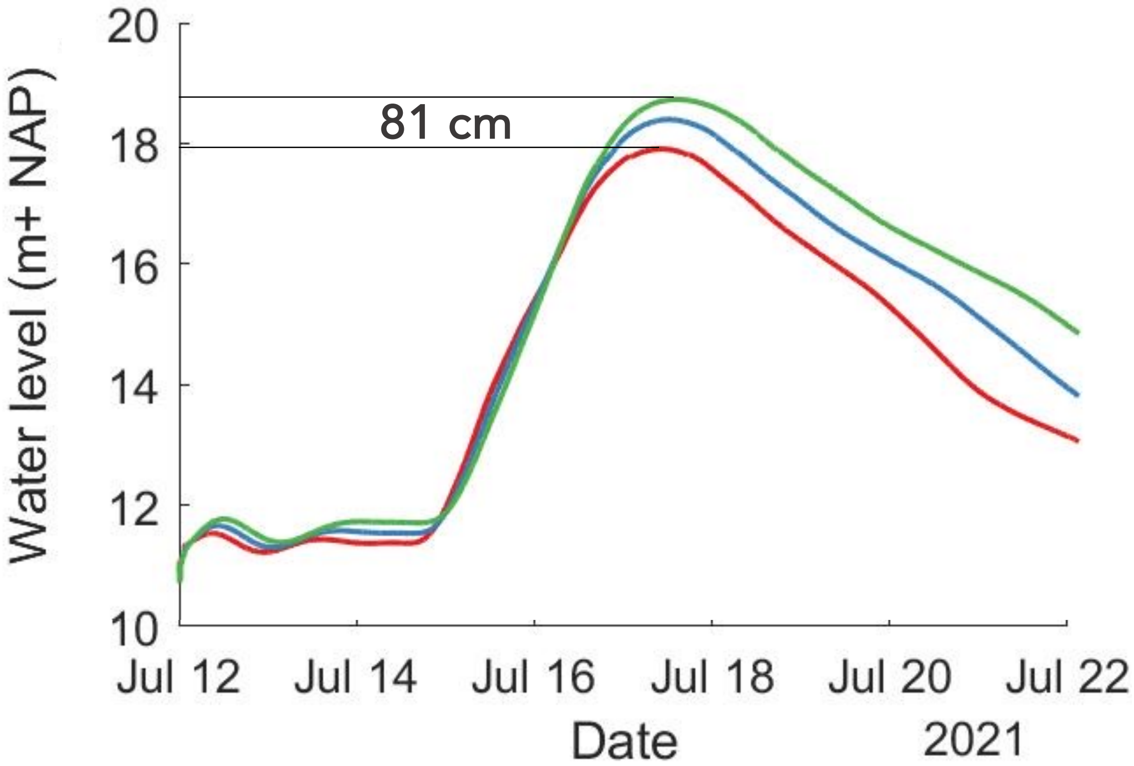
deVolkskrant

REPORTAGE

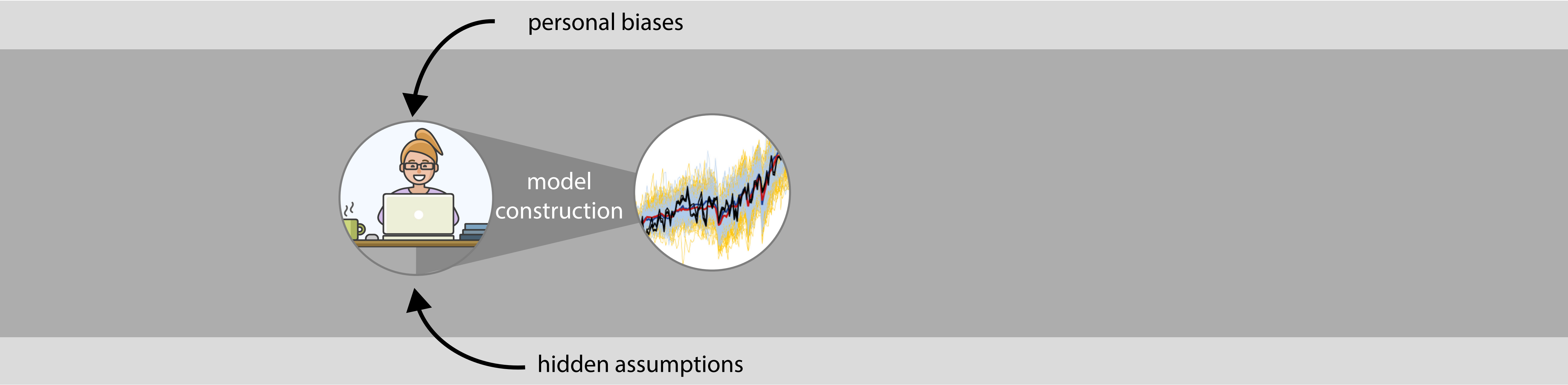
Het water rukt op in Roermond, maar: 'Wij zijn diehards, wij blijven'

Het hoge water van de Maas duwt zich tegen en langzaam over de kade in het centrum van Roermond. In het midden van de foto steken aanloopsteigers naar de boten in de haven schuin uit het water. Het hoge water duwt ze omhoog, omdat ze aan één kant vastzitten onder water. Beeld ANP

Mac van Dinther 17 juli 2021, 19:03



Subjectieve keuzes, maar ook waarden en normen worden in het model 'gematerialiseerd'.



Melsen, Vos, and Boelens (2018), What's the role of the model in socio-hydrology? Hydr. Sci. J.

Opdrachtgevers / financiers bepalen de onderzoeksvraag.

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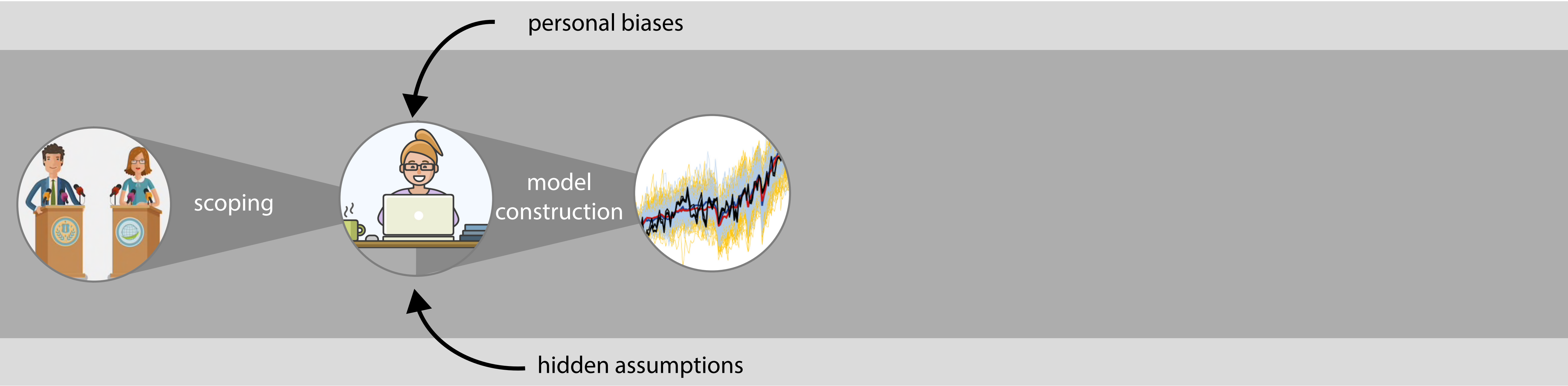

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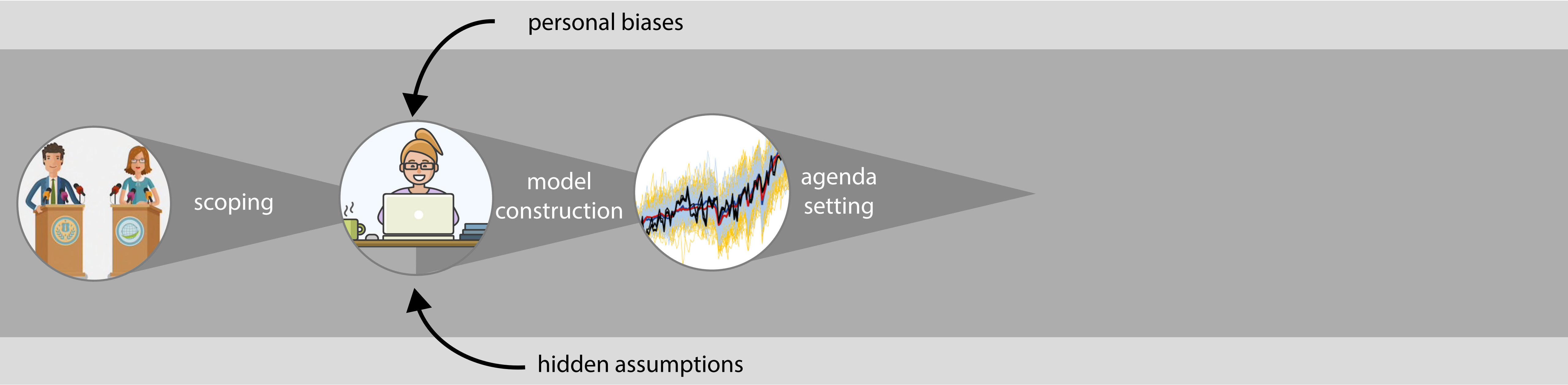
De resultaten van het model bepalen welke opties er besproken worden



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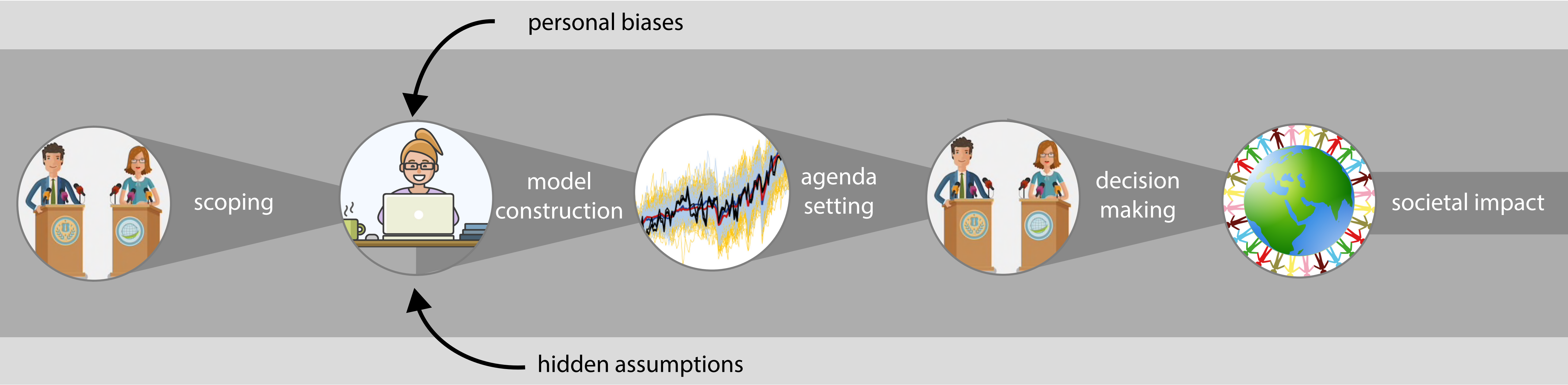
Modellen als "waarheids-makers"



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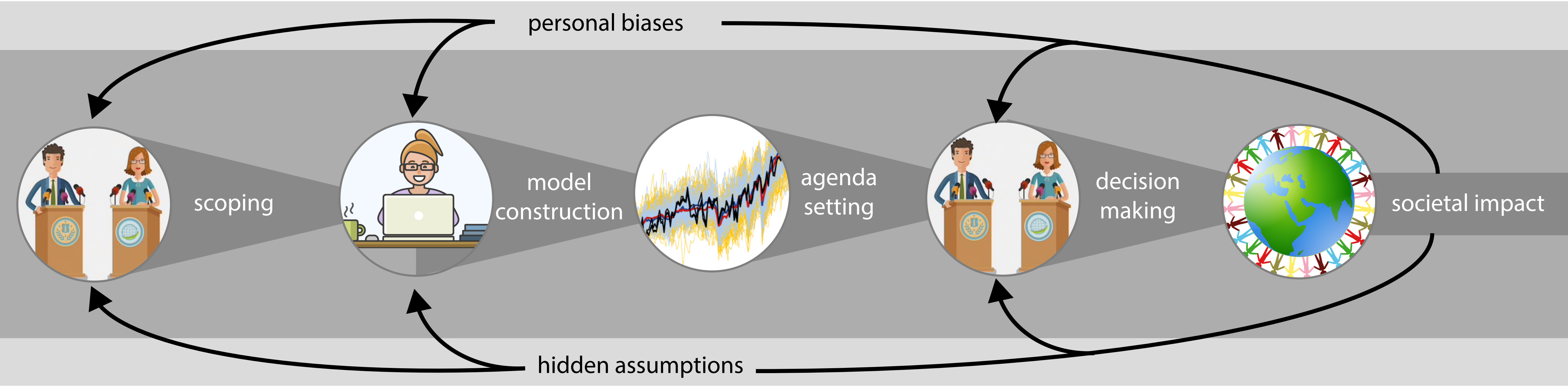
Opdrachtgevers / financiers bepalen de onderzoeksvraag.

Subjectieve keuzes, maar ook waarden en normen worden in het model 'gematerialiseerd'.

De resultaten van het model bepalen welke opties er besproken worden

Modellen als "waarheids-makers"



Melsen, Vos, and Boelens (2018), What's the role of the model in socio-hydrology? Hydr. Sci. J.

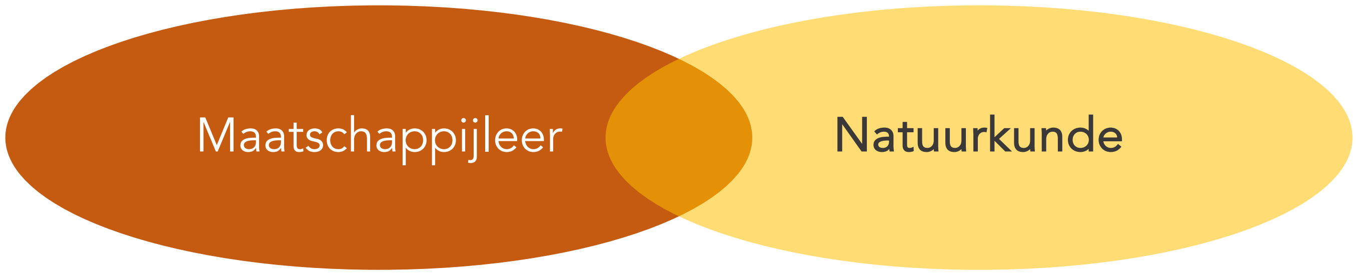
NOS Nieuws • Donderdag 7 juli 2022, 16:27

OM onderzoekt mogelijk gesjoemel bij berekening stikstofuitstoot Lelystad Airport

Het Openbaar Ministerie is een onderzoek gestart naar de mensen die voor Lelystad Airport hebben berekend hoeveel stikstof de luchthaven bij uitbreiding gaat uitstoten, meldt Omroep Flevoland. Volgens de regionale omroep wordt gekeken of er sprake is van kwade opzet bij het opstellen van de cijfers, waardoor een te gunstig beeld over de uitstoot ontstond.

Zijn modellen neutraal?

Nee, ze zijn sociaal geconstrueerd (en politiek).



Bedankt!

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