



Ny metode til at vurdere den udnyttelige grundvandsressource

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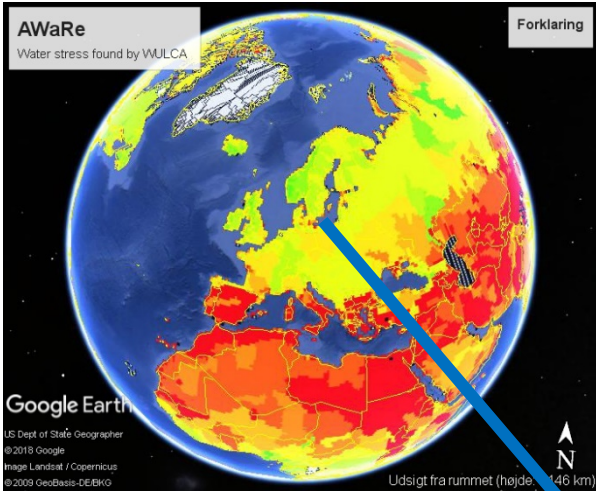
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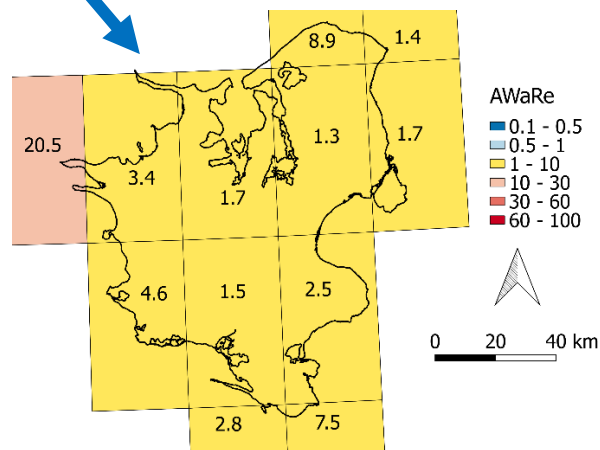
Ny metode til at vurdere den udnyttelige grundvandsressource

Fra den bæredygtige vandressource...

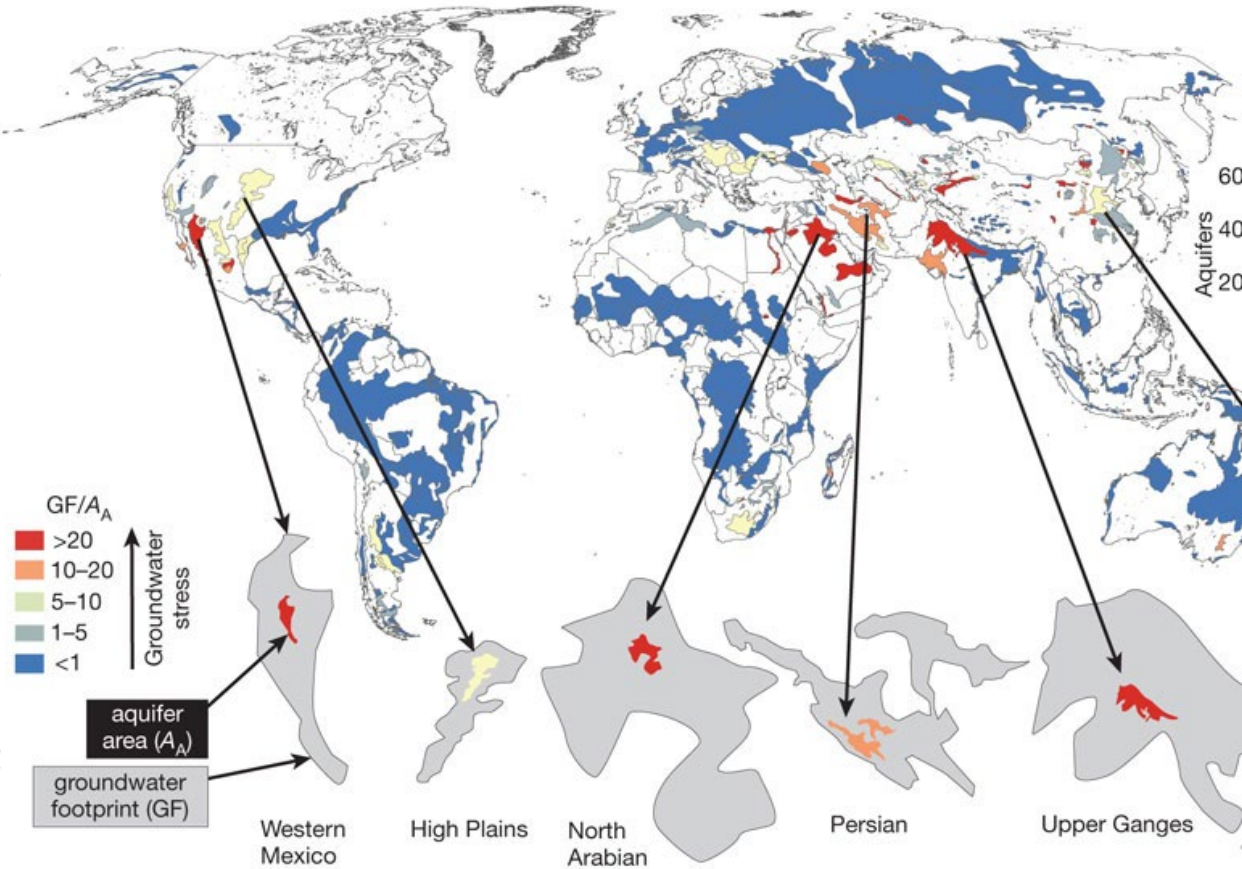


Ref: Boulay, AM., Bare, J., Benini, L. et al. The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE) Int J Life Cycle Assess (2018) 23: 368.

Data available at: <http://www.wulca-waterlca.org/aware.html>



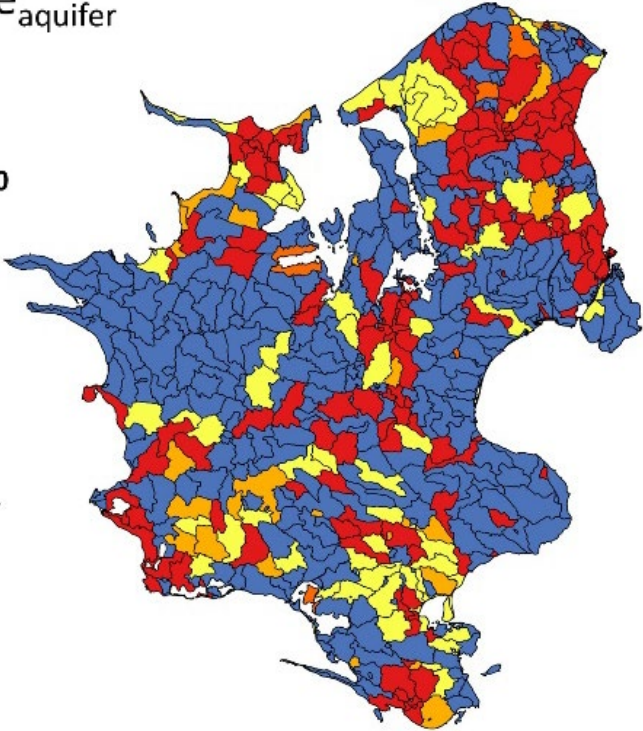
Gleeson, T., Wada, Y., Bierkens, M.F.P., van Beek, L.P.H., 2012. Water balance of global aquifers revealed by groundwater footprint. Nature 488, 197–200. <https://doi.org/10.1038/nature11295>.



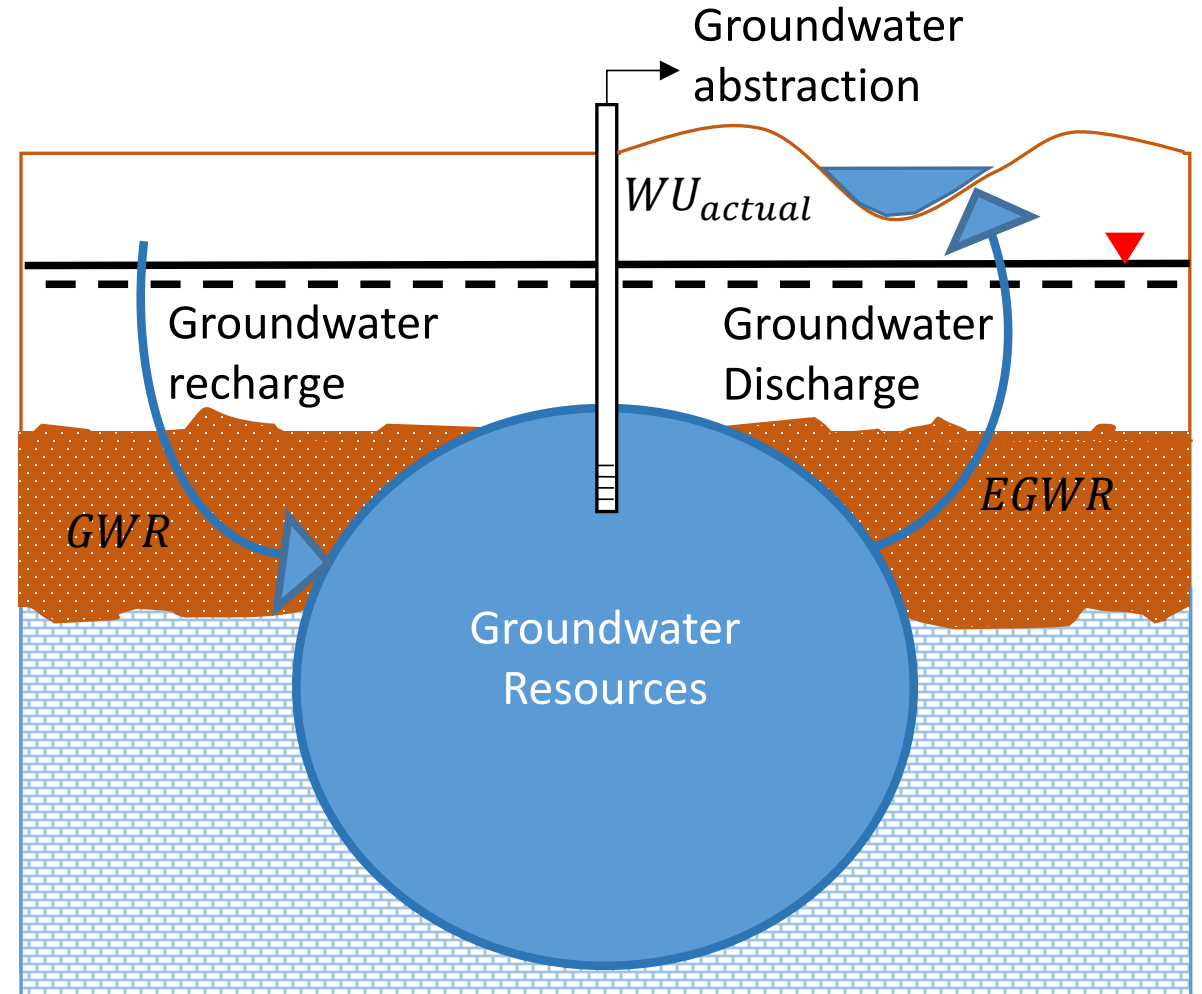
...til den udnyttelige grundvandsressource...

AGWaRe_{aquifer}

- 0.1 – 1
- 1 – 5
- 5 – 50
- 50 – 100
- 100



Gejl, et al. 2018, Integrating groundwater stress in life-cycle assessments – An evaluation of water abstraction <https://authors.elsevier.com/a/1X6Mn14Z6tX41h>

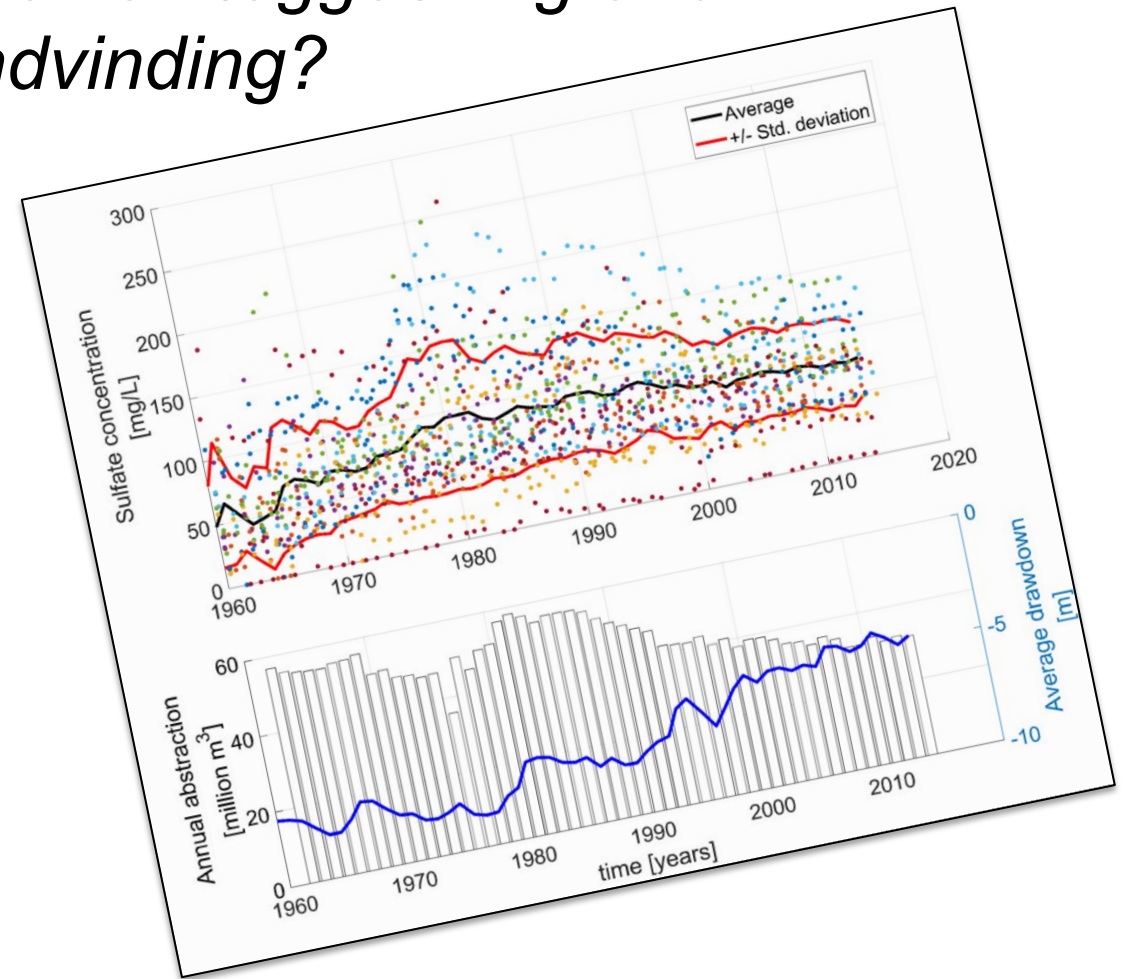


$$\textit{Availability Minus Demand: } AMD_{aquifer} = GWR - WU_{actual} - EGWR$$

Hvordan kan påvirkningen af vandkvalitet lægges til grund for opgørelsen af bæredygtig vandindvinding?

Relevant for forsyninger og vandressourceforvaltning:

- Benchmarking
- Planlægning af indvinding

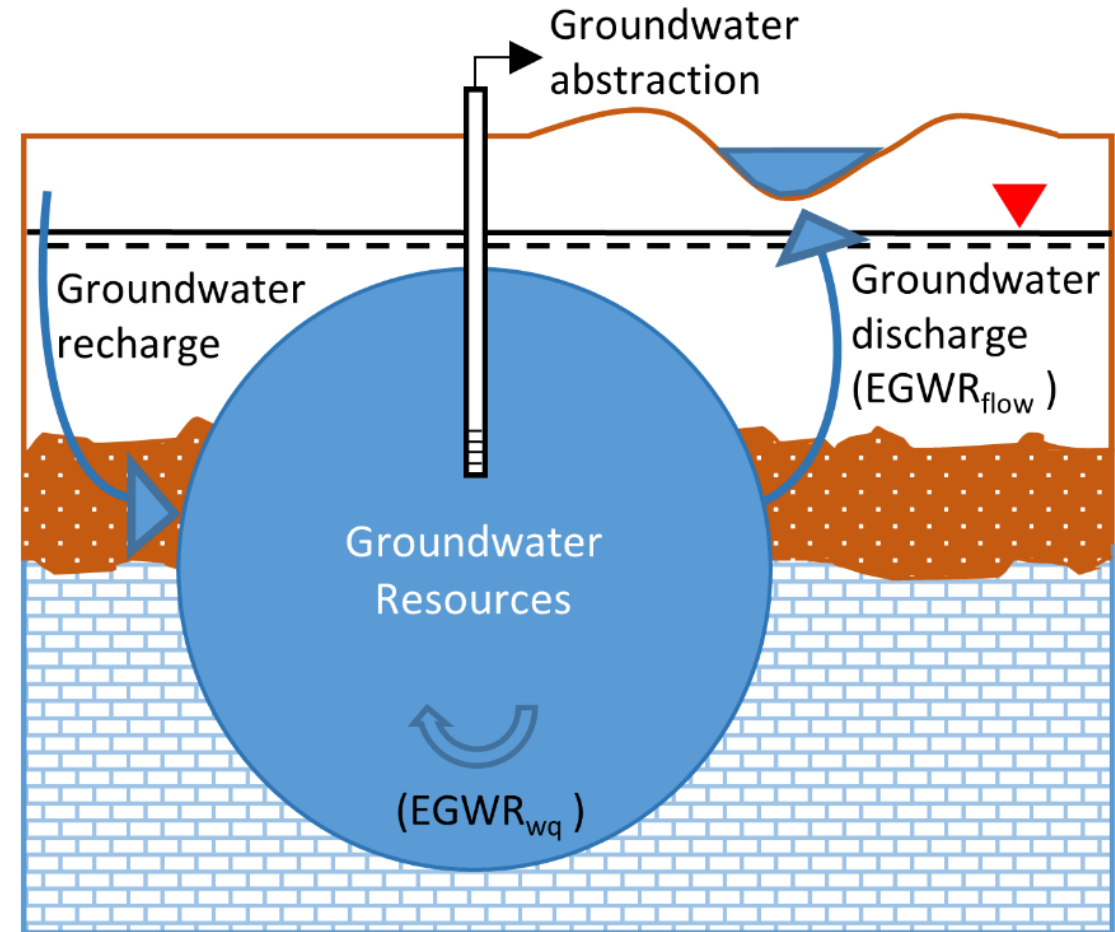


Ny definition af "naturens nødvendige vandbehov" (Environmental Groundwater Requirements EGWR)

EGWR:

"grundvand nødvendigt for vandføringer, grundvandsafhængige økosystemer og opretholdelse af grundvandskvaliteten"

$$EGWR = EGWR_{\text{flow}} + EGWR_{\text{wq}}$$



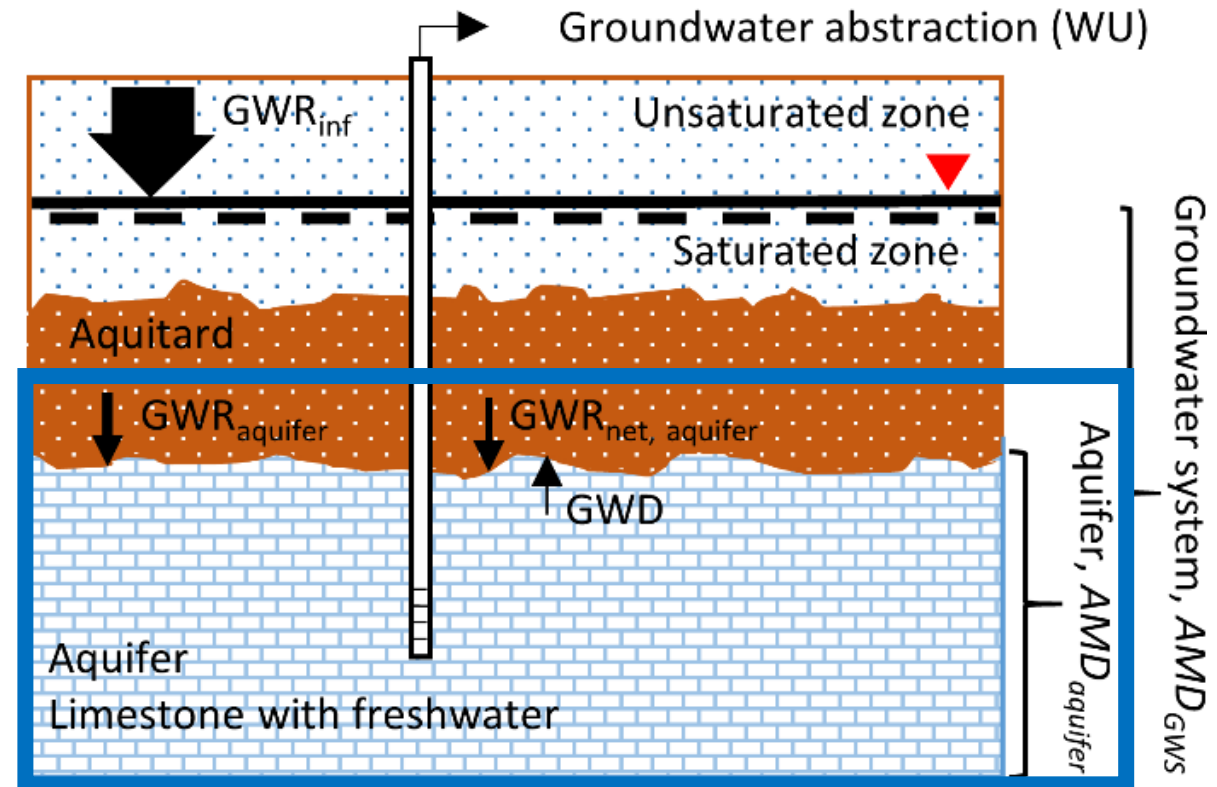
Metode

Model

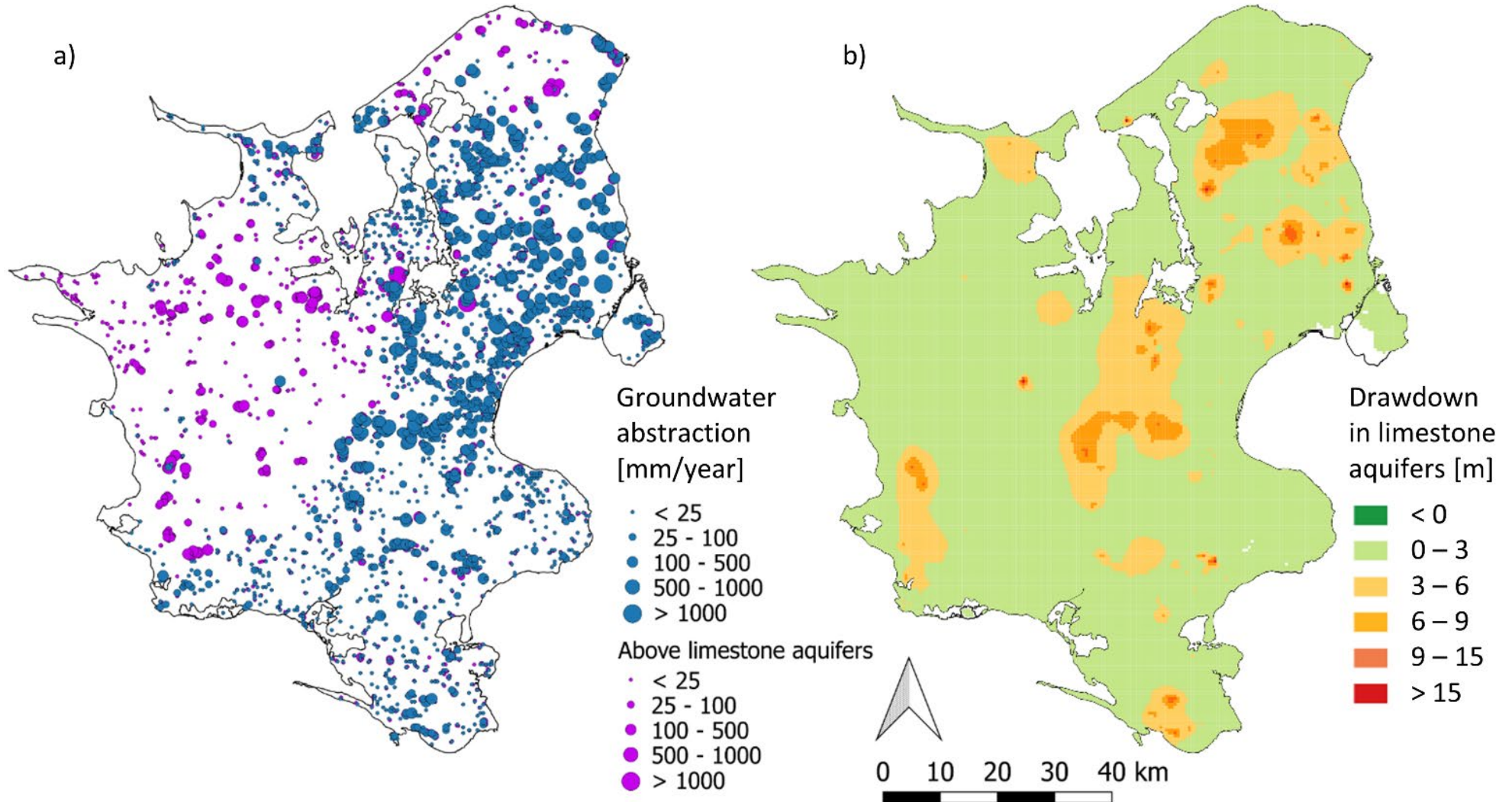
- DK-Model for Sjælland
- 500m x 500m hydrologisk grid
- Modellerer perioden 2003-2012

Afsækning og skala

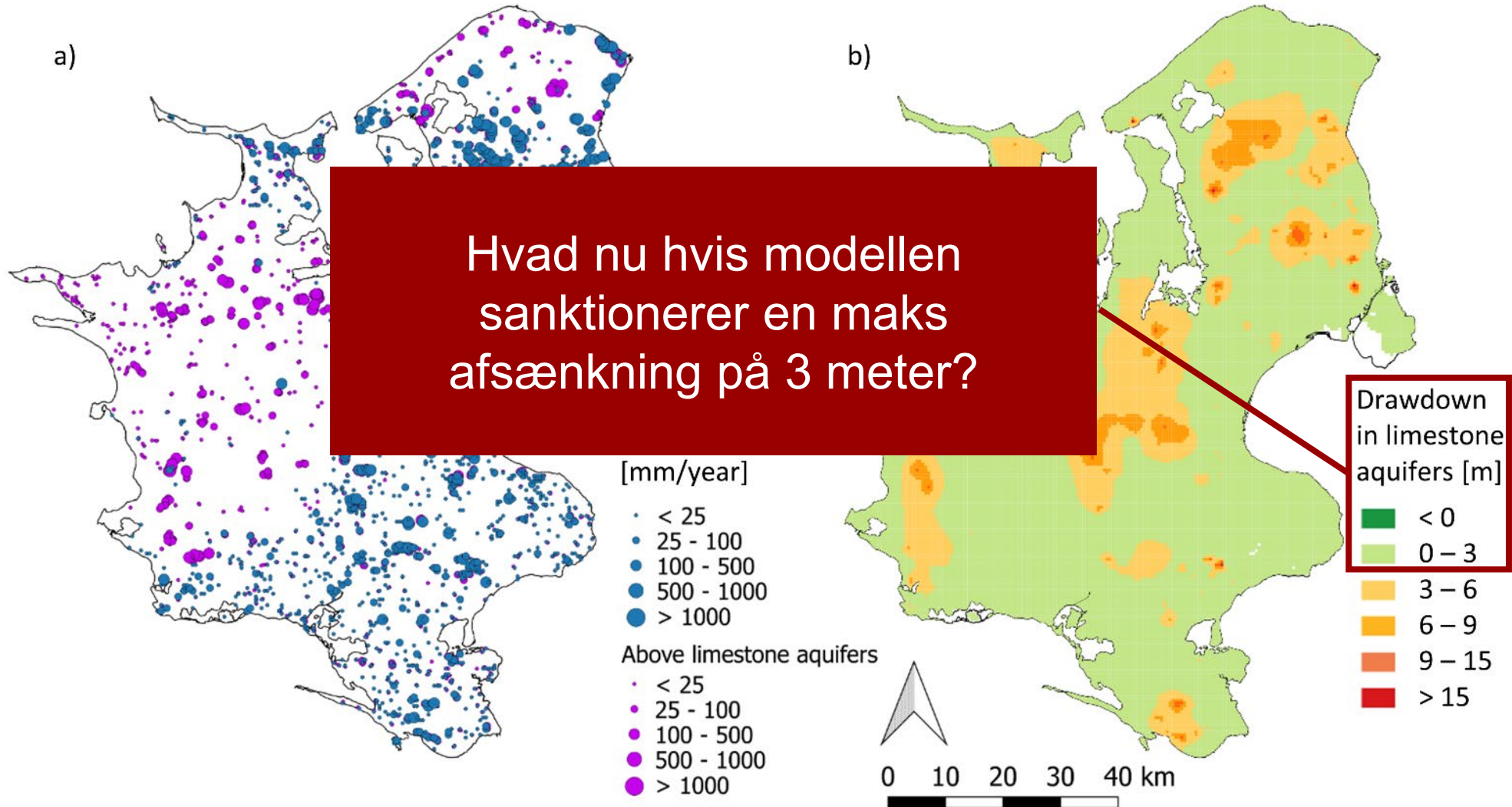
- Fokus på kalkakvifæren
- Offentlig vandindvinding
- "Naturlig tilstand" - Indvinding



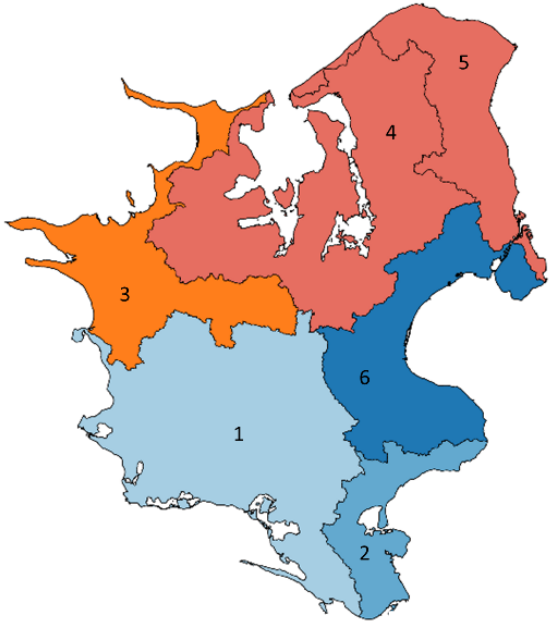
Den nuværende indvinding og afsænkning



Den nuværende indvinding og afsenkning



Den ydnyttelige vandressource under hensyntagen til maks afsænkning 3 meter

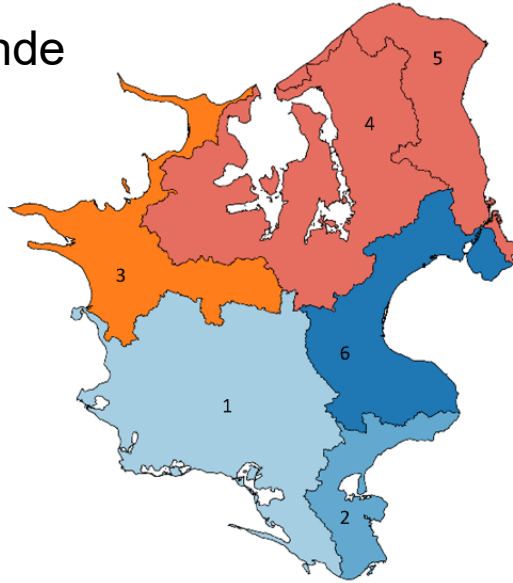


| Hovedvandopland | WU_{actual} | WU_{sus-3m} | Den tilbageværende tilgængelige vandressource |
|-----------------|------------------------------|------------------------------|---|
| nr. | (million m ³ /år) | (million m ³ /år) | $AMD_{aquifer}$ |
| | | | (million m ³ /år) |
| 1 | 16.3 | 22.3 | 6.0 |
| 2 | 2.7 | 8.3 | 5.6 |
| 3 | 1.0 | 1.7 | 0.7 |
| 4 | 40.6 | 36.4 | -4.2 |
| 5 | 19.5 | 12.5 | -7.1 |
| 6 | 32.0 | 57.6 | 25.5 |

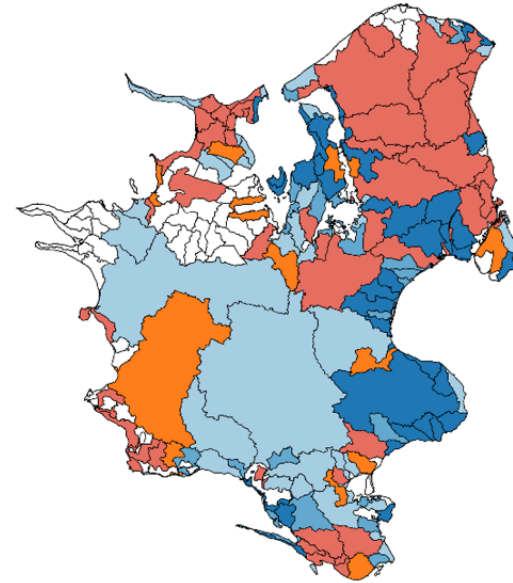
Availability Minus Demand: $AMD_{aquifer} = GWR_{sus-3m} - WU_{actual} - EGWR_{wq}$

En overvejelse: På hvilken skala?”

Hovedvandoplande



Vandløboplande



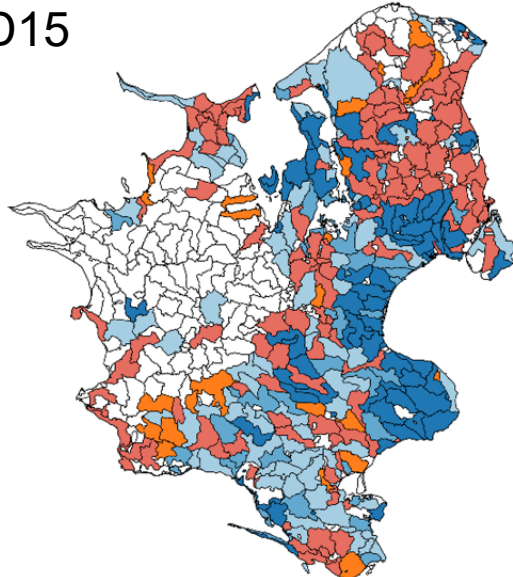
AMD for limestone aquifers
(mm/year)

- < 0
- 0 - 1
- 1 - 10
- 10 - 20
- > 20
- No abstraction

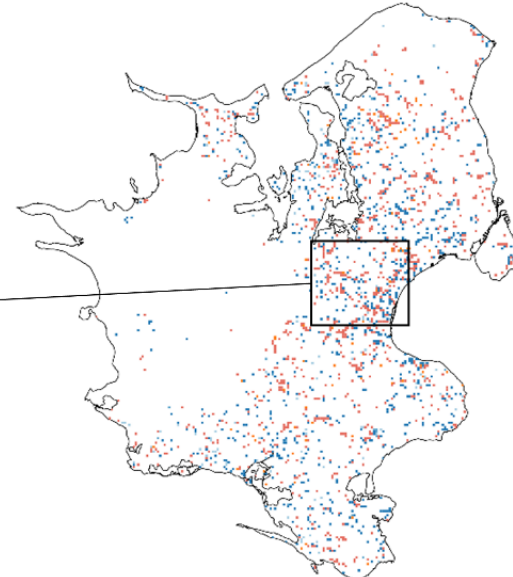
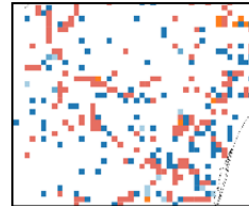


0 10 20 30 40 km

ID15



Modelopløsning



Sammenligning af $EGWR_{flow,10\%}$ and $EGWR_{wq,3m}$

Comparing the abstraction that secures $EGWR_{flow}$ with abstraction that secures $EGWR_{wq}$ for 634 stream stations in the period 2003-2012.

| | No. of stream stations |
|--|------------------------|
| $EGWR_{flow} > EGWR_{wq}$ for the whole period | 87 |
| $EGWR_{flow} < EGWR_{wq}$ for the whole period | 21 |
| Average $EGWR_{flow} >$ average $EGWR_{wq}$ | 374 |
| Average $EGWR_{flow} <$ average $EGWR_{wq}$ | 260 |

Konklusioner og perspektiver

- Første gang en opgørelse af den udnyttelige grundvandsressource inkluderer en ”beskyttelse” af grundvandkvaliteten
- Foreløbig opgørelse for Sjælland indikerer at et øget fokus på afsænkningen kan medføre en yderligere spredning af indvindingen – uden at indskrænke den totale tilgængelighed

- Metoden bør videreudvikles for andre geologier i Danmark
- Den generaliserede maks afsænkning på 3 m kan udfordres – fx med udgangspunkt i kildepladser med kendt begrænsning på afsænkningen
- Den udnyttelige grundvandsressource kan blive en del af vandforsyningernes benchmarking

Tak til

Dem der støttede: Innovationsfonden, HOFOR, VandCenter Syd og Aarhus Vand

Og dem, der hjalp: Troels Kærgaard Bjerre (VCS), Bo Vægter (AaV)

Referencer

Gejl RN, Bjerg PL, Henriksen H-J, Bitsch K, Troldborg L, Schullehner J, Rasmussen J, Rygaard M (2020) Relating wellfield drawdown and water quality to aquifer sustainability – A method for assessing safe groundwater abstraction, *Ecological Indicators*. <https://doi.org/10.1016/j.ecolind.2019.105782>

Gejl, R.N., P.L. Bjerg, H.J. Henriksen, M.Z. Hauschild, J. Rasmussen, and M. Rygaard (2018) Integrating groundwater stress in life-cycle assessments – An evaluation of water abstraction. *Journal of Environmental Management*. <https://10.1016/j.jenvman.2018.05.058>

