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Lectures Density dependent groundwater flow, IHE, Delft, 8-9-10 April 2024

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Exercises

Vertical interface:

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Henry's problem:

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Elder's problem:

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Additional material

Download: [info on numerical dispersion and oscillation: Chapter 8, p. 119-132](#)

Download: [animation Elder](#)

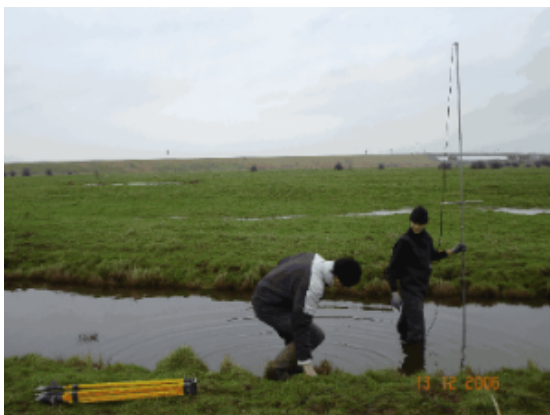
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Movies

- [Slim Water Management, case Rijnland](#)
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- [The Challenges of Saline Groundwater](#)
- [Zoetwater zelfvoorzienendheid, Deltaproof](#)
- [GO-FRESH: Ondergrondse waterbergingsproeven Proeftuin Zuidwestelijke Delta](#)
- [Kansrijke oplossingen voor een robuuste zoetwatervoorziening \(Uitleg GO-FRESH 3 proeven, 4m20s\)](#)
- [Kreekkrug Infiltratie Proef in bedrijf \(2m39s\)](#)
- [De effectiviteit van het doorspoelen van polders in Nederland](#)
- [De bronnen van verzilting, en de lange geschiedenis die eraan voorafgaat, case NL](#)
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Topic: Vulnerability of groundwater systems to flooding events

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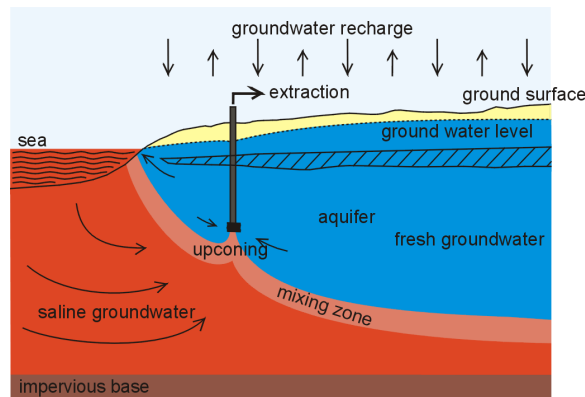
Regional Workshop on Saltwater Intrusion Modeling & Implications of Sea Level Rise, July 23-24, 2014

Lecture Notes Density Dependent Groundwater Flow: Salt water intrusion in coastal aquifers

Auteur: Gualbert Oude Essink

Dictaat: [Density Dependent Groundwater Flow](#)

- 1 Introduction
- 2 Characteristics of a density dependent groundwater system
- 3 Freshwater head
- 4 The concept of a fresh-saline interface
- 5 Control of salt water intrusion
- 6 Numerical modelling
- 7 Salt water intrusion in the Netherlands
- 8 Heat transport in porous media: introduction



Lecture Notes Groundwater Modelling

Auteur: Gualbert Oude Essink

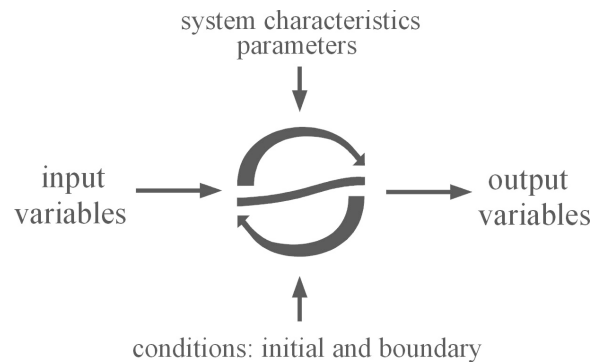
Dictaat: [Groundwater Modelling](#)

PART I Modelling Protocol

- 1 Introduction
- 2 Classification of mathematical models
- 3 Methodology of modelling
- 4 Data gathering

PART II Groundwater Modelling

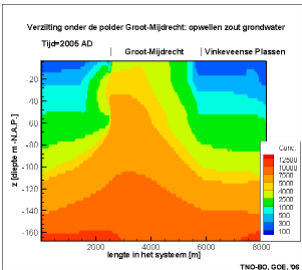
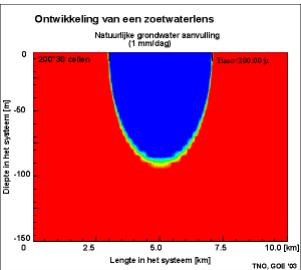
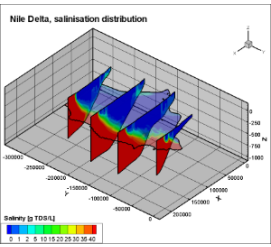
- 5 Introduction
- 6 Mathematical description of hydrogeologic processes
- 7 Solution techniques
- 8 Numerical aspects of groundwater models
- 9 Some selected groundwater codes



Animations: examples of salinisation processes

Henry's profile with sea level rise	3D zoet-zout verdeling ondergrond NL	Fresh water injection to combat salinisation	3D zoet-zout verdeling ondergrond Texel	Region partly c
Henry's profile with sea level rise	3D zoet-zout verdeling ondergrond NL	Fresh water injection to combat salinisation	3D zoet-zout verdeling ondergrond Texel	Regional captured
Physical barrier in the coastal zone	Dutch profile: extraction, upconing and low inland levels	Profile over 3D model: effect sea level rise on salinisation	Movement of the island De Griend (NL): creation of a freshwater lens	Evo lens

Salinisation of a groundwater flow system The change in salt content in the subsurface due to a physical barrier in the deep coastal aquifer and a sea level rise of 0.5 m per century Profile Amsterdam Waterworks-polder Groot-Mijdrecht Haast near polder Time after 1990 AD Time= 0.0 yr	Salinisation of the groundwater system Profile close to the Zandvoort-Haastmooienpolder	Rijnland model (profile of column 53) Automated development, sea level rise and land subsidence Columns 50-59 Time= 0.0 yr	Movement of the island of Grieland (Friesland) through the Waddenzee 7 km/year to the east Time=95.00 yr	Physical barrier in the coastal zone Dutch profile extraction, upconing and low inland levels Profile over 3D model: effect sea level rise on salinisation Movement of the island De Grieland (NL): creation of a freshwater lens Evolution
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Upconing saline groundwater under a low-lying area	Ontwikkeling van een zoetwaterlens	3D salinity groundwater distribution of the Nile Delta, Egypt	
Verziltig onder de polder Groot-Mijdrecht: opwelen zout grondwater Tijd=2005 AD Groot-Mijdrecht Vinkeveense Plassen  TNO-BO, DOE '05	Ontwikkeling van een zoetwaterlens Natuurlijke grondwater aanvulling (1 mm/dag) 2007.30 column Time=200.00 yr  TNO, DOE '05	Nile Delta, salinisation distribution  Salinity [g TDS/L] 0 5 10 15 20 25 30 35 40	Upconing saline groundwater under a low-lying area Development lens Nile delta

CRYSTECHSALIN

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[Proceedings Meeting 21-24 September 2002, Scanzano, Italy](#)

Homage Prof. Custodio:

article: [Salinisation of groundwater resources in the Dutch Deltaic Area: modelling, monitoring, Climate Change and Solutions](#)