Name

Prof. Dr. Pieter J. Stuyfzand
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Profile

Pieter Stuyfzand has an MSc degree in hydrogeology and obtained a PhD degree on the basis of his work on “Hydrochemistry and hydrology of the coastal dune area of the Western Netherlands”.

He has 34 years of professional experience in the fields of hydrogeochemistry and hydrogeology, with a focus on Managed Aquifer Recharge, water quality, and the hydrology and hydrogeochemistry of coastal dune aquifer systems. These focus areas are specified below (see Work experience).

Pieter is full professor with a chair in (chemical) hydrogeology since 2004, within the department of Hydrology and Geo-environmental sciences at the Faculty of Earth and Life Sciences of VU University Amsterdam. He is also employed at KWR Watercycle Research Institute (formerly part of Kiwa) in Nieuwegein, as a member of the internal scientific board of KWR, project leader and reviewer of many projects. The time division between both institutes is on average 2 days/week VU and 3 days/week KWR.
In addition, he is a member of the scientific advisory board of recurrent symposia on salt water intrusion (SWIM) and Managed Aquifer Recharge (ISMAR), and a member of the dutch Water Federation (KVWN), the dutch Hydrological society (NHV), IHA, IWA, the European Lysimeter Research Group, and the OBN expert team ‘Landscape of Dunes and Coasts’.

Education

- Ph.D. VU University Amsterdam on 'Hydrochemistry and hydrology of the coastal dune area of the Western Netherlands’, in 1993.
- M.Sc. in hydrogeology, VU University Amsterdam (cum laude), in 1978
- B.Sc. in physical geography, VU University Amsterdam, in 1974

Work experience

Specific expertise 1: Coastal zone / dune hydrology and hydrogeochemistry.
Research since 1978 on: (a) analytical solutions to calculate the size, shape and time of formation of fresh groundwater lenses on salt groundwater, and of vegetation water lenses (groundwater recharged under a specific vegetation unit); (b) palaeohydrological and hydrohistorical developments in coastal dunes; (c) the quality of atmospheric deposition on the dutch coastal plain; (d) effects of vegetation on quantity and quality of the groundwater recharge and of the upper groundwater in coastal dunes; (e) the quality evolution of coastal dune groundwater from infiltration in dunes to exfiltration in reclaimed lakes; (f) the geochemical composition of dune sand and its decalcification; and (g) geochemical effects of sand suppletion along the coast.

- Author of seven 1:25,000 maps with full description, on the hydrology and hydrochemistry of coastal dunes between Scheveningen and

Schiermonnikoog.

- Author of numerous publications on dune groundwater (see among 'Selected publications').
- Developer of several computer codes set in EXCEL spread sheet: HYDROLENS for calculating the size, shape and time of formation of fresh groundwater lenses on salt groundwater; and DUVELCHEM for modeling the quality of shallow (dune) groundwater and decalcification, including the effects of climate change and coastal re- or progression.

Specific expertise 2: Water quality.
Research since 1978 on: (a) the distinction between and analysis of hydrological and hydrochemical systems; (b) hydrochemical characterization of fresh and salt groundwater, and chemical processes during their mixing and intrusion, (c) chemical dating and multi-tracing of groundwater, incl. groundwater flow imaging by hydrochemical mapping; (d) chemical and hydrological characterization of aquifers, aquitards and sludges; (e) the set-up of monitoring networks; (f) interaction between atmosphere, natural vegetation, land-use and groundwater quantity and quality; (g) chemical aspects of artificial recharge and river bank filtration (for details see ad #3); (h) the behaviour of pollutants (major constituents, trace elements, organics, radionuclides, bacteria and viruses) in many types of groundwater flow systems; (i) the impact of well pumping and deep well injection on physical and chemical well clogging.

- Developer of dedicated methods to map and classify chemical watertypes, hydrochemical facies and water bodies. These methods are widely applied in a.o. the Netherlands, Belgium, Italy, Turkey, Northern Africa and various developing countries.
- Developer of tools for the management, presentation and interpretation of (a) water quality data using CHEMCAL which recently evolved into HyCA (**www.hyca.nl)** and HYDROGEOCHEMCAL, and (b) geochemical data using GEO-CHEMCAL.
- Author of numerous publications on groundwater quality related problems and solutions (see among 'Selected publications').
- During the past 20 years his experience has crystallized into various approaches (all set in EXCEL spread sheet) to model water quality and its transport (including all kinds of pollutants): REACTIONS+ for inverse modeling via the mass balance approach, to identify and quantify geochemical reactions and to determine the contribution of mixing end-members if present; COMPLEX2 to calculate complexation of 8 trace elements (As, Ba, Cd, Co, Cu, Ni, Pb and Zn) to inorganic and organic ligands; INFOMI 3.1 and TRANSATOMIC to quantify non-reactive transport of pollutants along a single flow tube, simulating dispersion, sorption and decay; and reactive transport models combining dispersion, sorption and decay with all kinds of chemical reactions with the porous medium (Easy-Leacher and AsR+, both expert models).

Specific expertise 3: Managed Aquifer Recharge.
Research since 1976 on: (1) the hydrochemical and microbiological processes during Artificial Recharge (AR) and River Bank Filtration (RBF), (2) (multi)tracer studies to reveal the areal extent of the infiltrated surface water, flow paths and age, (3) development of rain water lenses on laterally migrating infiltration water, (4) functioning of flow-through lakes adjacent to recharge ponds, (5) behaviour of contaminants (inorganic incl. trace elements, organics incl. pharmaceuticals, pathogenic micro-organisms), (6) leaching of aquifer materials, (7) accumulation and composition of underwater clogging layers (sludges) in recharge ponds, (8) modelling of water quality

changes and sludge accumulation, (9) monitoring design, (10) the sustainability of AR and RBF systems, incl. their environmental impact as compared to natural groundwater flow systems; and (11) environmental aspects of aquifer thermal energy storage.

- Involved in practically all recharge projects in the Netherlands: with basins (Castricum, Wijk aan Zee, Leiduin, Katwijk, Scheveningen, Monster, Ouddorp, Haamstede, St. Janssteen-Clinge, Lith, Epe and Enschede), ASTR wells on pilot plant scale (#12), ASTR wells on production plant scale (Watervlak, Waalsdorp), and ASR wells (Herten, Terschelling);
- Developer of dedicated computer codes for AR and RBF systems, like Easy-Leacher (2D reactive transport model for all solutes and pathogens, with constant input), INFOMI (1D transport model for conservative solutes, trace elements and organic micropollutants with variable input signal), MEXIWA (for optimizing the cycle testing and chemical monitoring program for ASR systems) and AsR+ (for modelling arsenic behaviour during ASR operations). Developer of quality indices for AR, RBF and natural groundwater systems, like MOC (Modified Oxidation Capacity), WAPI (Water Pollution Index), SOPI (SOil Pollution Index) and CHESS (CHEmical SuStainability index);
- Member of scientific committee of the dedicated symposium series on Managed Aquifer Recharge (ISMAR, each 2-3 years) since 1998
- Author of numerous publications on AR and RBF related issues many of which in MAR proceedings (see among 'Selected publications'). Invited participant in 2 granted EU-projects, on (a) the clogging, water quality changes (incl. micro-organisms) and their modelling in artificial recharge systems (1996-1999), and (b) early warning and on-line monitoring systems for artificial recharge systems (ARTDEMO, 2002-2005). Invited project reviewer for CSIRO in Australia (Bolivar deep well injection, 1999), for Mid Kent Water in UK (ASR Pilot, 2000), Kopenhagen Energy in Denmark (Arrenaes, 2005), Götenborg in Sweden (Dösebacka, 2005) and Perth Water Corporation (on-going).
- Invited speaker and participant to an IAEA specialists meeting on the use of isotopes in artificial recharge (Vienna, 2000), an EU advanced research workshop on Riverbank filtration hydrochemistry (Dresden, 1999), a NATO advanced research workshop on Riverbank filtration hydrology (Bratislava, 2004), an expert-meeting on arsenic mobilization during Aquifer Storage and Recovery (ASR) activities in Tampa USA (SW Florida Water Management District, 2006) and in Gainesville USA (ASR Systems, 2007), an expert-meeting on AR for Spain (Majorca, 2009), and a NATO workshop on RBF for water security in desert climates in Luxor (Egypt, 2009).
- Organizer of and single lecturer during a 2 days seminar on artificial recharge in Bologna 2006 and Ravenna 2011 (in italian).

Publications

In order: peer reviewed, lightly reviewed (Symposium papers and books), reports in english, and papers + reports in dutch.

Peer Reviewed

- STUYFZAND, P.J. 1987. Influences of filtration and storage of groundwater samples on sample composition. Trends in Anal. Chem. (TrAC), 6, 50-54.
- STUYFZAND, P.J. 1989. An accurate, relatively simple calculation of the saturation index of calcite for fresh to salt water. J. Hydrol. 105, 95-107.
- STUYFZAND, P.J. 1989. Hydrology and water quality aspects of Rhine bank ground water in The Netherlands. J. Hydrol. 106, 341-363.
- STUYFZAND, P.J. 1990. Hydrochemical facies analysis of coastal dunes and adjacent low lands : The Netherlands as an example. In "Dunes, European

coasts", T.W.M. Bakker, P.D. Jungerius & J.A. Klijn (eds), Catena Supplement 18, 121-132.

- STUYFZAND, P.J. 1993. Hydrochemistry and hydrology of the coastal dune area of the Western Netherlands. Ph.D Thesis Vrije Univ. Amsterdam, published by KIWA, ISBN 90-74741-01-0, 366 p.
- STUYFZAND, P.J. 1994. The impact of land reclamation on groundwater quality and future drinking water supply in The Netherlands. Proc. Intern. Conf. "Living with Water", Amsterdam 26-29 Sept. 1994, 101-110. Also in modified version: Water Sci & Technol. 31 (1995), 47-57.
- GROOTJANS, A.P., F.P. SIVAL & P.J. STUYFZAND 1996. Hydro-geochemical analysis of a degraded dune slack. Vegetatio 126, 27-38.
- VAN DER JAGT, H. & P.J. STUYFZAND 1996. Methods for trace element analysis in surface water, atomic spectrometry in particular. Fresenius J. Anal. Chem. 354, 32-40.
- GROOTJANS, A.P., W.H.O.ERNST & P.J. STUYFZAND 1998. European dune slack ecosystems: wetlands with many endangered species and strong interactions of biology, pedogenesis and hydrology. TREE 13, 96-100.
- STUYFZAND, P.J. 1999. Patterns in groundwater chemistry reflecting groundwater flow. Hydrogeol. J. 7, Theme issue 'Groundwater as a geologic agent', J. Tóth (ed), Hydrogeology J. (7), 15-27.
- SAALTINK, M.W., C. AYORA, P.J. STUYFZAND & H. TIMMER 2003. Analysis of a deep well recharge experiment by calibrating a reactive transport model with field data. J. Contaminant Hydrol 65, 1-18.
- VAN DER VELDE, R.T., P. HIEMSTRA, E.C.M. RUIJGROK, P.J. STUYFZAND, J.W. KOOIMAN & G. MESMAN 2005. The benefits of air pollution control to water supply in the Netherlands. Water Environment 21, December, 48-50.
- STUYFZAND, P.J. & J. KAPPELHOF. 2005. Floating, high-capacity desalting islands on renewable multi-energy supply. Desalination 177 (2005), 259-266.
- PROMMER, H. & P.J. STUYFZAND 2005. Identification of temperature-dependent water quality changes during a deep well injection experiment in a pyritic aquifer. Environ. Sci. & Technol. 39, 2200-2209.
- FOPPEN, J.W.A., M. VAN HERWERDEN, M. KEBTIE, A. NOMAN, J.F. SCHIJVEN, P.J. STUYFZAND & S. UHLENBROOK 2008. Transport of Escherichia Coli and solutes during waste water infiltration in an urban alluvial aquifer. J. Contam. Hydrol. 95 (2008) 1-16.
- PROMMER, H., J. GRESKOWIAK & P.J. STUYFZAND 2008. Simulating transient redox zonation and its impact on the fate of micropollutants during managed aquifer recharge. GEOCHIMICA ET COSMOCHIMICA ACTA Volume: 72 Issue 12, A764-A764, Supplement 1.
- Van Beek, C.G.E.M., R.J.M. Breedveld, & P.J. Stuyfzand 2009. Prevention of two types of well clogging. JAWWA 101(4), 125-134.
- Mendizabal, I. & P.J. Stuyfzand 2009. Guidelines for interpreting hydrochemical patterns in data from public supply well fields and their value for natural background groundwater quality determination. J Hydrol. 379 (2009), 151-163.
- Van Beek, C.G.E.M., R.J.M. Breedveld, M. Juhász-Holterman, A. Oosterhof & P.J. Stuyfzand 2009. Cause and prevention of well bore clogging by particles. Hydrogeol J. 17, 1877-1886.
- Van Beek, C.G.E.M., A.H. de Zwart, M. Balemans, J.W. Kooiman, C. van Rosmalen, H. Timmer, J. Vandersluys & P.J. Stuyfzand 2010. Concentration and size distribution of particles in abstracted groundwater. Water Research 44, 868–878.
- Stuyfzand, P.J. & K.J. Raat 2010. Benefits and hurdles of using brackish

groundwater as a drinking water source in the Netherlands. Hydrogeol. J. 18, 117-130.

- Mendizabal, I., P.J. Stuyfzand & A. Wiersma 2011. Hydrochemical system analysis of public supply well fields, to reveal water-quality patterns and define groundwater bodies:The Netherlands. Hydrogeology Journal 19, 83-100, DOI 10.1007/s10040-010-0614-0.
- de Louw P.G.B., G.H.P. Oude Essink, P.J. Stuyfzand, S.E.A.T.M. van der Zee 2010. Upward groundwater flow in boils as the dominant mechanism of salinization in deep polders, The Netherlands. J. Hydrology 394 (2010) 494–506.
- Wallis, I., H. Prommer, C.T. Simmons, V. Post & P.J. Stuyfzand 2010. Evaluation of conceptual and numerical models for arsenic mobilization and attenuation during managed aquifer recharge. Environ. Sci. Technol. 2010, 44, 5035–5041
- Eschauzier, C., J. Haftka, P.J. Stuyfzand and P. de Voogt 2010. Perfluorinated compounds in infiltrated river Rhine water and infiltrated rain water in coastal dunes. ES&T 44(19), 7450-7455, 10.1021/es100471z.
- Bonte, M., G. van den Berg, P.J. Stuyfzand & H. Boukes 2011. The effects of aquifer thermal energy storage on groundwater quality and the consequences for drinking water production: A case study from the Netherlands. Water Science and Technology 63 (9):1922-1931.
- Mendizabal, I. & P.J. Stuyfzand 2011. Quantifying the vulnerability of well fields towards anthropogenic pollution: The Netherlands as an example. J. Hydrology 398, 260-276.
- Mendizabal, I., P.J. Stuyfzand & P.K. Baggelaar 2012. Natural background quality and historical trends in groundwater bodies, based on 110 year monitoring of public supply well fields. Accepted J. Hydrology.
- Karlsen, R.H., F.J.C. Smits, P.J. Stuyfzand, T.N.Olsthoorn, B.M. van Breukelen 2012. A post audit and inverse modeling in reactive transport: 50 years of artificial recharge in the Amsterdam water supply dunes. J. Hydrol in press.
- Antoniou, E.A., B.M. van Breukelen, B. Putters & P.J. Stuyfzand 2012. Hydrogeochemical patterns, processes and mass transfers during aquifer storage & recovery (ASR) in an anoxic sandy aquifer. Accepted by Applied Geochemistry.

Lightly Reviewed (Symposium papers and books)

- STUYFZAND, P.J. 1984f. Groundwater quality evolution in the upper aquifer of the coastal dune area of the western Netherlands" IAHS Publ. 150, 87-98.
- VAN DER KOOIJ, D., J.T. GROENNOU, J.C. KRUITHOF, P.C. NOORDAM, A. NOORDSIJ, P.J. STUYFZAND & M.A. VAN DER GAAG 1985. Water quality aspects of riverbank filtration in the Netherlands. Water Supply 3, 41-50.
- STUYFZAND, P.J. 1986a. A new hydrochemical classification of water types : principles and application to the coastal dunes aquifer system of the Netherlands. Proc. 9th Salt Water Intrusion Meeting, Delft 12-16 may, Delft Univ. Techn., 641-655. Also published in 'Hydrogeology of salt water intrusion; a selection of SWIM papers', W. de Breuck (Ed), Intern. Contrib. to Hydrogeology (11), Verlag Heinz Heise, 329-343.
- ENGELEN, G.B., R.J. STUURMAN, & P.J. STUYFZAND 1986. A three-dimensional plexi-glass model of the hydrogeology, hydrochemistry and flow systems in the coastal dunes with artificial recharge, Castricum, Netherlands. Proc. 9th SWIM, Delft (The Netherlands), 12-16 May 1986, 193-197.
- STUYFZAND, P.J. 1987a. Effects of vegetation and air pollution on groundwater quality in calcareous coastal dunes near Castricum, the

Netherlands: Lysimetric observations. Proc. Intern. Symp on Acidification and water pathways, Bolkesjo Norway 4-8 may 1987, Norw. Nat. Comm. for Hydrol. (ed), vol.2 , 115-125

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- STUYFZAND, P.J. 1989e. Quality changes of river Rhine and Meuse water upon basin recharge in The Netherlands' coastal dunes : 30 years of experience. In : "Artificial recharge of Groundwater", Proc. Int. Symp. Anaheim USA, 21- 28 august 1988, Johnson, A.I. & D.J. Finlayson (eds), Am. Soc. Civil Eng., New York, 233-245.
- STUYFZAND, P.J. 1989g. A new hydrochemical classification of watertypes. IAHS Publ. 182, 89-98.
- STUYFZAND, P.J. 1989h. Factors controlling trace element levels in ground water in The Netherlands. Proc. Sixth Int. Symp. Water Rock Interaction, Malvern (UK), August 3-8 1989, D.L. Miles (ed), Balkema Rotterdam, 655-659.
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- STUYFZAND, P.J. 1993a. Behaviour of major and trace constituents in fresh and salt intrusion waters, in the Western Netherlands. In "Study and modelling of saltwater intrusion into aquifers", E. Custodio & A. Galofré (eds), Proc. 12th Salt Water Intrusion Meeting, November 1992 Barcelona, CIHS. CIMNE Barcelona, 143-160.
- BAKKER, T.W.M & P.J. STUYFZAND, 1993. Nature conservation and extraction of drinking water in coastal dunes : the Meijendel dunes. In : "Landscape ecology of a stressed environment", C.C. Vos & P. Opdam (eds), IALE-Studies in Landscape Ecology 1, Chapman & Hall, Lon-don, 244-262.
- LAMMERTS, E.V., A. GROOTJANS, P.J. STUYFZAND & F. SIVAL, 1993. Endangered dune slack plants; gastronomers in need of mineral water. Proc. 4th EUCC Con-gress, Marathon (Greece) 1993, in "Coastal Management and Habitat Protection 1, 355-369.
- STUYFZAND, P.J. 1994b. Advanced mapping of groundwater quality as an aid in designing monitoring programs and selecting areas for superprotection. Proc. Intern. Conf. "Living with Water", Amsterdam 26-29 Sept. 1994, 773-774.
- STUYFZAND, P.J. & G.A. BRUGGEMAN 1994. Analytical approximations for fresh water lenses in coastal dunes. Proc. 13th Salt Water Intrusion Meeting, June 1994, Cagliari Italy, G. Barrocu (ed), Univ. Cagliari, Fac. Engineering, 15-33; tevens Kiwa-rapport SWI-95.134, 19p.
- STUYFZAND, P.J. & R.J. STUURMAN 1994. Recognition and genesis of various brackish to hypersaline groundwaters in The Netherlands. Proc. 13th Salt Water Intrusion Meeting, June 1994, Cagliari Italy, G. Barrocu (ed), Univ. Cagliari, Fac. Engineering, 125-136; tevens Kiwa-rap-port SWI-95.133, 12p.
- STUYFZAND, P.J. 1995a. Behavior of phosphate in eutrophic surface water upon artificial recharge in the Western Ne-therlands. In : "Artificial recharge of Groundwater, II", Proc. SISAR (Second Int. Symp. on Artif. Recharge), Orlando USA, 17- 22 July 1994, John-son, A.I. & R.G.D. Pyne (eds), Am. Soc. Civil Eng., New York, 558-567; tevens als Kiwa-rapport SWI 95.135, 10p.
- STUYFZAND, P.J. 1995e. The geohydrochemical approach in optimizing groundwater quality monitoring. Poster presented at 19th IWSA Symposium, September 9-15, Durban (SA), and at workshop 'Monitoring Tailor-made II', Sept. 9-12, 1996, Nunspeet, the Neth.

- STUYFZAND, P.J. 1996a. Salinization of drinking water in the Netherlands: anamnesis, diagnosis and remediation. SGU Rapporter och Meddelander 87, Proc. 14th SWIM, 17-21 June 1996, Malmö, Geol. Survey Sweden, Uppsala, 168-177.
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- STUYFZAND, P.J. 1997a. Fate of pollutants during artificial recharge and bank filtration in the Netherlands. DVGW-Schriftenreihe Wasser 90, 131-146.
- SIVAL, F.P., A.P. GROOTJANS, P.J. STUYFZAND & T. VERSCHOORE DE LA HOUSSAYE 1997. Variation in groundwater composition and decalcification depth in a dune slack: effects on basiphilous vegetation. J. Coastal Conservation 3, 79-86.
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- STUYFZAND, P.J. 1998c. Quality changes upon injection into anoxic aquifers in the Netherlands: evaluation of 11 experiments. In: Peters J.H. (ed), Artificial recharge of groundwater, Proc. 3rd Intern. Symp. on Artificial Recharge, Amsterdam the Netherlands, Balkema, 283-291.
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- BRUN, A., F.D. CHRISTENSEN, J.S. CHRISTIANSEN, P.J. STUYFZAND & H. TIMMER 1998. Water quality modelling at the Langerak deep-well recharge site. In: Peters J.H. (ed), Artificial Recharge of groundwater, Proc. 3rd Intern. Symp. on Artificial Recharge, Amsterdam the Netherlands, Balkema, 305-310.
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- GRIFFIOEN, J. A.L. LOURENS, Ch.B.M. te STROET, B. MINNEMA, M.P. LAEVEN, P.J. STUYFZAND, C.G.-E.M. van BEEK & W. BEEKMAN 1998. An integrated groun-dwater quality model based on hydrogeochemical environments. Water-Rock Interaction, Proc. 9th Intern. Symp. on WRI, Taupo New Zealand, G.B. Arehart & J.R. Hulston (eds), Balkema, 153-156.
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