

14 THE NETHERLANDS: MERGELLAND

14.1 Overview

“Mergelland” (“Marl country”) is a region in the south of the Dutch province of Limburg (*Figure 56*). The name refers to the presence at shallow depth of limestone, called “Mergel” (Marl) by the local population. The area is known for its hilly countryside (which sticks out compared to the rest of the Netherlands), the natural beauty, and several picturesque villages and hamlets (“Mergelland”, 2020).

The region is roughly bounded by highways A2, A79 and A76 and the Dutch-German and the Dutch-Belgian border (*Figure 56*). The Margraten Plateau can be considered as the centre of “Mergelland”. This plateau is bounded by the valley of the river Meuse to the West and by the valley of the river Geul in the North. It is dissected by the valley of the Gulp brook and various dry valleys. The entire region is part of the catchment of the Meuse river (Van den Hoven & Van den Hoven, n.d.).

Due to the presence of loess deposits, the soils in Mergelland are fertile and are widely used for arable and dairy farming and fruit growing. Particular flora and fauna are present, for example on the slopes and in the smaller brook valleys. This has resulted in the designation of various nature areas, including Natura 2000 sites (“Natuur en Landschap”, n.d.).

The brooks are fed by several relatively small springs (*Figure 56*). In many of these springs and brooks nitrate concentrations are above 50 mg/l, due to leaching of agricultural fertilizer. This eutrophication has led to changes in vegetation. High nitrate concentrations are also found in groundwater in the area, thus having an impact on public and private water supplies (Hendrix & Meinardi, 2004).

The main aquifer in the area is the “kalksteenaquifer” (limestone aquifer). The saturated thickness of the limestone aquifer varies from 0 to 180 meters with an average of 66 meters. The thickness of the unsaturated zone of the aquifer varies from around 75 meters on the plateaus to 0 meters in the valleys of the rivers and brooks where the aquifer is fully saturated. Only the upper 40 m of the limestone aquifer are thought to be karstified to a certain degree (Vernes et al., 2009). Caves in the limestone are all manmade. To the north this aquifer is covered by a second stratified aquifer of quaternary and tertiary deposits. The hydrogeological situation at the location of the springs varies.

The discharge of the springs has only been measured or estimated occasionally. No continuous measurements are currently carried out at the sites of the springs.

St Brigida spring

The Sint-Brigida spring is the only site with some discontinuous time series data available. The discharge of this spring is characterized by a lack of a fast discharge component (Teuling, 2001). The Sint-Brigida spring is the main source of the Noor brook, which flows to the southwest into Belgium. The entire hydrological system of the Noor sub catchment behaves more or less homogeneously (Teuling, 2001).

The data analysis to identify methods of classifying the typology of karst aquifers (deliverable D5.3) will be done using the time series data of the St Brigida spring.

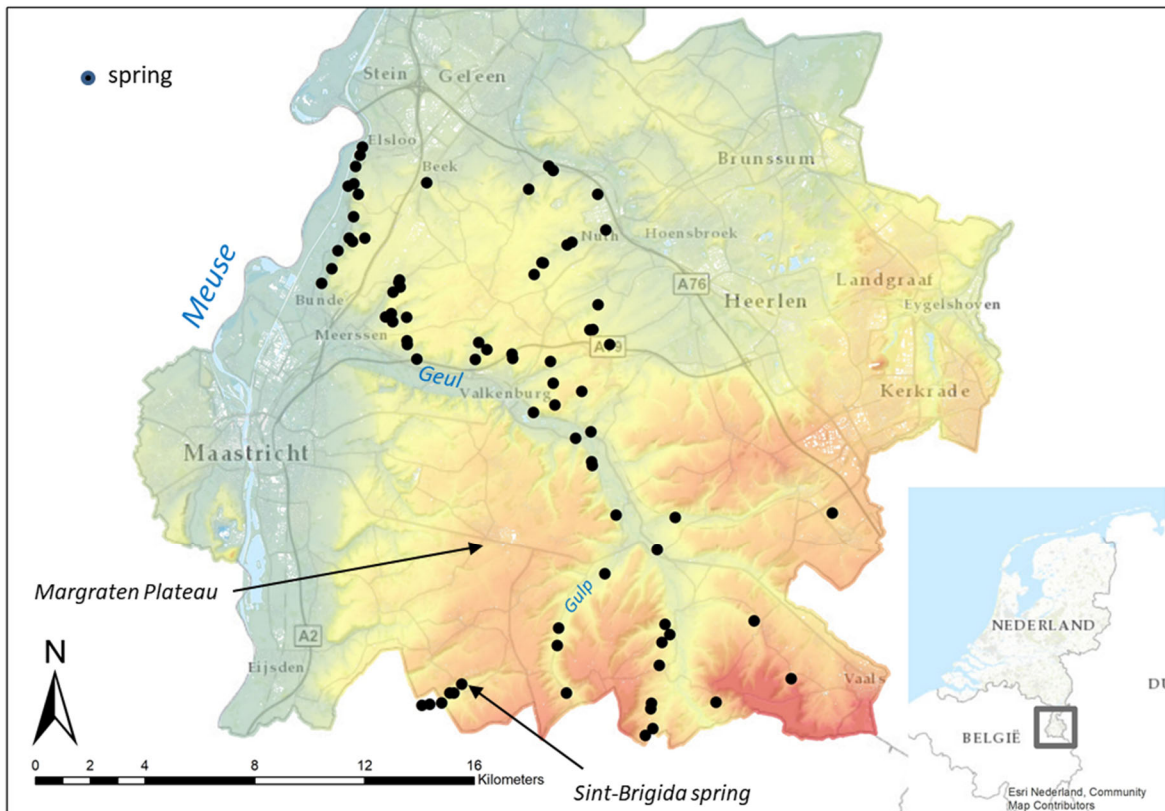


Figure 56: Location of “Mergelland” (“Marl country”) and springs in the south of the Dutch province of Limburg. The Margraten Plateau can be considered as the centre of “Mergelland”.

14.2 Geology

“Mergelland” is situated on the northern flank of the Rhenish Slate mountains (Rheinische Schiefergebirge), a chain of low mountains that stretches across Germany (the Eifel), Belgium and Luxembourg (the Ardennes) and the southernmost part of the Netherlands, and that predominately consist of Palaeozoic rocks (“Rijnlands leisteenplateau”, 2020). To the north the area is bounded by the Roer Valley Graben, an active rift zone that stretches out across the southern part of the Netherlands, the north-eastern part of Belgium and North Rhine-Westphalia in Germany.

The Palaeozoic basement of the Rhenish Slate mountains dips in a north-westerly direction and is covered by marine Upper-Cretaceous rocks, and to the north by marine Paleogene and Neogene deposits. Fluvial and/or aeolian Quaternary deposits are present as a cover layer in nearly the entire area (Figure 57).

The lowermost part of the Upper-Cretaceous deposits consists of partly consolidated sands, silts and clays (Aken Formation, Vaals Formation). Silts and clays are dominant. The upper part is made up of soft limestone (Gulpen Formation, Maastricht Formation). The Gulpen Formation predominantly consists of soft, fine-grained limestone. The lower part contains 50-90% CaCO_3 and glauconite. The upper part contains 80-95% CaCO_3 and distinctive flint nodules which may constitute up to 20% of its volume. (TNO-GSN, 2020a). The Gulpen Formation matches the

description of the Chalk in the United Kingdom (Van Rooijen, 1993). Within the Maastricht Formation two lithofacies can be distinguished (TNO-GSN, 2020b). In the southwestern part of Limburg, the Maastricht facies occur which are soft, fine to very coarse-grained yellow chalky limestones with intercalations of glauconitic limestones, hardgrounds and fossil beds. Flint is limited to the lower part. In the south-eastern part of Limburg, it consists of alternating hard and soft, light grey limestones (Kunrader facies). The overlying Houthem Formation, which is of Palaeocene age, also consists of soft limestone and together with the Gulpen and Maastricht formations makes up the “*kalksteenaquifer*” (*limestone aquifer*). The thickness of these soft limestones varies from 0 to 185 meters with an average thickness of 75 meters.

Younger Paleogene and Neogene deposits consist of an alternation of fine to medium sands and clays (Landen Formation, Tongeren Formation, Rupel Formation, Breda Formation). These are covered by coarse sands and gravels (Beegden Formation) and loess (Boxtel Formation) on the plateaus and hillslopes; and by local fluvial deposits (Boxtel Formation) in the brook valleys.

According to Van Rooijen (1993) a mature karst system is not present in the “*kalksteenaquifer*” (limestone aquifer) in Mergelland. Caves are all man-made. Although major solution caves are not known to exist, at a tunnel construction site near Maastricht cavities of substantial size were encountered (personal communication Björn Vink, 2019). However typical karst features are present: sink holes or dolines, dry valleys, narrow, vertical solution pipes and at the top of the chalk a residual of flint-bearing clay and sandy loam.

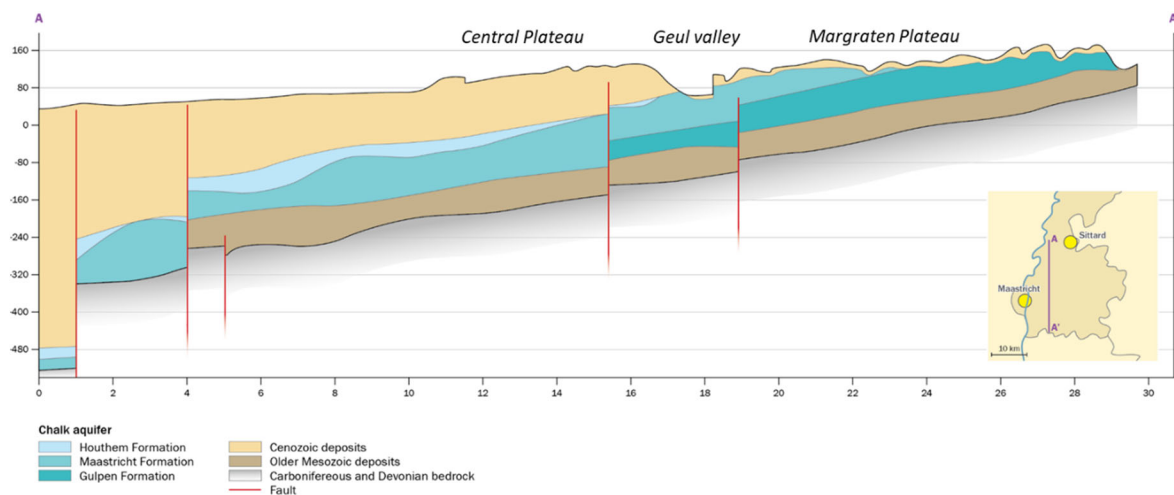


Figure 57: North-south geological cross-section through South-Limburg and “Mergelland” (Vernes et al., 2018)

14.3 Geomorphology

The Margraten Plateau can be considered as the centre of “Mergelland”. This plateau is bounded by the valley of the river Meuse to the west and by the valley of the river Geul in the north. The plateau is dissected by the valley of the Gulp brook and various smaller (dry) valleys.

The Sint-Brigida spring (Figure 58) is located just south of the Margraten Plateau, on the northern slope of the valley of the Noor brook. Dry valleys are present in the near vicinity.



Figure 58: Sint-Brigida spring, the source of the Noor brook.

14.4 Climate

According to the Köppen classification system, the climate of Mergelland is a temperate oceanic climate, code Cfb, with mild winters and cool summers (“Klimaat van Nederland”, 2020). The daily mean temperature at Maastricht is 10.7 °C, the annual precipitation is around 800 mm and the annual reference evaporation (Makkink) approximately 600 mm (KNMI, 2020).

14.5 Hydrogeology

The “kalksteenaquifer” (limestone aquifer), comprising the soft limestone of the Gulpen, Maastricht and Houthem formations, is the main aquifer in Mergelland (Figure 57). A subdivision can be made in the area in the north of the river Geul where the aquifer is overlain by Paleogene and Neogene deposits, of which the lower part acts as an aquitard; and the area in the south where these deposits are absent. The character of the “kalksteenaquifer” therefore changes from a confined aquifer in the north to a phreatic aquifer in the south.

The saturated thickness of the limestone aquifer varies from 0 to 180 meters with an average of 66 meters; the thickness of the unsaturated zone of the aquifer varies from around 75 meters on the plateaus to 0 meters in the valleys of the rivers and brooks where the aquifer is fully saturated. Due to the low permeability of some of the Paleogene deposits a perched water table with a regional extent is present just north of the river Geul above the “kalksteenaquifer”. Several small streams that drain this area become losing streams once the edge of the aquitard is crossed and some streams disappear completely. Springs are present, both in the northern and southern part of the “kalksteenaquifer” (see Figure 56). In the northern part these springs generally occur on the slopes of the valleys, at the level of poorly permeable layers within the Paleogene and Neogene

deposits. These springs are not fed by the “kalksteenaquifer” and could therefore have a different behaviour. Also, in the southern area, where the “kalksteenaquifer” is phreatic, there are springs which are not fed by the “kalksteenaquifer”, but by small local permeable zones present in fractured sand- and siltstones within the underlying generally poorly permeable Vaals and Aken formations.

Some of the locations of the springs coincide with the interface between the “kalksteenaquifer” and the underlying Vaals and Aken formations, one of which is the location of the Sint-Brigida spring. Further research is needed to get a better understanding of the hydrogeological system of the various springs.

The “kalksteenaquifer” is exploited for public water supply, industry (for example breweries, mineral water production and soft drink industry) and for agricultural purposes.

At various locations groundwater levels in the “kalksteenaquifer” are measured on a regular basis. Based on these data, maps were created (Vernes et al., 2009) that clearly reflect the different character of the aquifer in the north, where it is confined, versus the south where it is phreatic.

14.6 Hydrodynamic characteristics of the springs (and river)

The discharge of the springs has only been measured or estimated occasionally, except for the Sint-Brigida spring for which a (discontinuous) time series over the period of 12 February 1994 to 23 October 2001 exist. Based on single measurements and estimates provided by Hendrix & Meinardi (2004) for the end of 2001, the discharge rate of the springs is small compared to springs in mature karst systems and varies between 0.01 and 12 l/s (northern area) and between 0.05 and 23.8 l/s (southern area). Time series of the discharge of the Sint-Brigida spring for the period of 22 June 1994 – 23 April 2000 show fluctuations in discharge from 0 (dry) to 55 l/s. Some of the larger springs are thought to be related to karst features (Hendrix, 1990).

Teuling (2001) concluded that the discharge of Sint-Brigida spring is characterized by a lack of a fast discharge component. The Sint-Brigida spring is the main source of the Noor brook. The entire hydrological system of the Noor sub catchment behaves more or less homogeneously (Teuling, 2001). The brook flows into Belgium where it enters a tributary of the Meuse river.

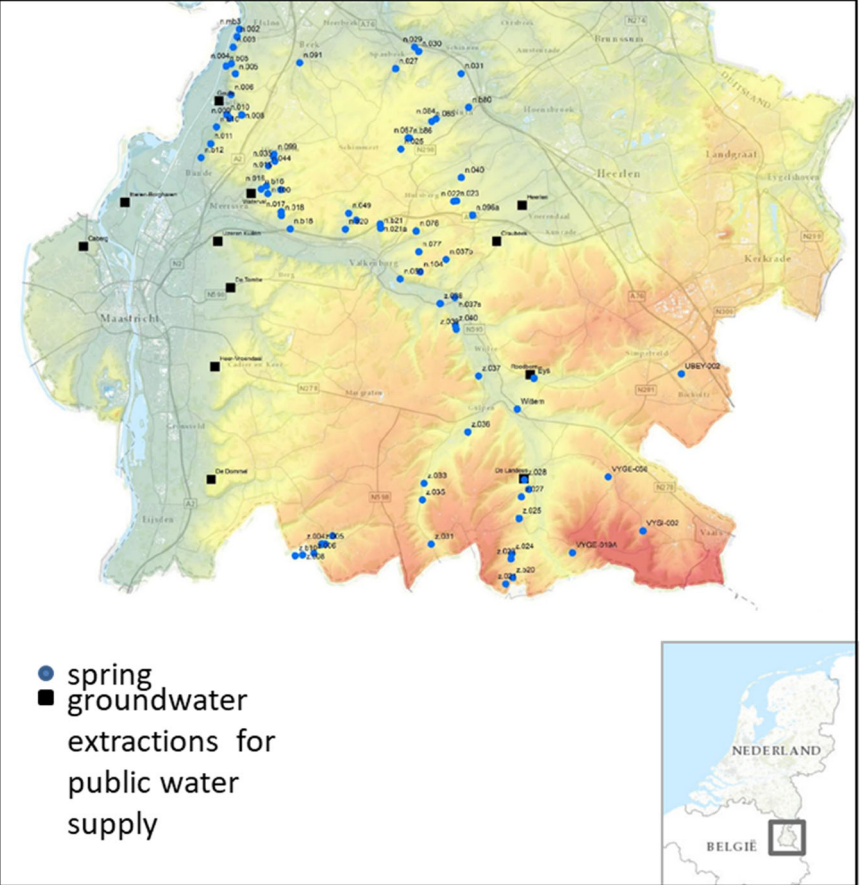
14.7 Data available for the project

1. Mergelland, springs			
Data type	Time step	Monitoring period	Time period
Level	-	-	-
Discharge: - St Brigida spring - Other springs	Every quarter-hour Occasionally	>10 year unknown	1994-2002 unknown
Temperature	One a year 4 times a year	>10 year	1991 – 2006 2007-present
Electrical conductivity	Once a year 4 times a year	>10 year	1991 – 2006 2007-present

1. Mergelland, springs			
Data type	Time step	Monitoring period	Time period
pH	Once a year 4 times a year	>10 year	1991 – 2006 2007-present
Dissolved oxygen O ₂	Once a year 4 times a year	>10 year	1991 – 2006 2007-present
Suspended matter	-	-	-
Major anions/cations	Once a year 4 times a year	>10 year	1991 – 2006 2007-present
Isotopes (tritium)	1 time per approx. 8 years	>10 year	2001 - 2018
Turbidity	-	-	-
Nutrients (NO ₃ ; PO ₄)	Once a year 4 times a year	>10 year	1991 – 2006 2007-present
TOC/DOC	Once a year 4 times a year	>10 year	1991 – 2006 2007-present
Other: metals, trace elements	Once a year 4 times a year	>10 year	1991 – 2006 2007-present

2. Mergelland, monitoring wells			
Data type	Time step	Monitoring period	Time period
Level	Once every 2 weeks / once a day	>10 year	different measurement periods
Discharge	-	-	-
Temperature	Once a year / Once every 2 years	>10 year	1992-2015
Electrical conductivity	Once a year / Once every 2 years	>10 year	1992-2015
pH	Once a year / Once every 2 years	>10 year	1992-2015
Dissolved oxygen O ₂	Once a year / Once every 2 years	>10 year	1992-2015
Suspended matter	-	-	-
Major anions/cations	Once a year / Once every 2 years	>10 year	1992-2015
Isotopes	-	-	-
Turbidity	-	-	-
Nutrients (NO ₃ ; PO ₄)	Once a year / Once every 2 years	>10 year	1992-2015
TOC/DOC	Once a year / Once every 2 years	>10 year	1992-2015
Other: metals, trace elements	Once a year / Once every 2 years	>10 year	1992-2015

14.8 Summary

Pilot name	Mergelland		
Country	The Netherlands	EU-region	North-western Europe
Area (km ²)	617	Lithology	Chalk
Short description:	Mergelland is the southernmost part of the Netherlands. The area consists of a number of plateaus, dissected by small valleys. The main river is the river Geul. Small springs are present at various locations. In the southern part these springs are fed by creataceous aquifers, to the north by Cenozoic aquifers. The Sint-Brigida spring, located on the southern edge of the area, is the only spring with a time series of discharge measurements.		
Monitored objects	 ● spring ■ groundwater extractions for public water supply		
Monitored data	Springs, wells and precipitation.		
Contact person	Groundwater levels, discharge (occasionally), temperature, electric conductivity, major anions/cations, stable isotopes, nutrients (NO ₃ ;PO ₄), TOC/DOC, other.		
	Mariëlle van Vliet (marielle.vanvliet@tno.nl) & Ronald Vernes (ronald.vernes@tno.nl)		

14.9 References

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