



Springs in Fischingen (TG): Mapping the Presence of Historical Springs and Monitoring their Seasonal Changes in Discharge and Water Chemistry

GEO 511 Master's Thesis

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Abstract

Springs are considered to be hotspots of biodiversity and should therefore be given special protection. However, increasing pressure from human activity has placed these ecosystems and their highly specialized spring communities at serious risk. Many natural and unmodified springs have been captured or have disappeared due to drinking water extraction and agricultural changes. This study examined the spring situation in the region of Fischingen, in the canton of Thurgau (Switzerland), based on the Historic Spring Atlas from 1912 and evaluated the water-bearing springs according to their structural characteristics. Springs in forested areas appear relatively resilient over time. Not only do three-quarters of the springs recorded in 1912 still exist, but the only remaining natural springs are also found within these forested areas. In contrast, grassland springs are much more vulnerable to degradation, with over half of them having disappeared and none surviving in their original, natural form. This contrast between grassland and forest is also reflected in the ecological value of the springs. Additionally, repeated assessments of discharge and stream chemistry revealed seasonal variations depending on weather and wetness conditions. The complex nature and behaviour of a spring can therefore only be captured to a very limited extent through a single measurement.

Zusammenfassung

Quellen, insbesondere natürliche Quellen, werden als Biodiversitäts-Hotspots bezeichnet und sollten daher besonders geschützt werden. Durch den stetig wachsenden Druck menschlicher Aktivitäten werden diese sensiblen Ökosysteme und ihre hochspezialisierten Quellgemeinschaften zunehmend gefährdet. Ein Grossteil der natürlichen und bisher unberührten Quellen wurden im Rahmen der Trinkwassernutzung gefasst, im Zuge der Intensivierung der Landwirtschaft drainiert und trockengelegt oder beim Bau von Verkehrswegen und Siedlungen eingedolt. Die vorliegende Arbeit untersucht die heutige Quellsituation in der Region Fischingen, im Kanton Thurgau (Schweiz). Anhand des Historischen Quellenatlas aus dem Jahr 1912 wurden 90 Quellstandorte aufgesucht und die 28 offenen und wasserführenden Quellen mittels der BAFU-Methode nach ihren strukturellen Merkmalen bewertet.

Die Ergebnisse haben gezeigt, dass knapp die Hälfte der historischen Quellen seit 1912 nicht mehr aufgefunden werden konnte. Quellen in bewaldeten Gebieten scheinen im Laufe der Zeit relativ widerstandsfähig gewesen zu sein. Drei Viertel der Quellen sind heute noch vorhanden, etwas weniger als die Hälfte davon befindet sich immer noch in ihrem natürlichen Zustand. Im Gegensatz dazu sind Quellen auf Wiesen und Weideland grösstenteils verschwunden. Über die Hälfte der historischen Quellen konnte nicht mehr aufgefunden werden, während die verbleibenden Quellen heute alle gefasst sind. Damit zusammenhängend wurde aufgezeigt, dass wenig bis mässig beeinflusste und damit ökologisch wertvolle Quellen besonders im Wald zu finden sind, während die gefassten Quellen auf Wiesen und Weideland durchgehend als ökologisch schlecht bewertet wurden. Diese Verteilung ist insbesondere für mögliche Renaturierungsprojekte spannend.

Darüber hinaus zeigten wiederholte Messungen des Abflusses und der Quellwasserchemie (pH, Leitfähigkeit, Wassertemperatur und gelöster Sauerstoff) saisonale Schwankungen in Abhängigkeit der Feuchtigkeits- bzw. Wetterverhältnisse. Das komplexe Verhalten einer Quelle kann daher nur sehr begrenzt durch eine einzelne Begehung und Messung erfasst werden. Solche Informationen, beispielsweise über die Schwankungsbreite der Schüttmenge oder das periodische Trockenfallen, sind jedoch besonders wichtig um Aussagen über die Biodiversität zu treffen, da nur hochspezialisierte trockenresistente Quellarten überleben können.

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1. Introduction

Switzerland is often called the ‘water tower of Europe’, a name inspired by its countless spring-fed streams and rivers that shape the landscape. However, truly natural and unmodified springs have become increasingly rare. Growing pressure from human activity, both direct and indirect, has put these ecosystems and their highly specialized spring communities at serious risk. Over the past century, many springs have been tapped for drinking water or captured for agricultural purposes, leading to the degradation or complete loss of their natural habitats (Zollhöfer 1997).

1.1. What Is a Spring? Definition and Characteristics

Generally, springs are natural discharge points where groundwater emerges at the Earth's surface, forming a critical interface between surface and groundwater ecosystems (van der Kamp, 1995; Zollhöfer, 1997). They are defined as spatially confined groundwater emergence points that must exhibit at least temporary discharge (Gerecke, 2016; Küry et al., 2019; Lubini-Ferlin et al., 2014). The occurrence of springs is primarily controlled by two hydrogeological conditions: 1) the presence of a sufficiently large catchment area to facilitate the accumulation of groundwater and 2) the existence of a permeable, water-bearing geological formation (aquifer) situated above or adjacent to a less permeable confining layer. Infiltrated precipitation within the catchment area percolates through the subsurface, follows the gradient of the underlying impermeable layer, and discharges at the surface where this confining layer intersects with the surface. At this emergence point, the spring water influences the adjacent environment, shaping a unique spring habitat (BAFU, 2021).

Due to their transitional nature, springs are considered ecotones, linking groundwater and surface water habitats and playing a key role in hydrological and ecological connectivity (BAFU, 2021; Gerecke, 2016). They are usually small in size and unlike rivers, streams and lakes, springs are characterized through relatively stable water chemistry and temperature (Andereggen et al., 2022; Audorff et al., 2011). Spring ecosystems are shaped by various factors such as the geological structure of the bedrock, soil properties, land use of the surrounding area, as well as vegetation and climatic conditions (Fernández-Martínez et al., 2024). Understanding the physical and ecological characteristics of springs provides the

foundation for their systematic classification, which can be approached from various hydromorphological perspectives.

1.1.1. Spring Classification

Springs are complex systems and therefore can be classified in multiple ways. One widely accepted classification approach involves examining springs from a hydromorphological perspective, dividing them based on their outlet flow type into three main categories: 1) rheocrenes, describing streams with a continuous flow of water, typically forming fast-flowing, stream-like habitats; 2) helocrenes describing seepages which emerge in wetland areas, typically characterized by slow-flowing or stagnant water, creating moist and marshy habitats; and 3) limnocrenes, describing pond springs with little to no flow. However, a clear distinction between these three main spring types is not always possible, creating additional mixed forms (Lubini-Ferlin et al., 2014).

A second common classification approach considers a hydrogeological background, separating springs according to the characteristics of their underground flow paths into joint springs, karst springs and springs emerging from loose rocks (Küry et al., 2019).

Besides these hydrological and geological subdivision, springs can further be classified based on ecological features, the occurring vegetation, their water chemistry and temperature or the human impact (Fernández-Martínez et al., 2024). Depending on the study area, there is need to define special categories, as for example in urban areas artificial spring outlets are very common. In addition to these factors, the classification of springs also considers the spatial distribution and connectivity of multiple spring outlets. When multiple outlets of the same type are found at or near the same location, they form a spring system, whereas a combination of different outlet types is defined as a spring complex (Küry et al., 2019).

1.1.2. Spring Hydrology

Springs are unique habitats, characterized by specific hydrological features such as stable temperatures, constant water discharge, low oxygen saturation, and stable pH and electrical conductivity. The flow regime of a spring is highly dependent on climate, the hydrostructure and lithological characteristics of the aquifer. Precipitation, infiltration, runoff and evapotranspiration determine whether a spring has permanent or intermittent flow. These

hydrological inputs not only control the amount of water feeding the spring but also influence seasonal flow variability and the resilience of spring discharge during dry periods (van de Kamp, 1995).

One defining factor is water temperature. Typically, spring water maintains the same temperature as the groundwater, which closely corresponds to the mean annual air temperature of the surrounding area. As a result, springs remain cool in summer and warm in winter, with only minimal temperature fluctuations – typically within a few tenths of a degree throughout the year (Lubini-Ferlin, 2015b).

Secondly, the chemistry of spring water is strongly influenced by the geological setting of the catchment area. Depending on the solubility of the minerals in the bedrock and the residence time of the water in the aquifer, the concentration of dissolved substances and ions can be very high (ibid.). Electrical conductivity (EC) can be used as a proxy for the total dissolved ion concentration, as it reflects this mineral content. Therefore, EC is a valuable indicator of geochemical processes in the subsurface. In general, EC in spring water is relatively stable due to the consistent geochemical conditions underground, however, it can vary with seasonal changes, precipitation events, or anthropogenic impacts. Higher EC values in spring water are generally associated with longer groundwater flow paths or prolonged contact with mineral-rich bedrock (Dahaan et al., 2016; Schmidt et al., 2012; Yilmaz & Koç, 2014).

Additionally, higher water temperatures can enhance reactivity and in consequence the weathering process. Precipitation can further accelerate weathering by increasing flow rates, which facilitates chemical reactions. However, precipitation can also lead to a dilution of ion concentrations in the water. Besides these lithological and climatic factors, vegetation and soil properties in the catchment area influence spring water chemistry by affecting infiltration rates, organic matter enrichment, and buffering capacity (Fernández-Martínez et al., 2024).

Equally, the pH of spring water is generally known to be stable, but can vary depending on geological, hydrological, and environmental factors (Fernández-Martínez et al., 2024; van der Kamp, 1995). Especially springs fed by deep groundwater are most likely to have a stable pH compared to near-surface springs, as external influences like precipitation, seasonal flow changes, and human impacts may cause fluctuations (Beierkuhnlein et al., 2024; van der Kamp, 1995).

Further, the dissolved oxygen concentration in spring water is often low because groundwater typically has a relatively long residence time underground. As a result, the water initially emerges at the surface with an oxygen deficit, but it will rapidly equilibrate and absorb oxygen once it begins flowing in a turbulent stream (Lubini-Ferlin, 2015b).

1.1.3. Springs as Habitats – Flora and Fauna

Despite their relatively small size, springs are known for their rich biodiversity. Scientifically, the entire set of microhabitats associated with a spring, meaning the groundwater, surface water and adjacent moist zones, is collectively referred to as the krenal. The biological communities inhabiting this environment are termed the krenon. The microhabitats form a mosaic structure with boundaries that shift depending on the moisture gradient and environmental influences such as discharge or precipitation. These changes strongly influence the composition of the spring's flora and fauna. While aquatic species dominate areas near the spring outlet, terrestrial species are more present in drier zones further away from the spring's center (Lubini-Ferlin, 2015a). Spring biodiversity is therefore closely linked to the eco-hydrogeological characteristics of the aquifer. Even under similar physical and chemical conditions, species composition can vary greatly from one site to another (Gerecke 2016; Lubini-Ferlin, 2015a). In Switzerland, approximately 100 species are known to depend on spring habitats. Of these, 73 % are classified as threatened or potentially threatened and are thus national priority species (BAFU, 2021). Springs not only provide vital habitats but also serve as refuges for glacial relict species and as shelters during periods of drought. However, springs are also highly sensitive to environmental changes. In springs that dry up periodically, biodiversity declines rapidly, as only drought-adapted specialist species are capable to survive (Lubini-Ferlin, 2025a). This underlines the ecological vulnerability of spring habitats.

1.2. The Importance of Springs – Context and Relevance

Springs in Switzerland have become increasingly rare in intensively used regions such as the Central Plateau, the Pre-Alps, and the Jura. While they are primarily important for drinking water supply, their role as habitats has long been overlooked. The preservation of these ecosystems is particularly crucial for highly specialized and endangered species listed on the Red List. As biodiversity hotspots, springs are considered both vulnerable, and in need of protection (BAFU, 2021). To understand the current spring situation in Switzerland, one has to take a look into the past.

In most regions of Switzerland, the distribution of spring habitats has drastically declined since the 19th century. More than 90 % of the originally existing natural springs have been captured or severely degraded as habitats (Küry, 2009). The greatest decline occurred in settlement areas, followed by intensively used agricultural lands. The reasons for this drastic decline are diverse and often interrelated. One significant factor is the tapping of springs for drinking water supply, with approximately 40 % of Swiss drinking water currently sourced from tapped springs (BAFU 2021).

Another issue arises when a spring is decommissioned and no longer serves for water extraction. Although the tapping infrastructure is no longer actively in use, the habitat does not recover naturally, if no restoration measures are implemented (Stucki, 2015). The second important factor is related to the intensification of agriculture since the 19th century. On one hand, seepage springs were extensively drained and dried out to enlarge the farmland, on the other hand, flowing springs in open meadows were drained towards forested areas (Küry, 2015). However, today these two factors are no longer the primary drivers of new biodiversity loss. In many cases, the construction of hydropower facilities and the sealing of natural surfaces have become the main threats to spring habitats (Stucki, 2015).

Not only the construction of settlements and transportation infrastructure poses a challenge, but also the management of existing open springs. With the intensification of agriculture arises another problematic issue, namely nutrient and pesticide runoff into the spring environment. Overfertilization may enhance plant growth of specific species and destabilize the natural flora-fauna situation, causing a decline in biodiversity (BAFU, 2021). In open grazing pastures, trampling through livestock is a major destruction factor. Springs near roads, for example in the forest are most likely channelled, if not captured. Further, forest management can affect

springs by depositing organic waste material near or in the sensitive spring habitat (Stucki, 2015). Springs have been and are used in various ways, not only for drinking water or agricultural purposes but also for energy generation, cooling, snow-making systems, fish farming or for example Kneipp therapy pools (BAFU, 2021).

However, spring decline is not a new phenomenon. Already at the end of the last century, J. Zollhöfer documented that over half of the springs in the Central Plateau were captured in 1880 (Lubini-Ferlin et al., 2014). In those days, around 20 springs per square kilometer could be found in the water-rich Central Plateau. However, it has to be noted, that even at this time, spring density could vary greatly over space with less than 2 springs / km² in the drier Jura and probably more than 20 springs / km² in the Alps (BAFU, 2021). Today, the majority of near natural springs can be found in forests, but often have a small discharge of less than 20 L/min (Frei et al., 2023). In agricultural areas, almost all springs have been captured due to intensive land use. The highest chance to find natural springs in open landscapes is at higher elevations slightly above the tree line, in moderately alpine regions and hillsides (BAFU, 2021). Although no comprehensive data on the current state of springs in Switzerland are available, estimates suggest that only 1 % of the original natural spring habitats in the Central Plateau remain intact (Frei et al., 2023).

Specialized spring species are particularly threatened by this loss of spring habitats. In 2016, 96 spring-associated species (73 %) were listed on the Red List of endangered or potentially endangered species. These include caddisflies, freshwater snails, stoneflies, dragonflies, and mayflies (Küry, 2015). However, problematic is not only the reduction in the number of habitats, but also their fragmentation. As the number of springs decreases, so does the density of spring habitats, leading to a decline in habitat connectivity, increasing isolation of individual spring ecosystems and reduction in biodiversity (Lubini-Ferlin et al., 2014). In addition, springs serve as cold-water refugia for relic species of spring fauna from the Ice Age. However, these species are increasingly under pressure due to climate change and the general rise in air temperatures (Andereggen et al., 2022; Lubini-Ferlin, 2015a). The spring situation highlights the need to protect these unique ecosystems and put effort in preserving their diversity.

1.3. Protecting Spring Habitats in Switzerland

1.3.1. Legal Basis

In Switzerland, springs and spring water are legally protected by several regulatory frameworks at both the federal and cantonal levels. As transitional zones between groundwater and surface water, springs cannot be clearly assigned to a single habitat type. Therefore, the applicable legal provisions depend on the specific context, whether the spring is used for drinking water supply, nature conservation, water protection, or falls under private ownership or user rights (AWA, 2016).

As natural water bodies, springs are protected under the Federal Act on the Protection of Waters (Waters Protection Act WPA / Gewässerschutzgesetz). The law applies to both public and private springs, including their associated habitats (Fedlex, 2023). This legislation generally prohibits the contamination of water bodies, including springs, and protects all natural waters from construction or other anthropogenic impacts that may lead to degradation. In contrast to water quality, the quantity of spring water is not directly regulated by law. It is only governed through the requirement of maintaining a minimum residual flow. This means that water abstraction is permissible as long as it does not significantly affect the flow regime of the surface water body (Lubini-Ferlin et al., 2014).

Likewise, spring habitats are not explicitly or directly protected under a specific provision, but may fall under the scope of the Federal Act on the Protection of Nature and Cultural Heritage (NCHA / Natur- und Heimatschutzgesetz) (Fedlex, 2022). However, legal protection is only granted if the spring and its surrounding area are classified as a habitat worthy of protection. If this classification is not made, the spring is not protected under current legislation. The determination of whether a spring habitat is worthy of protection is based on several criteria. The NCHA defines protected habitat types such as riparian zones, wetland area or specific forest communities and others. If such biotopes are present within the spring area, the habitat may be designated as worthy of protection. The same applies to the presence of Red List species or species of national priority. Whether or not a spring is considered worthy of protection, therefore depends on a combination of ecological indicators and must be evaluated individually for each case (Lubini-Ferlin et al., 2014).

1.3.2. The Swiss Biodiversity Strategy

“Biodiversity is an essential foundation for life on Earth and consequently a fundamental basis for human existence” (BAFU, 2012, p. 5, own translation). These are the words with which the Swiss Government introduces its Biodiversity Strategy (Strategie Biodiversität Schweiz SBS) in 2012. The term biodiversity not only includes ecosystems, species and genes, but also an immense variety of ecosystem services like providing food, influencing climate, soil formation, water and air quality, and lastly offering a space to relax. However, like other countries, Switzerland is facing massive losses in biodiversity. Studies and national reports from 2007, 2009 and 2011 showed how rapidly, but unnoticed by the society this change is happening. On an international scale, biodiversity is in discussion since the 1990s, as 193 states signed an agreement to preserve the biological diversity. On this base, the Swiss government took action and formulated a national strategy, defining ten strategic goals regarding the federal government’s priorities for preservation of species diversity, ecosystems and genetic diversity. (BAFU, 2012). Five years later in 2017 the Federal Department of the Environment, Transport, Energy and Communication DETEC has concretized the strategy with an Action Plan, defining 26 measures and 19 pilot projects to be implemented until 2023, later extended to 2024. In order to execute these measures, the federal government and the cantons have to work closely together. The pilot project A5.2 Tracing the value of water (A5.2 Dem Wert des Wassers auf der Spur) has been established to focus on springs. Together with two other projects, it contributes to the broader goal of raising public awareness about biodiversity. Since most of the Swiss population is unaware of biodiversity loss and its consequences for society and the economy, the projects aim to promote recognition of the issue and encourage biodiversity-friendly actions (BAFU, 2017).

The primary goal of the project is to assess how the Swiss population values used and unused streams or running waters. To achieve this, existing cantonal spring inventories will be updated and supplemented with a record of all natural, undisturbed water bodies. These inventories will be summarized in a national centralized database for spring habitats: the MIDAT-Sources for structural features and the MIDAT for fauna-related information. A method for recording and assessing spring habitats in terms of their structural properties and fauna was developed and published in advance (info fauna, 2025). Finally, a nationwide survey will be conducted to determine the values the Swiss population associates with used and unused running waters. The findings will be compared to identify possible conflicts and opportunities related to the

protection and use of Swiss streams, providing insights for future Swiss environmental policies (BAFU, 2017).

1.4. Spring Mapping Campaigns – Insight from Cantonal Approaches

The current status of spring documentation in Switzerland varies considerably between cantons. While some have already initiated and in some cases completed their systematic spring recording, others have only recently started this process. The following section outlines the efforts of selected cantons in the Central Plateau, highlighting both ongoing and completed spring documentation efforts. Generally, it has become evident, that cantonal authorities are not capable of documenting the springs entirely on their own and therefore collaborate with environmental organizations such as Pro Natura or WWF to meet the guidelines set by the FOEN. The interim evaluation conducted by the federal government on the Action Plan for preserving biodiversity concludes that there is a lack of personnel across all administrative levels – the federal government, the cantons and involved third-party organizations – to implement measures and pilot projects properly. The Covid-19 pandemic further delayed the progress. Nonetheless, the project A5.2 Tracing the value of water remains on track within the overall framework of the Action Plan (BAFU, 2023).

1.4.1. Cantons of Bern, Lucerne, Aargau

The canton of Bern was the first to initiate a spring inventory. Since 2014, the Laboratory for Water and Soil Protection (Gewässer- und Bodenschutzlabor, GBL) as part of the Cantonal Office for Water and Waste Management (Amt für Wasser und Abfall, AWA), has been mapping natural springs and collecting them into a newly created inventory, which complements previously recorded captured springs in water protection maps (AWA, 2023). In addition to the ongoing inventory work, the GBL also conducts biological studies on spring habitats and their spring species, providing data for the protection of these unique ecosystems and their flora and fauna. The springs are recorded using the Bernese-Method (Berner-Methode), a simplified initial mapping approach based on the BAFU-protocols. Particularly valuable springs undergo a more detailed assessment at a later stage (BVD, 2025). Since 2016, Pro Natura Bern has

supported the protection of springs with a citizen science project in four biogeographical pilot regions. During the two years, 1'130 springs were mapped and assessed based on structural criteria according to the Bernese-Method. The data is used to advise farmers, landowners or foresters, as well as to assess the potential for revitalization (UNA, 2018).

Beginning 2020, Lucerne has been developing a cantonal spring inventory. In the first two years, a preliminary map has been created based on existing geodata, identifying around 9'000 potential natural spring locations, categorized as 'not-captured' or 'unknown'. In July-September 2023/24 four to six interns verified these sites in the field, recording coordinates and basic characteristics. A third phase will assess selected springs for their protection value and compile particularly valuable spring habitats in an inventory (Iawa, no date).

In contrast to the described approaches before, the canton of Aargau searched for its springs based on Friedrich Mühlberg's Spring Atlas from 1901 (see chapter 1.5). Between 2018 and 2019, Pro Natura Aargau together with 37 trained volunteers revisited 1'100 spring locations across two pilot regions and evaluated the condition and structural diversity of the spring using the Bernese-Method (Rutishauser, 2021). By the end of 2024 the entire canton had been systematically surveyed using this method, with additional 30 selected springs evaluated in greater detail using the FOEN Structural Spring Protocol (BAFU Quellenprotokoll Struktur). According to Pro Natura Aargau (Personal correspondence with M. Rutishauser, 28.03.2025), revitalization measures are either already underway or currently being planned, now that the spring inventory has been completed. In parallel, excursions and workshops targeting specific groups, schools and the general public are being conducted to promote public awareness and education (Jurapark Aargau, 2022).

1.4.2. Canton of Thurgau

The canton of Thurgau has started its spring initiative in April 2019. Until March 2020, Pro Natura Thurgau examined 303 springs in multiple protected areas of the canton, assessing them based on the FOEN Structural Spring Protocol. These areas included cantonal forest reserves, fens, alluvial forests, amphibian breeding sites of national importance, other nationally protected areas, and reserves managed by Pro Natura. The aim of the project was to collect data on the ecological status of these springs and evaluate their potential for

revitalization. The Historic Spring Atlas from 1912, created under the direction of the secondary school teacher Jakob Engeli with contributions from local community members, served as the primary reference for spring identification (Eggenberger, 2020). This atlas was also utilized in the present master study. The spring initiative project was carried out on behalf of the Cantonal Office for Spatial Development (Amt für Raumentwicklung). Results showed that out of 303 examined springs, 72 were totally damaged and 67 were captured. For 127 springs revitalization was considered worthy (Kanton Thurgau, 2022). Following the initial mapping phase, revitalization dossiers were prepared for 38 springs, with concrete restoration measures already completed or scheduled in the near future for 28 sites. Additional 40 revitalization dossiers have since been developed and are currently being processed as part of the 'Aktion Biber' initiative (Eggenberger, 2020; Personal correspondence with Pro Natura TG, P. Taxböck, 31.03.2025.)

The spring evaluation is not intended to remain limited to protected areas, but will be expanded across the entire canton. As part of the Thurgau Biodiversity Strategy (2023-2028) the 1912 Spring Atlas will be revised under the coordination of the Cantonal Office for Environment (Amt für Umwelt). The project aims to complete the mapping by 2026 and produce an updated version of the approximately 2'500 springs recorded in 1912. This includes systematic assessment, conservation of the most valuable springs and restoration measures where necessary. In addition, the sustainable use of springs must be ensured to prevent overexploitation. The total costs for this initiative are estimated around 250'000 CHF (Kanton Thurgau, 2022). A detailed overview of the spring situation on the canton of Thurgau will only be possible in a few years, however this thesis will offer a preliminary insight in the region of Fischingen.

1.5. Spring Mapping in the Past – Historical Spring Atlases

As mentioned at the beginning of this thesis, springs have been used for centuries, however detailed records of their locations were not always maintained. The cantons of Aargau and Thurgau serve as prominent examples of regions where comprehensive spring atlases exist, providing detailed information on the distribution and characteristics of springs. In contrast, most other Swiss cantons lack such systematic documentation. Instead, some cantons possess

historical maps or data sheets that contain spring-related information, however not explicitly documented.

In 1901, the canton of Aargau became the first in Switzerland to develop a detailed spring inventory, initiated by the cantonal secondary school teacher and natural scientist Friedrich Mühlberg. The primary aim was to distinguish between safe and unsafe drinking water sources to prevent health issues. Additionally, the atlas sought to document discharge volumes, water quality, and their relation to geological formations. Following a presentation to the Aargau Natural Science Society (Aargauischen Naturforschenden Gesellschaft ANG), Mühlberg was commissioned to lead the Spring Map project. Together with a network of volunteers, mainly teachers, foresters, and water masters, springs were systematically mapped onto the 1:25'000 Siegfried map and documented in detail, including information on location, ownership, discharge, temperature, quality, and usage. Measurements were taken, when possible, while discharge estimates were often provided by local experts. The canton provided materials and covered printing and distribution costs. Most volunteers declined any financial compensation. Although the mapping process took longer than initially planned, each spring was carefully recorded in specific field booklets and later summarized as valuable information to the spring atlas (Mühlberg, 1901).

A few years later, in 1903, the annual meeting of the Thurgau Natural History Society (Thurgauische Naturforschenden Gesellschaft) decided, after a lecture on the spring conditions at the Seerücken, to expand the investigation of springs across the entire canton and create a spring map for the canton of Thurgau. The leadership of this project was given to Jakob Engeli, a secondary school teacher from Ermatingen and speaker of the lecture. Similar to the canton of Aargau, spring research in Thurgau was not carried out by government officials but by the teachers from the canton and municipalities. In 1904, the project began with the distribution of spring notebooks and the necessary sheets of the Siegfried map to 142 collaborators. However, due to lack of funds, there was no compensation for their work. The desired completion of the spring map within two years was delayed by several years. Fieldwork was only completed in the fall of 1911, and the finished Spring Atlas could be presented in 1912. Until then, the spring situation in the canton of Thurgau had been largely unknown (Engeli, 1913).

1.6. Research Questions & Hypotheses

In context of the federal guidelines to preserve and protect biodiversity and natural ecosystems, specifically spring habitats, this thesis is looking at three small study sites in the municipality of Fischingen, in the south of the canton of Thurgau.

The objective of this study is to investigate the occurrence of springs as well as their structural and chemical characteristics. As a base for the spring searching serves the cantonal Historic Spring Atlas of J. Engeli from 1912. The primary research question guiding this investigation therefore is:

How many of the springs in the Historic Spring Atlas from 1912 still exist today and in which form?

Building on this, a second research question addresses patterns of spring disappearance and persistence:

Which group of springs are most likely to have disappeared or to still remain?

It is hypothesised that most natural springs in grasslands used for agricultural purposes are gone or have been captured and that springs in steeper forested areas away from roads are more likely to still be in a near natural condition. In order to be able to answer this question, the spring type (natural, captured, gone / not found) will be recorded and the spring's condition, meaning the ecological value will be assessed for every water-bearing spring based on the FOEN Structural Spring Protocol.

The third research question is related to the chemical properties of the springs:

Is a one-time assessment of the discharge and water chemistry (as in the FOEN-Method) sufficient to capture the chemical state of a spring or does it change seasonally (during dry and wet conditions)?

The working hypothesis states that spring water pH and electrical conductivity (EC) values are lower during wet conditions compared to dry conditions.

To answer these questions, fieldwork started in late September and early October 2024 with the initial search for springs, followed by secondary discharge and water chemistry assessments in January and May 2025. This temporal spread captures seasonal variability in spring discharge, as well as in pH and electrical conductivity values and enables a more comprehensive understanding of spring dynamics under different hydrological conditions.

2. Study Site

2.1. Location

The research for this thesis was carried out in the study area situated within the municipality of Fischingen, located in the southern part of the canton of Thurgau (Figure 1). The springs have been searched within three research regions (Moosbach, Bodebach and Schärlibach), which roughly correspond to their respective catchment areas and are situated relatively near to one another. Elevations range from 605 to 843 meters above sea level (Figure 2). The site is characterized by a predominantly rural landscape with a diverse mix of land cover and land uses. The road network in the area consists mainly of narrow rural roads and pathways that connect the settlements to surrounding regions. In more remote areas, away from the main roads, many routes are gravel or unpaved, reflecting the region's focus on agriculture and forestry. Both parts of the study area do not include large villages. Rather scattered farmhouses or few clustered houses characterize the area.

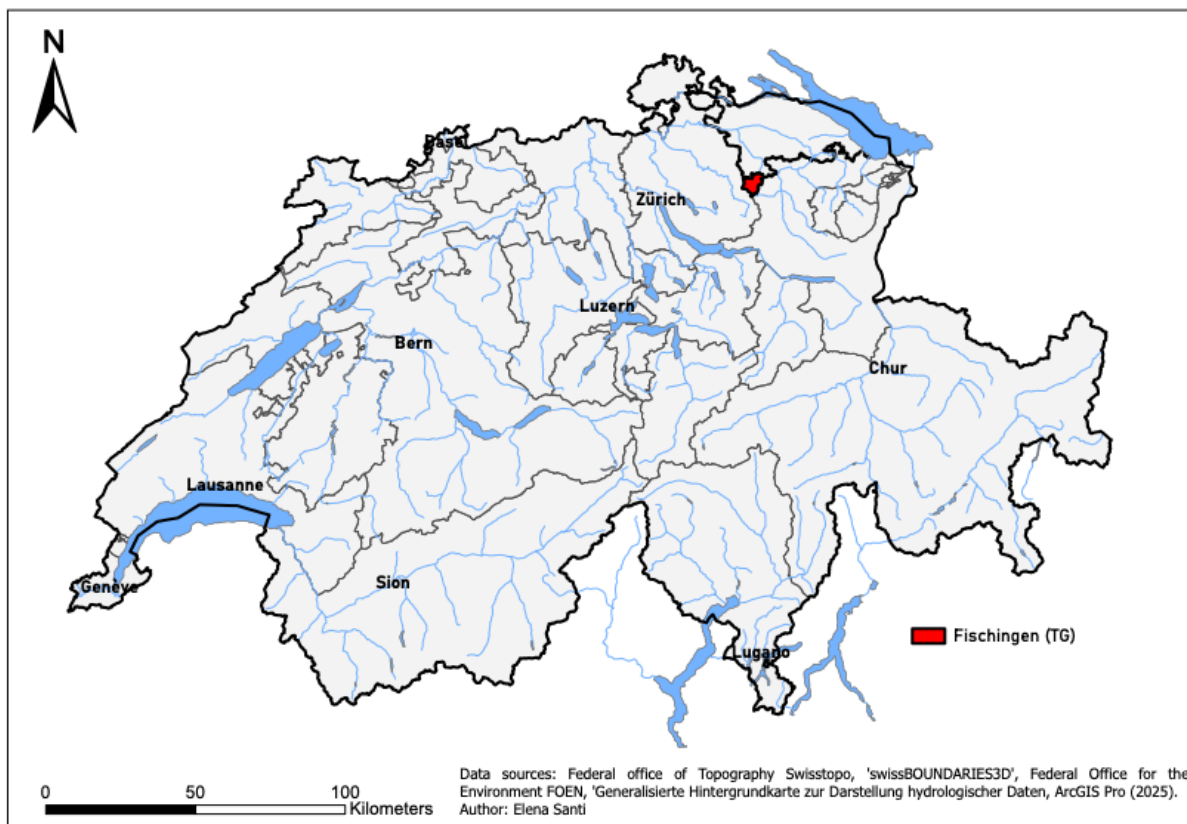


Figure 1: Location of the study area in the municipality of Fischingen in the canton of Thurgau marked in red.

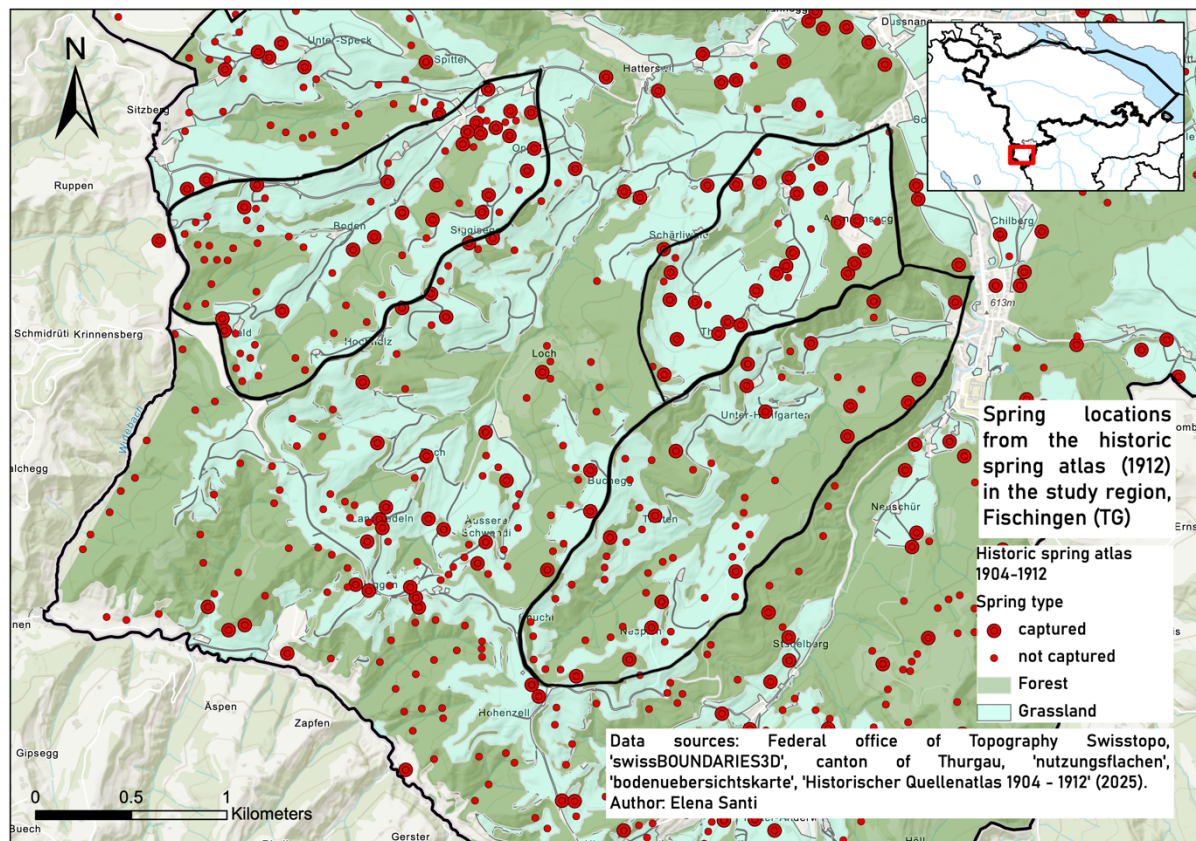


Figure 2: Locations of the springs shown in the Historic Spring Atlas from 1912 for the study area (red circles), with the outlines of the three surveyed regions in black. The background shading shows the land cover in 2024. The inset shows the location of the study area in the canton of Thurgau.

2.2. Climate

Long-term data from the nearby meteorological station Aadorf/Tänikon (539 m a.s.l.) indicate an average annual temperature of 8.8 °C and an annual precipitation total of 1157 mm for the period 1971–2023 (MeteoSwiss, 2024). The mean monthly temperature and precipitation for the reference period 1991–2020 (Table 1) indicate a temperate climate, with relatively moderate temperatures, reaching more than 10 °C in the warmest months and not falling below -3 °C in the cold season (Pratolongo et al., 2019). Furthermore, a trend towards increased precipitation during the summer months can be observed. However, temperatures also increase in these months, resulting in higher potential evapotranspiration.

When comparing the monthly values during the research period to the reference values, temperatures during the study were comparable to or slightly warmer than the reference period, especially since the beginning of 2025. Precipitation in 2024 was also within the range of the long-term reference period. However, January 2025 experienced twice the expected

amount of precipitation, while the months from February to April were exceptionally dry, receiving only about half of the usual precipitation.

Table 1: Mean monthly temperatures and precipitation for the reference period 1991–2020 and study period 2024/25 at the Meteostation Aadorf/Tänikon (MeteoSwiss 2024). Sampling months in 2024/25 are marked in yellow.

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Temp. [°C]	16.7	18.4	18.0	13.6	9.4	4.3	1.2	0.4	1.0	4.8	8.6	13.0
Precip. [mm]	124	124	126	90	89	83	97	75	71	80	85	125
2024/25 Temp [°C]	17.3	19.7	20.4	13.9	11	4.8	1.2	1.8	2.2	5.9	9.8	13.0
2024/25 Precip. [mm]	125.5	118.7	77.0	136	84	76.8	114.3	153.4	34.9	29.4	35.9	100.6
Difference Temp (%)	+3.6	+7.1	+13.3	+2.2	+17.0	+11.6	0.0	+350.0	+120.0	+22.9	+14.0	0.0
Difference Precip. (%)	+1.21	-4.3	-38.9	+51.1	-5.6	-7.4	+17.8	+104.5	-50.9	-63.3	-57.8	-19.5

2.3. Geology and Geomorphology

The study area in the municipality of Fischingen is located in the southernmost and highest part of the canton of Thurgau, known as the ‘Hinterthurgau’ region. It lies within the Northern Alpine Foreland Basin, also referred to as the Molasse Basin, a major geological structure that stretches over approximately 1’000 kilometers from Lake Geneva to the Vienna Basin and was formed during the Alpine orogeny (Rocholl et al., 2018). This geological setting predominantly features Upper Freshwater Molasse (OSM), consisting of horizontally layered sandstones, conglomerates (Nagelfluh), marls, and silts (Figure 3, a geological overview showing the spring locations of the Historic Spring Atlas from 1912 is given in Figure A1 in the appendix). These sediments were deposited under continental conditions in the Late Tertiary (approximately 18 to 14 million years ago), after having been transported into the foreland basin through erosion of the rising Alps (Nagra, 2025).

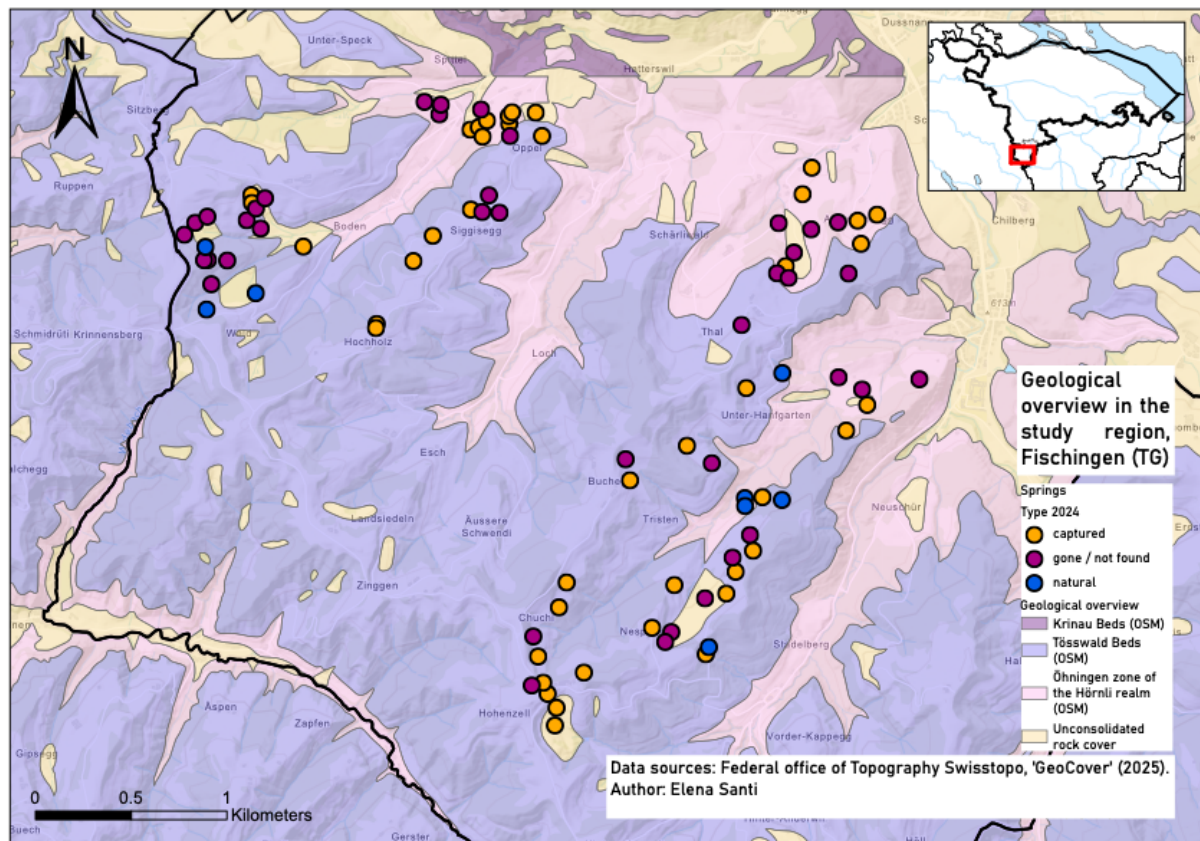


Figure 3: Geological overview in the study area showing the investigated spring locations (coloured circles). The Krinau Beds, Tösswald Beds and the Öhningen zone of the Hörnli realm are part of the Upper Freshwater Molasse (OSM).

In addition to this Tertiary bedrock, the region has been strongly shaped by Quaternary glacial processes. During the most recent ice ages, large parts of the area were overrun by glaciers, which deposited moraine material and fluvioglacial sediments (Nagra, 2025). Fischingen itself lies in a zone that remained largely unglaciated during the last glacial period—particularly the area around the Hörnli peak, which stayed ice-free. These geological processes have led to the development of a diverse landscape, characterized by rolling hills, valleys, and fertile soils.

From a hydrogeological perspective, the glacial gravel and sand deposits found in valleys and on elevated plains are especially important. Due to their high hydraulic conductivity, these sediments efficiently store and transmit infiltrated precipitation and river water. In contrast, the fractured aquifers of the Upper Freshwater Molasse have relatively low permeability and storage capacity, often resulting in springs with low to moderate discharge. Nevertheless, these springs still play an important role in local drinking water supply and should not be overlooked in hydrogeological assessments (Amf für Umwelt TG, 2025).

Overall, the geological and glacial-morphological characteristics of the Fischingen area have a decisive influence on spring distribution, discharge capacity, and soil retention properties.

These factors form the foundation for understanding the region's hydrological dynamics and the ecological significance of springs in this predominantly rural landscape (Amf für Umwelt TG, 2025).

2.4. Land Use

The landscape within the study area is predominantly shaped by grassland and forest. The municipality of Fischingen spans over a total area of 3'062 hectares, of which 1'415 hectares are covered by forest and shrubland, and 1'430 hectares are used for agricultural purposes, resulting in an almost equal distribution between forested and agricultural land. Settlement areas occupy only a small portion and extend across 193 hectares, including larger villages such as Fischingen, Dussnang, and Oberwangen, as well as smaller localities such as Au and Schurten (Gemeinde Fischingen, 2025).

This balanced land-use ratio is also broadly reflected in the three selected study sites, where agricultural land use is primarily characterized by grassland and meadows, with almost no presence of cultivated land. The forests in these areas are largely composed of mixed coniferous and mixed deciduous woodland (Swisstopo, 2025).

3. Methods

The objective of this thesis is to determine how many springs from the Historical Spring Atlas from 1912 still exist and in what form. The aim is to answer the question of which group of springs is most likely to have disappeared or to still remain, based on a detailed analysis of various factors such as topography and land use. Additionally, water chemistry and runoff will be analysed under both wet and dry conditions.

To address these research questions, three rounds of fieldwork were conducted to locate springs and collect the necessary data on spring structure, runoff, pH, electrical conductivity (EC), and water temperature during different wetness conditions. The methods used are explained in detail below. All related programming and statistical analyses were performed using R, while visualization and mapping were carried out in ArcGIS Pro.

3.1. Searching Design

As a first step, the springs had to be identified in the field. The digitalized historical map documenting spring locations from the Historical Spring Atlas 1904 – 1912 (openly accessible on the ThurGIS website) from the canton of Thurgau served as the basis for this research. The study area consists of three regions and was defined in advance based on accessibility and terrain characteristics. The three regions are located relatively close to one another and include both forested and grassland areas, making them representative of the entire municipality.

The selection of springs for this study was based on their accessibility in the field. A preliminary assessment was carried out using orthophotos, a digital elevation model (DEM), and slope data to exclude springs located in areas likely to be inaccessible due to a lack of nearby paths, presence of steep terrain, or dense vegetation. However, the final selection had to be adjusted during fieldwork. For example, springs located on fenced private property (e.g., a dog shelter in the Bodebach region) were excluded, as they could not be accessed.

The study aimed to survey 75 to 80 springs, distributing them evenly across the study area. In each catchment, at least half of the historically documented springs were to be visited in order to ensure representativeness of the current spring situation. The original location of each spring was derived from the historical map. If a spring could not be identified within a 20-

meter radius of the provided coordinates after 20 minutes of searching, it was classified as gone / not found. Otherwise, the springs were categorized as either natural or captured. In cases where a spring appeared more than 20 meters away from the original location but could clearly be associated with the historical spring (e.g., if it was the only visible spring in a meadow), it was interpreted to represent the original spring. Additionally, a shaft situated in the immediate vicinity of the historical spring location was considered to be a tapped spring outlet, rather than a drainage shaft. For all water-bearing springs (whether natural or captured) where access to water was possible, the FOEN Structural Spring Protocol was completed and the spring was documented photographically.

While the structural characteristics of each spring were assessed only once during the first fieldwork round, additional measurements of discharge and water chemistry were taken during all three sampling periods to monitor variability under dry and wet conditions. Spring flora was observed only to assess differences compared to the surrounding vegetation and to estimate the spatial extent of the spring. A more detailed analysis of flora and fauna was not conducted due to limited expertise in these domains.

Searching for springs had been spread on several days over a period of four weeks (27.09.–24.10.2024). Weather conditions were not of top priority in this initial stage of the thesis, as the main objective was to identify the locations of springs. Precipitation during this period was variable, with alternating days of rainfall and dry weather conditions. The two following rounds of fieldwork were carried out on one day to guarantee identical sampling conditions. The second round of fieldwork round was done on the 16th of January 2025, after six days of no precipitation to ensure dry conditions. Sampling during wet conditions were planned in March, however had to be postponed to the 6th of May as the period since February was very dry and a sufficient amount of rainfall was needed on the day before sampling.

3.2. Evaluation of Spring Conditions

To ensure a standardized assessment and evaluation of spring conditions, the Swiss Federal Office for the Environment (FOEN) has developed a method for systematically surveying and assessing spring habitats, known as the FOEN-Method (BAFU-Methode). This standardized approach is essential for comparing springs and their conditions across Switzerland. Due to the limited knowledge of the local flora and fauna, only the structural assessment aspect of

the FOEN-Method could be applied. All further analyses in this study are therefore based exclusively on the structural ecological conditions of the springs.

The structural mapping, using the FOEN Structural Spring Protocol (see examples in the appendix) consists of three main components: The first part documents the location, size, and characteristics of the spring. This includes the spring type (form of water emergence), slope (gradient and aspect), flow direction, as well as parameters such as average flow velocity and the extent of the spring area. Additionally, measurements of water temperature, spring discharge, and electrical conductivity are taken. However, these measurements represent only a snapshot at the specific time of the spring documentation and do not represent a yearly average. Furthermore, the distance to the nearest neighbouring spring is roughly estimated using GIS or field observation, and the spring is photographically documented.

In the second part, anthropogenic impacts are assessed, including structural modifications such as water extraction, relocation, artificial damming, construction within the first few meters of flow, damage from maintenance or trampling, nearby infrastructure, deposits, and additional discharges into the spring.

The third part focuses on the diversity of habitat structures. This involves recording the vegetation and land use in the immediate surroundings of the spring, as well as evaluating structural features such as substrate composition, flow diversity, and water-land connectivity. Based on the criteria in parts two and three, an ecological value is calculated to indicate how natural or degraded the spring is. The evaluation scale is presented in chapter 4 (Table 4).

In this study, all open, accessible, and water-bearing springs were evaluated using the FOEN-Method. Springs that have no overflow and thus cannot form secondary habitats are ecologically worthless (Lubini-Ferlin et al., 2014). Consequently, they were not part of the structural analysis, but were classified as captured. Furthermore, only the spring outlet or the secondary habitat at the visible outlet were assessed. Potential habitats located further away from the recorded spring outlet, e.g. a second emergence point of a captured spring, were not searched and not part of the analysis. However, a recommendation regarding revitalization was omitted due to a lack of sufficient expert knowledge to support such a decision. The slope category was initially estimated in the field and later confirmed by the slope gradient at the corresponding spring location on the map.

If two outlets were located directly adjacent to each other and discharged, for example, through two pipes at the same point, they were treated as a single spring. If two springs were situated close to one another and within visual range, they were considered to be part of a spring system or complex. In such cases, the distance between them was recorded, but each spring was still mapped separately, and individual measurements such as discharge, and water chemistry parameters were taken. Captured springs with no visible discharge could not be assessed.

3.3. Discharge

Runoff was determined during all three fieldwork rounds. Whenever possible, it was measured using the bucket method. Since most springs were very small, a 1-liter bucket with 0.1-liter markings was used directly. For springs with higher flow, a larger bucket was used to collect the water, which was then measured using a graduated measuring cup. However, this method could not be applied at every location. Some springs emerged directly at ground level, making it impossible to collect water with a bucket or bag. In such cases, runoff was estimated visually, acknowledging potential inaccuracies. At certain natural springs, runoff could not be measured at all, as the discharge was too low and the spring's presence was indicated only by moist soil. The highest discharge recorded during the entire sampling campaign served as an indicator of the spring size. Wherever runoff could be quantified, water chemistry was also measured.

3.4. Water Chemistry

Water chemistry, comprising water temperature, pH, electrical conductivity, and the percentage of dissolved oxygen, was measured at all spring locations with sufficient runoff during each of the three fieldwork rounds. Since discharge was often very low, a bucket was filled with spring water to allow submersion of the measuring device, rather than placing the probe directly into the flow. However, some springs did not provide enough moving water to fill the bucket or to fully submerge the device, potentially affecting the accuracy of the measurements.

All parameters were measured using the ProDSS YSI Digital Water Quality Meter, which was calibrated prior to each sampling day. To ensure reliable readings, the instrument was gently

moved multiple times while submerged to release any air bubbles trapped in or around the sensors. Furthermore, measurements were only recorded once the values had stabilized.

3.5. Data Analysis

The statistical analyses, as well as the creation of corresponding figures, were conducted in RStudio. For the comparison of the development of spring conditions since 1912, the current distribution of springs, and their ecological values, the complete dataset was used. However, for the statistical analysis of discharge and water quality, only springs with data available for both dry and wet conditions were included. Springs with missing values for either or both conditions were excluded, as a paired test (Wilcoxon signed-rank test for non-normally distributed data) was required to determine whether discharge and related water chemistry parameters (pH and EC) were significantly higher under different weather conditions.

All mapping and visual representations of spring locations and the study area were conducted using ArcGIS Pro. While the search regions were primarily defined manually in the field, the catchment area of the Mülbach, used for the spring loss estimation, was defined through a watershed analysis. This analysis was performed using the Spatial Analyst toolbox and the Hydrology toolset. The digital terrain model (DTM) from swissALTI3D (Swisstopo, 2025), with a resolution of 0.5 m (from the year 2019), served as the basis for the watershed calculation. However, a resolution of 5 m was considered sufficient to perform the watershed analysis over the target study area. This approach generally assumes that surface runoff follows the surface topology, while neglecting subsurface flow processes, which may follow different pathways depending on flow dynamics and water table gradients (van Meerveld et al., 2019). The pour point of the watershed was manually placed based on a topographic map to ensure that the resulting catchment remained within a hydrologically meaningful and appropriate extent for the spring loss estimation.

The slope was derived in GIS using the Slope function of the Spatial Analyst Tool, based on the 0.5 m resolution digital terrain model (swissALTI3D_2019.tif).

4. Results

4.1. Springs

4.1.1. Current Spring Situation in the Study Area

In total, 90 springs based on the Historic Spring Atlas from 1912 were surveyed across the three study regions. Figure 4 provides a first overview of the spring situation in Fischingen. The three study regions consist of 37 springs in the Moosbach region, 39 springs in the Bodebach region and 14 springs in the Schärlibach region. Across all three study regions, 8 springs (9 %) are still in a natural condition, 41 springs (48 %) are captured, and 39 springs (43 %) couldn't be found and are therefore assumed to be gone.

Additionally, the analysis of the spring's conditions over time reveals changes in spring types from 1912 to 2024 (Figure 5). 8 springs (9 %) remained natural, 22 springs (24 %) which were natural in 1912 have been captured until 2024, and 27 former natural springs (30 %) couldn't be found in 2024. A total of 21 springs (23 %) remained captured throughout this period, while 12 former captured springs (13 %) are assumed to be gone.

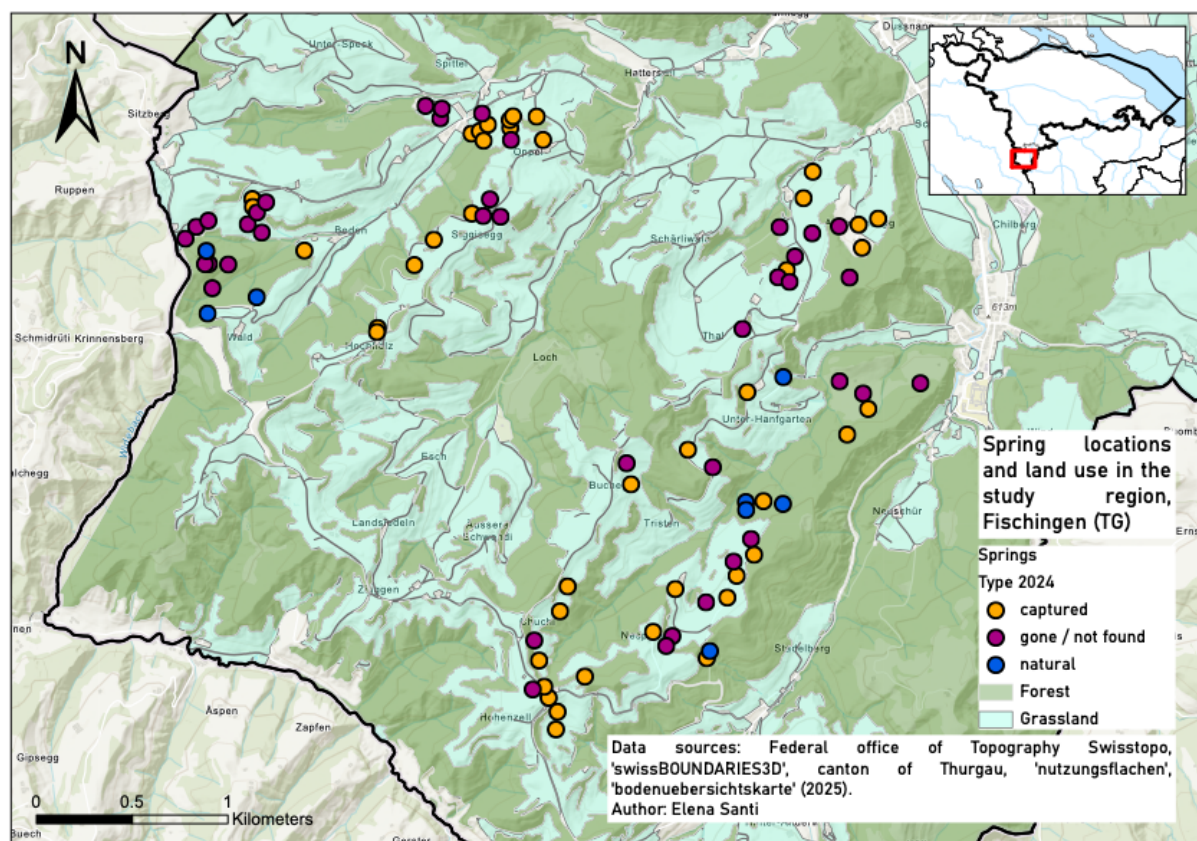


Figure 4: Locations of the investigated springs in the study area. The background shading shows the land cover in 2024.

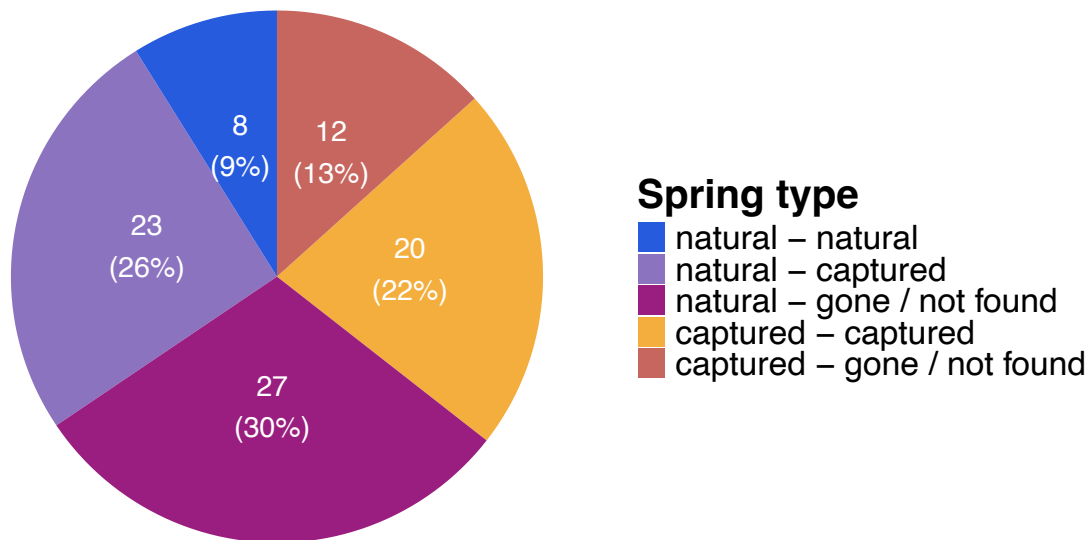


Figure 5: Distribution of spring types in the study area in 2024 (in absolute and relative numbers). The colors indicate changes in spring types since 1912, as presented in the Historic Spring Atlas.

Overall, more springs were surveyed in grassland areas (62 springs, 69 %) compared to forest areas (28 springs, 31 %). When analysing the distribution of natural versus captured springs, it was found that all natural springs were located in forested areas. Further, more than half of the springs in grasslands have not been found and therefore are assumed to be gone. In the forest, this proportion is only a quarter. Similarly, the number of captured springs is higher in grassland compared to forested areas.

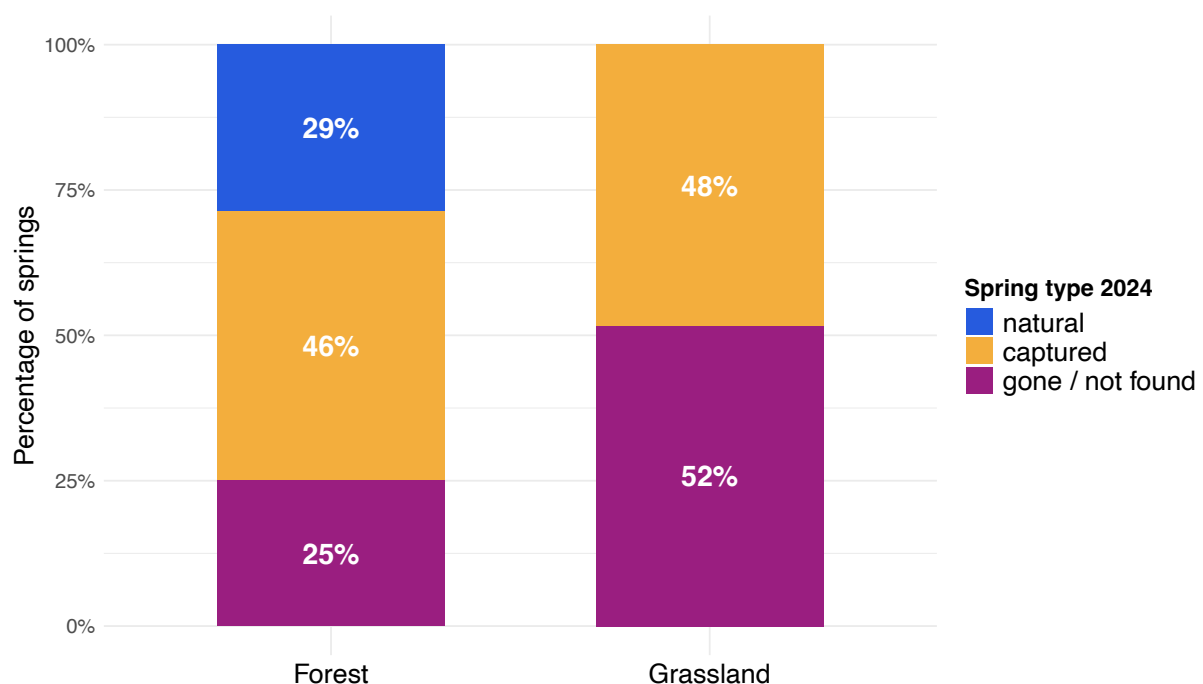


Figure 6: Relative distribution of spring types in the study area in 2024, separated by forest and grassland (land use).

4.1.2. Evolution of Springs over Time

When looking at the distribution of spring locations over time (Table 2), it becomes evident that all natural springs that would today be situated in grassland are either captured or mostly gone. In contrast, if a spring was already captured in 1912, the chances of still finding it are higher than the chances of it being gone. In the forest, the situation is the opposite: here, the likelihood of still finding a former natural spring, either in its natural or captured condition, is very high at 80 %.

Table 2: Evolution of the spring distribution from 1912 to 2024 in forest and grassland areas.

		2024							
		Forest				Grassland			
		natural	captured	gone / not found	total	natural	captured	gone / not found	total
1912	natural	32 %	48 %	20 %	100 %	0 %	31 %	69 %	100 %
	captured	0 %	33 %	67 %	100 %	0 %	67 %	33 %	100 %
	total	29 %	46 %	25 %	100 %	0 %	48 %	52 %	100 %

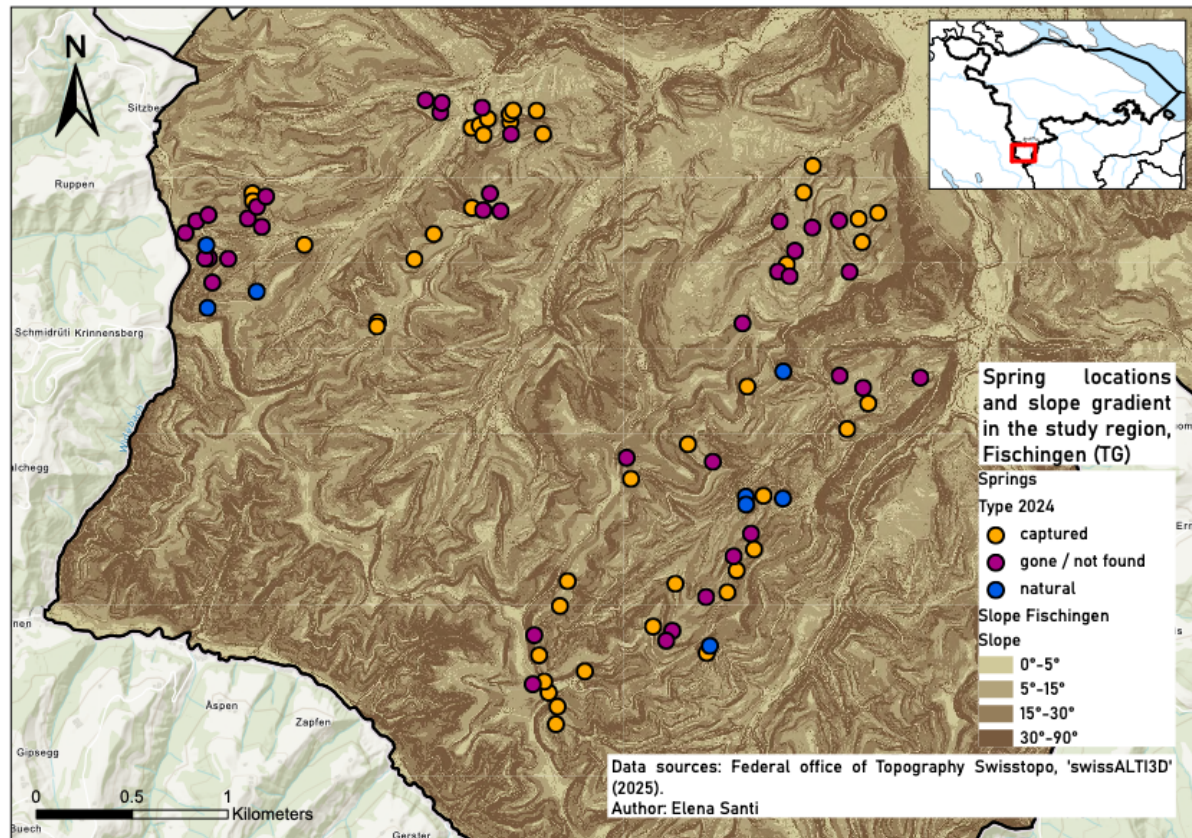


Figure 7: Slope gradient in the study area in 2024 showing the investigated spring locations separated by spring type (colored circles). Slope gradients are defined as: 0°-5° = gentle, 5°-15° = moderate, 15°-30° = steep, 30°-90° = very steep.

When not only considering the type of land use but also the slope, it becomes apparent that the majority of natural springs in forests are found on steeper areas, meaning slopes with an angle of 15° or more (Figure 8, Table 3). This aligns with the overall pattern that, in forested areas, most springs – whether captured or natural – are located in moderate to steep terrain. In grassland areas as well, the majority of captured springs are found in these slopes. At the same time, however, springs located on gentle or very steep slopes show a higher likelihood of having disappeared.

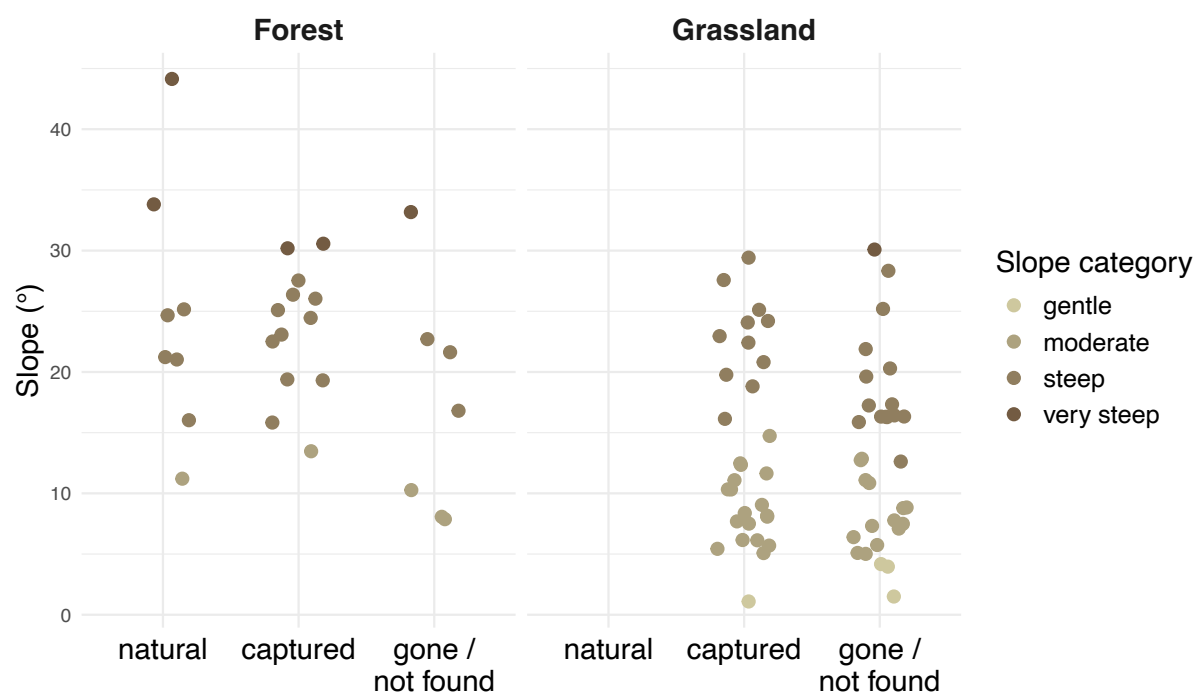


Figure 8: Variation in slope (color-coded by category), shown separately for forested and grassland areas in 2024. Slope gradients are defined as: 0°-5° = gentle, 5°-15° = moderate, 15°-30° = steep, 30°-90° = very steep.

Table 3: Spring distribution in the study area in 2024 across slope categories, differentiated by spring type and shown separately for forested and grassland areas.

	2024							
	Forest				Grassland			
	natural	captured	gone / not found	total	natural	captured	gone / not found	total
gentle (0°-5°)	0 %	0 %	0 %	100 %	0 %	25 %	75 %	100 %
moderate (5°-15°)	20 %	20 %	60 %	100 %	0 %	56 %	44 %	100 %
steep (15°-30°)	28 %	56 %	17 %	100 %	0 %	44 %	56 %	100 %
very steep (30°-90°)	40 %	40 %	20 %	100 %	0 %	0 %	100 %	100 %
total	29 %	46 %	25 %	100 %	0 %	48 %	52 %	100 %

Based on these findings, one can conclude that natural springs are most likely to be found in steeper forested areas, whereas springs are most likely to have disappeared on flatter grassland.

4.2. Ecological Condition of Springs

The ecological value of each spring was calculated using the official Structural Spring Protocol (Excel sheet) provided by the FOEN. In Section A, only structural features were assessed, with the lowest-rated parameter determining the section's score. Section B lists ecologically valuable features. If more than two of these are available, revitalization is considered possible, however this final decision must be made on expert judgement. The final ecological value is calculated automatically in the Excel sheet as the average of sections A and B: $(A + B) / 2$ (eventually subtracting a bonus for good structure). The corresponding classification scheme is presented in Table 4. Springs that are completely destroyed or captured with no visible discharge, are classified as 'not assessable'.

Table 4: Ecological value of a spring – Classification scheme according to the FOEN Structural Spring Protocol.

	Classification	Ecological value	Color
	near-natural	0.6 – 1.8	blue
	conditionally near-natural	1.81 – 2.6	green
	moderately impacted	2.61 – 3.4	yellow
	degraded	3.41 – 4.2	orange
	severely degraded	4.21 – 5.0	red

From 90 observed springs, less than 30 % did show a visible discharge and could be assessed. All Structural Spring Protocols of the 28 springs are provided in the appendix. The assessment (Figure 9) reveals that 5 out of the 28 springs were classified as near-natural, and four as conditionally near-natural. In contrast to these nine relatively unmodified springs, the majority are degraded and display different levels of ecological disturbances. However, to gain a more accurate understanding of the ecological status of the springs, it is important to examine the individual evaluations rather than relying solely on broad categorization.

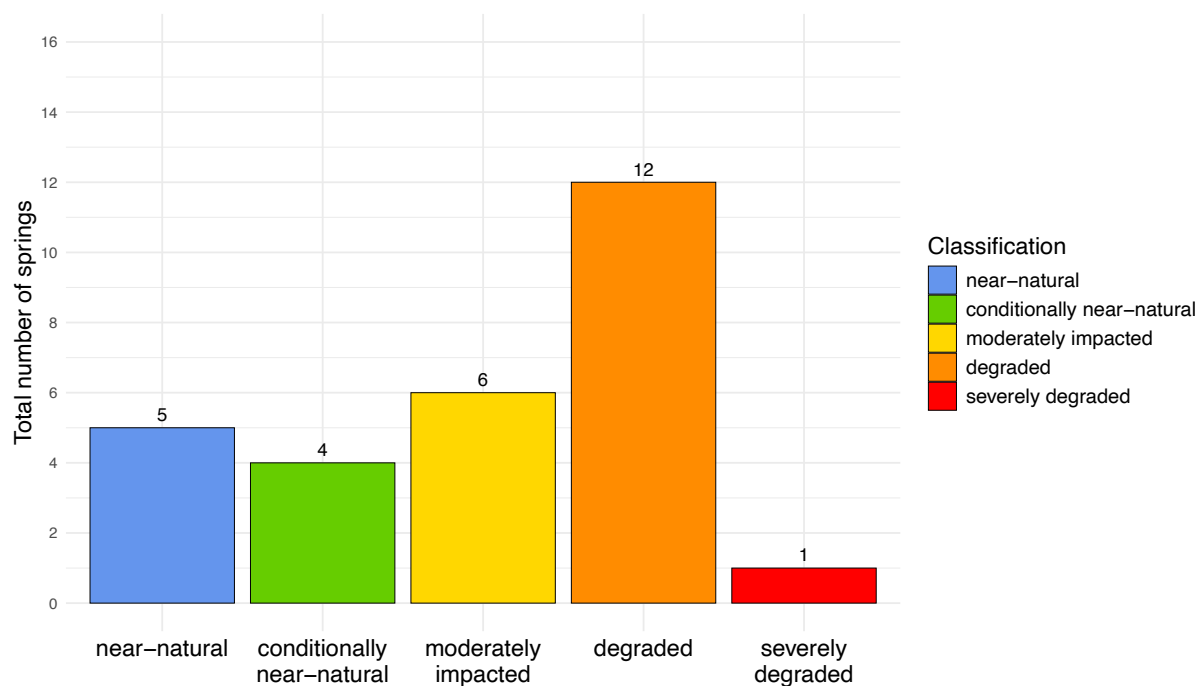


Figure 9: Distribution of the ecological value of springs in the study area in 2024.

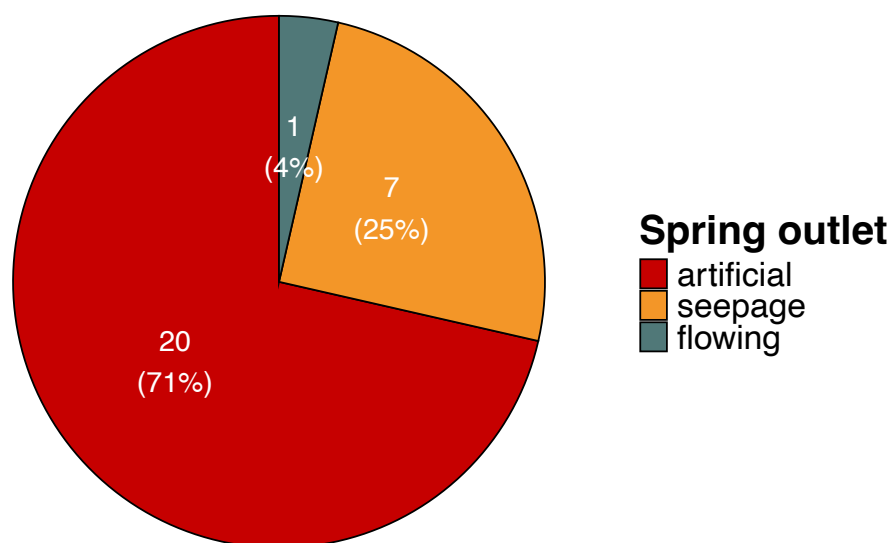


Figure 10: Spring outlet types in the study area in 2024 (in absolute and relative numbers).

In the study area, the majority of spring outlets are artificial. Among the few natural ones, seepage springs dominate, with only a single flowing spring observed (Figure 10). The main ecological damages are caused by the type of spring catchment, which is closely associated to the presence of concrete structures (Figure 11). This combination often leads to a moderately impacted or degraded ecological quality of the spring.

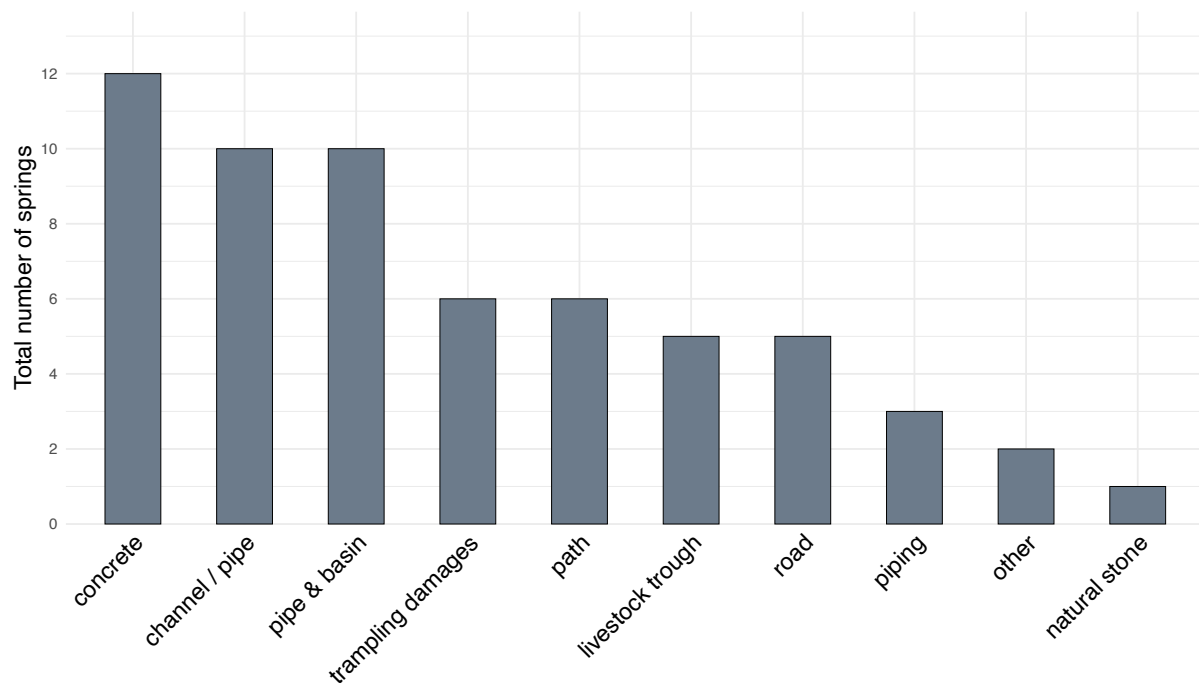


Figure 11: Type of damages of the spring habitats in the study area in 2024. Multiple damages per spring are possible.

When comparing the ecological values to the type of land use in which the springs are located, a clear pattern emerges (Figure 12). First, it should be noted that more data is available for springs in forested areas, with 19 springs found in forests compared to only nine water-bearing springs in grassland. Moreover, a broader range of ecologically valuable springs is observed in forests, ranging from near-natural, conditionally near-natural, moderately impacted to degraded. The first three categories are exclusively found in forested areas. In contrast, the range in grassland is much narrower, consisting mostly of degraded springs and one severely degraded spring.

Overall, a significant difference (Kruskal-Wallis test: $p\text{-value} < 0.001$) between the two land use categories is evident. In grassland, only heavily impacted springs (degraded or even severely degraded) are present, whereas springs in forested areas tend to be in a more near-natural condition. For further information about the variation of the ecological value of a spring in relation to slope, see Figure A2 in the appendix).

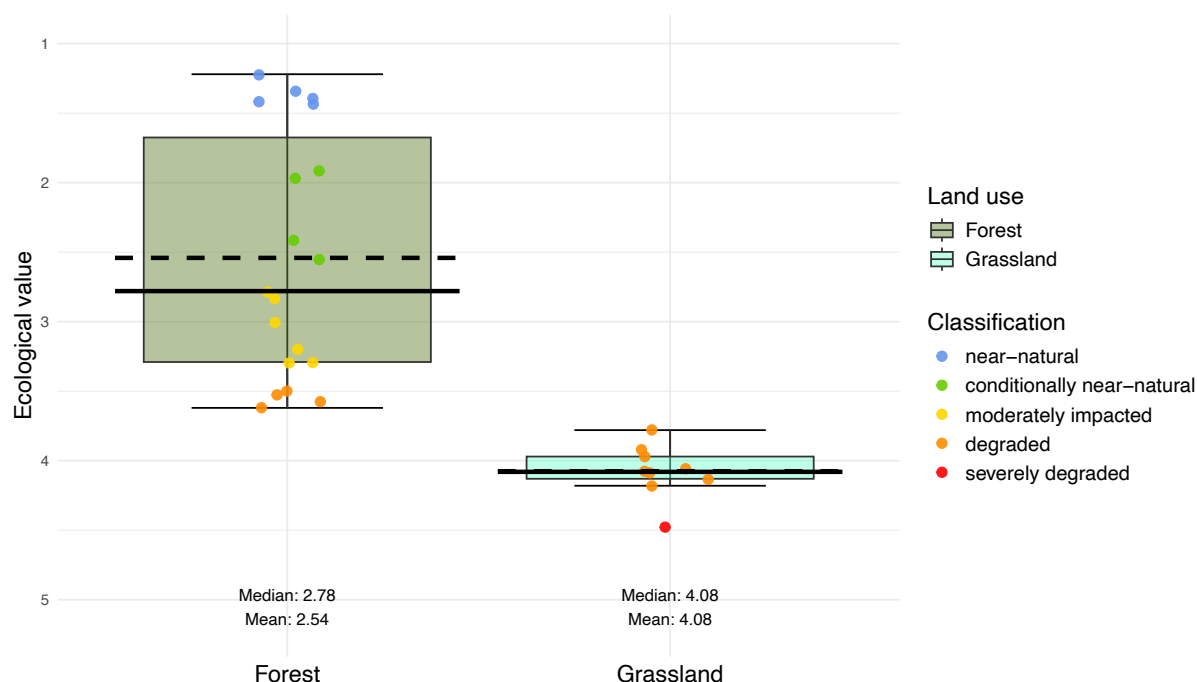


Figure 12: Box plots of the ecological values for the springs in the study area per land use category in 2024 (forest and grassland). The box represents the interquartile range, the thick line the median and the dashed line the mean. The whiskers extend to 1.5 times the interquartile range.

A meaningful comparison between the study regions is only possible for the two larger areas, Bodebach and Moosbach, as only one data point is available for Schaerlibach. The overall pattern observed in these two regions reflects the general trends already described (see Figure A3 in the appendix).

4.3. Discharge

The highest discharge (based on the three measurement dates) of the natural springs was mostly in the 1-10 L/min range, whereas captured spring generally show higher discharges, with a maximum of up to 60 L/min (Table 5).

Table 5: Maximal measured discharge (in liters per minute) of natural and captured springs recorded in the study area over the 2024/25 sampling period.

	Natural		Captured	
Discharge (L/min)	Number of springs	Percent (%)	Number of springs	Percent (%)
30-100	0	0	2	11
10-30	3	30	10	56
1-10	7	70	5	28
<1	0	0	1	6

The discharge did not only vary between individual springs but also across the different measurement conditions. For 5 of the 28 water-bearing springs (18 %) the soil was muddy and the discharge couldn't be measured during dry or wet conditions, and were therefore excluded from further analyses. The discharge (Table 6) was overall significantly higher during wet conditions than during dry conditions ($p = 0.002$). This was particularly the case for the springs in the forest for which there was a significantly higher discharge after wet conditions compared to dry conditions ($p = 0.002$). There was no such trend for the springs in the grassland (all of which are captured) (Figure 13). There was no statistically significant difference in the maximum discharge between land use types ($p = 0.084$).

Table 6: Overview of statistical test results for discharge, pH and electrical conductivity (EC) comparisons. The table lists the applied tests, corresponding p-values and highlights significance based on a threshold of 0.05. Statistically significant results are marked in green, non-significant ones in red.

Data comparison	Statistical test	p-value		
		Discharge	pH	EC
forest vs. grassland	unpaired test: Wilcoxon rank sum test	0.055	0.047	0.449
wet vs dry for all springs	paired test: Wilcoxon signed rank test	0.002	0.001	0.043
wet vs dry for forest springs	paired test: Wilcoxon signed rank test	0.002	0.002	0.151
wet vs dry for grassland springs	paired test: Wilcoxon signed rank test	0.273	0.098	0.020

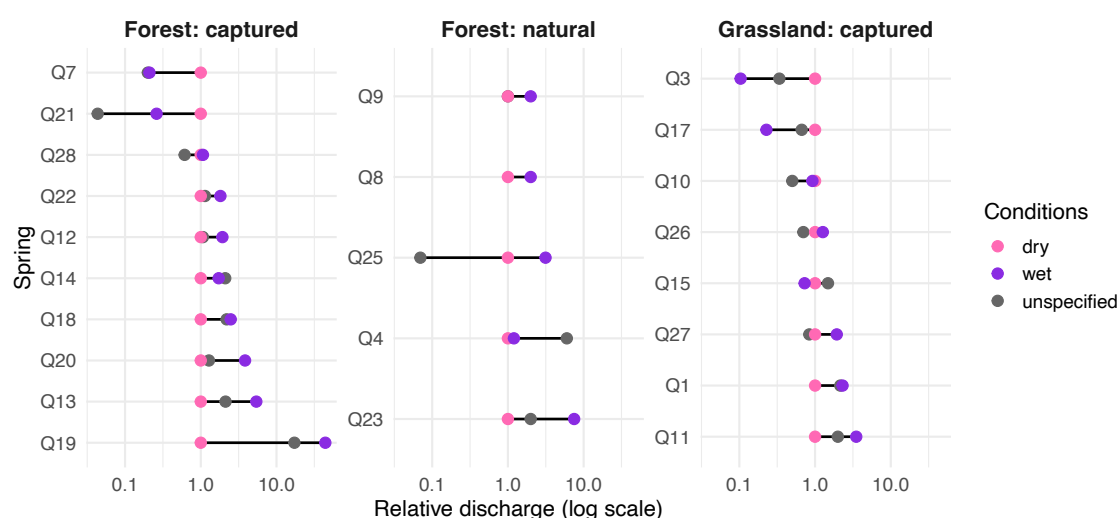


Figure 13: Relative discharge (logarithmic scale) of natural and captured springs in the study area in 2024/25, separated by land use category during different wetness conditions. The three measurements were taken during the sampling period and reflect varying hydrological conditions: dry (January 2025), wet (May 2025) and unspecified (September / October 2024).

4.4. Stream Chemistry

4.4.1. pH

The pH of the spring water varied between 6.91 and 8.34. The pH of the water was generally higher for springs in the forest than in grassland (Figure 14, Figure 15). The pH was also significantly higher during dry conditions than during wet conditions ($p = 0.001$). However, this was only clear for the forested springs (Figure 15).

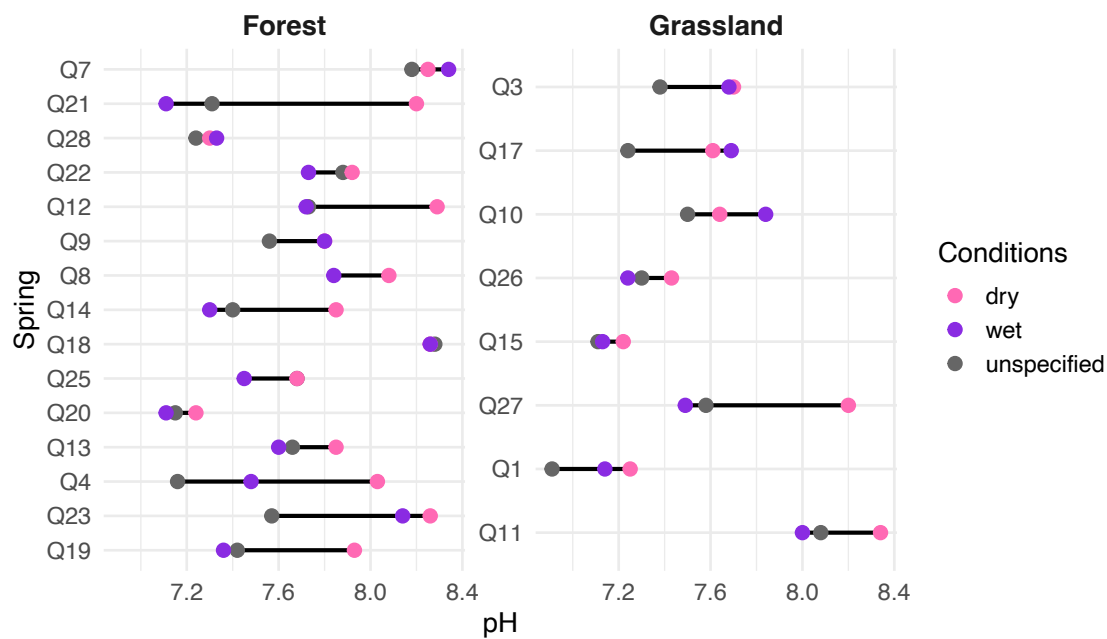


Figure 14: pH values of natural and captured springs in the study area in 2024/25, separated by land use category (forest and grassland) during different wetness conditions.

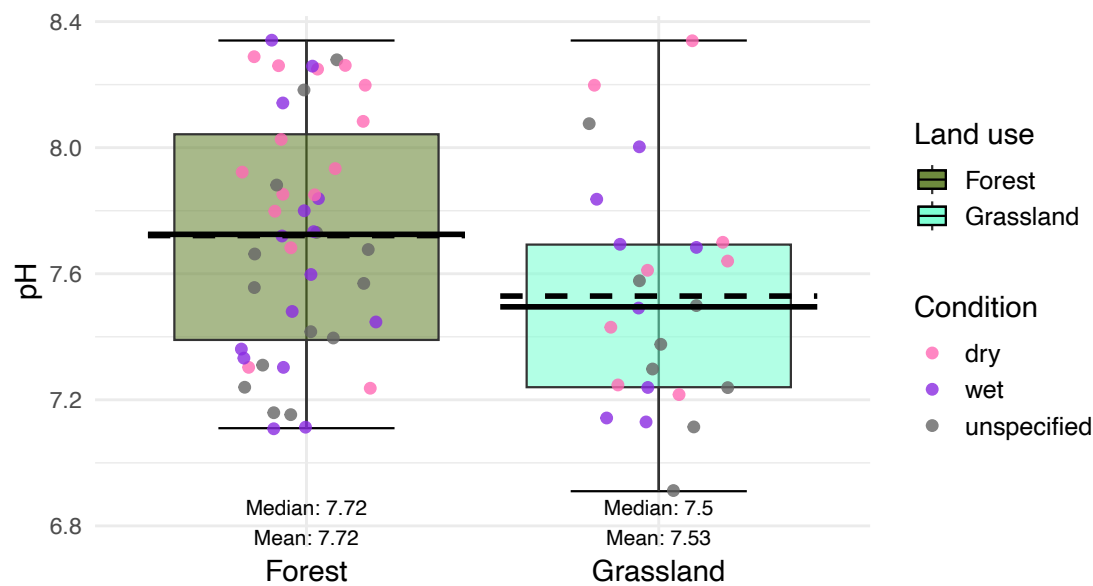


Figure 15: Box plots of the pH values of the spring water measured for the springs in the study area, separated by land use category (forest and grassland) in 2024/25. The measurements were taken in the sampling period 2024/25 and reflect different hydrological conditions: dry (January 2025), wet (May 2025), unspecified (September / October 2024).

4.4.2. Electrical Conductivity

The electrical conductivity (EC) varied between 255 and 794 $\mu\text{S}/\text{cm}$ (Figure 16). In contrast to the pH, there was no significant difference in the EC of the water for the springs in the forest and the grasslands. As expected, the EC was overall significantly higher during dry conditions than during wet conditions ($p = 0.043$). However, this was only the case for the spring in grassland (Figure 17).

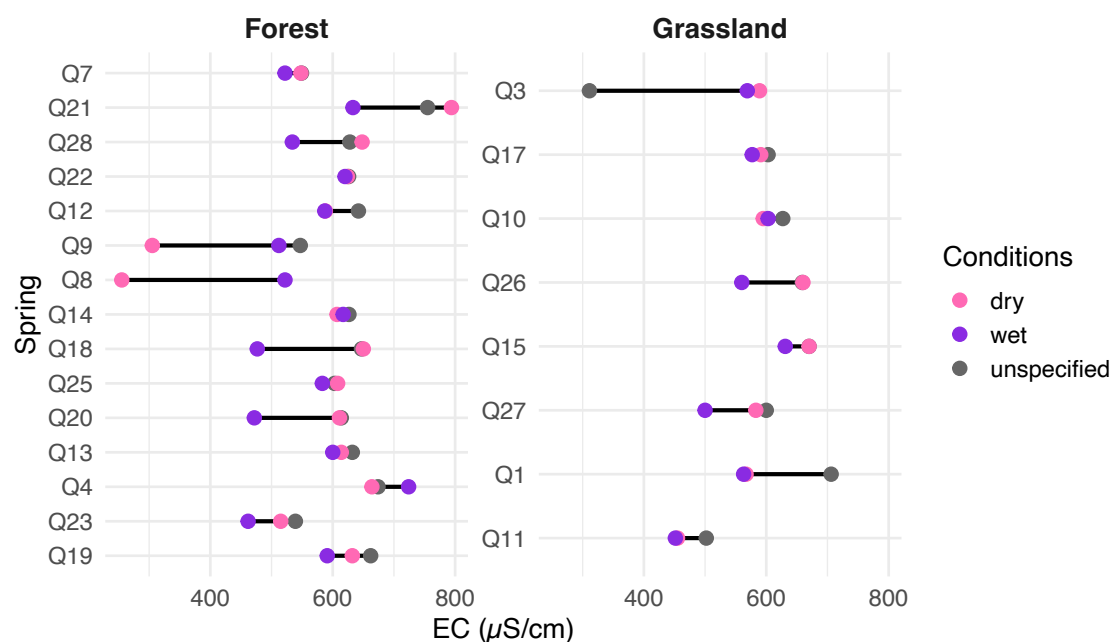


Figure 16: Electrical conductivity values of natural and captured springs in the study area in 2024/25, separated by land use category (forest and grassland) during different wetness conditions.

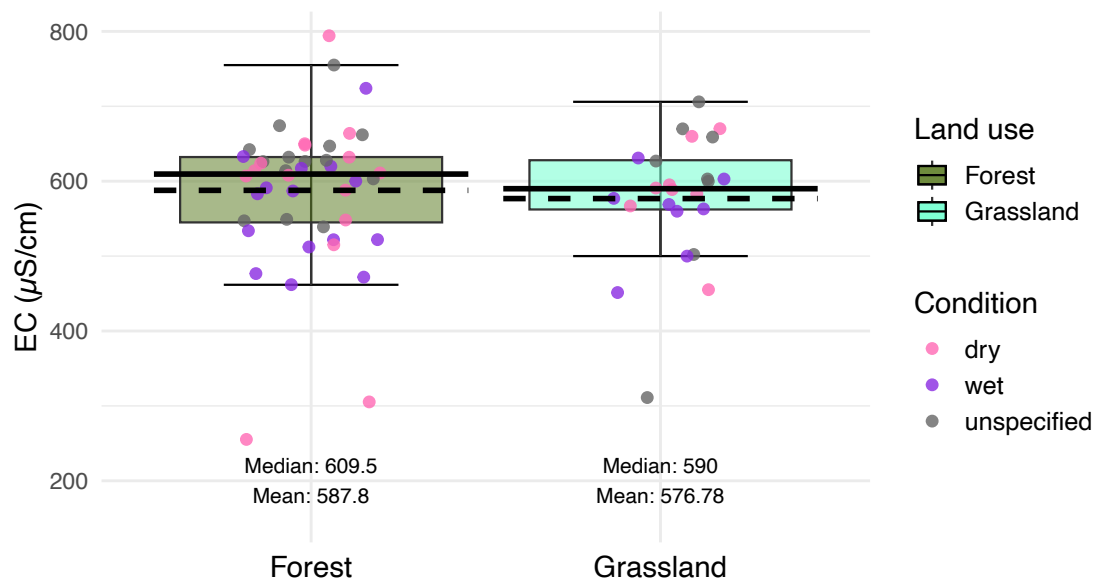


Figure 17: Box plots of the electrical conductivity values of the spring water measured for the springs in the study area per land use category (forest and grassland) in 2024/25.

In conclusion, the results confirm the hypothesis that pH and EC are seasonally variable, with generally higher values during dry conditions than during wet periods. However, the findings also indicate that these parameters are highly variable across the springs and that the trends differ per land use category.

Further water temperature and dissolved oxygen were assessed. Temperature values were generally variable across all measurements, recording lowest temperatures in January and highest in October (see Figure A4, Figure A5, Table A1 in the appendix). Dissolved oxygen was mainly close to 90 % across all measuring dates (see Figure A6, Figure A7, Table A1 in the appendix).

5. Discussion

The objective of this thesis was to monitor the spring situation in the study region in Fischingen (TG). The research questions therefore do not only ask for the existence of springs, but include as well their structural and ecological properties. In order to understand the springs behavior to different hydrological conditions, three assessments of discharge and water chemistry have been taken. The study provides valuable insights into the spring situation today, which can be used for further assessments in the study region, as well as the adjacent area.

5.1. Historical Springs from 1912 to Today – Persistence and Disappearance

5.1.1. Statistical Comparison – How many Springs have Disappeared?

The first research question of this thesis asks how many of the springs mapped in the Historic Spring Atlas from 1912 still exist today and in which form. It has been expected based on previous studies completed by other cantons and environmental organizations (UNA, Küry, 2009, BAFU, 2021, Rutishauser, 2021), that the majority of the springs from 1912 could not be found today and are therefore assumed to be gone. Further a large proportion was expected to be captured, as the majority of the springs have been tapped for drinking water purposes or captured for agricultural reasons (Küry, 2009). Only a few of the searched springs would therefore be still natural. The results, presented in the previous sections confirm these expectations. Before analyzing these results, it has to be mentioned, that the springs have mostly been searched in an area which is easily accessible by foot, meaning near roads and paths, as well as not too steep terrain.

The observed loss of natural spring habitats is not surprising. Over the last 100 years, some major changes have happened, especially in settlement areas and intensively used agricultural land (BAFU 2021). Estimates state, that more than 90 % of the originally existing natural springs in the Swiss Plateau have been captured or significantly degraded as habitats (Küry 2009, BAFU 2021). Of course, in 1912 as well, springs already have been captured for several purposes – mostly for drinking water. Therefore, only the natural springs documented in 1912 should be considered in order to get a comparable percentage to this estimate. Out of the observed 90

springs, 86 % of the former 57 natural springs are either captured or lost today. This proportion is lower than the expected 90 %, however could be possible, as settlement areas were mostly excluded in the study area.

Similarly, the ratio between captured and natural springs today is not surprising. Already in 1997 J. Zollhöfer documented, that more than half of the springs in the central Plateau were captured (Frei et al., 2023). Today the percentage of present captured springs is much higher, at 84.3 %. However, it has to be noted, that the study area of this thesis does not represent the average of the Swiss Plateau, as almost no settlement areas are present and the study area is mostly covered by forests and grasslands. Therefore, the strong decline of spring habitats in settlement areas, which is described in previous studies (BAFU, 2021), is not documented here. It is however expected, that the number of captured and lost springs would be higher, if settlement areas are included.

5.1.2. Likelihood of Disappearance – Key Influencing Factors and their Causes

There are several factors that influence the occurrence of springs. At the beginning of this study, general factors contributing to the decline of springs in the past were already mentioned: construction in settlement areas, capturing of springs for drinking water purposes and in many cases, the construction of hydropower facilities and the sealing of natural surfaces have become the main threats to spring habitats (Stucki, 2015).

In this study, two key factors were identified as decisive for the presence or absence of natural and captured springs. First and foremost, land use plays a crucial role. The results show a clear distinction between forested areas and grasslands, which are consistent with findings of previous cantonal spring studies (Küry, 2009; UNA, 2018). All natural springs were found in forested areas, and significantly more lost springs are located in grassland areas than in forests ($p = 0.022$). These results are in line with the findings of Daniel Küry, who stated that “most near-natural springs are located in forests” (Küry, 2009, p. 89, own translation). Additionally, this supports the conclusion that the intensification of agricultural land use since the 19th century has had a major impact on the spring situation (BAFU, 2021). Many flowing streams in open meadows were redirected toward forested areas to make the land suitable for agriculture (Küry, 2015). It is therefore not surprising that all natural springs were found in forested areas and not in grassland.

Secondly, the role of slope has been examined in detail. Steep slopes increase the likelihood that the groundwater table intersects the land surface, making them important for the emergence of springs (Winter et al., 1998). Springs generally appear where subsurface water reaches the surface (Ashley, 2016; BAFU, 2021). In steep terrain, soils tend to be shallow, bedrock may be exposed, and both vertical and lateral groundwater movement can occur more rapidly (Jencso et al., 2009). Additionally, the groundwater table may more closely follow surface topography, resulting in a strong hydraulic gradient and faster flow toward discharge zones (Barackman & Brusseau, 2002). As elevation changes rapidly on slopes, the land surface can intersect subsurface flow paths, allowing groundwater to emerge. Moreover, steep slopes often coincide with terrain breaks, faults, or erosional features that can serve as preferential pathways for groundwater discharge (Winter et al., 1998). Springs commonly occur at the base of slopes, along terrace edges, or in concave landforms where groundwater is naturally forced to the surface (Tóth, 1963).

However, several studies have shown that groundwater dynamics and flow paths are highly non-linear and more complex than these simplified assumptions suggest (Buttle et al., 2004; Hinton et al., 1993; Rodhe & Seibert, 2011). Therefore, the assumption that springs are more common in steep, topographically complex regions must be considered with caution.

In the present study area, natural springs were primarily found in steeper, forested terrain, whereas those on flatter grassland have largely disappeared or have been captured. When considering all potential causes for the disappearance of springs, it is likely that human activities, drainage, spring capturing or constructions, rather than slope alone, are the main reasons for their loss in flatter areas. Nevertheless, these factors likely interact in complex ways, and the disappearance of a spring cannot be attributed to a single cause.

5.1.1. Expected Spring Loss in the Mülibach Catchment

In the previous chapter, it was determined how many historical springs still exist today and in what form they occur. The results of this investigation can be used to draw conclusions about the spring situation in the surrounding area, meaning in the area of Fischingen and the southern part of the Thurgau. Using the Mülibach catchment area as a case study, the aim is to show how many springs are still to be expected and where they are most likely to occur in order to better guide future searches.

In the entire area, 75 historical springs have been mapped (30 in forests, 45 on grasslands), of which one third were captured and two thirds were not (Figure 18, Table 7). Applying the calculated probabilities, it can be assumed that a total of 9 natural and 36 captured springs can still be found in the area, the rest having disappeared over time (Table 8).

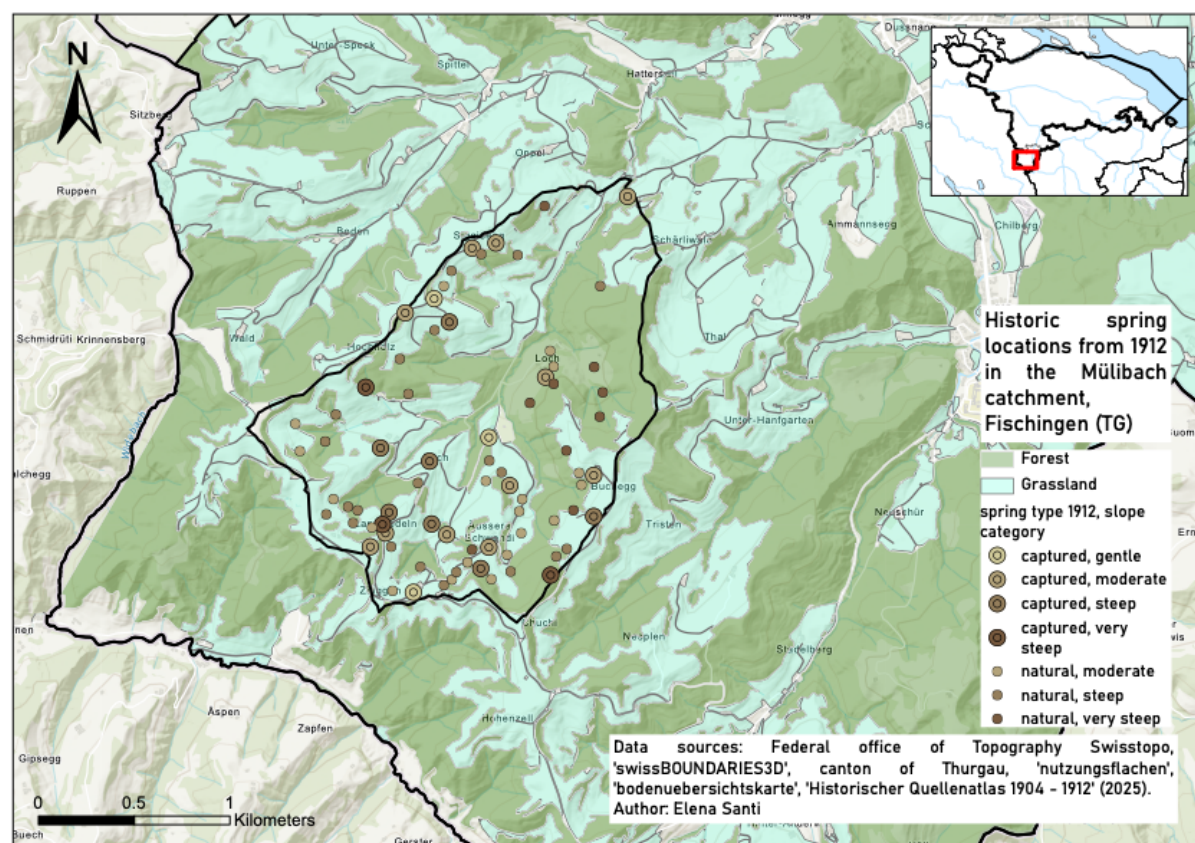


Figure 18: Locations of the springs shown in the Historic Spring Atlas from 1912 for the Mülibach catchment (circles). The size of the spring indicates the spring type of the spring in 1912; the color of the circles indicates the slope category in which the spring is situated. The background shading shows the land cover in 2024.

Table 7: Count of springs in the Mülibach catchment in 1912 in relation to the land use category in 2024.

		2024		
		Forest	Grassland	total
1912	natural	24	27	51
	captured	6	18	24
	total	30	45	75

Table 8: Predicted presence of historic springs in the Mülilbach catchment. The table presents probabilities (%) and total counts of spring persistence from 1912 to 2024 by land use category (forest and grassland), and spring type, based on distribution trends observed in the three study regions (as detailed in Table 2).

		2024							
		Forest				Grassland			
		natural	captured	gone / not found	total	natural	captured	gone / not found	total
1912	natural	32%	48%	20 %	100 %	0 %	31 %	69 %	100 %
		8	12	5	24	0	8	19	27
	captured	0 %	33 %	67 %	100 %	0 %	67 %	33 %	100 %
		0	2	4	6	0	12	6	18
	total	27 %	46 %	25 %	100 %	0 %	48 %	52 %	100 %
		8	14	8	30	0	22	23	45

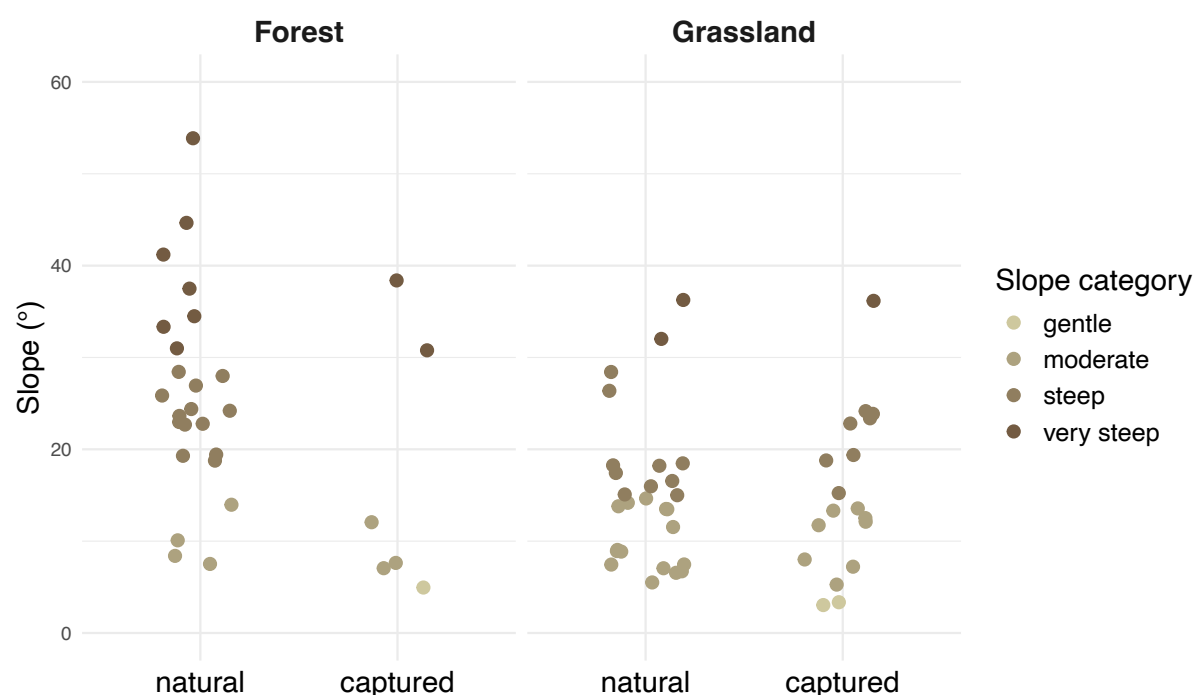


Figure 19: Variation in slope (color-coded by category), of the springs shown in the Historic Spring Atlas from 1912 in the Mülilbach catchment, shown separately for forested and grassland areas in 2024.

The distribution of springs in relation to the slope (Figure 19) is similar to that in the study area, thus it can be assumed that nowadays the springs in the flatter area are more likely to be captured or no longer detectable. Newly captured springs on grassland or in the forest may have already been recorded in the course of capturing or as part of another use. It is therefore advisable to focus search efforts for natural springs particularly on forested areas, for example in the eastern and southern part of the catchment area.

5.2. Ecological Value

The second research question looks at the ecological value and asks which group of springs is most likely to have disappeared or to still remain. Generally, when looking at the habitats in terms of their ecological value, a clear distinction between forest and grassland can be made. In total, 31.11 % (28 out of 90 springs) of the springs could be assessed. All 5 springs (5.56 %) with the best ecological values, categorized as near-natural are found in forested areas. This percentage is half of the findings from Rutishauser (2021) in the canton of Aargau, where 11 % of the surveyed springs are still natural. Further, the researchers mention, that there is still a high number of unknown drainage and modified springs and therefore, they assume that the percentage of natural spring in the canton is even smaller. Results of UNA Bern (2018) revealed that around 36 % of the surveyed springs were in a natural condition. Compared to this background, the study area in Fischingen has lost a major number of natural springs. However, an estimation from Jens Zollhöfer in 1997 for the Swiss Plateau for example only estimates 0.5 % of the springs to remain natural. At this point it has to be kept in mind that studies in the cantons of Aargau and in Bern used the simplified Bernese-Methode which only consists of the categories: natural, impacted and destroyed. Natural is equivalent to the FOEN category near-natural, impacted describes the FOEN categories: conditionally near-natural, moderately impacted, degraded and heavily degraded. Therefore, only a more advanced comparison between other slightly impacted or almost natural springs between the studies is not possible.

To answer the research question stated above, it can be said that springs in forested areas are relatively resilient over time. A high proportion (75 %) of the springs documented in 1912 still exist, of which almost 30 % remained in their original natural state. Grassland springs in contrast are much more prone to loss, as over half of the original count have disappeared. Natural springs in grasslands have been especially vulnerable, as no spring has survived in its natural form. These findings confirm the hypothesis that most natural spring in an agricultural setting, meaning grassland have either been captured or lost over time.

When looking at the distribution of ecologically valuable springs, the picture remains consistent. All captured springs in grassland are in a bad condition and degraded, whereas in forested areas the ecological value varies from very good to degraded as well.

The second hypothesis considers the slope and land use, in order to predict the ecological value of a spring in a certain setting. Most ecologically valuable springs are found in forested areas with a slope steeper than 10° (Table 3). However degraded and impacted springs are found as well in steeper forested areas. Therefore, the hypothesis cannot be confirmed.

What do these results therefore mean for the canton of Thurgau? Generally searching springs based on the Historic Spring Atlas is a good beginning. The study showed, that a little more than half (56.6 %) of the springs are still present. Therefore, the advantage of already having a spring map should be used to update the current spring inventory. Of course, some newer springs may be neglected by this searching design, and springs might be assumed to be gone as they could not be found, but overall, the spring atlas is pretty accurate and gives a first impression of where to search, especially for natural and ecologically valuable springs. In terms of the Swiss Biodiversity Strategy, these biodiversity hotspots are of great interest and should be investigated by the canton. They could most likely be found in forested areas, thus special interest should be given to this land use type. However, not only natural springs should be investigated, as they do mostly have the best ecological value, but captured springs as well could be valuable – especially in the forest. Captured springs can as well be interesting for revitalization measures or projects to improve biodiversity, as already other cantons have done (Jurapark Aargau, 2022).

In conclusion, the findings of this study provide an initial impression of the spring situation in the southern part of the canton of Thurgau. However, it should be kept in mind that forecasting based on these results for other regions within the canton is limited. This is particularly true for areas where settlement and urban infrastructure are more dominant, as the likelihood of both captured and lost springs is expected to differ and may be higher than what is presented here (Rutishauser 2021).

Among other reasons, this area was chosen as a study site due to its comparatively high proportion of forest cover relative to other parts of the canton. It was assumed that this specific land use composition would provide the best conditions for the presence and detection of natural springs. This is also a crucial factor for the second part of the study, which aims to analyse the water quality of both natural and captured springs.

In this sense, the results are representative of an area characterized by a patchwork of open grasslands and forested areas, with minimal urban influence, and can serve as a basis for

understanding the situation and developing a spring searching strategy for regions with similar settings.

5.3. Repeated Measurements of Discharge and Stream Chemistry

Water quality and discharge were assessed at three different times. The purpose of the repeated assessments was to evaluate whether a single measurement of water chemistry, as done in the FOEN-Method, is sufficient, or whether seasonal variation in flow and water chemistry affect the measured parameters.

5.3.1. Discharge

Discharge was generally low, with maximum values around 60 L/min and most springs having flows between 1 and 30 L/min. These results are consistent with expectations, as previous studies (Frei et al., 2023; Rutishauser, 2021) suggested that most large springs have already been captured. Springs with a discharge of 20 L/min or less are typically too small to be of interest for water capture and thus remained untouched.

As expected, discharge was higher after rainfall than during prolonged dry periods, especially for the springs in the forest. Discharge of springs in grassland however, seemed relatively stable. The discharge varied by 96 – 4'317 % between the different monitoring days (median: 48 %). If a measurement error of ± 10 % is assumed, the discharge changes for all of the springs beyond the measurement errors. Although the discharge varied over the three monitoring periods, this had no impact on the classification according to the FOEN-Method, as discharge, water chemistry, and the spring size are not considered in the ecological value calculation. Whether including or excluding these factors is the right approach does not change the fact that understanding a spring's variability, its response to seasonal patterns, and different weather conditions is crucial for the organisms living there. Spring revitalization and restorations aim to create an undisturbed habitat. A spring with a high ecological value may seem to be a biodiversity hotspot, but if it dries up occasionally, the flora and fauna will change. Thus, knowing about the spring dynamics is essential when assessing biodiversity.

The more variable discharge of the springs in the forest could be an indication that these springs are more sensitive to changes in the wetness conditions. Forests can promote higher infiltration due to dense vegetation, extensive root systems, and largely undisturbed soils, which can enhance groundwater recharge. In contrast, the grasslands in the study area are primarily used for grazing, where soil compaction and reduced vegetation cover may limit infiltration and instead favour surface runoff (Atalar et al., 2025). This phenomenon was observed in the field: after the rainfall event in May, no runoff could be measured at a captured spring, although surface water was visible on the soil approximately 30 meters downhill on the way to the basin. However, other studies present evidence that grasslands may be more efficient than forests in facilitating groundwater recharge due to the lower evapotranspiration losses, highlighting the complexity of the underlying hydrological processes (Adane et al., 2018; Owuor et al., 2016). If one assumes that the springs are mainly locations of groundwater discharge (rather than soil water exfiltration), then the differences in infiltration rates should lead to a minimal effect on the discharge variation due to the large storage capacity and slow water flow through the aquifers. Nonetheless, flow through fractures can lead to quick groundwater flow (Cai et al., 2021; Barackman & Brusseau, 2002; Farkas-Karay & Hajnal, 2015). The variation in geology (Figure 3) is limited and therefore, there is no clear reason why the springs are more sensitive to changes in wetness conditions. Their location on steeper hillslopes could be an alternative suggestion as shorter and shallower flow pathways may lead to faster responses to rainfall. However, because all springs on the grasslands were captured, it is also possible that their discharge is regulated and not natural. A clear conclusion regarding the dominant recharge mechanisms in this context, therefore remains elusive.

5.3.2. Stream Chemistry

The pH of spring water was >6.91 , which reflects the carbonate rich geology (Lin et al., 2023; Sherlock et al., 1995). Springs in the forested areas had a higher pH compared to those in grasslands. These results are surprising, as more organic material coming from the forest surrounding, is usually lowering pH (Bösch et al., 2023). The electrical conductivity (EC), on the other hand, did not differ significantly between land uses. Even though the chemical composition of groundwater is highly influenced by site specific factors like soil characteristics, bedrock material, biological processes and residence time, these findings suggest that the EC of the spring water is more dependent on the underground geology, than on specific small

scale land use (Kiewiet et al., 2019). The observed individual EC values range from 255 to 794 $\mu\text{S}/\text{cm}$, with a median of median: 600 $\mu\text{S}/\text{cm}$. These values are comparable to those reported by Floriancic et al. (2019), who found median discharge EC values between 458 and 906 $\mu\text{S}/\text{cm}$ for catchments in the Swiss Plateau. The slightly lower EC values in Fischingen suggest either less weathering due to shorter residence times or a more resistant or slightly different geology material. Their study area mainly was situated in a similar geological setting, dominated by quaternary deposits and sedimentary rocks, therefore no obvious differences between the two studies can be established. Nevertheless, the presented results still fall within the expected range.

The results of the pH and EC assessments in the study area partially confirm the hypothesis that both parameters are influenced by seasonal conditions, with generally higher values observed during dry periods than under wet conditions. The seasonal variation in pH was evident across all springs and was particularly pronounced in forested areas, where pH was significantly higher during dry periods. The EC was also significantly higher during dry conditions, but this effect was only clear for the grassland springs. The lower EC is likely due to the higher concentration of dissolved ions during low-flow periods when less flow through fast flow pathways lead to longer interaction time with soil and rock minerals. In contrast, the observed seasonal pattern, namely the drop in pH and electrical conductivity (EC) following a rainfall event, may indicate a first-flush effect (Beierkuhlein et al. 2024; Kiewiet et al. 2019). Although sampling took place in May after a rainfall event, the preceding period, dating back to February, was marked by very low precipitation. The sudden influx of rain after this prolonged dry phase may have mobilized accumulated CO_2 , organic acids, and other solutes into the spring water. This mechanism could explain the significantly lower pH values recorded during the wet sampling in May compared to the dry conditions observed in January, when sampling was conducted under snow-covered conditions, infiltration was minimal and spring discharge was primarily sustained by buffered groundwater inputs (Lee et al., 2004). The pH of the springs in the forests may change more due to additions of soil water due to the more acidic soil water under forests than grasslands (Beierkuhlein et al., 2024). More flow from shallower soil layers with a low EC would explain the lower values for the grassland sites. That the EC mainly changed for the grassland springs for which the flow rates did not vary greatly,

suggests that these flow rates are indeed managed flows, or that the flushing effect is not caused by a higher flow.

In addition to dilution by soil water or differences in buffering capacity, water quality may also be affected by inputs of substances such as fertilizers, especially on managed grasslands (Shi et al., 2021; Zhan et al., 2016). However, since the sampling occurred between October and May, when agricultural activity on grassland is reduced, the influence of fertilizer application may have been less pronounced than during the summer. On actively grazed pastures, greater seasonal variation in pH might be expected, as grazing intensity might influence nitrogen inputs and soil nutrient dynamics, that can alter soil pH and in ultimately spring water pH (Raniolo et al., 2025; Shi et al., 2021).

The results of the water temperature and dissolved oxygen assessments showed that water temperature changes were related to air temperatures on the sampling dates, with the lowest water temperatures recorded in January and the highest in October. This pattern is especially evident at natural springs, where runoff is shallow (Q9, Q23), and the surrounding air temperature can have a great impact on the water temperature of the spring stream. Dissolved oxygen levels remained relatively stable, close to 90 % throughout the entire sampling period. The observed value of 26 % at Q1 is considered a measurement error.

The variations in pH and EC highlight the role of both land use and recent hydrological conditions in shaping spring water discharge and chemistry. A one-time assessment, as proposed in the FOEN Structural Spring Protocol and conducted during a spring mapping campaign, can provide valuable insights for a specific point in time as there were no very large changes in pH or EC, however, it cannot fully capture the dynamic nature of spring water discharge and quality. Therefore, a longer-term assessment with repeated measurements, ideally covering a full annual cycle, is recommended. Discharge, pH, and EC can vary significantly depending on both long-term conditions and short-term events. Even though discharge and stream chemistry are not part of the ecological value calculation, information about rapid changes, temporary dry-outs, low flows, and general spring behaviour may be particularly important when evaluating the hydrology and biodiversity of a spring, especially for further protection measures or potential protection (Lubini-Ferlin, 2015a).

5.4. Limitations

The study area for this thesis was chosen based on its characteristic landscape mosaic of forest and grassland, as it was expected that a high number of natural and water-bearing springs would still be present in this region. Additionally, its proximity to Zurich allowed for spontaneous and efficient fieldwork. Unlike to the rest of the canton, the southern region where the study area is located, is characterized by minimal urban areas. Consequently, settlement areas were largely excluded from this research. While this choice facilitated the searching for relatively undisturbed springs, it also limits the representativeness of the findings. Specifically, the study area does neither reflect the conditions of the entire canton nor the broader Swiss Plateau, where settlement density and anthropogenic influences are typically higher.

The methodology for spring identification was influenced by practical restrictions such as vegetation density, private property boundaries and steep terrain. Especially in the forest, some steep and densely vegetated areas were left out of the study. As a result, easily accessible springs, particularly those near roads and paths in the forest and on open grassland, were more likely to be documented. This accessibility bias may have led to an overestimation of the percentages of captured and lost springs. Contrarily, the exclusion of settlement areas, where higher rates of spring loss and capture are expected, may shift the results of the study towards an overrepresentation of the present springs. Thus, the findings are only representative for largely rural landscapes with no large settlement areas, such as the areas of Fischingen, and should not be generalized for more urbanized areas in other parts of the canton.

Further, the searching strategy may have influenced the likelihood of spring detection. The time spent for searching a spring was set to 20 minutes and the search radius to 20 meters. In particular, captured springs with underground piping may appear up to 50 meters away from their natural outlet. In this research design they were then defined as gone/not found. Therefore, results may differ if the searching time and radius would be enlarged or minimalized. Furthermore, the observer's level of expertise likely plays a role in the number and quality of springs found. Another person may detect features or interpret signs differently, introducing further variability, especially if springs in the whole canton may be searched by different people.

Due to limited ecological expertise, the study did not include a detailed assessment of flora and fauna, which are critical components of a spring's ecological value and biodiversity. In future studies, this inclusion would be essential to comprehensively evaluate the habitat quality and biodiversity, particularly for spring species that rely on unique and stable spring environments.

Additionally, measurement challenges introduced potential inaccuracies. Discharge could not always be measured, as only wet and muddy soils were visible or bucket-based measurements were not feasible. Estimating runoff on leaf-covered ground was particularly difficult and may have led to under- or overestimation of the generally small flow. Similarly, the accuracy of pH, electrical conductivity (EC), temperature, and dissolved oxygen (DO %) readings may have been affected in shallow springs where the measuring device could not be fully submerged.

As previously discussed, it is important to recognize that pH and EC values can be influenced not only by precipitation but also by underlying soil properties. Furthermore, the timing of the fieldwork (between autumn and early spring) may have reduced the visibility of certain agricultural impacts, such as fertilization and grazing. In summer time, the seasonal patterns may be more pronounced.

Additionally, there were more springs observed in forested areas than on grassland, providing a broader dataset and potentially capturing a wider range of hydrological behaviours.

Generally, the documentation of the spring inventory should ideally be conducted during late spring to late summer, when vegetation is fully developed. Technically weather conditions do not matter, however, drier conditions can facilitate the assessment of the spring size and flow, as there is no misinterpreting with rainwater. The FOEN Structural Spring Protocol is useful for characterizing the spring structure and ecological condition through a one-time assessment. However, as parameters like discharge and water quality are highly variable over time, multiple measurements are essential to understand seasonal dynamics, particularly to determine whether a spring dries up during droughts, a factor that is crucial for biodiversity and ecological planning.

For future analyses, expanding the study area to include both settlement zones and more remote or less accessible regions would provide a broader understanding of spring distribution, ecological value, and hydrological function across the entire spectrum of environmental conditions of the region.

6. Conclusion

This study analyzed the spring situation in three study catchments in the region of Fischingen (TG) based on the Historic Spring Atlas from 1912 and investigated the occurrence of springs as well as their structural and chemical characteristics. Additionally, the study elaborated, whether these findings can predict possible spring locations in the southern part of the canton of Thurgau in order to better guide future spring searching campaigns.

The findings show that most of the identified springs have either been captured or lost over time, while only a small proportion remained in their natural state. Land use emerged as a key factor influencing whether springs persist or disappear. Springs in forested areas appear relatively resilient over time. Not only do three-quarters of the springs recorded in 1912 still exist, but they are also the only ones found in a natural condition. Grassland springs in contrast are much more vulnerable to degradation, as over half of them have disappeared and none have survived in their original, natural form.

Regarding their ecological value, the condition of a spring closely corresponds to land use patterns. All captured springs in grassland are in a poor and degraded condition, whereas some springs in the forest are in a near-natural state. Therefore, searching efforts in the southern part of the canton of Thurgau should be intensified in forested areas when identifying ecologically valuable springs or potential sites for restoration.

Further, discharge and stream chemistry assessments highlighted the dynamic nature of a spring in relation to underlying hydrological processes. Discharge and water quality were highly influenced by seasonal wetness conditions, with generally higher pH and EC values, and lower discharge observed during dry periods than under wet conditions. A one-time assessment, as conducted during a spring mapping campaign, can thus provide valuable information at a specific point in time, but does not fully capture the variability of a spring. A long-term assessment with repeated measurements under different weather conditions is therefore recommended. Even though discharge and stream chemistry do not alter the ecological value of a spring, such information about periodically dry-outs, low flows, and the general behaviour of a spring may be considered when evaluating a spring for protection or restoration measures.

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Appendix

A1 Geology

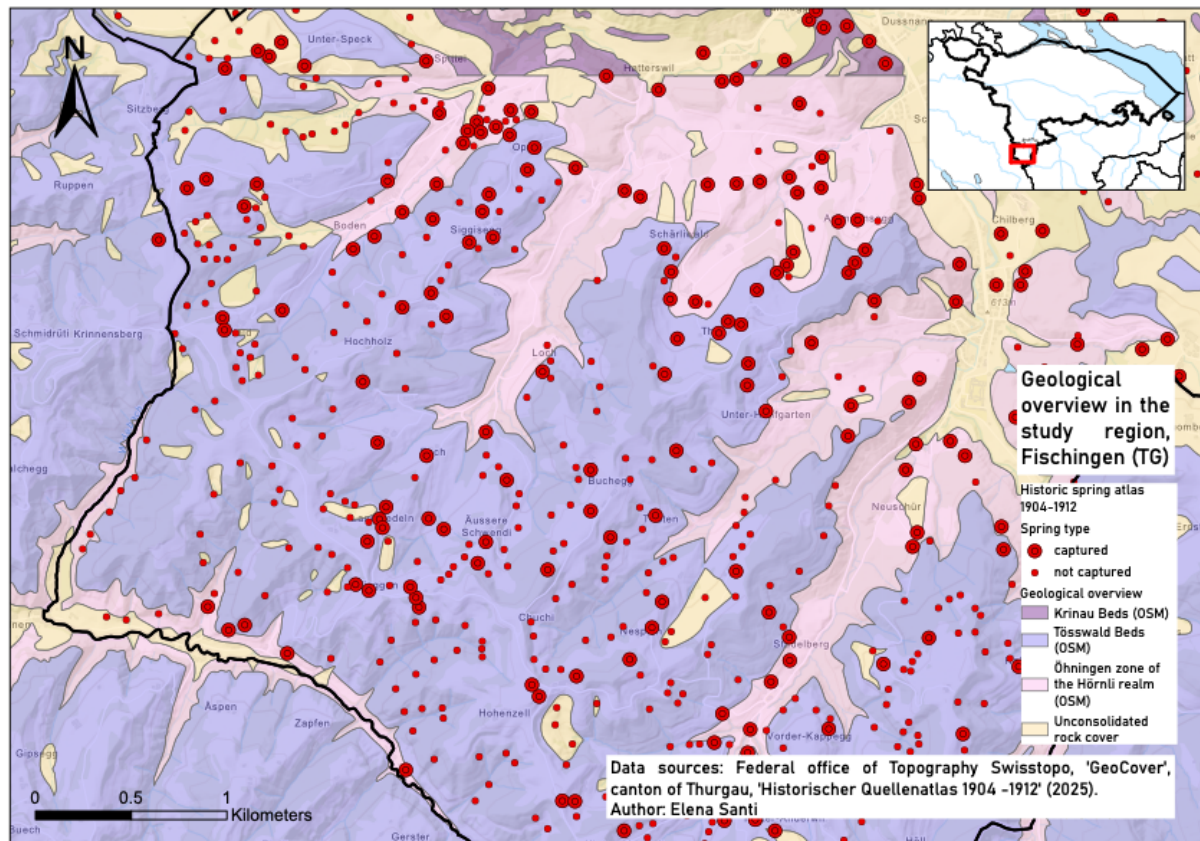


Figure A1: Geological overview in the study area showing the spring locations from the Historic Spring Atlas (1912) (red circles). The Krinau Beds, Tösswald Beds and the Öhningen zone of the Hörnli realm are part of the Upper Freshwater Molasse (OSM).

A2 Ecological Value

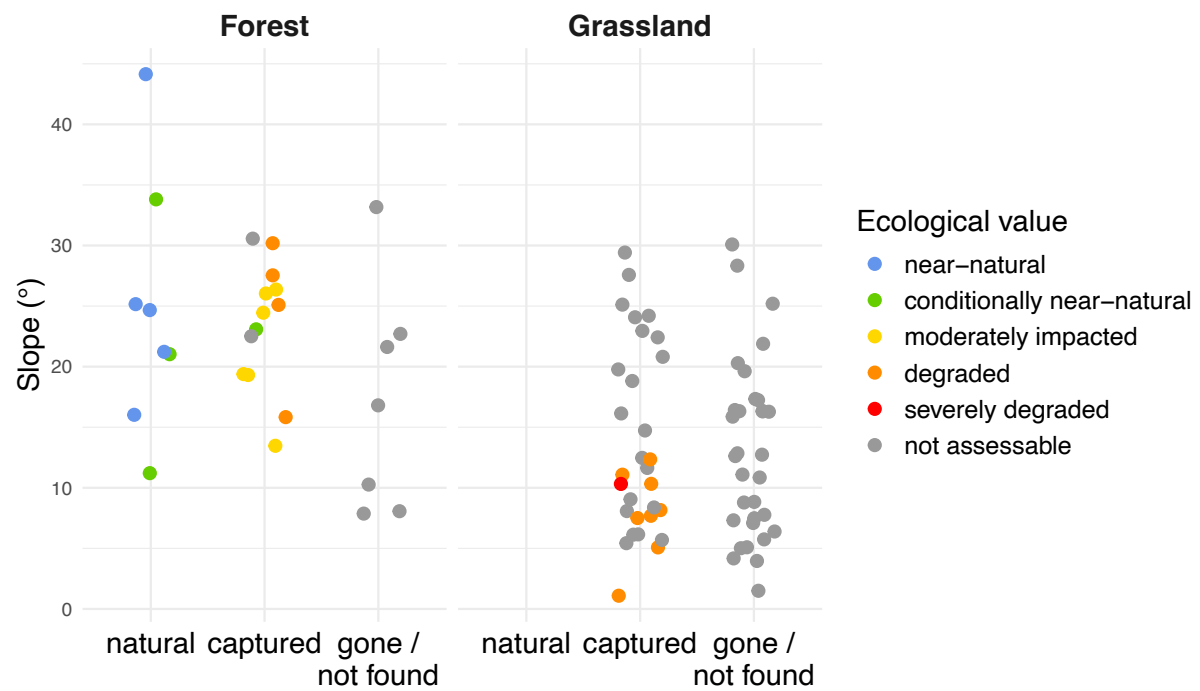


Figure A2: Variation in the ecological value (color-coded) per spring type in relation to slope, shown separately for forested and grassland areas in 2024.

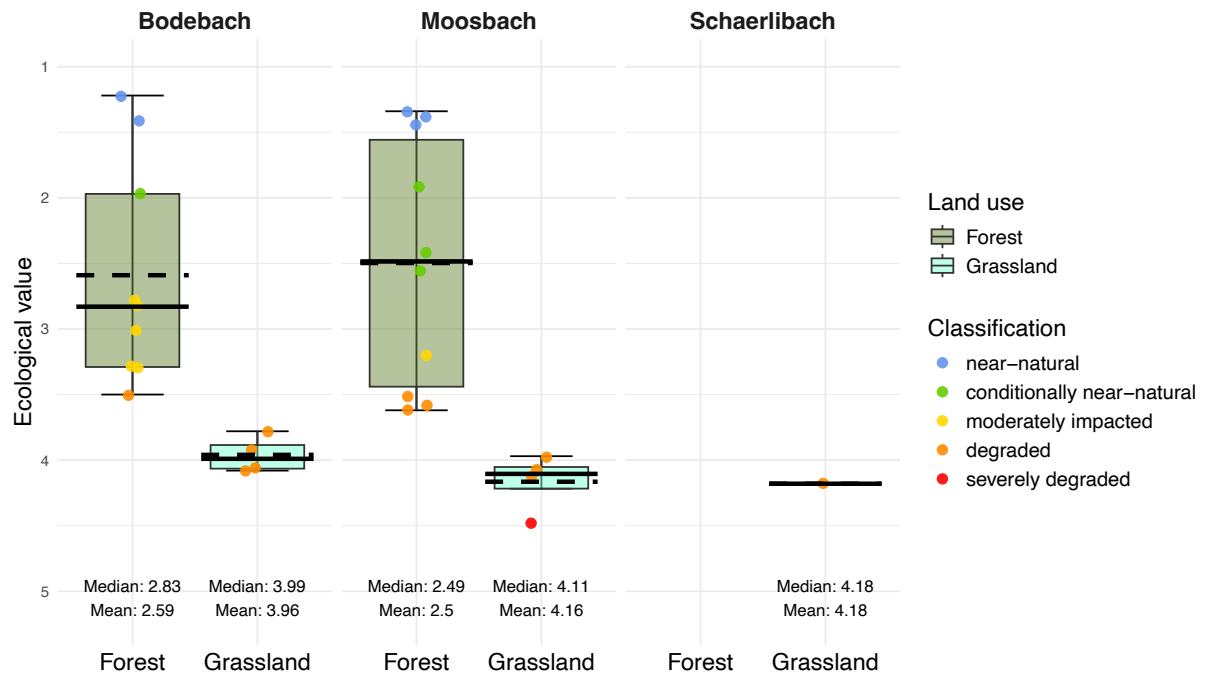


Figure A3: Box plots of the ecological values for the springs in the three study regions per land use category in 2024 (forest and grassland).

A3 Water Chemistry – Water Temperature & Dissolved Oxygen

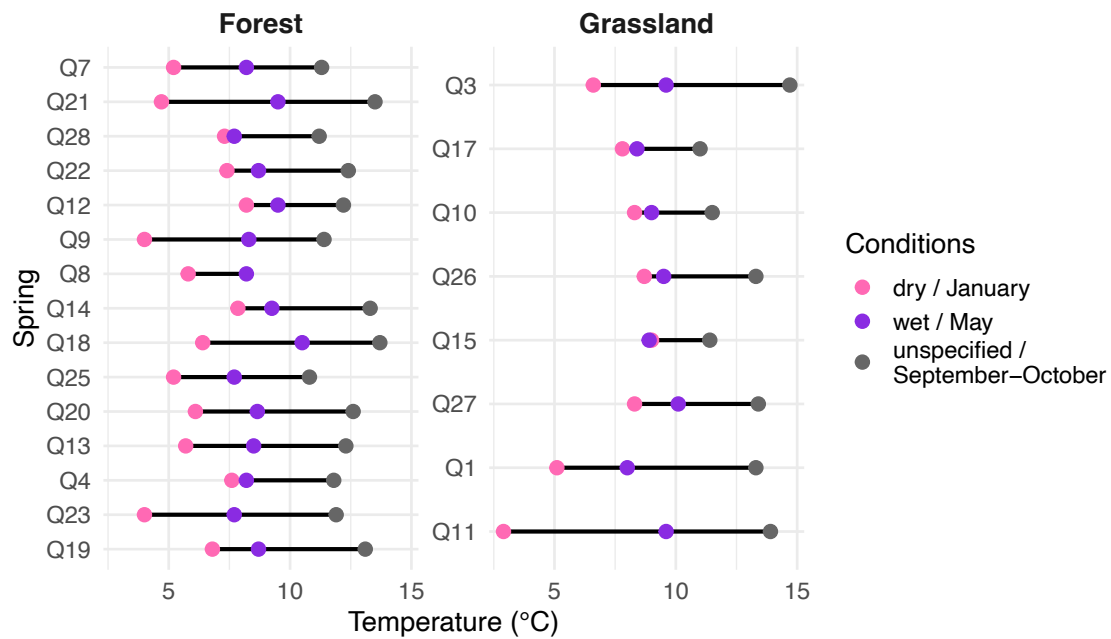


Figure A4: Water temperature values of natural and captured springs in the study area in 2024/25, separated by land use category (forest and grassland) during different wetness conditions.

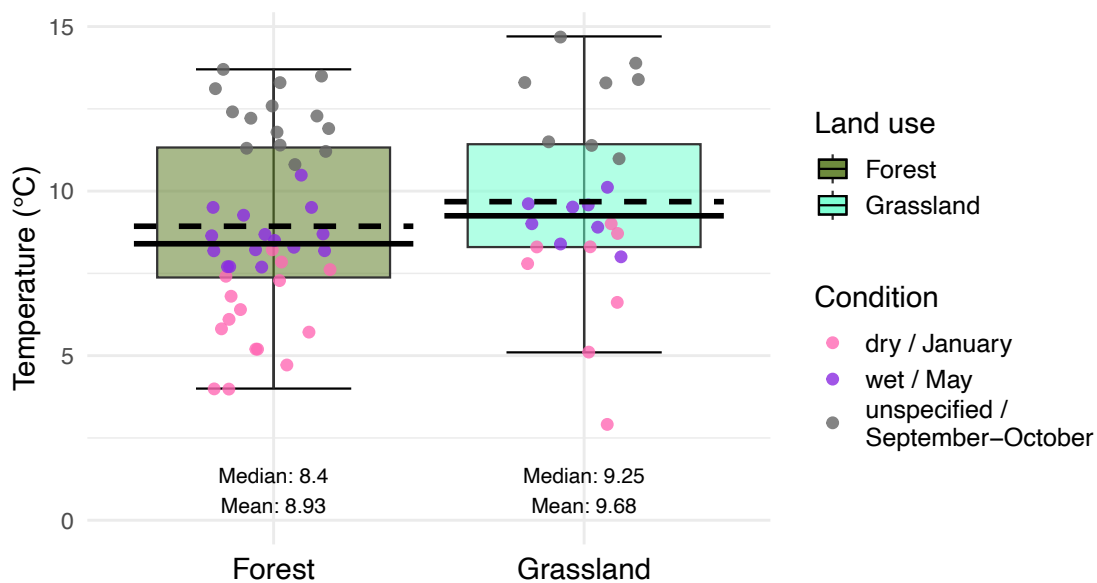


Figure A5: Box plots of the water temperature values of the spring water measured for the springs in the study area per land use category (forest and grassland) in 2024/25.

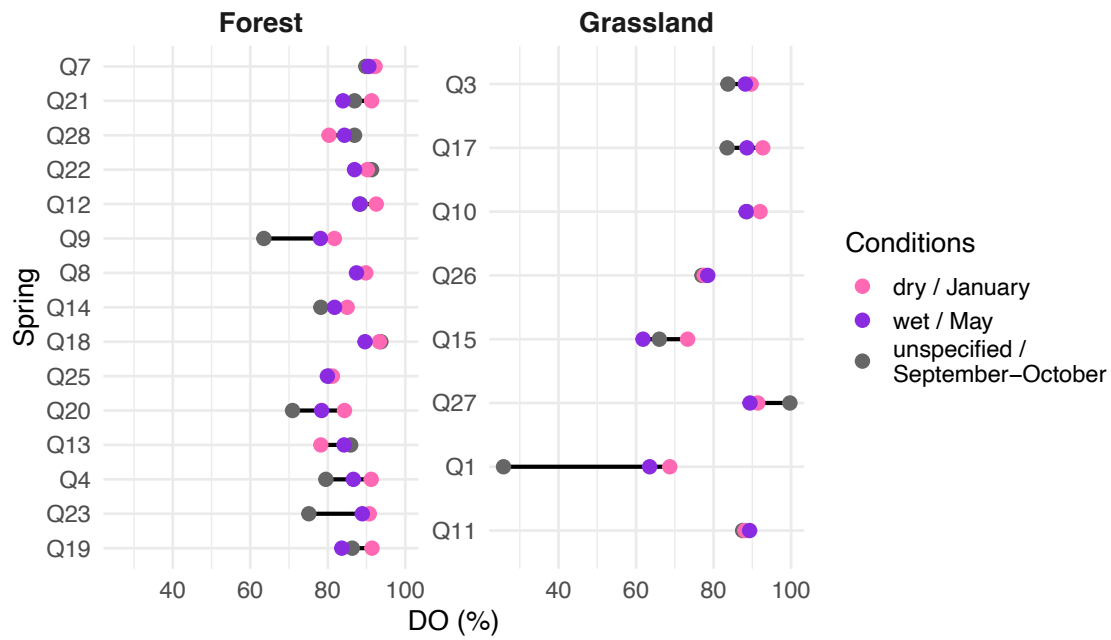


Figure A6: Dissolved oxygen values (in %) of natural and captured springs in the study area in 2024/25, separated by land use category (forest and grassland) during different wetness conditions.

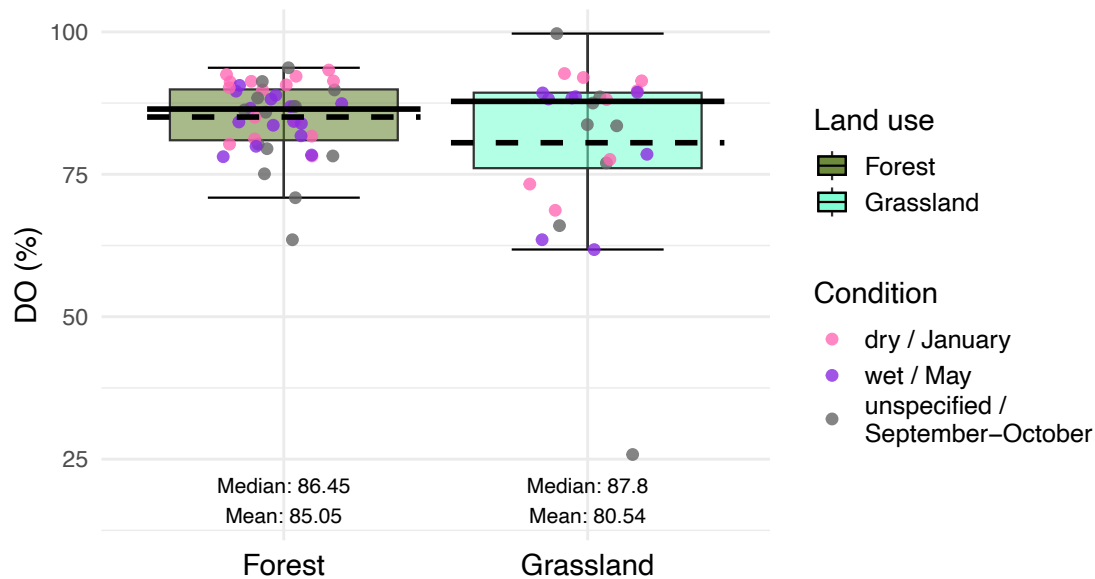


Figure A7: Box plots of the dissolved oxygen values (in %) of the spring water measured for the springs in the study area per land use category (forest and grassland) in 2024/25.

Table A1: Median and Mean Absolute Deviation (MAD) calculated for spring water temperature and dissolved oxygen during the three measurement dates.

		Water temperature (°C)		Dissolved oxygen (%)	
Measurement time	n	Median	MAD	Median	MAD
Dry / January 2025	23	6.60	1.40	89.8	2.70
Wet / May 2025	23	8.7	0.55	86.6	2.70
Unspecified / September-October 2024	22	12.35	0.95	84.8	5.15

A4 Spring Locations and Measurement Data

Table A2: Spring locations of all natural and captured water-bearing springs found in the study area. The table summarizes spring characteristics as well as the three discharge and water chemistry measurements during the study period September 2024 – May 2025. The measurement dates indicate different wetness conditions: Sept-Oct = unspecified, Jan = dry, May = wet

FOEN Structural Spring Protocol	Longitude	Latitude	Type 1912	Type 2024	Land use 2024	Slope (°)	Discharge (L/min)			pH			EC (µS/cm)			Water temperature (°C)			Dissolved oxygen (%)		
							QSept- Oct	QJan	QMay	pHSept- Oct	pHJan	pHMay	ECSept- Oct	ECJan	ECMay	TempSept- Oct	TempJan	TempMay	DOSept- Oct	DOJan	DOMay
Q1	2714838.70	1253125.10	captured	captured	grassland	5.1	1.4	0.65	1.5	6.91	7.25	7.14	706	567	563	13.3	5.1	8	25.8	68.7	63.5
Q2	2714427.50	1252449.40	natural	natural	forest	44.1	5	NA	NA	7.69	NA	NA	676	NA	NA	12	NA	NA	82.6	NA	NA
Q3	2713929.50	1252069.80	captured	captured	grassland	11.1	2.6	7.7	0.8	7.38	7.7	7.68	311.1	589	569	14.7	6.6	9.6	83.7	89.7	88.2
Q4	2714028.00	1250980.00	natural	captured	forest	23.1	6	1	1.2	7.16	8.03	7.48	674	664	724	11.8	7.6	8.2	79.5	91.2	86.6
Q5	2714044.00	1251017.00	natural	natural	forest	21.0	2.4	0.7	NA	7.66	7.96	NA	364.7	340.1	NA	11.6	6.5	NA	85.4	89.6	NA
Q6	2714425.70	1251786.60	natural	natural	forest	33.8	7	NA	NA	8.1	NA	NA	486.2	NA	NA	11.2	NA	NA	86.2	NA	NA
Q7	2714324.00	1251801.00	natural	captured	forest	26.4	6	30	6.3	8.18	8.25	8.34	549	548	522	11.3	5.2	8.2	89.8	92.2	90.6
Q8	2714232.00	1251796.00	natural	natural	forest	25.2	NA	1	2	NA	8.08	7.84	NA	255.3	522	NA	5.8	8.2	NA	89.8	87.4
Q9	2714233.00	1251755.00	natural	natural	forest	16.0	1	1	2	7.56	7.8	7.8	547	305.2	512	11.4	4	8.3	63.5	81.7	78.1
Q10	2713863.60	1251341.50	captured	captured	grassland	8.2	30	60	55.4	7.5	7.64	7.84	627	595	603	11.5	8.3	9	88.6	92	88.4
Q11	2713202.00	1250773.00	captured	captured	grassland	10.3	0.2	0.1	0.35	8.08	8.34	8	502	455	451.5	13.9	2.9	9.6	87.5	88.1	89.3
Q12	2713179.00	1250831.00	natural	captured	forest	27.5	16	15	29	7.73	8.29	7.72	642	588	587	12.2	8.2	9.5	88.4	92.5	88.2
Q13	2713152.00	1250968.00	natural	captured	forest	30.2	5.1	2.4	13	7.66	7.85	7.6	632	614	600	12.3	5.7	8.5	85.9	78.2	84.2
Q14	2713261.00	1251225.00	natural	captured	forest	25.1	18.3	8.7	15	7.4	7.85	7.3	626.5	607	617	13.3	7.85	9.25	78.2	85	81.75
Q15	2713301.00	1251355.00	natural	captured	grassland	7.7	16.3	11	8	7.11	7.22	7.13	670	670	631	11.4	9	8.9	66	73.3	61.8
Q16	2712842.20	1253734.90	captured	captured	grassland	1.1	1.7	0.13	NA	7.45	7.89	NA	604	594	NA	11.8	4.7	NA	84.9	86.6	NA
Q17	2712862.00	1253685.30	captured	captured	grassland	7.5	8.2	12.3	2.8	7.24	7.61	7.69	603	591	577	11	7.8	8.4	83.5	92.7	88.6
Q18	2712800.90	1253304.20	natural	captured	forest	19.3	18	8.2	20.4	8.28	8.26	8.26	647	650	476.7	13.7	6.4	10.5	93.7	93.3	89.6
Q19	2712601.90	1253167.30	natural	captured	forest	13.5	20.7	1.2	53	7.42	7.93	7.36	662	632	591	13.1	6.8	8.7	86.3	91.4	83.6
Q20	2712500.44	1253034.90	natural	captured	forest	19.4	10	7.8	30	7.15	7.24	7.11	614	611	471.9	12.6	6.1	8.65	70.9	84.3	78.4
Q21	2712309.00	1252706.00	natural	captured	forest	24.5	0.5	11.5	3	7.31	8.2	7.11	755	794	633	13.5	4.7	9.5	86.9	91.3	83.9
Q22	2712305.00	1252685.00	natural	captured	forest	26.0	7.5	6.6	12	7.88	7.92	7.73	626	624	620	12.4	7.4	8.7	91.3	90.2	86.9
Q23	2711420.10	1252781.50	natural	natural	forest	24.7	2.4	1.2	9	7.57	8.26	8.14	539	515	461.7	11.9	4	7.7	75.1	90.7	88.9
Q24	2711676.90	1252867.20	natural	natural	forest	21.2	NA	1.6	NA	NA	8.29	NA	NA	646	NA	NA	4.1	NA	NA	89.7	NA
Q25	2711414.00	1253109.00	natural	natural	forest	11.2	0.6	8.6	27	7.68	7.68	7.45	603	608	583	10.8	5.2	7.7	80.3	81.2	79.9
Q26	2711654.00	1253380.00	captured	captured	grassland	10.3	2.1	3	3.8	7.3	7.43	7.24	659	660	560	13.3	8.7	9.5	77	77.6	78.5
Q27	2711657.00	1253339.00	captured	captured	grassland	12.3	5.2	6.2	12	7.58	8.2	7.49	600	583	500	13.4	8.3	10.1	99.7	91.4	89.4
Q28	2711925.90	1253110.70	natural	captured	forest	15.8	6.3	10.3	11	7.24	7.3	7.33	628	648	534	11.2	7.3	7.7	86.9	80.3	84.3

Table A3: Spring locations and characteristics of all captured (no water visible) and springs not found in the study area.

Longitude	Latitude	Type 1912	Type 2024	Land use 2024	Slope (°)
2714922.80	1253277.50	natural	captured	grassland	24.2
2714718.80	1253237.30	captured	gone / not found	grassland	5.7
2714773.50	1252969.90	captured	gone / not found	forest	7.9
2714239.40	1252371.10	captured	captured	grassland	9.1
2714059.20	1251978.10	natural	gone / not found	grassland	16.3
2715143.80	1252417.40	captured	gone / not found	forest	10.3
2714844.50	1252363.90	natural	gone / not found	grassland	5.1
2714721.50	1252427.30	natural	gone / not found	grassland	7.8
2714871.10	1252283.00	captured	captured	grassland	6.2
2714761.30	1252148.90	captured	captured	forest	30.6
2714259.00	1251603.00	natural	gone / not found	grassland	12.7
2714275.00	1251521.00	natural	captured	forest	22.5
2714168.00	1251485.00	natural	gone / not found	grassland	28.3
2714184.00	1251411.00	captured	captured	grassland	11.6
2714024.00	1251272.00	captured	gone / not found	grassland	16.3
2714135.00	1251297.00	natural	captured	grassland	22.4
2713847.90	1251095.80	natural	gone / not found	grassland	10.9
2713816.00	1251044.00	natural	gone / not found	grassland	25.2
2713747.30	1251118.00	captured	captured	grassland	25.1
2713391.00	1250884.00	captured	captured	grassland	19.8
2713248.00	1250700.00	natural	captured	grassland	18.8
2713240.00	1250608.00	natural	captured	grassland	29.4
2713119.00	1250817.00	captured	gone / not found	grassland	12.6
2713127.00	1251073.00	natural	gone / not found	grassland	4.0
2713632.00	1251889.00	natural	captured	grassland	24.1
2713609.00	1251999.00	natural	gone / not found	grassland	17.2
2714214.80	1252701.00	captured	gone / not found	grassland	30.1
2714445.70	1253008.70	captured	captured	grassland	5.4
2714400.00	1252971.30	captured	gone / not found	grassland	7.3
2714460.40	1252947.20	natural	gone / not found	grassland	5.0
2714408.80	1253233.20	natural	gone / not found	grassland	12.8

Longitude	Latitude	Type 1912	Type 2024	Land use 2024	Slope (°)
2714488.30	1253079.60	captured	gone / not found	grassland	8.8
2714578.40	1253200.80	natural	gone / not found	grassland	11.1
2714533.20	1253384.80	captured	captured	grassland	5.7
2714581.80	1253522.90	natural	captured	grassland	23.0
2712558.60	1253867.20	natural	gone / not found	grassland	17.3
2712636.10	1253801.80	captured	gone / not found	grassland	7.5
2712644.00	1253852.50	natural	gone / not found	grassland	7.1
2712798.80	1253722.10	captured	captured	grassland	8.1
2712884.50	1253769.10	natural	captured	grassland	6.1
2713001.00	1253752.80	natural	captured	grassland	20.8
2712998.70	1253793.40	natural	captured	grassland	14.7
2713015.80	1253812.80	captured	captured	grassland	16.1
2712854.00	1253827.00	natural	gone / not found	grassland	8.8
2713139.20	1253811.10	captured	captured	grassland	8.4
2713172.40	1253689.00	captured	captured	grassland	27.6
2713005.20	1253689.00	captured	gone / not found	grassland	16.3
2712895.00	1253378.90	captured	gone / not found	grassland	1.5
2712950.40	1253287.80	natural	gone / not found	grassland	4.2
2712859.80	1253291.50	captured	gone / not found	grassland	6.4
2711361.00	1253235.00	natural	gone / not found	grassland	15.9
2711424.00	1253267.00	natural	gone / not found	grassland	21.9
2711528.00	1253038.00	natural	gone / not found	forest	33.2
2711427.00	1253041.00	natural	gone / not found	forest	16.8
2711407.00	1253040.00	natural	gone / not found	forest	21.6
2711445.00	1252914.00	natural	gone / not found	forest	22.7
2711304.00	1253173.00	natural	gone / not found	forest	8.1
2711630.10	1253248.20	natural	gone / not found	grassland	16.4
2711678.10	1253309.90	natural	gone / not found	grassland	20.3
2711725.30	1253363.60	natural	gone / not found	grassland	16.3
2711703.00	1253205.00	natural	gone / not found	grassland	19.6

A5 Structural Spring Protocols

Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q1	
Quelle: Q1		Datum : 27.09.24		Koordinaten (X/Y) : 714838 253125			
Flurname : Moosbach		Höhe ü.M. : 704		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²])		Vernetzung		Einzelquelle ☒ Q-system ☐ Q-komplex ☐	
Hanglage		Quellbereich [m²]		Dist. zur Nachbarquelle (m)		Anz. Austritte 1	
Abflussrichtung		Quellbachlänge [m]		Bemerkungen		Quelle gefasst - Grösse nicht erkennbar. DO [%]: 25.8, pH: 6.91.	
Geländeneignung		Wassertemperatur [°C]		Fotos und andere Dokumente		ID TG_Q1_20240927.pdf	
Quellschüttung		Quellschüttung [l/s]		Trinkwassernutzung		Schutzstatus ☐ Kulturhistorische Bedeutung ☐	
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm]					
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf				standorttyp. Vegetation			
Rohr und Becken				standortfremd. Vegetation			
nur Rohr/Rinne				Moosgesellschaften			
Wasserentnahme				Zwergstrauchheiden			
Bemerkung / Zweck :				Hochstaudenfluren			
Verlegung				Laubwald			
Aufstau				Mischwald			
künstlicher Absturz				Gebüsch			
Verbau* (Ufer, Sohle)				standorttyp. Nadelwald			
Unterhalt/Trittschäden				standortfremd. Nadelwald			
Infrastruktur				extensivgenutz. Offenland			
Ablagerung*				intensivgenutz. Offenland			
Einleitungen				Acker/ Sonderkultur			
Wert A : Beeinträchtigung (höchster Wert)				Sommerbeschattung			
Revitalisierungsobjekt (Einschätzung)				Struktur			
Klassierung / Classement :				Substrat			
Gesamteindruck als Bewertungsvergleich				Anzahl Substrate			
Bewertung / Evaluation				Wasser-Land-Verzahnung			
Besondere Strukturen				Anzahl Strukturen			
Quelle nicht bewertbar :				Gesamtergebnis [(A+B)/2]-b			
Zutreffendes ankreuzen [x]				Quelle zerstört			
				kein Abfluss			

TG_Q1



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q2	
Quelle: Q2		Datum : 27.09.24		Koordinaten (X/Y) : 714427 252449			
Flurname : Moosbach		Höhe ü.M. : 706		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²]) 3		Vernetzung Einzelquelle ☐ Q-system ☒ Q-komplex ☐			
Hanglage		Quellbereich [m²] 10		Dist. zur Nachbarquelle (m) 87		Anz. Austritte	
Abflussrichtung		Quellbachlänge [m] 10		Bemerkungen DO [%]: 82.6, pH: 7.69.			
Geländeneignung		Wassertemperatur [°C] 12.5					
Quellschüttung		Quellschüttung [l/s] 1.0		Fotos und andere Dokumente ☒		ID TG_Q2_20240927.pdf	
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm] 676		Trinkwassernutzung ☐		Schutzstatus ☐ Kulturhistorische Bedeutung ☐	
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren 1				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren 1			
Einträge/Verbau				Vegetation/Nutzung			
Fassung neu alt verfallen				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf ☐ ☐ ☐				standorttyp. Vegetation 1 1 1 1			
Rohr und Becken ☐ ☐ ☐				standortfremd. Vegetation ☐ ☐ ☐ ☐			
nur Rohr/Rinne ☐ ☐ ☐				Moosgesellschaften ☐ ☐ ☐ ☐			
				Zwergstrauchheiden ☐ ☐ ☐ ☐			
				Hochstaudenfluren ☐ ☐ ☐ ☐			
Wasserentnahme >60% 30-59% <30% / unbekannt keine				Laubwald ☐ ☐ ☐ ☐			
☐ ☐ ☐ 1				Mischwald 1 1 ☐ ☐			
Bemerkung / Zweck :				Gebüsch ☐ ☐ ☐ ☐			
Verlegung 10-100m <10m unbekannt				standorttyp. Nadelwald ☐ ☐ ☐ ☐			
alt ☐ ☐ ☐				standortfremd. Nadelwald ☐ ☐ ☐ ☐			
neu ☐ ☐ ☐				extensivgenutz. Offenland ☐ ☐ ☐ ☐			
				intensivgenutz. Offenland ☐ ☐ ☐ ☐			
				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
				unbefestigter Weg ☐ ☐ ☐ ☐			
				befestigter Weg/Strasse ☐ ☐ ☐ ☐			
				künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
Aufstau nach <10m nach >=10-49m unbekannt				Sommerbeschattung unbeschattet schwach mittel stark			
Hauptschluss, 1-5 m2 ☐ ☐ ☐				Sommerbeschattung ☐ ☐ ☐ 1			
Hauptschluss, >5 m2 ☐ ☐ ☐				stark & Überdachung oder Nadelforst ☐			
Nebenschluss ☐ ☐ ☐							
				Struktur			
				Substrat			
				stark (>50%) mittel (>20%) gering (>1%)			
künstlicher Absturz Gesamtabfluss Teilabfluss nein				->natürlich			
☐ ☐ ☐ 1				Fels/Blöcke (>20 cm) ☐ ☐ ☐			
Verbau* (Ufer, Sohle) stark mittel gering				(Kiesel) Steine (6-20 cm) ☐ ☐ ☐ 1			
Holz ☐ ☐ ☐				Kies/Schotter (0.2-6 cm) ☐ ☐ ☐			
Steinschüttung ☐ ☐ ☐				Sand (0.1 - 2 mm) ☐ ☐ ☐			
wilder Verbau ☐ ☐ ☐				Feinmaterial (<0.1 mm) 1 ☐ ☐			
Naturstein ☐ ☐ ☐				Moospolster ☐ ☐ ☐			
Beton ☐ ☐ ☐				Wurzeln ☐ ☐ 1 ☐			
Verrohrung ☐ ☐ ☐				Totholz ☐ ☐ 1 ☐			
				Pflanzen ☐ ☐ 1 ☐			
				Falllaub 1 ☐ ☐ ☐			
				Detritus/Org.Schlamm ☐ ☐ ☐			
Unterhalt/Trittschäden gering mässig stark keine				Kalksinter...* ☐ ☐ ☐			
☐ ☐ ☐ 1				Anzahl Substrate 6 stark (>50%) mittel (>20%) gering (>1%)			
Ursache :				künstlich ☐ ☐ ☐			
Infrastruktur				->verändert (nur Infos) Fadenalgen ☐ ☐ ☐			
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐				Strömungs- Spritzwasser ☐ glatt ☐ fliegend ☐ überfliegend 1			
Wildfütterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges ☐				diversität geripelt ☐ plätschernd ☐ überstürzend ☐ fallend ☐			
Anzahl Infr. 0 Sonstiges :				Anzahl Strömungen 1			
Ablagerung* Deckungsgrad : vollständig teilweise vereinzelt				Wasser-Land-Verzahnung gross 1 mittel ☐ gering ☐			
Haus-/ Gewerbemüll ☐ ☐ ☐				Besondere Laufverzweigung ☐ Inselstruktur ☐ Quelfflur ☐ Sandwirbel ☐			
Holzabfall ☐ ☐ ☐				Strukturen gr. Tiefenvarianz ☐ natürl. Pools ☐ Kaskaden ☐ Wasserfall ☐			
Pflanzenabfall ☐ ☐ ☐				Fließshindernisse 1 Wassermoss ☐ Lückensyst. ☐ Rieselfflur ☐			
Erdaushub/ Bauschutt ☐ ☐ ☐				Anzahl Strukturen 1			
org. Reste/ Faulschlamm ☐ ☐ ☐							
Einleitungen unverdünnt ☐ Oberfläche / Strasse ☐							
Rohr trocken ☐ Drainage / Graben ☐							
Distanz zum Quellaustritt (m)							
Wert A : Beeinträchtigung (höchster Wert) 1				Wert B : Vegetation-Nutzung-Struktur 1.69			
Revitalisierungsobjekt (Einschätzung) JA / NEIN				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Gesamtergebnis [(A+B)/2]-b 1.34			
naturnah x blau				Quelle nicht bewertbar : Q. zerstört			
bedingt naturnah grün				Zutreffendes ankreuzen [x] kein Abfluss			
mässig beeinträchtigt gelb							
geschädigt orange							
stark geschädigt rot							

TG_Q2



TG_Q3



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q4	
Quelle: Q4		Datum : 27.09.24		Koordinaten (X/Y) : 714028 250980			
Flurname : Moosbach		Höhe ü.M. : 781		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen			
Austrittsform (Liste)		Quelle (Grösse [m²]) 10		Vernetzung Einzelquelle ☐ Q-system ☐ Q-komplex ☒			
Hanglage		Quellbereich [m²] 8		Dist. zur Nachbarquelle (m) 20 Anz. Austritte 2			
Abflussrichtung		Quellbachlänge [m] 10		Bemerkungen Nachbarquelle Q5. DO [%]: 79.5, pH: 7.16			
Geländeneignung		Wassertemperatur [°C] 11.8		Fotos und andere Dokumente ☒ ID TG_Q4_20240927.pdf			
Quellschüttung		Quellschüttung [l/s] 1.0		Trinkwassernutzung ☐ Schutzstatus ☐ Kulturhistorische Bedeutung ☐			
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm] 674					
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf ☐ alt ☐ verfallen ☐				standorttyp. Vegetation 1 1 1 1			
Rohr und Becken ☐ alt ☐ verfallen ☐				standortfremd. Vegetation ☐ ☐ ☐ ☐			
nur Rohr/Rinne ☐ alt ☒ verfallen ☐				Moosgesellschaften ☐ 1 1 1			
keine ☐				Zwergstrauchheiden ☐ ☐ ☐ ☐			
Wasserentnahme				Hochstaudenfluren ☐ ☐ ☐ ☐			
>60% ☐ 30-59% ☐ <30% / unbekannt ☐ keine ☒				Laubwald ☐ ☐ ☐ ☐			
Bemerkung / Zweck :				Mischwald 1 1 ☐ ☐			
Verlegung				Gebüsch ☐ ☐ ☐ ☐			
10-100m ☐ <10m ☐ unbekannt ☐				standorttyp. Nadelwald ☐ ☐ ☐ ☐			
alt ☐ ☐ 1				standortfremd. Nadelwald ☐ ☐ ☐ ☐			
neu ☐ ☐ keine ☐				extensivgenutz. Offenland ☐ ☐ ☐ ☐			
keine ☐				intensivgenutz. Offenland ☐ ☐ ☐ ☐			
Aufstau				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
nach <10m ☐ nach >=10-49m ☐ unbekannt ☐				unbefestigter Weg ☐ ☐ ☐ ☐			
Hauptschluss, 1-5 m2 ☐ ☐ ☐				befestigter Weg/Strasse ☐ ☐ ☐ ☐			
Hauptschluss, >5 m2 ☐ ☐ ☐				künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
Nebenschluss ☐ ☐ kein ☒							
künstlicher Absturz				unbeschattet schwach mittel stark			
Gesamtabfluss ☐ Teilabfluss ☐ nein ☒				Sommerbeschattung ☐ ☐ 1 ☐			
Verbau* (Ufer, Sohle)				stark & Überdachung oder Nadelforst ☐			
stark mittel gering				Struktur			
Holz ☐ ☐ ☐				Substrat			
Steinschüttung ☐ ☐ ☐				stark (>50%) mittel (>20%) gering (>1%)			
wilder Verbau ☐ ☐ ☐				->natürlich			
Naturstein ☐ ☐ ☐				Fels/Blöcke (>20 cm) ☐ ☐ ☐			
Beton ☐ ☐ ☐				(Kiesel) Steine (6-20 cm) ☐ ☐ 1			
Verrohrung ☐ ☐ ☐				Kies/Schotter (0.2-6 cm) ☐ ☐ 1			
kein ☒				Sand (0.1 - 2 mm) ☐ ☐ 1			
Unterhalt/Trittschäden				Feinmaterial (<0.1 mm) ☐ ☐ ☐			
gering mässig stark keine				Moospolster ☐ 1 ☐			
Ursache :				Wurzeln ☐ ☐ ☐			
Infrastruktur				Totholz ☐ 1 ☐			
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐				Pflanzen ☐ 1 ☐			
Wildfütterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges 1				Falllaub 1 ☐ ☐ ☐			
Anzahl Infr. 1 Sonstiges : Strasse oberhalb der Quelle ca. 20m enl				Detritus/Org.Schlamm ☐ ☐ ☐			
Ablagerung*				Kalksinter...* ☐ ☐ 1			
Deckungsgrad : vollständig teilweise vereinzelt				Anzahl Substrate 8 stark (>50%) mittel (>20%) gering (>1%)			
Haus-/ Gewerbemüll ☐ ☐ ☐				->verändert (nur Infos)			
Holzabfall ☐ ☐ ☐				Fadenalgen ☐ ☐ ☐			
Pflanzenabfall ☐ ☐ ☐				Strömungs-			
Erdaushub/ Bauschutt ☐ ☐ ☐				Spritzwasser ☐ glatt ☐ fliegend ☐ überfliegend 1			
org. Reste/ Faulschlamm ☐ ☐ ☐				diversität			
keine ☒				geripfelt ☐ plätschernd ☐ überstürzend ☐ fallend ☐			
Einleitungen				Anzahl Strömungen 1			
unverdünt ☐ Oberfläche / Strasse ☐				Wasser-Land-Verzahnung			
Rohr trocken ☐ Drainage / Graben ☐				gross ☐ mittel 1 gering ☐			
keine ☒				Besondere			
Distanz zum Quellaustritt (m)				Laufverzweigung ☐ Inselstruktur 1 Quellflur ☐ Sandwirbel ☐			
Wert A : Beeinträchtigung (höchster Wert) 3				Strukturen			
Revitalisierungsobjekt (Einschätzung) JA / NEIN				gr. Tiefenvarianz ☐ natürl. Pools ☐ Kaskaden ☐ Wasserfall ☐			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Fließshindernisse 1 Wassermooos ☐ Lückensyst. ☐ Rieselflur ☐			
naturnah				Anzahl Strukturen 2			
bedingt naturnah				Wert B : Vegetation-Nutzung-Struktur 1.81			
mässig beeinträchtigt				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
geschädigt				Gesamtergebnis ((A+B)/2)-b 2.41			
stark geschädigt				Quelle nicht bewertbar : ☐ Q. zerstört			
				Zutreffendes ankreuzen [x] ☐ kein Abfluss			

TG_Q4



Quellen Protokoll - Struktur

Kanton : TG

ID : TG_Q5

Quelle: Q5

Datum : 27.09.24

Koordinaten (X/Y) : 714044 251017

Flurname : Moosbach

Höhe ü.M. : 783

BearbeiterIn (leg) : Elena Santi

KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) ! Ausfüllen oder zutreffendes ankreuzen ☒

Austrittsform (Liste)	Sickerquelle	Quelle (Grösse [m ²])	10	Vernetzung	Einzelquelle ☐	Q-system ☐	Q-komplex ☒
Hanglage	Mittelhang	Quellbereich [m ²]	10	Dist. zur Nachbarquelle (m)	20	Anz. Austritte	2
Abflussrichtung	SO	Quellbachlänge [m]	10	Bemerkungen	Nachbarquelle Q4. DO[%]: 85.4, pH: 7.66.		
Geländeneignung	mässig	Wassertemperatur [°C]	11.6	Fotos und andere Dokumente	1	ID	TG_Q5_20240927.pdf
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Trinkwassernutzung	☐	Schutzstatus	☐
mittl. Fliessgesch.	langsam	Leitfähigkeit [µS20/cm]	364	Kulturhistorische Bedeutung	☐		

Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren **1** **Bewertung Teil B : Vegetation-Nutzung-Struktur** Zutreffendes mit "1" markieren **1**

Einträge/Verbau	neu	alt	verfallen
Fassung			
Brunnenstube mit Überlauf	☐	☐	☐
Rohr und Becken	☐	☐	☐
nur Rohr/Rinne	☐	☐	☐
	keine 1		
Wasserentnahme	>60%	30-59%	<30% / unbekannt
	☐	☐	☐
Bemerkung / Zweck :			
Verlegung	10-100m	<10m	unbekannt
	☐	☐	☐
alt	☐	☐	☐
neu	☐	☐	☐
	keine 1		
Aufstau	nach <10m	nach >=10-49m	unbekannt
	☐	☐	☐
Hauptschluss, 1-5 m2	☐	☐	☐
Hauptschluss, >5 m2	☐	☐	☐
Nebenschluss	☐	☐	☐
	kein 1		
künstlicher Absturz	Gesamtabfluss	Teilabfluss	nein
	☐	☐	☐
Verbau* (Ufer, Sohle)	stark	mittel	gering
	☐	☐	☐
Holz	☐	☐	☐
Steinschüttung	☐	☐	☐
wilder Verbau	☐	☐	☐
Naturstein	☐	☐	☐
Beton	☐	☐	☐
Verrohrung	☐	☐	☐
	kein 1		
Unterhalt/Trittschäden	gering	mässig	stark
	☐	☐	☐
Ursache :			
Infrastruktur	Bänke / Parkplatz	Zuwegung	Trittsteine
	☐	☐	☐
Wildfutterstelle	Viehtränke	Feuerstelle	Sonstiges
	☐	☐	☐
Anzahl Infr.	1	Sonstiges : Strasse ca. 20-30m oberhalb der Quelle	
Ablagerung*	Deckungsgrad :	vollständig	teilweise
	☐	☐	☐
Haus-/ Gewerbemüll	☐	☐	☐
Holzabfall	☐	☐	☐
Pflanzenabfall	☐	☐	☐
Erdaushub/ Bauschutt	☐	☐	☐
org. Reste/ Faulschlamm	☐	☐	☐
	keine 1		
Einleitungen	unverdünt	Oberfläche / Strasse	
	☐	☐	☐
Rohr trocken	☐	Drainage / Graben	
	☐	☐	☐
	keine 1		
Distanz zum Quellaustritt (m)			

Vegetation/Nutzung	Einzugsgebiet	Umfeld	Quellbereich	Quellufer	Quellbach
	☐	☐	☐	☐	☐
standorttyp. Vegetation	☐	☐	☐	☐	☐
standortfrem. Vegetation	☐	☐	☐	☐	☐
Moosgesellschaften	☐	☐	☐	☐	☐
Zwergstrauchheiden	☐	☐	☐	☐	☐
Hochstaudenfluren	☐	☐	☐	☐	☐
Laubwald	☐	☐	☐	☐	☐
Mischwald	☐	☐	☐	☐	☐
Gebüsch	☐	☐	☐	☐	☐
standorttyp. Nadelwald	☐	☐	☐	☐	☐
standortfremd. Nadelwald	☐	☐	☐	☐	☐
extensivgenutz. Offenland	☐	☐	☐	☐	☐
intensivgenutz. Offenland	☐	☐	☐	☐	☐
Acker/ Sonderkultur	☐	☐	☐	☐	☐
unbefestigter Weg	☐	☐	☐	☐	☐
befestigter Weg/Strasse	☐	☐	☐	☐	☐
künstl. veg.-frei/Siedlung	☐	☐	☐	☐	☐
Sommerbeschattung	unbeschattet	schwach	mittel	stark	
	☐	☐	☐	☐	☐
	stark & Überdachung oder Nadelforst				☐
Struktur					
Substrat	stark (>50%)	mittel (>20%)	gering (>1%)		
->natürlich	☐	☐	☐	☐	
Fels/Blöcke (>20 cm)	☐	☐	☐	☐	
(Kiesel) Steine (6-20 cm)	☐	☐	☐	☐	
Kies/Schotter (0.2-6 cm)	☐	☐	☐	☐	
Sand (0.1 - 2 mm)	☐	☐	☐	☐	
Feinmaterial (<0.1 mm)	☐	☐	☐	☐	
Moospolster	☐	☐	☐	☐	
Wurzeln	☐	☐	☐	☐	
Totholz	☐	☐	☐	☐	
Pflanzen	☐	☐	☐	☐	
Fallaub	☐	☐	☐	☐	
Detritus/Org.Schlamm	☐	☐	☐	☐	
Kalksinter...*	☐	☐	☐	☐	
Anzahl Substrate	7	stark (>50%)	mittel (>20%)	gering (>1%)	
	☐	☐	☐	☐	☐
künstlich	☐	☐	☐	☐	
->verändert (nur Infos)	☐	☐	☐	☐	
Strömungsdiversität	Spritzwasser	glatt	fließend	überfließend	1
	☐	☐	☐	☐	☐
gerippt	☐	plätschernd	überstürzend	fallend	☐
	☐	☐	☐	☐	☐
Anzahl Strömungen	1				
Wasser-Land-Verzahnung	gross	mittel	1	gering	
	☐	☐	☐	☐	☐
Besondere Strukturen	Laufverzweigung	Inselstruktur	Quellflur	Sandwirbel	
	☐	☐	☐	☐	☐
gr. Tiefenvarianz	☐	natürl. Pools	Kaskaden	Wasserfall	
	☐	☐	☐	☐	☐
Fliesshindernisse	☐	Wassermooos	Lückensyst.	Rieselflur	
	☐	☐	☐	☐	☐
Anzahl Strukturen	2				

Wert A : Beeinträchtigung (höchster Wert)	2	Wert B : Vegetation-Nutzung-Struktur	1.81
Revitalisierungsobjekt (Einschätzung)	☐	Bonus b -0,4 Punkte bei guter Struktur ->	Aufwertung -
Klassierung / Classement :	Gesamteindruck als Bewertungsvergleich	Bewertung / Evaluation	Gesamtergebnis [(A+B)/2]-b
naturnah	☐	☐	1.91
bedingt naturnah	☐	☐	
mässig beeinträchtigt	☐	☐	
geschädigt	☐	☐	
stark geschädigt	☐	☐	
Quelle nicht bewertbar :	☐	Quelle zerstört	☐
Zutreffendes ankreuzen [x]	☐	kein Abfluss	☐

TG_Q5



TG_Q6



Quellen Protokoll - Struktur

Kanton : TG

ID : TG_Q7

Quelle: Q7

Datum : 10.10.24

Koordinaten (X/Y) : 714324 251801

Flurname : Moosbach

Höhe ü. M. : 722

BearbeiterIn (leg) : Elena Santi

KOPFDATEN

(nicht bewertet, nur Infos)

! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !

Ausfüllen oder zutreffendes ankreuzen

x

Austrittsform (Liste)

künstlich

Quelle (Grösse [m²])

10

Vernetzung

Einzelquelle

x

Q-system

Q-komplex

Hanglage

Mittelhang

Quellbereich [m²]

10

Dist. zur Nachbarquelle (m)

100

Anz. Austritte

Abflussrichtung

NW

Quellbachlänge [m]

10

Bemerkungen

DO [%]: 89.8, pH: 8.18.

Geländeneignung

schroff

Wassertemperatur [°C]

11.3

Fotos und andere Dokumente

x

ID

TG_Q7_20241010.pdf

Quellschüttung

ganzjährig

Quellschüttung [l/s]

1.0

Trinkwassernutzung

Schutzstatus

Kulturhistorische Bedeutung

mittl. Fliessgesch.

langsam

Leitfähigkeit [µS20/cm]

549

Bewertung Teil A : Beeinträchtigung

Zutreffendes mit "1" markieren

1

Bewertung Teil B : Vegetation-Nutzung-Struktur

Zutreffendes mit "1" markieren

1

Einträge/Verbau

Fassung

neu

alt

verfallen

Brunnenstube mit Überlauf

Rohr und Becken

nur Rohr/Rinne

1

keine

Wasserentnahme

>60%

30-59%

<30% / unbekannt

keine

1

Bemerkung / Zweck :

Verlegung

10-100m

<10m

unbekannt

alt

1

neu

keine

Aufstau

nach <10m

nach >=10-49m

unbekannt

Hauptschluss, 1-5 m2

Hauptschluss, >5 m2

Nebenschluss

kein

1

künstlicher Absturz

Gesamtabfluss

Teilabfluss

nein

1

Verbau* (Ufer, Sohle)

stark

mittel

gering

Holz

Steinschüttung

wilder Verbau

Naturstein

Beton

Verrohrung

kein

1

Unterhalt/Trittschäden

gering

mässig

stark

keine

Ursache :

Infrastruktur

Bänke / Parkplatz

Zuwegung

1

Trittsteine

Überdachung

Wildfütterstelle

Viehtränke

Feuerstelle

Sonstiges

Anzahl Infr.

1

Sonstiges :

Ablagerung*

Deckungsgrad :

vollständig

teilweise

vereinzelt

Haus-/ Gewerbemüll

Holzabfall

Pflanzenabfall

Erdaushub/ Bauschutt

org. Reste/ Faulschlamm

keine

1

Einleitungen

unverdünt

Oberfläche / Strasse

Rohr trocken

Drainage / Graben

keine

1

Distanz zum Quellaustritt (m)

Vegetation/Nutzung

Einzugsgebiet

Umfeld

Quellbereich

Quellufer

Quellbach

standorttyp. Vegetation

1

1

1

standortfrem. Vegetation

Moosgesellschaften

1

1

1

Zwergstrauchheiden

Hochstaudenfluren

Laubwald

Mischwald

1

1

1

Gebüsch

standorttyp. Nadelwald

standortfremd. Nadelwald

extensivgenutz. Offenland

intensivgenutz. Offenland

Acker/ Sonderkultur

unbefestigter Weg

befestigter Weg/Strasse

1

1

künstl. veg.-frei/Siedlung

Sommerbeschattung

unbeschattet

schwach

mittel

stark

1

stark & Überdachung oder Nadelforst

Struktur

Substrat

stark (>50%)

mittel (>20%)

gering (>1%)

->natürlich

Fels/Blöcke (>20 cm)

(Kiesel) Steine (6-20 cm)

1

Kies/Schotter (0.2-6 cm)

1

Sand (0.1 - 2 mm)

Feinmaterial (<0.1 mm)

Moospolster

1

Wurzeln

1

Totholz

1

Pflanzen

1

Fallaub

1

Detritus/Org.Schlamm

Kalksinter...*

Anzahl Substrate

7

stark (>50%)

mittel (>20%)

gering (>1%)

künstlich

1

->verändert (nur Infos)

Fadenalgen

Strömungs-

Spritzwasser

glatt

fliegend

1

überfliegend

diversität

geripfelt

plätschernd

überstürzend

fallend

1

Anzahl Strömungen

2

Wasser-Land-Verzahnung

gross

mittel

gering

1

Besondere

Laufverzweigung

Inselstruktur

Quellflur

Sandwirbel

Strukturen

gr. Tiefenvarianz

natürl. Pools

Kaskaden

Wasserfall

Fliesshindernisse

1

Wassermoos

Lückensyst.

Rieselflur

Anzahl Strukturen

1

Wert A : Beeinträchtigung (höchster Wert)

4

Revitalisierungsobjekt (Einschätzung)

JA / NEIN

Klassierung / Classement :

Gesamteindruck als Bewertungsvergleich

naturnah

bedingt naturnah

mässig beeinträchtigt

geschädigt

stark geschädigt

blau

grün

gelb

orange

rot

Wert B : Vegetation-Nutzung-Struktur

2.40

Bonus b -0,4 Punkte bei guter Struktur ->

Aufwertung -

0

Gesamtergebnis [(A+B)/2]-b

3.20

Quelle nicht bewertbar :

Q. zerstört

Zutreffendes ankreuzen [x]

kein Abfluss

TG_Q7



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q8	
Quelle: Q8		Datum : 10.10.24		Koordinaten (X/Y) : 714232 251796			
Flurname : Moosbach		Höhe ü. M. : 695		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) ! Ausfüllen oder zutreffendes ankreuzen ☒							
Austrittsform (Liste)	Sickerquelle	Quelle (Grösse [m ²])	10	Vernetzung	Einzelquelle ☐ Q-system ☒ Q-komplex ☐		
Hanglage	Mittelhang	Quellbereich [m ²]	3	Dist. zur Nachbarquelle (m)	40 Anz. Austritte 2		
Abflussrichtung	N	Quellbachlänge [m]	10	Bemerkungen	Nachbarquelle Q9. kein Abfluss. 2 Quellaustritte fliessen nach 10m zusammen.		
Geländeneignung	mässig	Wassertemperatur [°C]		Fotos und andere Dokumente	1 ID TG_Q8_20241010.pdf		
Quellschüttung	ganzjährig	Quellschüttung [l/s]		Trinkwassernutzung	☐ Schutzstatus ☐ Kulturhistorische Bedeutung ☐		
mittl. Fliessgesch.	stehend	Leitfähigkeit [µS20/cm]					
Bewertung Teil A : Beeinträchtigung			Zutreffendes mit "1" markieren 1	Bewertung Teil B : Vegetation-Nutzung-Struktur			
Zutreffendes mit "1" markieren 1			Zutreffendes mit "1" markieren 1				
Einträge/Verbau			Vegetation/Nutzung				
Fassung			Einzugsgebiet Umfeld Quellbereich Quellaufer Quellbach				
Brunnerstube mit Überlauf ☐ neu ☐ alt ☐ verfallen ☐			standorttyp. Vegetation 1 1 1				
Rohr und Becken ☐			standortfrem. Vegetation ☐				
nur Rohr/Rinne ☐			Moosgesellschaften ☐				
keine 1			Zwergstrauchheiden ☐				
Wasserentnahme			Hochstaudenfluren ☐				
>60% ☐ 30-59% ☐ <30% / unbekannt ☐ keine 1			Laubwald ☐				
Bemerkung / Zweck :			Mischwald 1 1 1				
Verlegung			Gebüsch ☐				
10-100m ☐ <10m ☐ unbekannt ☐			standorttyp. Nadelwald ☐				
alt ☐ neu ☐			standortfremd. Nadelwald ☐				
keine 1			extensivgenutz. Offenland ☐				
Aufstau			intensivgenutz. Offenland ☐				
nach <10m ☐ nach >=10-49m ☐ unbekannt ☐			Acker/ Sonderkultur ☐				
Hauptschluss, 1-5 m2 ☐			unbefestigter Weg ☐				
Hauptschluss, >5 m2 ☐			befestigter Weg/Strasse ☐				
Nebenschluss ☐			künstl. veg.-frei/Siedlung ☐				
kein 1							
künstlicher Absturz			unbeschattet schwach mittel stark				
Gesamtabfluss ☐ Teilabfluss ☐ nein 1			Sommerbeschattung ☐				
Verbau* (Ufer, Sohle)			stark & Überdachung oder Nadelforst ☐				
stark ☐ mittel ☐ gering ☐			Struktur				
Holz ☐			Substrat				
Steinschüttung ☐			stark (>50%) mittel (>20%) gering (>1%)				
wilder Verbau ☐			->natürlich				
Naturstein ☐			Fels/Blöcke (>20 cm) ☐				
Beton ☐			(Kiesel) Steine (6-20 cm) ☐				
Verrohrung ☐			Kies/Schotter (0.2-6 cm) ☐				
kein 1			Sand (0.1 - 2 mm) ☐				
Unterhalt/Trittschäden			Feinmaterial (<0.1 mm) ☐				
gering ☐ mässig ☐ stark ☐ keine 1			Moospolster ☐				
Ursache :			Wurzeln ☐				
Infrastruktur			Totholz ☐				
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐			Pflanzen ☐				
Wildfutterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges ☐			Falllaub 1 ☐				
Anzahl Infr. 0 Sonstiges :			Detritus/Org.Schlamm ☐				
Ablagerung*			Kalksinter...* ☐				
Deckungsgrad : vollständig teilweise vereinzelt			Anzahl Substrate 7				
Haus-/ Gewerbemüll ☐			stark (>50%) mittel (>20%) gering (>1%)				
Holzabfall ☐			künstlich ☐				
Pflanzenabfall ☐			->verändert (nur Infos) Fadenalgen ☐				
Erdaushub/ Bauschutt ☐			Strömungs-				
org. Reste/ Faulschlamm ☐			Spritzwasser ☐ glatt ☐ fließend ☐ überfließend 1				
keine 1			diversität				
Einleitungen			gerippt ☐ plätschernd ☐ überstürzend ☐ fallend ☐				
unverdünt ☐ Oberfläche / Strasse ☐			Anzahl Strömungen 1				
Rohr trocken ☐ Drainage / Graben ☐			Wasser-Land-Verzahnung				
keine 1			gross ☐ mittel 1 ☐ gering ☐				
Distanz zum Quellaustritt (m)			Besondere				
			Laufverzweigung ☐ Inselstruktur ☐ Quelfflur ☐ Sandwirbel ☐				
Wert A : Beeinträchtigung (höchster Wert) 1			Strukturen				
Revitalisierungsobjekt (Einschätzung) JA / NEIN			gr. Tiefenvarianz ☐ natürl. Pools 1 ☐ Kaskaden ☐ Wasserfall ☐				
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich			Fließhindernisse 1 ☐ Wassermooos ☐ Lückensyst. ☐ Rieselflur ☐				
naturnah ☐			Anzahl Strukturen 2				
bedingt naturnah ☐			Bewertung / Evaluation				
mässig beeinträchtigt ☐			X 0.6 - 1.8 ☐				
geschädigt ☐			1.81 - 2.6 ☐				
stark geschädigt ☐			2.61 - 3.4 ☐				
			3.41 - 4.2 ☐				
			4.21 - 5.0 ☐				
			Gesamtergebnis [(A+B)/2]-b 1.44				
			Quelle nicht bewertbar : ☐ Q. zerstört				
			Zutreffendes ankreuzen [x] ☒ kein Abfluss				

AQ/ps_ver_20180315

TG_Q8



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q9	
Quelle: Q9		Datum : 10.10.24		Koordinaten (X/Y) : 714233 251755			
Flurname : Moosbach		Höhe ü.M. : 699		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)	Sickerquelle	Quelle (Grösse [m²])	10	Vernetzung	Einzelquelle ☐	Q-system ☒	Q-komplex ☐
Hanglage	Mittelhang	Quellbereich [m²]	5	Dist. zur Nachbarquelle (m)	40	Anz. Austritte	
Abflussrichtung	N	Quellbachlänge [m]	20	Bemerkungen Nachbarquelle Q8. Sehr schlammiges Wasser. DO [%]: 63.5, pH: 7.56.			
Geländeneignung	mässig	Wassertemperatur [°C]	11.4				
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Fotos und andere Dokumente	1	ID	TG_Q9_20241010.pdf
mittl. Fliessgesch.	stehend	Leitfähigkeit [µS20/cm]	547	Trinkwassernutzung	☐	Schutzstatus	☐
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet			
Brunnerstube mit Überlauf				Umfeld			
Rohr und Becken				Quellbereich			
nur Rohr/Rinne				Quellufer			
keine				Quellbach			
Wasserentnahme				standorttyp. Vegetation			
>60%				standorfrem. Vegetation			
30-59%				Moosgesellschaften			
<30% / unbekannt				Zwergstrauchheiden			
keine				Hochstaudenfluren			
Bemerkung / Zweck :				Laubwald			
Verlegung				Mischwald			
10-100m				Gebüsch			
<10m				standorttyp. Nadelwald			
unbekannt				standortfremd. Nadelwald			
alt				extensivgenutz. Offenland			
neu				intensivgenutz. Offenland			
keine				Acker/ Sonderkultur			
Aufstau				unbefestigter Weg			
nach <10m				befestigter Weg/Strasse			
nach >=10-49m				künstl. veg.-frei/Siedlung			
unbekannt							
Hauptschluss, 1-5 m2							
Hauptschluss, >5 m2							
Nebenschluss							
kein							
künstlicher Absturz							
Gesamtabfluss							
Teilabfluss							
nein							
Verbau* (Ufer, Sohle)							
stark							
mittel							
gering							
Holz							
Steinschüttung							
wilder Verbau							
Naturstein							
Beton							
Verrohrung							
kein							
Unterhalt/Trittschäden							
gering							
mässig							
stark							
keine							
Ursache :							
Infrastruktur							
Bänke / Parkplatz							
Zuwegung							
Trittsteine							
Überdachung							
Wildfütterstelle							
Viehtränke							
Feuerstelle							
Sonstiges							
Anzahl Infr. 0							
Sonstiges :							
Ablagerung*							
Deckungsgrad :							
vollständig							
teilweise							
vereinzelt							
Haus-/ Gewerbemüll							
Holzabfall							
Pflanzenabfall							
Erdaushub/ Bauschutt							
org. Reste/ Faulschlamm							
keine							
Einleitungen							
unverdünt							
Oberfläche / Strasse							
Rohr trocken							
Drainage / Graben							
keine							
Distanz zum Quellaustritt (m)							
Wert A : Beeinträchtigung (höchster Wert)				Wert B : Vegetation-Nutzung-Struktur			
1				1.78			
Revitalisierungsobjekt (Einschätzung)				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung -			
JA / NEIN				0			
Klassierung / Classement :				Gesamtergebnis [(A+B)/2]-b			
Gesamteindruck als Bewertungsvergleich				1.39			
naturnah				Quelle nicht bewertbar :			
bedingt naturnah				Q. zerstört			
mässig beeinträchtigt				Zutreffendes ankreuzen [x]			
geschädigt				kein Abfluss			
stark geschädigt							
Bewertung / Evaluation							
x 0.6 - 1.8							
1.81 - 2.6							
2.61 - 3.4							
3.41 - 4.2							
4.21 - 5.0							

TG_Q9



Quellen Protokoll - Struktur

Kanton : TG

ID : TG_Q10

Quelle: Q10

Datum : 10.10.24

Koordinaten (X/Y) : 713863

251341

Flurname : Moosbach

Höhe ü.M. : 755

BearbeiterIn (leg) : Elena Santi

KOPFDATEN

(nicht bewertet, nur Infos)

! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !

Ausfüllen oder zutreffendes ankreuzen

x

Austrittsform (Liste)	künstlich	Quelle (Grösse [m ²])	9	Vernetzung	Einzelquelle	☒	Q-system	☐	Q-komplex	☐	
Hanglage	Mittelhang	Quellbereich [m ²]	9	Dist. zur Nachbarquelle (m)	65	Anz. Austritte					
Abflussrichtung	O	Quellbachlänge [m]	-	Bemerkungen	Quelle gefasst - Grösse schwer abschätzbar. DO [%]: 88.6, pH: 7.5.						
Geländeneignung	mässig	Wassertemperatur [°C]	11.5	Fotos und andere Dokumente	☒	ID	TG_Q10_20241010.pdf				
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Trinkwassernutzung	☐	Schutzstatus	☐	Kulturhistorische Bedeutung		☐	
mittl. Fliessgesch.	schnell	Leitfähigkeit [µS20/cm]	627								

Bewertung Teil A : Beeinträchtigung

Zutreffendes mit "1" markieren

1

Bewertung Teil B : Vegetation-Nutzung-Struktur

Zutreffendes mit "1" markieren

1

Einträge/Verbau

Fassung	neu	alt	verfallen
Brunnenstube mit Überlauf	☐	☐	☐
Rohr und Becken	☐	☒	☐
nur Rohr/Rinne	☐	☐	☐
	keine ☐		

Wasserentnahme	>60%	30-59%	<30% / unbekannt	keine
	☐	☐	☒	☐
Bemerkung / Zweck :				

Verlegung	10-100m	<10m	unbekannt
alt	☐	☐	☒
neu	☐	☐	☐
	keine ☐		

Aufstau	nach <10m	nach >=10-49m	unbekannt
Hauptschluss, 1-5 m2	☐	☐	☐
Hauptschluss, >5 m2	☐	☐	☐
Nebenschluss	☐	☐	☐
	kein ☒		

künstlicher Absturz	Gesamtabfluss	Teilabfluss	nein
	☐	☐	☒

Verbau* (Ufer, Sohle)	stark	mittel	gering
Holz	☐	☐	☐
Steinschüttung	☐	☐	☐
wilder Verbau	☐	☐	☐
Naturstein	☐	☐	☐
Beton	☒	☐	☐
Verrohrung	☐	☐	☐
	kein ☐		

Unterhalt/Trittschäden	gering	mässig	stark	keine
	☐	☐	☒	☐
Ursache :	Liegt auf Kuhweide			

Infrastruktur

Bänke / Parkplatz	☐	Zuwegung	☐	Trittsteine	☐	Überdachung	☐
Wildfutterstelle	☐	Viehtränke	☒	Feuerstelle	☐	Sonstiges	☐
Anzahl Infr.	1	Sonstiges :					

Ablagerung*	Deckungsgrad :	vollständig	teilweise	vereinzelt
Haus-/ Gewerbemüll	☐	☐	☐	☐
Holzabfall	☐	☐	☐	☒
Pflanzenabfall	☐	☐	☐	☐
Erdaushub/ Bauschutt	☐	☐	☐	☐
org. Reste/ Faulschlamm	☐	☐	☐	☐
	keine ☐			

Einleitungen

unverdünt	☐	Oberfläche / Strasse	☐
Rohr trocken	☐	Drainage / Graben	☐
			keine ☒
Distanz zum Quellaustritt (m)			

Vegetation/Nutzung

	Einzugsgebiet	Umfeld	Quellbereich	Quellufer	Quellbach
standorttyp. Vegetation	☒	☐	☒	☒	☒
standortfrem. Vegetation	☐	☐	☐	☐	☐
Moosgesellschaften	☒	☐	☒	☐	☐
Zwergstrauchheiden	☐	☐	☐	☐	☐
Hochstaudenfluren	☐	☐	☐	☐	☐
Laubwald	☐	☐	☐	☐	☐
Mischwald	☐	☐	☐	☐	☐
Gebüsch	☐	☐	☐	☐	☐
standorttyp. Nadelwald	☐	☐	☐	☐	☐
standortfremd. Nadelwald	☐	☐	☐	☐	☐
extensivgenutz. Offenland	☒	☒	☒	☒	☒
intensivgenutz. Offenland	☐	☐	☐	☐	☐
Acker/ Sonderkultur	☐	☐	☐	☐	☐
unbefestigter Weg	☐	☐	☐	☐	☐
befestigter Weg/Strasse	☒	☐	☐	☐	☐
künstl. veg.-frei/Siedlung	☐	☐	☐	☐	☐

	unbeschattet	schwach	mittel	stark
Sommerbeschattung	☒	☐	☐	☐
	stark & Überdachung oder Nadelforst ☐			

Struktur

Substrat	stark (>50%)	mittel (>20%)	gering (>1%)	
->natürlich	Fels/Blöcke (>20 cm)	☐	☐	☐
	(Kiesel) Steine (6-20 cm)	☐	☐	☐
	Kies/Schotter (0.2-6 cm)	☐	☐	☐
	Sand (0.1 - 2 mm)	☐	☐	☐
	Feinmaterial (<0.1 mm)	☐	☐	☐
	Moospolster	☐	☒	☐
	Wurzeln	☐	☐	☐
	Totholz	☐	☐	☐
	Pflanzen	☐	☐	☒
	Fallaub	☐	☐	☐
	Detritus/Org.Schlamm	☐	☐	☐
	Kalksinter...*	☐	☐	☐
Anzahl Substrate	2	stark (>50%)	mittel (>20%)	gering (>1%)
	künstlich	☒	☐	☐
->verändert (nur Infos)	Fadenalgen	☐	☐	☐

Strömungsdiversität	Spritzwasser	☐	glatt	☐	fließend	☐	überfließend	☐
	gerippt	☐	plätschernd	☒	überstürzend	☒	fallend	☒
Anzahl Strömungen	3							

Wasser-Land-Verzahnung

	gross	☐	mittel	☐	gering	☒		
Besondere Strukturen	Laufverzweigung	☐	Inselstruktur	☐	Quellflur	☐	Sandwirbel	☐
	gr. Tiefenvarianz	☐	natürl. Pools	☐	Kaskaden	☐	Wasserfall	☐
	Fliesshindernisse	☐	Wassermooos	☐	Lückensyst.	☐	Rieselflur	☐
Anzahl Strukturen	0							

Wert A : Beeinträchtigung (höchster Wert)

5

Revitalisierungsobjekt (Einschätzung)

JA / NEIN

Klassierung / Classement :

Gesamteindruck als Bewertungsvergleich

naturnah

bedingt naturnah

mässig beeinträchtigt

geschädigt

stark geschädigt

blau

grün

gelb

orange

rot

x

Bewertung / Evaluation

	0.6 - 1.8	☐
	1.81 - 2.6	☐
	2.61 - 3.4	☐
x	3.41 - 4.2	☒
	4.21 - 5.0	☐

Wert B : Vegetation-Nutzung-Struktur

3.27

Bonus b -0,4 Punkte bei guter Struktur ->

Aufwertung -

0

Gesamtergebnis [(A+B)/2]-b

4.13

Quelle nicht bewertbar :

Q. zerstört

Zutreffendes ankreuzen [x]

kein Abfluss

TG_Q10



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q11	
Quelle: Q11		Datum : 10.10.24		Koordinaten (X/Y) : 713202 250773			
Flurname : Moosbach		Höhe ü.M. : 854		BearbeiterIn (leg) : Elena Sant			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)	künstlich	Quelle (Grösse [m²])	2	Vernetzung	Einzelquelle ☒ Q-system ☐ Q-komplex ☐		
Hanglage	Mittelhang	Quellbereich [m²]	2	Dist. zur Nachbarquelle (m)	Anz. Austritte		
Abflussrichtung	O	Quellbachlänge [m]	-	Bemerkungen	Quelle gefasst - Grösse schwer abschätzbar. DO [%]: 87.5, pH: 8.08.		
Geländeneignung	mässig	Wassertemperatur [°C]	13.9	Fotos und andere Dokumente	☒ ID TG_Q11_20241010.pdf		
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Trinkwassernutzung	☐ Schutzstatus ☐ Kulturhistorische Bedeutung ☐		
mittl. Fliessgesch.	langsam	Leitfähigkeit [µS20/cm]	502				
Bewertung Teil A : Beeinträchtigung		Zutreffendes mit "1" markieren		Bewertung Teil B : Vegetation-Nutzung-Struktur			
Einträge/Verbau				Zutreffendes mit "1" markieren			
Fassung		neue alt verfallen		Vegetation/Nutzung			
Brunnenstube mit Überlauf		☐ ☐ ☐		Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Rohr und Becken		☐ 1 ☐		standorttyp. Vegetation 1 1 ☐ ☐			
nur Rohr/Rinne		☐ ☐ keine ☐		standortfremd. Vegetation ☐ ☐ ☐ ☐			
Wasserentnahme		>60% 30-59% <30% / unbekannt keine		Moosgesellschaften ☐ ☐ ☐ ☐			
Bemerkung / Zweck :		☐ ☐ 1 ☐		Zwergstrauchheiden ☐ ☐ ☐ ☐			
Verlegung		10-100m <10m unbekannt		Hochstaudenfluren ☐ ☐ ☐ ☐			
alt		☐ ☐ 1 ☐		Laubwald ☐ ☐ ☐ ☐			
neu		☐ ☐ keine ☐		Mischwald ☐ ☐ ☐ ☐			
Aufstau		nach <10m nach >=10-49m unbekannt		Gebüsch ☐ ☐ ☐ ☐			
Hauptschluss, 1-5 m2		1 ☐ ☐ ☐		standorttyp. Nadelwald ☐ ☐ ☐ ☐			
Hauptschluss, >5 m2		☐ ☐ ☐		standortfremd. Nadelwald ☐ ☐ ☐ ☐			
Nebenschluss		☐ ☐ ☐ kein ☐		extensivgenutz. Offenland 1 1 1 1			
künstlicher Absturz		Gesamtabfluss Teilabfluss nein		intensivgenutz. Offenland ☐ ☐ ☐ ☐			
1 ☐ ☐ ☐				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
Verbau* (Ufer, Sohle)		stark mittel gering		unbefestigter Weg ☐ ☐ ☐ ☐			
Holz		☐ ☐ ☐		befestigter Weg/Strasse 1 1 1 1			
Steinschüttung		☐ ☐ ☐		künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
wilder Verbau		☐ ☐ ☐					
Naturstein		☐ ☐ ☐		unbeschattet schwach mittel stark			
Beton		1 ☐ ☐		Sommerbeschattung 1 ☐ ☐ ☐			
Verrohrung		☐ ☐ ☐ kein ☐		stark & Überdachung oder Nadelforst ☐			
Unterhalt/Trittschäden		gering mässig stark keine		Struktur			
Ursache :		☐ ☐ ☐ 1 ☐		Substrat			
Infrastruktur				stark (>50%) mittel (>20%) gering (>1%)			
Bänke / Parkplatz 1 Zuwegung Trittsteine Überdachung				->natürlich Fels/Blöcke (>20 cm) ☐ ☐ ☐			
Wildfütterstelle Viehtränke Feuerstelle Sonstiges 1				(Kiesel) Steine (6-20 cm) ☐ ☐ ☐			
Anzahl Infr. 2 Sonstiges : Strasse				Kies/Schotter (0.2-6 cm) ☐ ☐ ☐			
Ablagerung*		Deckungsgrad : vollständig teilweise vereinzelt		Sand (0.1 - 2 mm) ☐ ☐ ☐			
Haus-/ Gewerbemüll		☐ ☐ ☐		Feinmaterial (<0.1 mm) ☐ ☐ ☐			
Holzabfall		☐ ☐ ☐		Moospolster ☐ ☐ 1 ☐			
Pflanzenabfall		☐ ☐ ☐		Wurzeln ☐ ☐ ☐			
Erdaushub/ Bauschutt		☐ ☐ ☐		Totholz ☐ ☐ ☐			
org. Reste/ Faulschlamm		☐ ☐ ☐ keine 1 ☐		Pflanzen ☐ ☐ ☐			
Einleitungen		unverdünt Oberfläche / Strasse		Falllaub ☐ ☐ ☐			
Rohr trocken Drainage / Graben		☐ ☐ keine 1 ☐		Detritus/Org.Schlamm ☐ ☐ ☐ 1 ☐			
Distanz zum Quellaustritt (m)				Kalksinter...* ☐ ☐ ☐			
Wert A : Beeinträchtigung (höchster Wert)		5		Anzahl Substrate 2 stark (>50%) mittel (>20%) gering (>1%)			
Revitalisierungsobjekt (Einschätzung)		JA / NEIN		künstlich 1 ☐ ☐ ☐			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				->verändert (nur Infos) Fadenalgen ☐ ☐ ☐			
naturnah				Strömungsdiversität Spritzwasser glatt fliegend überfliegend			
bedingt naturnah				geripfelt 1 plätschernd überstürzend fallend 1			
mässig beeinträchtigt				Anzahl Strömungen 2			
geschädigt				Wasser-Land-Verzahnung gross mittel gering 1			
stark geschädigt		x		Besondere Laufverzweigung Inselstruktur Quelflur Sandwirbel			
				Strukturen gr. Tiefenvarianz natürl. Pools Kaskaden Wasserfall			
				Fließshindernisse Wassermooos Lückensyst. Rieselflur			
				Anzahl Strukturen 0			
				Wert B : Vegetation-Nutzung-Struktur 3.97			
				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
				Gesamtergebnis ((A+B)/2)-b 4.48			
				Quelle nicht bewertbar : Q. zerstört			
				Zutreffendes ankreuzen [x] kein Abfluss			

TG_Q11



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q12	
Quelle: Q12		Datum : 10.10.24		Koordinaten (X/Y) : 713179 250831			
Flurname : Moosbach		Höhe ü.M. : 844		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²]) 15		Vernetzung Einzelquelle ☒ Q-system ☐ Q-komplex ☐			
Hanglage Mittelhang		Quellbereich [m²] 15		Dist. zur Nachbarquelle (m) 62		Anz. Austritte	
Abflussrichtung NO		Quellbachlänge [m] 10		Bemerkungen Ev. mit Q11 (65m) Q13 (140m) & Q14 (400m) vernetzt. Verrohrung unter Strasse hindurch bis in Wald. DO[%]: 88.4, pH: 7.73.			
Geländeneignung schroff		Wassertemperatur [°C] 12.2					
Quellschüttung ganzjährig		Quellschüttung [l/s] 1.0		Fotos und andere Dokumente ☒ ID TG_Q12_20241010.pdf			
mittl. Fliessgesch. langsam		Leitfähigkeit [µS20/cm] 642		Trinkwassernutzung ☐ Schutzstatus ☐ Kulturhistorische Bedeutung ☐			
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren 1				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren 1			
Einträge/Verbau				Vegetation/Nutzung			
Fassung neu alt verfallen				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf ☐ ☐ ☐				standorttyp. Vegetation 1 1 1 1			
Rohr und Becken ☐ ☐ ☐				standortfrem. Vegetation ☐ ☐ ☐ ☐			
nur Rohr/Rinne ☐ 1 ☐				Moosgesellschaften 1 1 1 1			
keine ☐				Zwergsträucherheiden ☐ ☐ ☐ ☐			
Wasserentnahme >60% 30-59% <30% / unbekannt keine				Hochstaudenfluren ☐ ☐ ☐ ☐			
☐ ☐ 1 ☐				Laubwald ☐ ☐ ☐ ☐			
Bemerkung / Zweck :				Mischwald 1 ☐ ☐ ☐ ☐			
Verlegung 10-100m <10m unbekannt				Gebüsch ☐ ☐ ☐ ☐			
alt ☐ ☐ 1 ☐				standorttyp. Nadelwald ☐ ☐ ☐ ☐			
neu ☐ ☐ ☐				standortfremd. Nadelwald ☐ ☐ ☐ ☐			
keine ☐				extensivgenutz. Offenland ☐ ☐ ☐ ☐			
Aufstau nach <10m nach >=10-49m unbekannt				intensivgenutz. Offenland ☐ ☐ ☐ ☐			
Hauptschluss, 1-5 m2 ☐ ☐ ☐				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
Hauptschluss, >5 m2 ☐ ☐ ☐				unbefestigter Weg ☐ ☐ ☐ ☐			
Nebenschluss ☐ ☐ ☐				befestigter Weg/Strasse 1 1 ☐ ☐			
kein 1 ☐				künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
künstlicher Absturz Gesamtabfluss Teilabfluss nein				unbeschattet schwach mittel stark			
☐ 1 ☐ ☐				Sommerbeschattung ☐ ☐ 1 ☐			
Verbau* (Ufer, Sohle) stark mittel gering				stark & Überdachung oder Nadelforst ☐			
Holz ☐ ☐ ☐				Struktur			
Steinschüttung ☐ ☐ ☐				Substrat			
wilder Verbau ☐ ☐ ☐				stark (>50%) mittel (>20%) gering (>1%)			
Naturstein ☐ ☐ ☐				->natürlich Fels/Blöcke (>20 cm) ☐ 1 ☐			
Beton ☐ ☐ ☐				(Kiesel) Steine (6-20 cm) ☐ ☐ 1 ☐			
Verrohrung 1 ☐ ☐ ☐				Kies/Schotter (0.2-6 cm) ☐ ☐ ☐			
kein ☐				Sand (0.1 - 2 mm) ☐ ☐ ☐			
Unterhalt/Trittschäden gering mässig stark keine				Feinmaterial (<0.1 mm) ☐ ☐ ☐			
☐ ☐ ☐ 1 ☐				Moospolster 1 ☐ ☐ ☐			
Ursache :				Wurzeln ☐ ☐ ☐ 1 ☐			
Infrastruktur				Totholz ☐ ☐ ☐ 1 ☐			
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐				Pflanzen ☐ ☐ ☐ 1 ☐			
Wildfutterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges 1 ☐				Falllaub ☐ ☐ 1 ☐			
Anzahl Infr. 1 Sonstiges : Strasse oberhalb Quelle				Detritus/Org.Schlamm ☐ ☐ ☐			
Ablagerung* Deckungsgrad : vollständig teilweise vereinzelt				Kalksinter...* ☐ ☐ ☐			
Haus-/ Gewerbemüll ☐ ☐ ☐				Anzahl Substrate 7 stark (>50%) mittel (>20%) gering (>1%)			
Holzabfall ☐ ☐ ☐				☐ künstlich 1 ☐ ☐			
Pflanzenabfall ☐ ☐ ☐				->verändert (nur Infos) Fadenalgen ☐ ☐ ☐			
Erdaushub/ Bauschutt ☐ ☐ ☐				Strömungs- Spritzwasser ☐ glatt ☐ fließend ☐ überfließend 1 ☐			
org. Reste/ Faulschlamm ☐ ☐ ☐				diversität geripelt ☐ plätschernd ☐ überstürzend 1 ☐ fallend 1 ☐			
keine 1 ☐				Anzahl Strömungen 3			
Einleitungen unverdünnt Oberfläche / Strasse				Wasser-Land-Verzahnung gross mittel gering 1 ☐			
Rohr trocken Drainage / Graben				Besondere Laufverzweigung Inselstruktur 1 Quellflur Sandwirbel			
keine 1 ☐				Strukturen gr. Tiefenvarianz natürl. Pools Kaskaden Wasserfall			
Distanz zum Quellaustritt (m)				Fließshindernisse 1 Wassermoss 1 Lückensyst. Rieselflur			
Wert A : Beeinträchtigung (höchster Wert) 5				Wert B : Vegetation-Nutzung-Struktur 2.04			
Revitalisierungsobjekt (Einschätzung) JA / NEIN				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Gesamtergebnis [(A+B)/2]-b 3.52			
naturnah				Bewertung / Evaluation			
bedingt naturnah				0.6 - 1.8			
mässig beeinträchtigt				1.81 - 2.6			
geschädigt				2.61 - 3.4			
stark geschädigt				3.41 - 4.2			
x				4.21 - 5.0			
blau							
grün							
gelb							
orange							
rot							
Quelle nicht bewertbar : Q. zerstört							
Zutreffendes ankreuzen [x] kein Abfluss							

TG_Q12



TG_Q13



Quellen Protokoll - Struktur

Kanton : TG

ID : TG_Q14B

Quelle: Q14 - Brunnen

Datum : 10.10.24

Koordinaten (X/Y) : 713242

251267

Flurname : Moosbach

Höhe ü.M. : 814

BearbeiterIn (leg) : Elena Santi

KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) ! Ausfüllen oder zutreffendes ankreuzen ☒

Austrittsform (Liste)	☒ künstlich	Quelle (Grösse [m ²])	☒ 10	Vernetzung	Einzelquelle ☐	Q-system ☒	Q-komplex ☐
Hanglage	☒ Mittelhang	Quellbereich [m ²]	☒ 2	Dist. zur Nachbarquelle (m)	☒ 101	Anz. Austritte	☒ 2
Abflussrichtung	☒ NO	Quellbachlänge [m]	☒ -	Bemerkungen	Quelle gefasst - Grösse schwer abschätzbar. Fliesst unterhalb Strasse durch zu TG_Q14R. Ev. mit Q13 (312m) und Q15 (101 m) verbunden. DO [%]: 62.1, pH:		
Geländeneignung	☒ mässig	Wassertemperatur [°C]	☒ 13.2	Fotos und andere Dokumente	☒	ID	TG_Q14B_20241010.pdf
Quellschüttung	☒ ganzjährig	Quellschüttung [l/s]	☒ 1.0	Trinkwassernutzung	☐	Schutzstatus	☐
mittl. Fliessgesch.	☒ schnell	Leitfähigkeit [µS20/cm]	☒ 621	Kulturhistorische Bedeutung	☐		

Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren ☒Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren ☒

Einträge/Verbau

Fassung	neu	alt	verfallen
Brunnenstube mit Überlauf	☐	☐	☐
Rohr und Becken	☐	☒ 1	☐
nur Rohr/Rinne	☐	☐	☐
	keine ☐		

Wasserentnahme	>60%	30-59%	<30% / unbekannt	keine
	☐	☐	☒ 1	☐
Bemerkung / Zweck :				

Verlegung	10-100m	<10m	unbekannt
alt	☐	☐	☒ 1
neu	☐	☐	☐
	keine ☐		

Aufstau	nach <10m	nach >=10-49m	unbekannt
Hauptschluss, 1-5 m2	☒ 1	☐	☐
Hauptschluss, >5 m2	☐	☐	☐
Nebenschluss	☐	☐	☐
	kein ☐		

künstlicher Absturz	Gesamtabfluss	Teilabfluss	nein
	☒ 1	☐	☐

Verbau* (Ufer, Sohle)	stark	mittel	gering
Holz	☐	☐	☐
Steinschüttung	☐	☐	☐
wilder Verbau	☐	☐	☐
Naturstein	☐	☐	☐
Beton	☒ 1	☐	☐
Verrohrung	☒ 1	☐	☐
	kein ☐		

Unterhalt/Trittschäden	gering	mässig	stark	keine
	☐	☐	☐	☒ 1
Ursache :				

Infrastruktur

Bänke / Parkplatz	☐	Zuwegung	☒ 1	Trittsteine	☐	Überdachung	☐
Wildfutterstelle	☐	Viehtränke	☐	Feuerstelle	☐	Sonstiges	☐
Anzahl Infr.	☒ 1	Sonstiges :					

Ablagerung*	Deckungsgrad :	vollständig	teilweise	vereinzelt
Haus-/ Gewerbemüll	☐	☐	☐	☐
Holzabfall	☐	☐	☐	☐
Pflanzenabfall	☐	☐	☐	☐
Erdaushub/ Bauschutt	☐	☐	☐	☐
org. Reste/ Faulschlamm	☐	☐	☐	☐
	keine ☒ 1			

Einleitungen

unverdünt	☐	Oberfläche / Strasse	☐
Rohr trocken	☐	Drainage / Graben	☐
			keine ☒ 1
Distanz zum Quellaustritt (m)			

Vegetation/Nutzung

Einzugsgebiet	Umfeld	Quellbereich	Quellufer	Quellbach
standorttyp. Vegetation	☒ 1	☒ 1	☒ 1	☒ 1
standortfrem. Vegetation	☐	☐	☐	☐
Moosgesellschaften	☒ 1	☒ 1	☒ 1	☒ 1
Zwergstrauchheiden	☐	☐	☐	☐
Hochstaudenfluren	☐	☐	☐	☐
Laubwald	☐	☐	☐	☐
Mischwald	☒ 1	☒ 1	☒ 1	☒ 1
Gebüsch	☐	☐	☐	☐
standorttyp. Nadelwald	☐	☐	☐	☐
standortfremd. Nadelwald	☐	☐	☐	☐
extensivgenutz. Offenland	☒ 1	☐	☐	☐
intensivgenutz. Offenland	☐	☐	☐	☐
Acker/ Sonderkultur	☐	☐	☐	☐
unbefestigter Weg	☐	☐	☐	☐
befestigter Weg/Strasse	☒ 1	☐	☐	☐
künstl. veg.-frei/Siedlung	☒ 1	☐	☐	☐

Sommerbeschattung	unbeschattet	schwach	mittel	stark
	☐	☐	☒ 1	☐
	stark & Überdachung oder Nadelforst ☐			

Struktur

Substrat	stark (>50%)	mittel (>20%)	gering (>1%)
->natürlich	Fels/Blöcke (>20 cm)	☐	☐
	(Kiesel) Steine (6-20 cm)	☐	☐
	Kies/Schotter (0.2-6 cm)	☐	☐
	Sand (0.1 - 2 mm)	☐	☐
	Feinmaterial (<0.1 mm)	☐	☐
	Moospolster	☒ 1	☐
	Wurzeln	☐	☒ 1
	Totholz	☐	☒ 1
	Pflanzen	☐	☒ 1
	Fallaub	☐	☒ 1
	Detritus/Org.Schlamm	☐	☐
	Kalksinter...*	☐	☐
Anzahl Substrate	5	stark (>50%)	mittel (>20%)
	künstlich	☒ 1	☐
->verändert (nur Infos)	Fadenalgen	☐	☐

Strömungsdiversität	Spritzwasser	☐	glatt	☐	fliegend	☒ 1	überfliegend	☒ 1
	gerippt	☐	plätschernd	☐	überstürzend	☐	fallend	☒ 1
Anzahl Strömungen	☒ 3							

Wasser-Land-Verzahnung gross ☐ mittel ☐ gering ☒ 1

Besondere Strukturen	Laufverzweigung	☐	Inselstruktur	☐	Quellflur	☐	Sandwirbel	☐
	gr. Tiefenvarianz	☐	natürl. Pools	☐	Kaskaden	☐	Wasserfall	☒ 1
	Fließhindernisse	☒ 1	Wassermoo	☐	Lückensyst.	☐	Rieselflur	☐
Anzahl Strukturen	☒ 2							

Wert A : Beeinträchtigung (höchster Wert)

5

Revitalisierungsobjekt (Einschätzung)

JA / NEIN

Klassierung / Classement :

Gesamteindruck als Bewertungsvergleich

naturnah

bedingt naturnah

mässig beeinträchtigt

geschädigt

stark geschädigt

blau
grün
gelb
orange
rot

x

Bewertung / Evaluation

	0.6 - 1.8	☐
	1.81 - 2.6	☐
	2.61 - 3.4	☐
x	3.41 - 4.2	☒
	4.21 - 5.0	☐

Wert B : Vegetation-Nutzung-Struktur

2.24

Bonus b -0,4 Punkte bei guter Struktur ->

Aufwertung -

0

Gesamtergebnis [(A+B)/2]-b

3.62

Quelle nicht bewertbar :

Q. zerstört

Zutreffendes ankreuzen [x]

kein Abfluss

TG_Q14B



TG_Q14R



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q15	
Quelle: Q15		Datum : 10.10.24		Koordinaten (X/Y) : 713301 25355			
Flurname : Moosbach		Höhe ü.M. : 816		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²])		Vernetzung		Einzelquelle ☒ Q-system ☐ Q-komplex ☐	
Hanglage		Quellbereich [m²]		Dist. zur Nachbarquelle (m)		Anz. Austritte 1	
Abflussrichtung		Quellbachlänge [m]		Bemerkungen		Quelle gefasst - Grösse schwer abschätzbar. Ev. mit Q14 (135m) und Q13 (400m) verbunden. DO [%]: 66, pH: 7.11.	
Geländeneignung		Wassertemperatur [°C]		Fotos und andere Dokumente		ID TG_Q15_20241010.pdf	
Quellschüttung		Quellschüttung [l/s]		Trinkwassernutzung		Schutzstatus ☐ Kulturhistorische Bedeutung ☐	
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm]					
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnerstube mit Überlauf				standorttyp. Vegetation			
Rohr und Becken				standortfrem. Vegetation			
nur Rohr/Rinne				Moosgesellschaften			
Wasserentnahme				Zwergstrauchheiden			
Bemerkung / Zweck :				Hochstaudenfluren			
Verlegung				Laubwald			
Aufstau				Mischwald			
künstlicher Absturz				Gebüsch			
Verbau* (Ufer, Sohle)				standorttyp. Nadelwald			
Unterhalt/Trittschäden				standortfremd. Nadelwald			
Infrastruktur				extensivgenutz. Offenland			
Ablagerung*				intensivgenutz. Offenland			
Einleitungen				Acker/ Sonderkultur			
Wert A : Beeinträchtigung (höchster Wert)				Sommerbeschattung			
Revitalisierungsobjekt (Einschätzung)				Struktur			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Substrat			
naturnah				->natürlich			
bedingt naturnah				Fels/Blöcke (>20 cm)			
mässig beeinträchtigt				(Kiesel) Steine (6-20 cm)			
geschädigt				Kies/Schotter (0.2-6 cm)			
stark geschädigt				Sand (0.1 - 2 mm)			
				Feinmaterial (<0.1 mm)			
				Moospolster			
				Wurzeln			
				Totholz			
				Pflanzen			
				Falllaub			
				Detritus/Org.Schlamm			
				Kalksinter...*			
				Anzahl Substrate			
				->verändert (nur Infos)			
				Strömungsdiversität			
				Wasser-Land-Verzahnung			
				Besondere Strukturen			
				Anzahl Strukturen			
				Wert B : Vegetation-Nutzung-Struktur			
				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung -			
				Gesamtergebnis ((A+B)/2)-b			
				Quelle nicht bewertbar :			
				Zutreffendes ankreuzen [x]			

TG_Q15



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q16	
Quelle: Q16		Datum : 17.10.24		Koordinaten (X/Y) : 712842 253734			
Flurname : Bodebach		Höhe ü.M. : 681		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²])		Vernetzung		Einzelquelle ☐ Q-system ☒ Q-komplex ☐	
Hanglage		Quellbereich [m²]		Dist. zur Nachbarquelle (m)		Anz. Austritte	
Abflussrichtung		Quellbachlänge [m]		Bemerkungen		Nachbarquelle Q17 (50m) und weitere gefasste Quellen im Umkreis von 200m. DO [%]: 84.9, pH: 7.45.	
Geländeneignung		Wassertemperatur [°C]		Fotos und andere Dokumente		ID	
Quellschüttung		Quellschüttung [l/s]		Trinkwassernutzung		Schutzstatus	
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm]		Kulturhistorische Bedeutung			
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet			
Brunnerstube mit Überlauf				Umfeld			
Rohr und Becken				Quellbereich			
nur Rohr/Rinne				Quellufer			
keine				Quellbach			
Wasserentnahme				standorttyp. Vegetation			
>60%				standorfrem. Vegetation			
30-59%				Moosgesellschaften			
<30% / unbekannt				Zwergsträucherheiden			
keine				Hochstaudenfluren			
Bemerkung / Zweck : unbekannt.				Laubwald			
Verlegung				Mischwald			
10-100m				Gebüsch			
<10m				standorttyp. Nadelwald			
alt				standorfremd. Nadelwald			
neu				extensivgenutz. Offenland			
keine				intensivgenutz. Offenland			
Aufstau				Acker/ Sonderkultur			
nach <10m				unbefestigter Weg			
nach >=10-49m				befestigter Weg/Strasse			
Hauptschluss, 1-5 m2				künstl. veg.-frei/Siedlung			
Hauptschluss, >5 m2							
Nebenschluss							
kein							
künstlicher Absturz				unbeschattet			
Gesamtabfluss				schwach			
Teilabfluss				mittel			
nein				stark			
Verbau* (Ufer, Sohle)				Sommerbeschattung			
stark				stark & Überdachung oder Nadelforst			
mittel							
gering							
Holz							
Steinschüttung							
wilder Verbau							
Naturstein							
Beton							
Verrohrung							
kein							
Unterhalt/Trittschäden				Struktur			
gering				Substrat			
mässig				stark (>50%)			
stark				mittel (>20%)			
keine				gering (>1%)			
Ursache : nicht sichtbar: Quelle befindet sich auf einer Wiese/Landw				->natürlich			
Infrastruktur				Fels/Blöcke (>20 cm)			
Bänke / Parkplatz				(Kiesel) Steine (6-20 cm)			
Zuwegung				Kies/Schotter (0.2-6 cm)			
Trittsteine				Sand (0.1 - 2 mm)			
Überdachung				Feinmaterial (<0.1 mm)			
Wildfütterstelle				Moospolster			
Viehtränke				Wurzeln			
Feuerstelle				Totholz			
Sonstiges				Pflanzen			
Anzahl Infr. 1				Falllaub			
Sonstiges :				Detritus/Org.Schlamm			
Ablagerung*				Kalksinter...*			
Deckungsgrad :				Anzahl Substrate			
vollständig				stark (>50%)			
teilweise				mittel (>20%)			
vereinzel				gering (>1%)			
Haus-/ Gewerbemüll				->verändert (nur Infos)			
Holzabfall				Fadenalgen			
Pflanzenabfall				Strömungs-			
Erdaushub/ Bauschutt				diversität			
org. Reste/ Faulschlamm				Anzahl Strömungen			
keine				Wasser-Land-Verzahnung			
Einleitungen				gross			
unverdünt				mittel			
Oberfläche / Strasse				gering			
Rohr trocken							
Drainage / Graben							
keine							
Distanz zum Quellaustritt (m)				Besondere			
				Laufverzweigung			
				Inselstruktur			
				Quellflur			
				Sandwirbel			
				Strukturen			
				gr. Tiefenvarianz			
				natürl. Pools			
				Kaskaden			
				Wasserfall			
				Fließhindernisse			
				Wassermoos			
				Lückensyst.			
				Rieselflur			
				Anzahl Strukturen			
Wert A : Beeinträchtigung (höchster Wert)				Wert B : Vegetation-Nutzung-Struktur			
5				3.17			
Revitalisierungsobjekt (Einschätzung)				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung			
JA / NEIN				0			
Klassierung / Classement :				Gesamtergebnis [(A+B)/2]-b			
Gesamteindruck als Bewertungsvergleich				4.08			
naturnah				Quelle nicht bewertbar :			
bedingt naturnah				Q. zerstört			
mässig beeinträchtigt				Zutreffendes ankreuzen [x]			
geschädigt				kein Abfluss			
stark geschädigt							

TG_Q16



TG_Q17



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q18	
Quelle: Q18		Datum : 17.10.24		Koordinaten (X/Y) : 712800 253304			
Flurname : Bodebach		Höhe ü.M. : 747		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) ! Ausfüllen oder zutreffendes ankreuzen ☒							
Austrittsform (Liste)	künstlich	Quelle (Grösse [m ²])	15	Vernetzung	Einzelquelle ☒ Q-system ☐ Q-komplex ☐		
Hanglage	Mittelhang	Quellbereich [m ²]	5	Dist. zur Nachbarquelle (m)	240 Anz. Austritte 1		
Abflussrichtung	W	Quellbachlänge [m]	10	Bemerkungen	Rohr kommt von Strasse her. Nachbarquelle Q19 (240m) entfernt. DO [%]: 93.7%, pH 8.28.		
Geländeneignung	stark	Wassertemperatur [°C]	13.7	Fotos und andere Dokumente	☒ ID TG_Q18_20241017.pdf		
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Trinkwassernutzung	☐ Schutzstatus ☐ Kulturhistorische Bedeutung ☐		
mittl. Fliessgesch.	schnell	Leitfähigkeit [µS20/cm]	647				
Bewertung Teil A : Beeinträchtigung		Zutreffendes mit "1" markieren 1		Bewertung Teil B : Vegetation-Nutzung-Struktur			
Zutreffendes mit "1" markieren 1				Zutreffendes mit "1" markieren 1			
Einträge/Verbau		Vegetation/Nutzung					
Fassung		Einzugsgebiet Umfeld Quellbereich Quellaufer Quellbach					
Brunnerstube mit Überlauf ☐ neu ☐ alt ☐ verfallen ☐		standorttyp. Vegetation ☒ ☐ ☐ ☐ ☐					
Rohr und Becken ☐		standortfrem. Vegetation ☐ ☐ ☐ ☐ ☐					
nur Rohr/Rinne ☐		Moosgesellschaften ☒ ☐ ☐ ☐ ☐					
keine ☐		Zwergstrauchheiden ☐ ☐ ☐ ☐ ☐					
Wasserentnahme		Hochstaudenfluren ☐ ☐ ☐ ☐ ☐					
>60% ☐ 30-59% ☐ <30% / unbekannt ☒ keine ☐		Laubwald ☐ ☐ ☐ ☐ ☐					
Bemerkung / Zweck : von Richtung Weg/Strasse her kommend.		Mischwald ☒ ☐ ☐ ☐ ☐					
Verlegung		Gebüsch ☐ ☐ ☐ ☐ ☐					
10-100m ☐ <10m ☐ unbekannt ☐		standorttyp. Nadelwald ☐ ☐ ☐ ☐ ☐					
alt ☐ neu ☐		standortfremd. Nadelwald ☐ ☐ ☐ ☐ ☐					
keine ☐		extensivgenutz. Offenland ☒ ☐ ☐ ☐ ☐					
Aufstau		intensivgenutz. Offenland ☐ ☐ ☐ ☐ ☐					
nach <10m ☐ nach >=10-49m ☐ unbekannt ☐		Acker/ Sonderkultur ☐ ☐ ☐ ☐ ☐					
Hauptschluss, 1-5 m2 ☐		unbefestigter Weg ☐ ☐ ☐ ☐ ☐					
Hauptschluss, >5 m2 ☐		befestigter Weg/Strasse ☐ ☐ ☐ ☐ ☐					
Nebenschluss ☐		künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐ ☐					
kein ☐							
künstlicher Absturz		unbeschattet schwach mittel stark					
Gesamtabfluss ☒ Teilabfluss ☐ nein ☐		Sommerbeschattung ☐ ☐ ☒ ☐					
Verbau* (Ufer, Sohle)		stark & Überdachung oder Nadelforst ☐					
stark mittel gering							
Holz ☐							
Steinschüttung ☐							
wilder Verbau ☐							
Naturstein ☐							
Beton ☐							
Verrohrung ☐							
kein ☐							
Unterhalt/Trittschäden							
gering mässig stark keine							
Ursache :							
Infrastruktur							
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐							
Wildfutterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges ☐							
Anzahl Infr. 0 Sonstiges :							
Ablagerung*							
Deckungsgrad : vollständig teilweise vereinzelt							
Haus-/ Gewerbemüll ☐							
Holzabfall ☐							
Pflanzenabfall ☐							
Erdaushub/ Bauschutt ☐							
org. Reste/ Faulschlamm ☐							
keine ☐							
Einleitungen							
unverdünt ☐ Oberfläche / Strasse ☐							
Rohr trocken ☐ Drainage / Graben ☐							
keine ☐							
Distanz zum Quellaustritt (m)							
Wert A : Beeinträchtigung (höchster Wert) 4		Wert B : Vegetation-Nutzung-Struktur 1.66					
Revitalisierungsobjekt (Einschätzung) JA / NEIN		Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0					
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich		Bewertung / Evaluation		Gesamtergebnis [(A+B)/2]-b 2.83			
naturnah		0.6 - 1.8					
bedingt naturnah		1.81 - 2.6					
mässig beeinträchtigt		2.61 - 3.4					
geschädigt		3.41 - 4.2					
stark geschädigt		4.21 - 5.0					
Quelle nicht bewertbar : ☐ Q. zerstört							
Zutreffendes ankreuzen [x] ☐ kein Abfluss							

AQ/ps_ver_20180315

TG_Q18



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q19	
Quelle: Q19		Datum : 17.10.24		Koordinaten (X/Y) : 712602 253167			
Flurname : Bodebach		Höhe ü.M. : 763		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²]) 10		Vernetzung Einzelquelle ☒ Q-system ☐ Q-komplex ☐			
Hanglage Mittelhang		Quellbereich [m²] 5		Dist. zur Nachbarquelle (m) 170		Anz. Austritte 1	
Abflussrichtung NW		Quellbachlänge [m] 10		Bemerkungen Rohr kommt von Strasse her. Nachbarquellen Q20 (170m) & Q18 (240m) entfernt. DO [%]: 86.3, pH 7.42.			
Geländeneignung stark		Wassertemperatur [°C] 13.1					
Quellschüttung ganzjährig		Quellschüttung [l/s] 1.0		Fotos und andere Dokumente ☒		ID TG_Q19_20241017.pdf	
mittl. Fliessgesch. schnell		Leitfähigkeit [µS20/cm] 662		Trinkwassernutzung ☐		Schutzstatus ☐ Kulturhistorische Bedeutung ☐	
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren 1				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren 1			
Einträge/Verbau				Vegetation/Nutzung			
Fassung neu alt verfallen				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf ☐ ☐ ☐				standorttyp. Vegetation 1 1 1 1			
Rohr und Becken ☐ ☐ ☐				standortfremd. Vegetation ☐ ☐ ☐ ☐			
nur Rohr/Rinne ☐ 1 ☐				Moosgesellschaften 1 1 1 1			
				Zwergsträucherheiden ☐ ☐ ☐ ☐			
keine ☐				Hochstaudenfluren ☐ ☐ ☐ ☐			
Wasserentnahme >60% 30-59% <30% / unbekannt keine				Laubwald ☐ ☐ ☐ ☐			
☐ ☐ 1 ☐				Mischwald 1 1 1 ☐			
Bemerkung / Zweck : Wasserentnahme durch Schlauch.				Gebüsch ☐ 1 1 ☐			
Verlegung 10-100m <10m unbekannt				standorttyp. Nadelwald ☐ ☐ ☐ ☐			
alt ☐ ☐ 1 ☐				standortfremd. Nadelwald ☐ ☐ ☐ ☐			
neu ☐ ☐ ☐				extensivgenutz. Offenland 1 1 1 1			
keine ☐				intensivgenutz. Offenland ☐ ☐ ☐ ☐			
Aufstau nach <10m nach >=10-49m unbekannt				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
Hauptschluss, 1-5 m2 ☐ ☐ 1 ☐				unbefestigter Weg ☐ ☐ ☐ ☐			
Hauptschluss, >5 m2 ☐ ☐ ☐				befestigter Weg/Strasse 1 ☐ ☐ ☐			
Nebenschluss ☐ ☐ ☐				künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
kein ☐							
künstlicher Absturz Gesamtabfluss Teilabfluss nein				unbeschattet schwach mittel stark			
☐ 1 ☐ ☐				Sommerbeschattung ☐ ☐ ☐ 1			
Verbau* (Ufer, Sohle) stark mittel gering				stark & Überdachung oder Nadelforst ☐			
Holz ☐ ☐ ☐							
Steinschüttung ☐ ☐ ☐							
wilder Verbau ☐ ☐ ☐							
Naturstein ☐ ☐ ☐							
Beton ☐ ☐ ☐							
Verrohrung ☐ ☐ ☐							
kein 1 ☐							
Unterhalt/Trittschäden gering mässig stark keine				stark (>50%) mittel (>20%) gering (>1%)			
☐ ☐ ☐ 1 ☐				->natürlich Fels/Blöcke (>20 cm) ☐ ☐ ☐			
Ursache : Quelle befindet sich unterhalb des Wegs/Strasse.				(Kiesel) Steine (6-20 cm) ☐ ☐ 1			
Infrastruktur				Kies/Schotter (0.2-6 cm) ☐ ☐ 1			
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐				Sand (0.1 - 2 mm) ☐ ☐ ☐			
Wildfütterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges ☐				Feinmaterial (<0.1 mm) ☐ ☐ ☐			
Anzahl Infr. 0 Sonstiges :				Moospolster ☐ 1 ☐			
Ablagerung* Deckungsgrad : vollständig teilweise vereinzelt				Wurzeln ☐ ☐ 1 ☐			
Haus-/ Gewerbemüll ☐ ☐ ☐				Totholz ☐ ☐ 1 ☐			
Holzabfall ☐ ☐ ☐				Pflanzen 1 ☐ ☐ ☐			
Pflanzenabfall ☐ ☐ ☐				Falllaub 1 ☐ ☐ ☐			
Erdaushub/ Bauschutt ☐ ☐ ☐				Detritus/Org.Schlamm ☐ ☐ ☐			
org. Reste/ Faulschlamm ☐ ☐ ☐				Kalksinter...* ☐ ☐ 1			
keine 1 ☐				Anzahl Substrate 8 stark (>50%) mittel (>20%) gering (>1%)			
				☐ ☐ ☐			
				->verändert (nur Infos) Fadenalgen ☐ ☐ 1			
				Strömungsdiversität Spritzwasser 1 glatt ☐ fliegend 1 überfliegend ☐			
				gerippt ☐ plätschernd ☐ überstürzend ☐ fallend 1			
				Anzahl Strömungen 3			
				Wasser-Land-Verzahnung gross ☐ mittel 1 gering ☐			
				Besondere Laufverzweigung ☐ Inselstruktur ☐ Quelflur ☐ Sandwirbel ☐			
				Strukturen gr. Tiefenvarianz ☐ natürl. Pools ☐ Kaskaden 1 Wasserfall 1			
				Fließshindernisse 1 Wassermooos ☐ Lückensyst. ☐ Rieselflur ☐			
				Anzahl Strukturen 3			
Distanz zum Quellaustritt (m)							
Wert A : Beeinträchtigung (höchster Wert) 4				Wert B : Vegetation-Nutzung-Struktur 1.57			
Revitalisierungsobjekt (Einschätzung) JA / NEIN				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Gesamtergebnis ((A+B)/2)-b 2.78			
naturnah				Bewertung / Evaluation			
bedingt naturnah				0.6 - 1.8			
mässig beeinträchtigt				1.81 - 2.6			
geschädigt				2.61 - 3.4			
stark geschädigt				3.41 - 4.2			
				4.21 - 5.0			
				Quelle nicht bewertbar : Q. zerstört			
				Zutreffendes ankreuzen [x] kein Abfluss			

TG_Q19



TG_Q20



TG_Q21



TG_Q22



TG_Q23



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q24	
Quelle: Q24		Datum : 17.10.24		Koordinaten (X/Y) : 711677 252867			
Flurname : Bodebach		Höhe ü.M. : 772		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²]) 10		Vernetzung Einzelquelle ☒ Q-system ☐ Q-komplex ☐			
Hanglage		Quellbereich [m²] 3		Dist. zur Nachbarquelle (m)		Anz. Austritte	
Abflussrichtung		Quellbachlänge [m] 10		Bemerkungen kein Abfluss; feuchter, matschiger Boden.			
Geländeneignung		Wassertemperatur [°C]					
Quellschüttung		Quellschüttung [l/s]		Fotos und andere Dokumente ☒		ID TG_Q24_20241017.pdf	
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm]		Trinkwassernutzung ☐		Schutzstatus ☐ Kulturhistorische Bedeutung ☐	
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren 1				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren 1			
Einträge/Verbau				Vegetation/Nutzung			
Fassung neu alt verfallen				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf ☐ ☐ ☐				standorttyp. Vegetation 1 1 1 1			
Rohr und Becken ☐ ☐ ☐				standortfrem. Vegetation ☐ ☐ ☐ ☐			
nur Rohr/Rinne ☐ ☐ ☐				Moosgesellschaften 1 1 1 1			
				Zwergsträuchheiden ☐ ☐ ☐ ☐			
				Hochstaudenfluren ☐ ☐ ☐ ☐			
Wasserentnahme >60% 30-59% <30% / unbekannt keine				Laubwald ☐ ☐ ☐ ☐			
☐ ☐ ☐ 1				Mischwald 1 1 ☐ 1			
Bemerkung / Zweck :				Gebüsch ☐ ☐ ☐ ☐			
Verlegung 10-100m <10m unbekannt				standorttyp. Nadelwald ☐ ☐ ☐ ☐			
alt ☐ ☐ ☐				standortfremd. Nadelwald ☐ ☐ ☐ ☐			
neu ☐ ☐ ☐				extensivgenutz. Offenland 1 ☐ ☐ ☐ ☐			
				intensivgenutz. Offenland ☐ ☐ ☐ ☐			
				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
				unbefestigter Weg ☐ ☐ ☐ ☐			
				befestigter Weg/Strasse ☐ ☐ ☐ ☐			
				künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
Aufstau nach <10m nach >=10-49m unbekannt				Sommerbeschattung unbeschattet schwach mittel stark			
Hauptschluss, 1-5 m2 ☐ ☐ ☐				Sommerbeschattung ☐ ☐ 1 ☐			
Hauptschluss, >5 m2 ☐ ☐ ☐				stark & Überdachung oder Nadelforst ☐			
Nebenschluss ☐ ☐ ☐							
				Struktur			
				Substrat			
künstlicher Absturz Gesamtabfluss Teilabfluss nein				stark (>50%) mittel (>20%) gering (>1%)			
☐ ☐ 1				->natürlich			
Verbau* (Ufer, Sohle) stark mittel gering				Fels/Blöcke (>20 cm) ☐ ☐ ☐			
Holz ☐ ☐ ☐				(Kiesel) Steine (6-20 cm) ☐ ☐ ☐			
Steinschüttung ☐ ☐ ☐				Kies/Schotter (0.2-6 cm) ☐ ☐ ☐			
wilder Verbau ☐ ☐ ☐				Sand (0.1 - 2 mm) ☐ ☐ ☐			
Naturstein ☐ ☐ ☐				Feinmaterial (<0.1 mm) ☐ ☐ ☐			
Beton ☐ ☐ ☐				Moospolster ☐ 1 ☐			
Verrohrung ☐ ☐ ☐				Wurzeln ☐ ☐ 1 ☐			
				Totholz ☐ ☐ 1 ☐			
				Pflanzen 1 ☐ ☐ ☐			
				Falllaub 1 ☐ ☐ ☐			
				Detritus/Org.Schlamm ☐ ☐ ☐			
				Kalksinter...* ☐ ☐ ☐			
Unterhalt/Trittschäden gering mässig stark keine				Anzahl Substrate 5 stark (>50%) mittel (>20%) gering (>1%)			
☐ ☐ ☐ 1				☐ ☐ ☐			
Ursache :				->verändert (nur Infos)			
Infrastruktur				Fadenalgen ☐ ☐ ☐			
Bänke / Parkplatz ☐ Zuwegung ☐ Trittsteine ☐ Überdachung ☐				Strömungsdiversität Spritzwasser ☐ glatt ☐ fliegend ☐ überfliegend 1			
Wildfütterstelle ☐ Viehtränke ☐ Feuerstelle ☐ Sonstiges ☐				geripfelt ☐ plätschernd ☐ überstürzend ☐ fallend ☐			
Anzahl Infr. 0 Sonstiges :				Anzahl Strömungen 1			
Ablagerung* Deckungsgrad : vollständig teilweise vereinzelt				Wasser-Land-Verzahnung gross 1 mittel ☐ gering ☐			
Haus-/ Gewerbemüll ☐ ☐ ☐				Besondere Laufverzweigung ☐ Inselstruktur ☐ Quelflur ☐ Sandwirbel ☐			
Holzabfall ☐ ☐ ☐				Strukturen gr. Tiefenvarianz ☐ natürl. Pools ☐ Kaskaden ☐ Wasserfall ☐			
Pflanzenabfall ☐ ☐ ☐				Fließshindernisse 1 Wassermooos ☐ Lückensyst. ☐ Rieselflur ☐			
Erdaushub/ Bauschutt ☐ ☐ ☐				Anzahl Strukturen 1			
org. Reste/ Faulschlamm ☐ ☐ ☐							
Einleitungen unverdünnt ☐ Oberfläche / Strasse ☐							
Rohr trocken ☐ Drainage / Graben ☐							
Distanz zum Quellaustritt (m)							
Wert A : Beeinträchtigung (höchster Wert) 1				Wert B : Vegetation-Nutzung-Struktur 1.83			
Revitalisierungsobjekt (Einschätzung) JA / NEIN				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Gesamtergebnis ((A+B)/2)-b 1.42			
naturnah x blau				Quelle nicht bewertbar : Q. zerstört			
bedingt naturnah grün				Zutreffendes ankreuzen [x] 1 kein Abfluss			
mässig beeinträchtigt gelb							
geschädigt orange							
stark geschädigt rot							

TG_Q24



TG_Q25



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q26	
Quelle: Q26		Datum : 24.10.24		Koordinaten (X/Y) : 711654 253380			
Flurname : Bodebach		Höhe ü.M. : 777		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)	künstlich	Quelle (Grösse [m²])	2	Vernetzung	Einzelquelle ☐	Q-system ☒	Q-komplex ☐
Hanglage	Mittelhang	Quellbereich [m²]	2	Dist. zur Nachbarquelle (m)	40	Anz. Austritte	1
Abflussrichtung	O	Quellbachlänge [m]	-	Bemerkungen	Quelle gefasst - Grösse schwer abschätzbar. Nachbarquelle Q27 (40m, Brunnen). DO [%]: 77.0, pH: 7.3.		
Geländeneignung	mässig	Wassertemperatur [°C]	13.3	Fotos und andere Dokumente	☒	ID	TG_Q26_20241024.pdf
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Trinkwassernutzung	☐	Schutzstatus	☐
mittl. Fliessgesch.	langsam	Leitfähigkeit [µS20/cm]	659	Kulturhistorische Bedeutung	☐		
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet			
neu alt verfallen				Umfeld			
Brunnenstube mit Überlauf ☐ ☐ ☐				Quellbereich			
Rohr und Becken ☐ 1 ☐				Quellufer			
nur Rohr/Rinne ☐ ☐ ☐				Quellbach			
keine ☐				standorttyp. Vegetation 1 1 1 1			
Wasserentnahme				standorfrem. Vegetation ☐ ☐ ☐ ☐			
>60% 30-59% <30% / unbekannt keine				Moosgesellschaften ☐ 1 1 1			
☐ ☐ 1 ☐				Zwergstrauchheiden ☐ ☐ ☐ ☐			
Bemerkung / Zweck :				Hochstaudenfluren ☐ ☐ ☐ ☐			
Verlegung				Laubwald ☐ ☐ ☐ ☐			
10-100m <10m unbekannt				Mischwald 1 1 1 ☐			
alt ☐ ☐ 1				Gebüsch ☐ ☐ ☐ ☐			
neu ☐ ☐ ☐				standorttyp. Nadelwald ☐ ☐ ☐ ☐			
keine ☐				standortfremd. Nadelwald ☐ ☐ ☐ ☐			
Aufstau				extensivgenutz. Offenland 1 1 1 1			
nach <10m nach >=10-49m unbekannt				intensivgenutz. Offenland ☐ ☐ ☐ ☐			
Hauptschluss, 1-5 m2 ☐ ☐ 1				Acker/ Sonderkultur ☐ ☐ ☐ ☐			
Hauptschluss, >5 m2 ☐ ☐ ☐				unbefestigter Weg ☐ ☐ ☐ ☐			
Nebenschluss ☐ ☐ ☐				befestigter Weg/Strasse ☐ 1 ☐ ☐ ☐			
kein ☐				künstl. veg.-frei/Siedlung ☐ ☐ ☐ ☐			
künstlicher Absturz				unbeschattet schwach mittel stark			
Gesamtabfluss Teilabfluss nein				Sommerbeschattung ☐ 1 ☐ ☐ ☐			
1 ☐ ☐ ☐				stark & Überdachung oder Nadelforst ☐			
Verbau* (Ufer, Sohle)				Struktur			
stark mittel gering				Substrat			
Holz ☐ ☐ ☐				stark (>50%) mittel (>20%) gering (>1%)			
Steinschüttung ☐ ☐ ☐				->natürlich			
wilder Verbau ☐ ☐ ☐				Fels/Blöcke (>20 cm) ☐ ☐ ☐			
Naturstein ☐ ☐ ☐				(Kiesel) Steine (6-20 cm) ☐ ☐ ☐			
Beton 1 ☐ ☐ ☐				Kies/Schotter (0.2-6 cm) ☐ ☐ ☐			
Verrohrung ☐ ☐ ☐				Sand (0.1 - 2 mm) ☐ ☐ ☐			
kein ☐				Feinmaterial (<0.1 mm) ☐ ☐ ☐			
Unterhalt/Trittschäden				Moospolster ☐ ☐ 1			
gering mässig stark keine				Wurzeln ☐ ☐ ☐			
1 ☐ ☐ ☐				Totholz ☐ ☐ ☐			
Ursache : Strasse				Pflanzen ☐ ☐ 1			
Infrastruktur				Falllaub ☐ ☐ ☐			
Bänke / Parkplatz ☐ Zuwegung 1 Trittsteine ☐ Überdachung ☐				Detritus/Org.Schlamm ☐ ☐ ☐			
Wildfütterstelle ☐ Viehtränke 1 Feuerstelle ☐ Sonstiges ☐				Kalksinter...* ☐ ☐ 1			
Anzahl Infr. 2 Sonstiges :				Anzahl Substrate 3 stark (>50%) mittel (>20%) gering (>1%)			
Ablagerung*				->verändert (nur Infos)			
Deckungsgrad : vollständig teilweise vereinzelt				Fadenalgen ☐ ☐ 1			
Haus-/ Gewerbemüll ☐ ☐ ☐				Strömungsdiversität			
Holzabfall ☐ ☐ ☐				Spritzwasser 1 glatt ☐ fliegend 1 überfliegend ☐			
Pflanzenabfall ☐ ☐ ☐				geripfelt 1 plätschernd ☐ überstürzend ☐ fallend 1			
Erdaushub/ Bauschutt ☐ ☐ ☐				Anzahl Strömungen 4			
org. Reste/ Faulschlamm ☐ ☐ ☐				Wasser-Land-Verzahnung			
keine 1				gross ☐ mittel ☐ gering 1			
Einleitungen				Besondere			
unverdünt ☐ Oberfläche / Strasse ☐				Laufverzweigung ☐ Inselstruktur ☐ Quelflur ☐ Sandwirbel ☐			
Rohr trocken ☐ Drainage / Graben ☐				Strukturen			
keine 1				gr. Tiefenvarianz ☐ natürl. Pools ☐ Kaskaden ☐ Wasserfall 1			
Distanz zum Quellaustritt (m)				Fließshindernisse 1 Wassermooos ☐ Lückensyst. ☐ Rieselflur ☐			
Wert A : Beeinträchtigung (höchster Wert) 5				Wert B : Vegetation-Nutzung-Struktur 2.56			
Revitalisierungsobjekt (Einschätzung) JA / NEIN				Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung - 0			
Klassierung / Classement : Gesamteindruck als Bewertungsvergleich				Gesamtergebnis ((A+B)/2)-b 3.78			
naturnah				Bewertung / Evaluation			
bedingt naturnah				0.6 - 1.8			
mässig beeinträchtigt				1.81 - 2.6			
geschädigt				2.61 - 3.4			
stark geschädigt				3.41 - 4.2			
				4.21 - 5.0			
				Quelle nicht bewertbar : Q. zerstört			
				Zutreffendes ankreuzen [x] kein Abfluss			

TG_Q26



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q27	
Quelle: Q27		Datum : 24.10.24		Koordinaten (X/Y) : 711657 253339			
Flurname : Bodebach		Höhe ü.M. : 771		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)		Quelle (Grösse [m²])		Vernetzung		Einzelquelle ☐ Q-system ☒ Q-komplex ☐	
Hanglage		Quellbereich [m²]		Dist. zur Nachbarquelle (m)		Anz. Austritte 1	
Abflussrichtung		Quellbachlänge [m]		Bemerkungen Nachbarquelle Q26 (40m, Brunnen). DO [%]: 99.7, pH: 7.58. Wasser läuft aus Becken raus und fliesst bei Tolle ab.			
Geländeneignung		Wassertemperatur [°C]		Fotos und andere Dokumente ☒ ID TG_Q27_20241024.pdf			
Quellschüttung		Quellschüttung [l/s]		Trinkwassernutzung ☐ Schutzstatus ☐ Kulturhistorische Bedeutung ☐			
mittl. Fliessgesch.		Leitfähigkeit [µS20/cm]					
Bewertung Teil A : Beeinträchtigung Zutreffendes mit "1" markieren				Bewertung Teil B : Vegetation-Nutzung-Struktur Zutreffendes mit "1" markieren			
Einträge/Verbau				Vegetation/Nutzung			
Fassung				Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach			
Brunnenstube mit Überlauf				standorttyp. Vegetation			
Rohr und Becken				standorfrem. Vegetation			
nur Rohr/Rinne				Moosgesellschaften			
Wasserentnahme				Zwergstrauchheiden			
Bemerkung / Zweck :				Hochstaudenfluren			
Verlegung				Laubwald			
Aufstau				Mischwald			
künstlicher Absturz				Gebüsch			
Verbau* (Ufer, Sohle)				standorttyp. Nadelwald			
Unterhalt/Trittschäden				standortfremd. Nadelwald			
Infrastruktur				extensivgenutz. Offenland			
Ablagerung*				intensivgenutz. Offenland			
Einleitungen				Acker/ Sonderkultur			
Wert A : Beeinträchtigung (höchster Wert)				Sommerbeschattung			
Reitalisierungsobjekt (Einschätzung)				Struktur			
Klassierung / Classement :				Substrat			
Gesamteindruck als Bewertungsvergleich				Anzahl Substrate			
Bewertung / Evaluation				Wasser-Land-Verzahnung			
Besondere Strukturen				Anzahl Strukturen			
Quelle nicht bewertbar :				Gesamtergebnis ((A+B)/2)-b			
Zutreffendes ankreuzen [x]				Quelle zerstört			
				kein Abfluss			

TG_Q27



Quellen Protokoll - Struktur				Kanton : TG		ID : TG_Q28	
Quelle: Q28		Datum : 24.10.24		Koordinaten (X/Y) : 711925 253110			
Flurname : Bodebach		Höhe ü.M. : 733		BearbeiterIn (leg) : Elena Santi			
KOPFDATEN (nicht bewertet, nur Infos) ! Skizze / Bemerkungen / Gefährdung / Massnahmen => auf der Rückseite (wird gescannt) !				Ausfüllen oder zutreffendes ankreuzen ☒			
Austrittsform (Liste)	künstlich	Quelle (Grösse [m²])	6	Vernetzung	Einzelquelle ☒ Q-system ☐ Q-komplex ☐		
Hanglage	Oberhang	Quellbereich [m²]	6	Dist. zur Nachbarquelle (m)	Anz. Austritte 1		
Abflussrichtung	N	Quellbachlänge [m]	-	Bemerkungen DO: [%]: 86.9%, pH 7.24. Wasser versickert im Boden.			
Geländeneignung	mässig	Wassertemperatur [°C]	13.4				
Quellschüttung	ganzjährig	Quellschüttung [l/s]	1.0	Fotos und andere Dokumente ☒	ID TG_Q28_20241024.pdf		
mittl. Fliessgesch.	mässig	Leitfähigkeit [µS20/cm]	600	Trinkwassernutzung ☐	Schutzstatus ☐ Kulturhistorische Bedeutung ☐		
Bewertung Teil A : Beeinträchtigung		Zutreffendes mit "1" markieren 1		Bewertung Teil B : Vegetation-Nutzung-Struktur			
Zutreffendes mit "1" markieren 1				Zutreffendes mit "1" markieren 1			
Einträge/Verbau		Vegetation/Nutzung					
Fassung		Einzugsgebiet Umfeld Quellbereich Quellufer Quellbach					
Brunnenstube mit Überlauf ☐		standorttyp. Vegetation 1 1 1 1					
Rohr und Becken ☐		standorfrem. Vegetation ☐					
nur Rohr/Rinne ☐		Moosgesellschaften 1 1 1 1					
		Zwergstrauchheiden ☐					
		Hochstaudenfluren ☐					
		Laubwald ☐					
		Mischwald 1 1 1 1					
		Gebüsch ☐					
		standorttyp. Nadelwald ☐					
		standortfremd. Nadelwald ☐					
		extensivgenutz. Offenland 1 ☐					
		intensivgenutz. Offenland ☐					
		Acker/ Sonderkultur ☐					
		unbefestigter Weg ☐					
		befestigter Weg/Strasse ☐					
		künstl. veg.-frei/Siedlung ☐					
Wasserentnahme		Sommerbeschattung					
>60% ☐		unbeschattet ☐ schwach 1 mittel ☐ stark ☐					
30-59% ☐		stark & Überdachung oder Nadelforst ☐					
<30% / unbekannt 1 ☐							
keine ☐							
Bemerkung / Zweck :							
Verlegung		Struktur					
10-100m ☐		Substrat					
<10m ☐		stark (>50%) mittel (>20%) gering (>1%)					
unbekannt ☐		->natürlich					
alt ☐		Fels/Blöcke (>20 cm) ☐					
neu ☐		(Kiesel) Steine (6-20 cm) ☐					
		Kies/Schotter (0.2-6 cm) ☐					
		Sand (0.1 - 2 mm) ☐					
		Feinmaterial (<0.1 mm) ☐					
		Moospolster 1 ☐					
		Wurzeln ☐					
		Totholz ☐					
		Pflanzen 1 ☐					
		Falllaub ☐					
		Detritus/Org.Schlamm ☐					
		Kalksinter...* ☐					
		Anzahl Substrate 8					
		stark (>50%) mittel (>20%) gering (>1%)					
		künstlich ☐					
		->verändert (nur Infos) Fadenalgen ☐					
		Strömungsdiversität					
		Spritzwasser 1 glatt ☐ fliegend 1 überfliegend ☐					
		gerippt 1 plätschernd 1 überstürzend ☐ fallend 1					
		Anzahl Strömungen 5					
		Wasser-Land-Verzahnung					
		gross ☐ mittel ☐ gering 1					
Aufstau		Besondere Strukturen					
nach <10m ☐		Laufverzweigung ☐ Inselstruktur ☐ Quelflur ☐ Sandwirbel ☐					
nach >=10-49m ☐		gr. Tiefenvarianz ☐ natürl. Pools ☐ Kaskaden ☐ Wasserfall 1					
unbekannt ☐		Fließshindernisse 1 Wassermooos ☐ Lückensyst. ☐ Rieselflur ☐					
Hauptschluss, 1-5 m2 ☐		Anzahl Strukturen 2					
Hauptschluss, >5 m2 ☐							
Nebenschluss ☐							
kein ☐							
künstlicher Absturz							
Gesamtabfluss 1 ☐							
Teilabfluss ☐							
nein ☐							
Verbau* (Ufer, Sohle)							
stark ☐							
mittel ☐							
gering ☐							
Holz ☐							
Steinschüttung ☐							
wilder Verbau ☐							
Naturstein ☐							
Beton 1 ☐							
Verrohrung ☐							
kein ☐							
Unterhalt/Trittschäden							
gering ☐							
mässig ☐							
stark ☐							
keine 1 ☐							
Ursache :							
Infrastruktur							
Bänke / Parkplatz ☐							
Zuwegung ☐							
Trittsteine ☐							
Überdachung ☐							
Wildfütterstelle ☐							
Viehtränke ☐							
Feuerstelle ☐							
Sonstiges ☐							
Anzahl Infr. 0							
Sonstiges :							
Ablagerung*							
Deckungsgrad :							
vollständig ☐							
teilweise ☐							
vereinzelt ☐							
Haus-/ Gewerbemüll ☐							
Holzabfall ☐							
Pflanzenabfall ☐							
Erdaushub/ Bauschutt ☐							
org. Reste/ Faulschlamm ☐							
keine 1 ☐							
Einleitungen							
unverdünt ☐							
Oberfläche / Strasse ☐							
Rohr trocken ☐							
Drainage / Graben ☐							
keine 1 ☐							
Distanz zum Quellaustritt (m)							
Wert A : Beeinträchtigung (höchster Wert)		5		Wert B : Vegetation-Nutzung-Struktur			
Revitalisierungsobjekt (Einschätzung)		JA / NEIN		2.00			
Klassierung / Classement :		Gesamteindruck als Bewertungsvergleich		Bonus b -0,4 Punkte bei guter Struktur -> Aufwertung -			
naturnah				0			
bedingt naturnah				Gesamtergebnis ((A+B)/2)-b			
mässig beeinträchtigt				3.50			
geschädigt				Quelle nicht bewertbar :			
stark geschädigt				Q. zerstört			
				Zutreffendes ankreuzen [x]			
				kein Abfluss			

TG_Q28



Personal Declaration

I hereby declare that the submitted thesis is the result of my own, independent work. All external sources are explicitly acknowledged in the thesis. Artificial Intelligence (AI) was used to generate R code, correct grammatical errors in individual text paragraphs and improve sentence structure. The content, structure and interpretation of this thesis are entirely my own work.

Zürich, 14. August 2025

A handwritten signature in black ink, reading "E. Santi". The signature is written in a cursive, flowing style.

Elena Santi