



Naturpark
Møllerdall
Geopark

APPLICATION DOSSIER

for UNESCO Global Geopark



Møllerdall Geopark



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The following annexes exist as separate documents:

- Annexe 1: Self-evaluation document
- Annexe 2: A separate copy of section B
“Geological Heritage”
- Annexe 3: Letters of endorsement and support
- Annexe 4: A large scale map of the proposed
UNESCO Global Geopark
- Annexe 5: 1-page geological and geographical
summary

A Identification of the Area

A1. Name of the proposed Geopark: Mëllerdall Geopark

“Mëllerdall” is the Luxembourgish expression for „valley of the mills”. Being originally the name of a small hamlet in the area, Mëllerdall (also spelled Mullerthal or Müllerthal) has become the established name of a larger region in the east of Luxembourg. This region has its own designated strategies for regional planning and is also used by different organizations such as LEADER-LAG¹, ORT-MPSL² and the Nature Park Mëllerdall. The name originates from the numerous mills that, in former times,

operated along the river Sauer and its tributaries Black Ernz and White Ernz as well as along smaller creeks. The water that feeds the rivers emerges out of the important Luxembourg Sandstone aquifer in addition to other sandstone and dolomitic units. Today, several of these springs are used for the supply of drinking water, allowing the municipalities of the region to be nearly fully self-sufficient in this respect.

Since the late 19th century, the rocky landscape of the Luxembourg Sandstone Formation has been touristically promoted as “Luxembourg’s Little Switzerland” (“Petite Suisse Luxembourgeoise”). With its great variety of sedimentary and weathering structures, the up to 100 m thick sandstone unit forms one of the most spectacular and impressive sandstone landscapes in Western Europe. The formation constitutes the central part of a small-scale cuesta landscape with a large variety of geomorphological forms. The sequence of different rock types has provided areas for settlement and farming and allowed the exploitation of natural resources such as groundwater or building stones. Since the Stone Age, the influence of human activity has turned the natural landscape into a cultural one, rich in biodiversity and with a large diversity of ecological niches.

A2. Location of the proposed Geopark

The Geopark is situated in Eastern Luxembourg. Address and geographical coordinates of the park administration:

Maison du Parc:

8, rue de l’Auberge,
L-6315 Beaufort

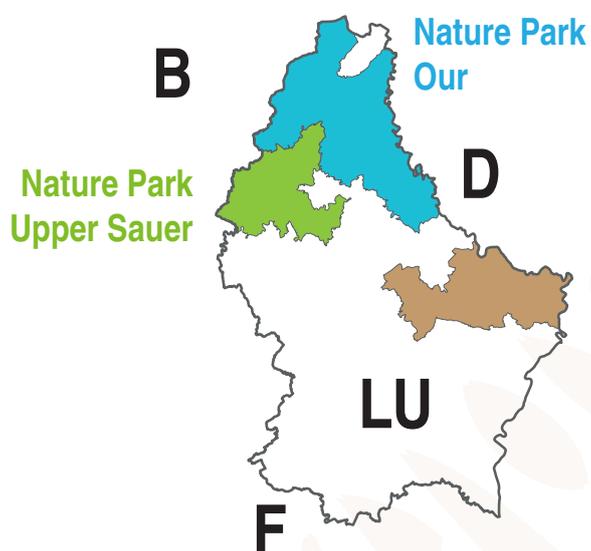
(6° 17’ 31.7” E | 49° 50’ 04.2” N)

Luxembourg is one of the smallest countries in Western Europe with an area of 2586 km², bordering France, Belgium and Germany. It is situated in the centre of the Saar-Lor-Lux region, the so-called “Greater Region”.

¹: LEADER-LAG: “Liaison Entre Actions de Développement de l’Economie Rurale”, a European initiative, Local Action Group LEADER Region Mëllerdall

²: ORT-MPSL: Regional Tourism Organisation “Mullerthal – Luxembourg’s Little Switzerland”

Location of the Mëllerdall Geopark

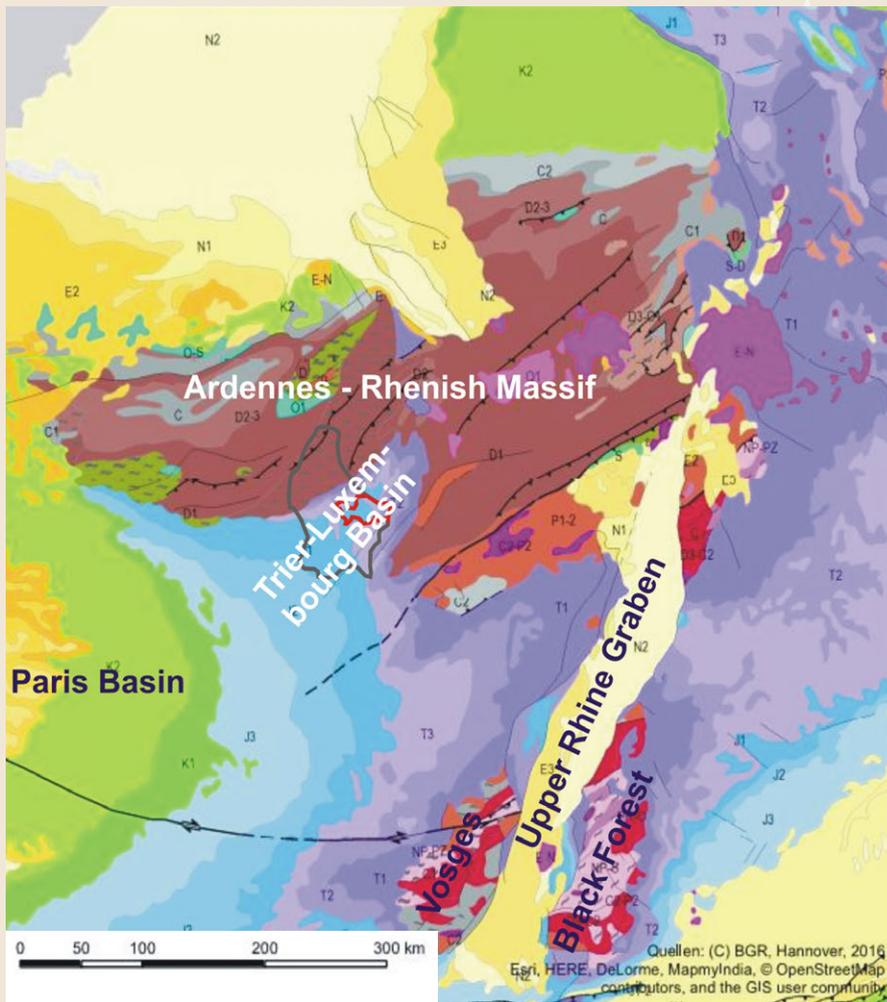


Nature Park Mëllerdall Geopark



The Mëllerdall Geopark's surface is defined by 12 municipalities which also form the outer borders of the park. The river Sauer forms a natural border to Germany on the eastern and north-eastern side of the park.

Location on the geological map



The Mëllerdall Geopark is situated in the centre of the Trier-Luxembourg Basin, a synclinal structure of Mesozoic Rocks on the north-eastern rim of the Paris Basin, extending into the Rhenish Massif.

Luxembourg is geologically divided into a southern half, called “Guttland” (“good land”) and a northern half, called “Éislek”, which is a part of the Ardennes – Rhenish Massif area. The Mëllerdall Geopark is located in the north-eastern part of Guttland, the border of the Éislek is around 10 km to the North.

The youngest sediments of the region are characterized by the Luxembourg Sandstone, a sandy facies of Lower Liassic age (a sandstone with calcareous cement) which is a lenticular body embedded into a clayey and marly³ “Lorraine normal facies”.

A3. Surface area, physical and human geography characteristics of the proposed Geopark

The **surface area** of the Mëllerdall Geopark is 256 km², which is about 1/10 of the country’s total surface area. The area of the Park has a permanent population of about 23,000 inhabitants (4.5 % of the population of the country). Seasonal tourism however, especially during high season (July and August) increases the area’s population by a fivefold.

The **largest town** and centre of the region with 5,500 inhabitants is **Echternach**. It is also the oldest town of Luxembourg, founded in 698 by Saint Willibrord, a Northumbrian missionary, who established the famous Abbey of Echternach, where his remains are buried and where monks developed one of the most important scriptoria in the Frankish Empire.

³: “marly” and “marl” are used in the sense of (like a) “marlstone”, an indurated marine deposit



The **Dancing Procession of Echternach** is founded on the cult of Saint Willibrord. It is a religious event, deeply rooted in regional traditions and is expressed through prayer, song and dance. Nowadays, the procession is supported by the civil and religious authorities and attracts an average of 13,000 participants each year from Luxembourg and the neighbouring regions. In 2010, the procession was included in the Representative List of the Intangible Cultural Heritage of Humanity of UNESCO.

In 1886, thanks to the invention of the lead accumulator by the Luxembourgish engineer Henri Tudor (1859 - 1928) **Echternach was amongst the first cities in the world to have electrical light.**

The Mëllerdall Geopark is part of the **cuesta landscape of the Luxembourg Guttland**, the southern part of Luxembourg (the name "Guttland" referring to the climatic and soil-conditions, which are favourable for agriculture). It is formed by sediments of Triassic and Jurassic age and is characterized by three geomorphological units, roughly differentiated into:

- » the plateaus of the Luxembourg Sandstone Formation and the dolomites, extending to altitudes slightly above 400 m and deeply incised by rivers and creeks,
- » gently undulating hillsides in marly substrate and
- » the major valleys of the rivers Sauer and Alzette.

The **lowest point** of the Geopark, with an altitude of about 140 m, is located in the south-east of the area, in the Sauer valley. The rivers Alzette, White Ernz and Black Ernz are tributaries of the river Sauer. The whole area is part of the drainage basin of the Moselle river.

The **annual mean temperatures** in the region are 8 - 9.5 °C, with 17 °C in the summer and 0 °C in the winter in mild positions. Annual precipitation is about 700 - 800 mm. The climate is characterized by transitional conditions from atlantic to continental and is favourable for agriculture.

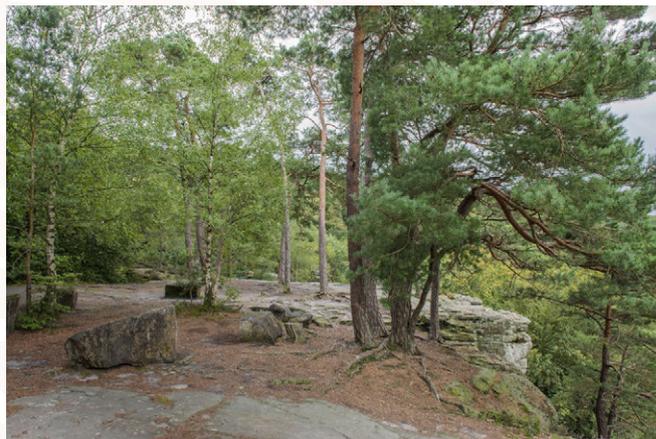
The Luxembourg **Sandstone Formation** is the most important aquifer in terms of **drinking water supply**, with a long-term continuous discharge



and excellent filtering capacities. Water from dolomitic layers of the Muschelkalk is used to a minor extent. Smaller groundwater reservoirs in limestone, dolomite and sandstone layers often run dry during the summer months, while small rivers on marly substrate run only periodically after precipitation events.

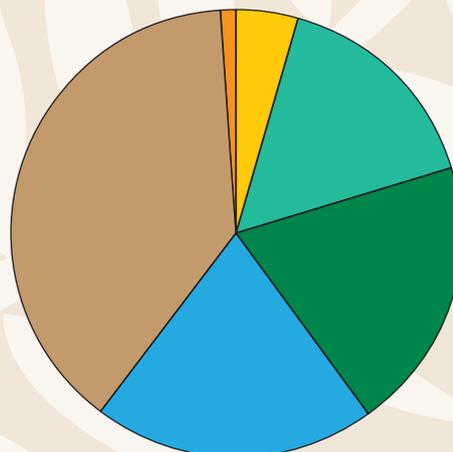
The Möllerdall Geopark is a **rural area**. Land use changes depending on topography and soil types and changes depending on the substrate. The plains, plateaus and shallow slopes with fertile soils on marly or dolomitic substrate are mostly used for agriculture. Meadow orchards are typical elements of this historically grown cultural landscape. The steep slopes, mainly constituted by dolomites or sandstone, are covered by wood, mainly deciduous and mixed forests (*Melico-* and *Luzulo-Fagetum*, on regolith also *Tilio-Aceretum*). *Ilex aquifolium* is proof of the atlantic climatic conditions in the valleys. *Pinus sylvestris* is present on the sandy, easily parched edges of the plateaus. While *Pinus sylvestris* might be autochthonous, as are *Juniperus communis* and *Taxus baccata*, other conifers are of anthropogenic origin.

The region is highly regarded for its **botanical specifics**. Extreme microclimatic conditions along the high rock faces and in narrow gorges which tend to mimic the oceanic climate of the European Atlantic fringe, favour the occurrence of a great variety of ferns and mosses worth protecting. Some of these have one of their rare incidences in Continental Europe here (e.g. *Hymenophyllum tunbrigense* and *Trichomanes speciosum*).



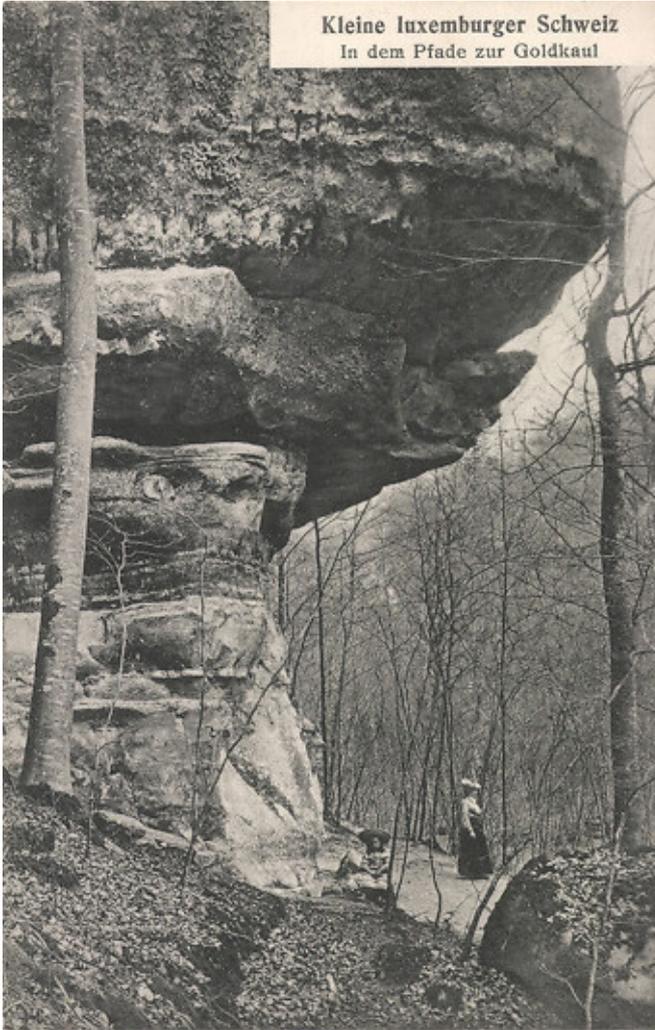
Land use

- artificial surfaces (4.5 %)
- arable land (16 %)
- pastures (20 %)
- heterogenous agricultural areas (20.5 %)
- forests (39 %)
- water bodies (< 1%)



Database:
Corine Landcover

Kleine luxemburger Schweiz
In dem Pfade zur Goldkaul



The **natural resources** of the Geopark region have been used by man since prehistoric times. Archaeological findings show the Mëlldall to be an important archive of the early history of Luxembourg. The oldest human skeleton in Luxembourg was found in the area, in the valley of the Black Ernz. In ancient times, geomorphological forms like ledges, rock overhangs, caves and open joints have been used as temporary settlement areas, shelter and burial grounds. Remnants of a Roman villa and some medieval castles are present and can be visited in the area as well. Today, the main settlement areas are plateaus and hillsides, as well as the valleys of the rivers Sauer and White Ernz, which are used mainly for agriculture. Natural resources like water and building stones have been exploited by man since his early days, and today the region is nearly self-sufficient in its supply of drinking-water from groundwater. Some water is even exported to neighbouring municipalities.

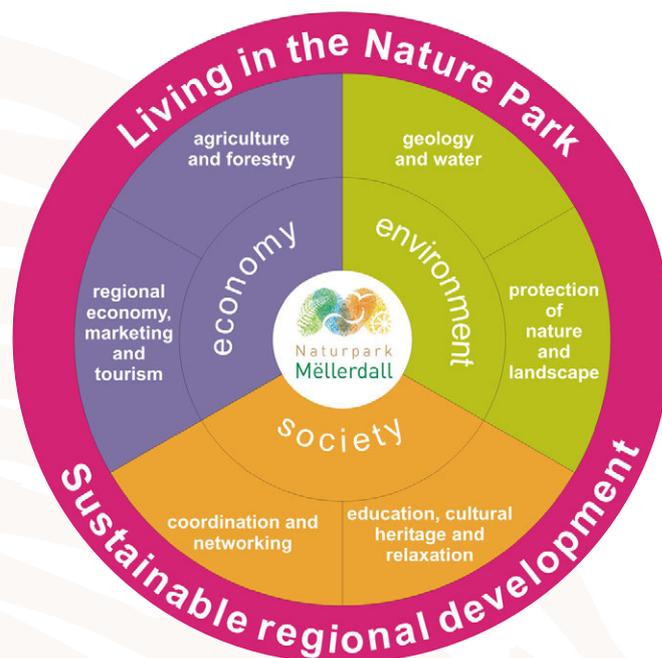
The **touristic tradition** dates back to the late 19th century and is mainly based on the picturesque landscapes and is still highly active today. Activities such as hiking and rock climbing take place on well signposted trails and in defined areas.



A4. Organization in charge and management structure (description, function and organogram) of the proposed Geopark

The Nature Park Mëllerdall is in charge of the management of the Mëllerdall Geopark since 2016. Since 2011, the activities of the Geopark were managed and coordinated by the Geology working group. This group comprised of members of a number of scientific, administrative and touristic organizations. Members of this group have carried out a large number of projects, that were partly managed by the RIM⁴ and co-financed by LEADER.

The Nature Park Mëllerdall is a recognized body under national legislation (Law of 10th August 1993 on Nature Parks). It was established by the by-law of 17th March 2016 (Règlement grand-ducal du 17 mars 2016 portant déclaration du Parc naturel du "Mëllerdall").



According to Luxembourg law, a Nature Park is an instrument of **regional planning and focuses on regional sustainable development** and therefore

shares common goals with the Geopark.

The objectives as defined in legislation are:

- » preservation and restauration of its high-value natural and cultural heritage;
- » protection of air, water and soil quality;
- » promotion and orientation of economic and sociocultural development and improvement of employment possibilities and local quality of life;
- » promotion and orientation of touristic and leisure activities.

The active involvement of the national and municipal government in the Nature Park and the Geopark ensures the preservation and further development of the specific characteristics of the region.

Based on the specialized knowledge of the staff and the structural framework of the park, the Nature Park Mëllerdall is an important platform for networking and for offering various services in the region. It creates considerable and sustainable synergies between different actors.

The overall concept of the Nature Park Mëllerdall has been developed in a **bottom-up approach** by local people, municipalities and national institutions. The concept is defined in a master plan, the so called "étude détaillée", which is valid for a period of 10 years.

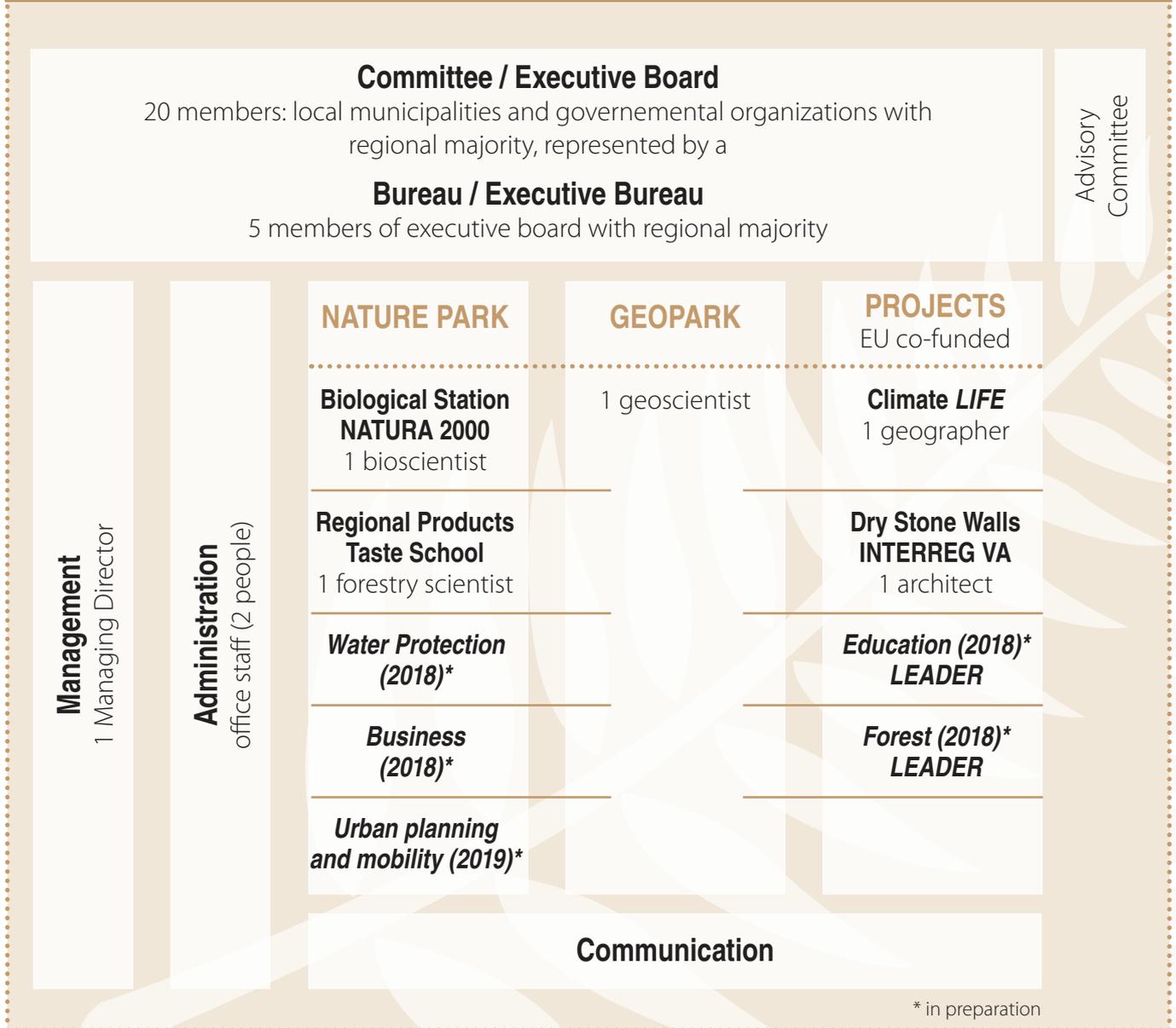
The guiding themes are

- » Development and promotion of regional products
- » Promotion of the use of regional timber,
- » Self-sufficiency in drinking water
- » Diversity of landscapes
- » Transfer of knowledge
- » Preserving a livable region for all creatures and inhabitants.

A **special master plan** and a **plan of action** for the topic "**Geology**" has been developed with their main goals being the strengthening of regional identity through improving knowledge of the region, raising awareness on the value of landscapes, as well as strengthening of tourism and regional development. The park's guiding motto is: "You only see what you know".

⁴: RIM: "Regional Initiative Mëllerdall", a non-profit association and a predecessor organization of the Nature Park, founded to improve regional development

The Mëllerdall Geopark is integrated in the structure of the Nature Park as follows:



The committee includes one administrative member from each of the 12 municipalities and one member from the following governmental bodies:

- » Ministry of Sustainable Development and Infrastructure (Spatial Planning, Environment, Water Management, Nature- and Forest management)
- » Ministry of Agriculture, Viticulture and Consumer Protection
- » Ministry of Culture
- » Ministry of Home Affairs
- » Ministry of the Economy, Tourism

The work of the Executive Committee is supported by an Advisory Committee comprising delegates from social, economic, ecological, touristic and cultural organizations, as well as the local population.

The Geopark cooperates with various stakeholders in order to reach the objectives:

- » The **Geology working group** unites various regional stakeholders, members of municipalities, ministries, administrations, associations and citizens. It accompanies the Mëllerdall Geopark through initiating projects and assuring their follow-up, as well as assisting with their implementation. The group meets at least 4 times a year.
- » The **scientific committee** of the Mëllerdall Geopark unites partners of national and international scientific institutions. It consists of the following members: the Geological Survey of Luxembourg (SGL), the National Water Management



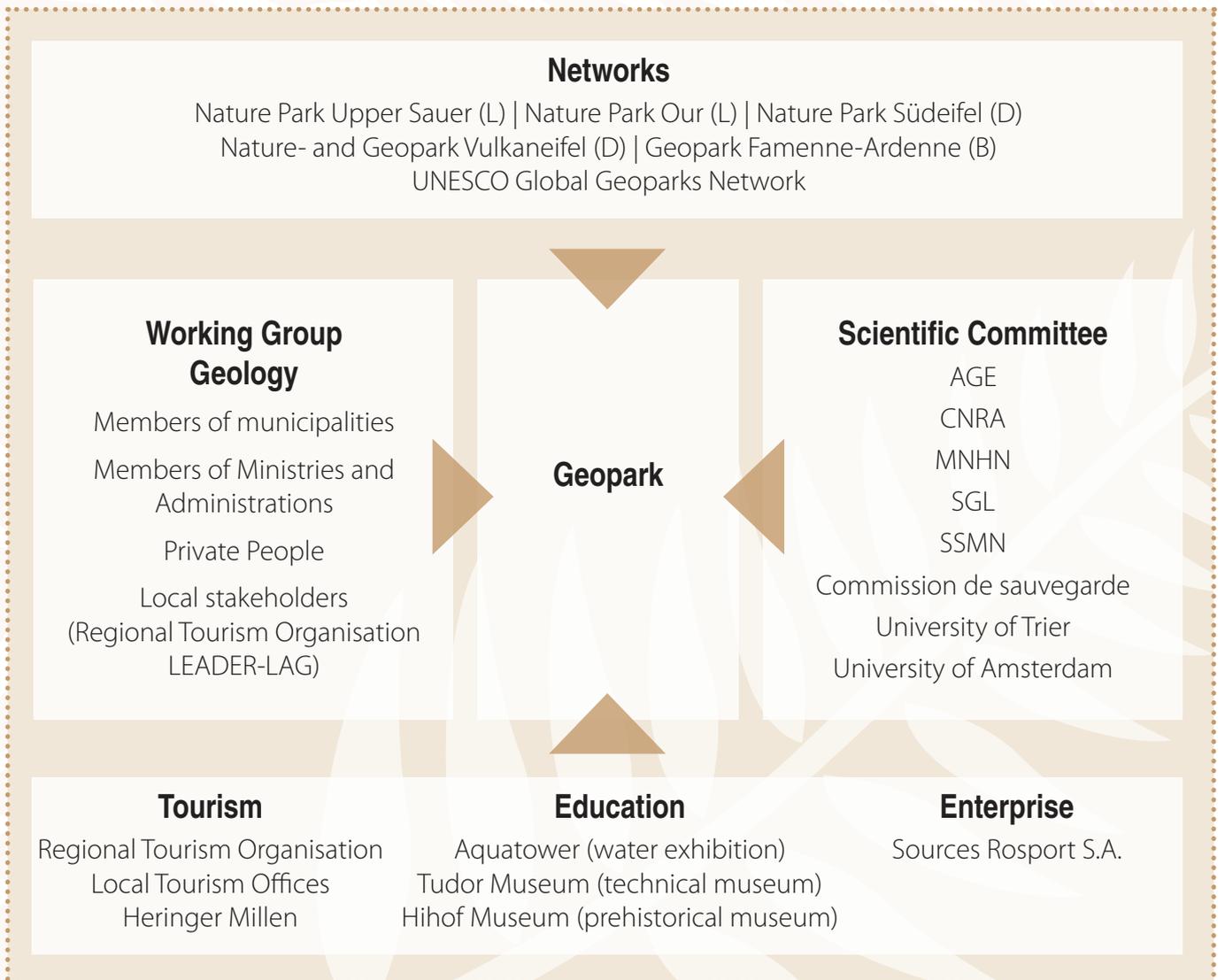
Agency (AGE), the Museum of Natural History (MNHN), the National Archaeological Research Centre (CNRA), the National Service of Sites and Monuments (SSMN), the Commission for the protection of the sandstone landscape (Commission de sauvegarde de la "Petite-Suisse" et de la région du grès de Luxembourg), the University of Trier (D) and the University of Amsterdam (NL). The committee comes together at least two times per year.

» **Tourism:** The Regional Tourism Organisation and local tourist offices assist in the promotion of the Mëllerdall Geopark through the display of leaflets and brochures.

» **Education:** Different museums and schools are integrated in the concepts of the Geopark. Their role is to raise young people's awareness of their region and the sustainable handling of the environment.

» **Enterprises:** Some enterprises that are related to geology cooperate with the Geopark.

» **Networks:** Cooperation and networking with other Nature Parks and Geoparks helps with enhancing the work of the Geopark.





The **budget of the Mëllerdall Geopark** is decided on an annual basis by the Committee. The Nature- and Geopark's income consists mainly of contributions from member municipalities and of the Luxembourgish government. Additionally, some income is generated through services and interests as well as through donations and bequests.

The staff of the Nature Park and Geopark is co-financed (between 50 % and 80 %) by the Ministry of Sustainable Development and Infrastructure. The Ministry is also financing an important part of the management fees. The co-financing is formally determined by specific conventions between the Ministry and the Nature Park structure. Further projects concerning the Nature Park and the Geopark are annually paid by the Ministry of Sustainable Development and Infrastructure.

Furthermore, the Nature Park and Geopark are, together with international partners, involved in different sustainability projects that are co-financed by the European Union (INTERREG VA, LEADER, LIFE) and by the government. Current projects include the INTERREG VA project on dry stone walls and the LIFE-IP project ZENAPA ("Zero Emission Nature Protection Areas"). These projects favour international networking among scientific institutions and other Nature- or Geoparks.

The Ministry of Sustainable Development and Infrastructure, in partnership with the three Luxembourgish Nature Parks, is currently working on the creation of a label for regional products. A specialized member of the staff is co-financed by these 4 partners in order to further develop and interconnect the network of regional farmers and producers.



A5. Application contact person (name, position, tel./fax, e-mail)

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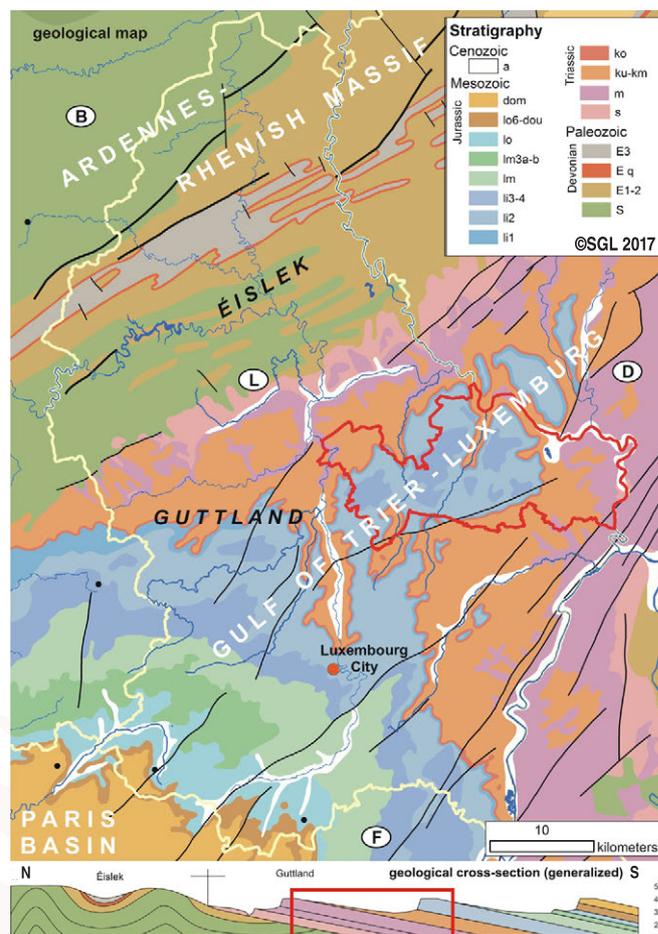
B Geological Heritage

B1. General geological description of the proposed Geopark

The proposed Geopark comprises the central part of the Trier-Luxembourg Basin, an extension of the Paris Basin to the north-east. The geological subsoil of the proposed Geopark is formed by different sedimentary strata. The detritic and evaporitic layers were deposited during the Triassic and the Lower Jurassic. Today, the area forms a small-scaled cuesta landscape with a high geodiversity in a south-west north-east oriented synclinal structure. Many outcrops and geomorphological forms tell the story of the geologic and geomorphological evolution of the landscape. This makes the region a textbook-illustration of sedimentology and geomorphology. The landscape is also an archive of human history, as different natural resources related to geology have been used by man since the early days. Examples include easily accessible drinking water and the quarrying of building stone. Geomorphological forms were used as (temporary) settlement areas, shelter or burial ground.

Geological history Mesozoic

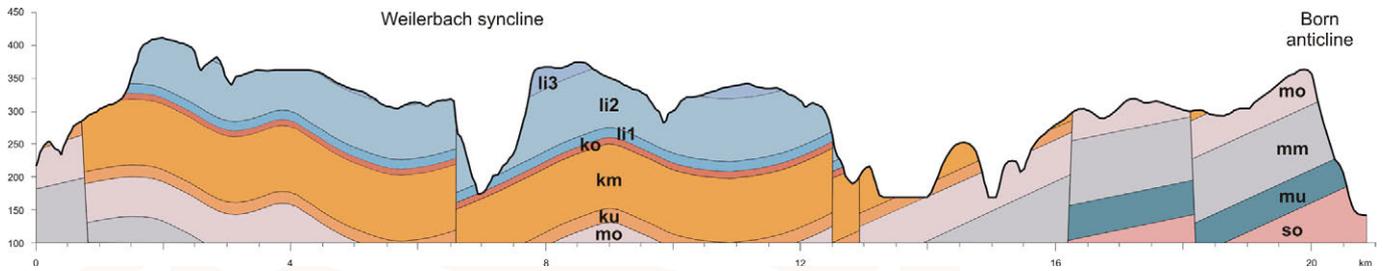
The sedimentary rocks of the region were deposited in a (tectonical induced) depression of the fold axis in the eroded and subsided Variscan mountain belt. This depression formed a sub-basin between the London-Brabant Massif and the Rhenish Massif at the western edge of the German Triassic Basin during the early Triassic and a subbasin of the north-eastern Paris Basin since the late Triassic. The general direction of the near coastlines changed from their general north/south to an east/west orientation during that time. The German Triassic Basin expanded continuously to the west and as such holds deposits of continental and marine environments as littoral facies from lagoons and inland seas of only shallow depth. The preserved Mesozoic rocks, with a total thickness of about 500 m, are subdivided into lithostratigraphic units, using the nomenclature of the German Triassic subgroup with its tripartite subdivision of Buntsandstein, Muschelkalk and Keuper. The Lower Jurassic units show subdivisions used in the Paris Basin and are also deposits of a shallow marine environments.



Together, these rocks form the “Gulf of Trier-Luxembourg”, an erosional remnant of the initially further-reaching deposits of the Trier-Luxembourg Basin.

Due to its post-Variscan tectonics, mainly characterised by fracture tectonics affecting the consolidated crust, the Trier-Luxembourg Basin is subdivided by large-scale undulations and by some SE-NW striking faults. The main structures in the region of the Geopark are the Weilerbach syncline and the Born anticline. The succession of Triassic to Lower Jurassic sedimentary rock fills in this synclinal structure south of the transition to the Palaeozoic rocks of the Éislek.

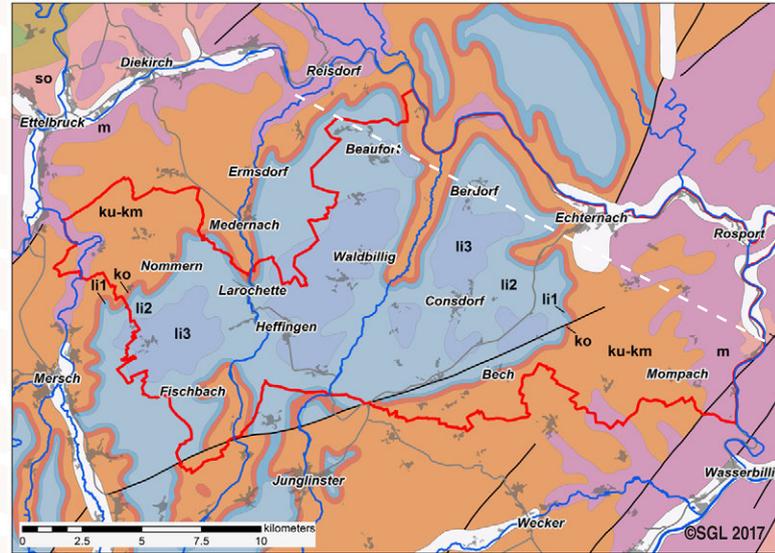
The oldest rocks in the area of the Geopark are of Lower Triassic age and belong to the Buntsandstein group. Some 40 m red-coloured, mainly fluvial **sandstones** crop out in the Born anticline as the uppermost part of this up to several hundred meter thick unit, which lies unconformably on the Variscan basement. Transgressive marine conditions



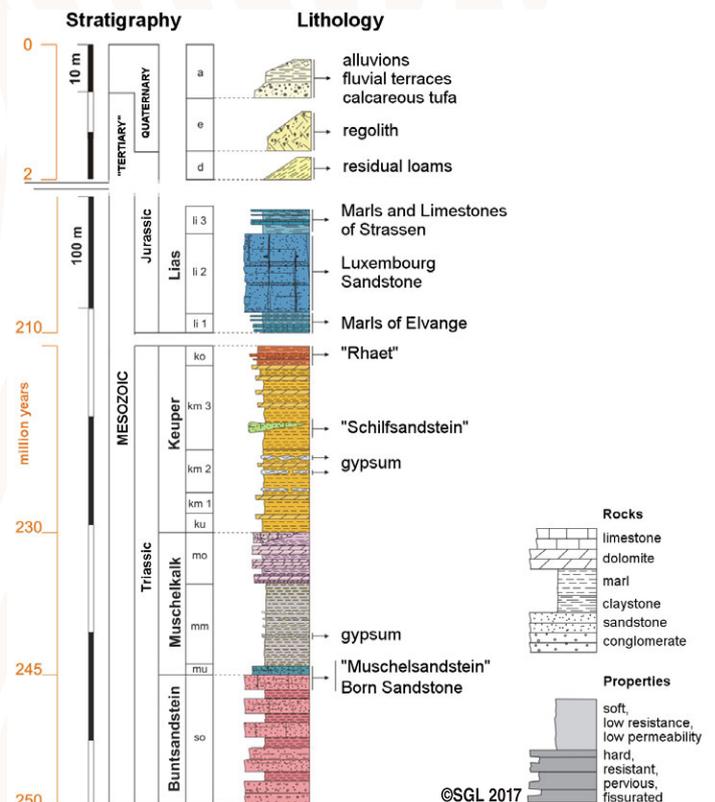
during the Muschelkalk led to a succession from a sandstone during the Lower Muschelkalk to evaporitic and dolomitic **marls with gypsum lenses** of a lagoon environment (100 m) and further on to the about 50 m thick **dolomitic succession** of the Upper Muschelkalk group. A regional regression triggered the return to a clastic-evaporitic environment of the Lower and Middle Keuper. More or less monotonous series of **marls** of up to 170 m thickness with intercalated **gypsum lenses** and **sandstone** channels of the "Schilfsandstein" were deposited at that time.

The Upper Keuper (Rhaetian) marks the return to a fully marine environment of the Lias, when detritic material was delivered from the north through the "Eifel Depression" between the London-Brabant Massif and the Rhenish Massif. While the sediments of Lower Jurassic age (Lorraine normal facies) are generally blueish grey, fine grained, marly and locally calcareous, here, in the vicinity of the coastline of the Ardenne mainland, the large sand body of the **Luxembourg Sandstone** developed as a tidal influenced offshore sandwave complex, intercalated in the Lorraine normal facies. It is a 50 - 100 m thick quartz sandstone with calcareous cement, more cemented parts being classified as calcareous sandstone whilst less cemented parts as sandstones. The different content of calcareous matrix results from the diagenetic redistribution of calcite. Its yellowish colour above the permanent water table derives from oxidized Pyrite, while below the permanent water table, its colour is grey.

The name Luxembourg Sandstone, coined in 1828, is derived from its important outcrops in Luxembourg City. The stratigraphic term, the Hettangian, has been defined near the city of Hettange-Grande (F) in the Luxembourg Sandstone, only some 45 km to the south of the Geopark. The sandstone unit was deposited diachronously in a south-western direction, following the Weilerbach syncline in the region of the Geopark. The synclinal structure induces a dipping of the strata towards the axis of the syncline, while the general dip of the strata is very slightly to the south-west, towards the cen-



tre of the Paris Basin. The Luxembourg Sandstone, outcropping in the centre of the syncline, extends from the Bitburger Gutland in the east (Germany) towards Charleville-Mézières in the west (France and Belgium). It is believed, that Middle Jurassic sediments, outcropping in southern Luxembourg, did not reach as far as the Geopark region, this area has probably been mainland since.



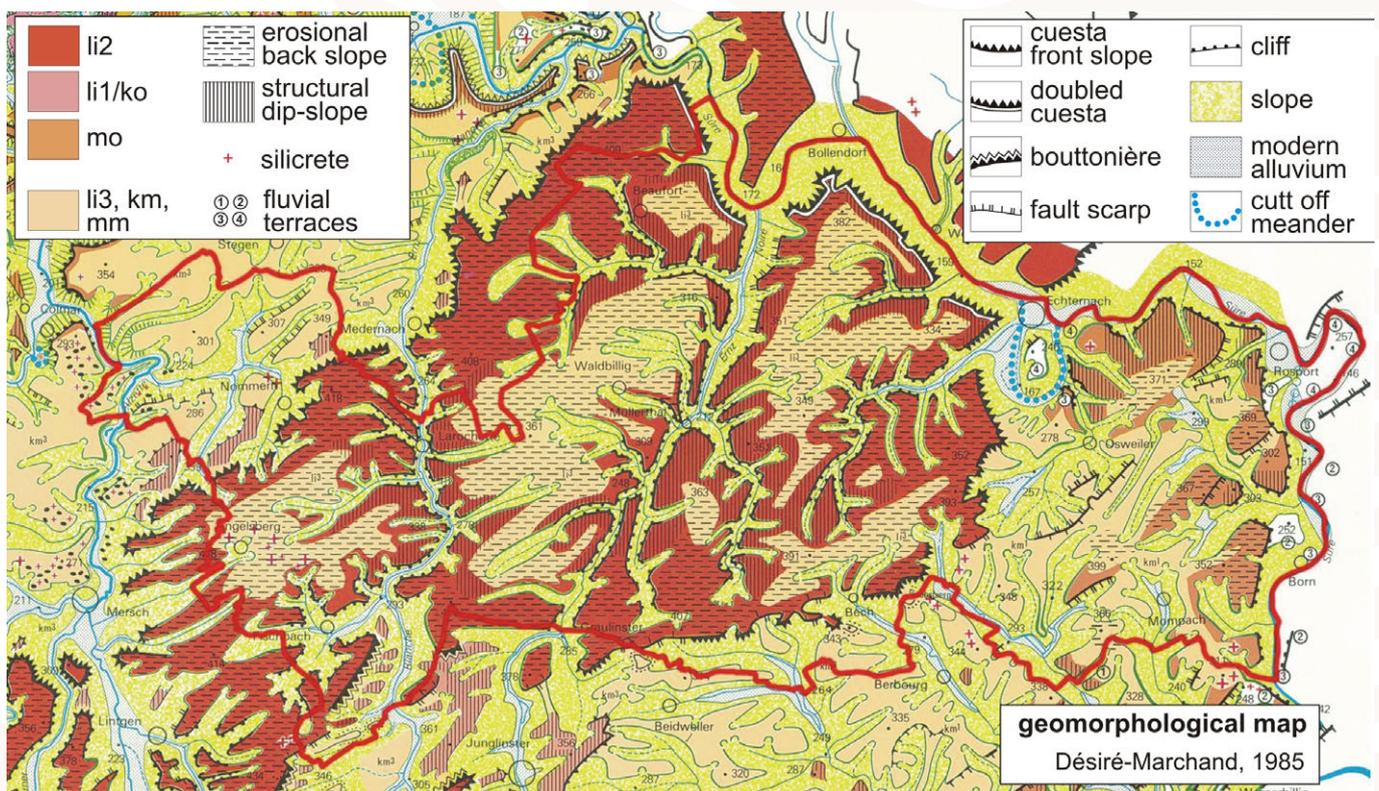
Cenozoic (Geomorphology)

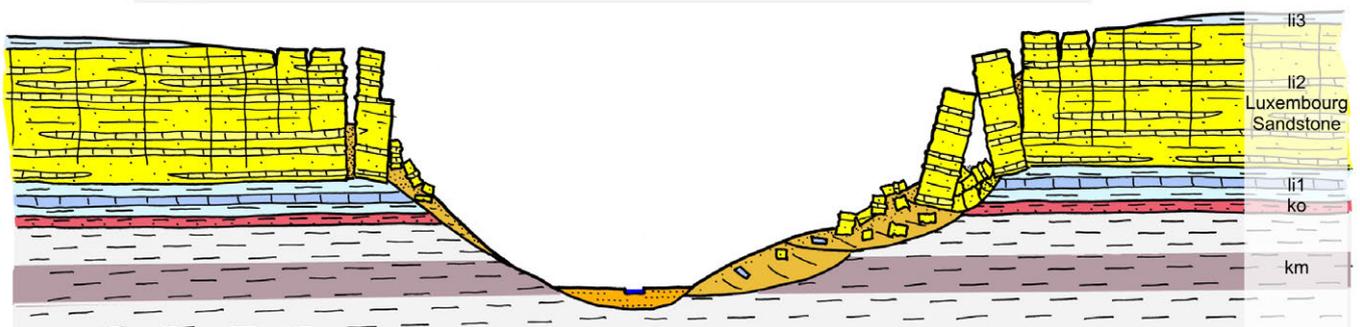
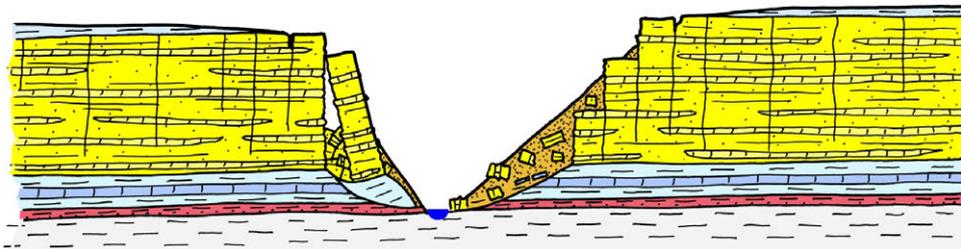
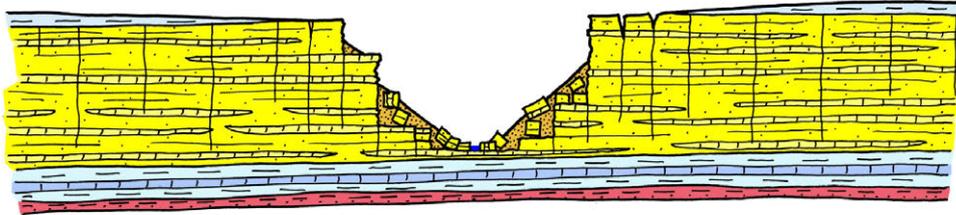
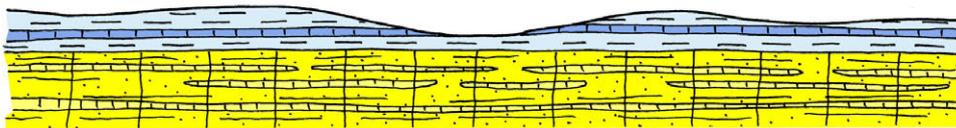
Evidence for the evolution of the landscape (the geomorphological history) exists mainly for the Cenozoic. During the warm and humid Palaeogene, an erosional surface existed slightly above sealevel, cutting the succession of the inclined strata nearly horizontally, with no larger differences in altitude. At that time, the formation of bog iron ore took place, which was an important resource for steel-production in the Geopark region until the midst of the 19th century.

The late Cenozoic geomorphological history is characterized mainly by fluvial and gravitational processes, which were induced both by tectonics and climate. Lowering of the sea-level and uplift of the region took place probably during the Eocene, finally since the Miocene and accelerated in the last 800,000 years. During the climatic conditions of the Pleistocene, varying resistance to weathering and erosion of the different rock types became more important. The rivers cut epigenetically through the Jurassic and Triassic strata. In consequence, fluvial and gravitational processes shaped a cuesta landscape with a high geodiversity in the succession of hard and soft rocks. In today's cuesta landscape, remnants of the Palaeogene erosional surface can only be found on the escarpments in altitudes of 400 m. This is the same in the 4 main cuestas of Luxembourg's Gutland. The relatively thin strata

and their dipping of less than 10 ° caused a cuesta landscape with a high range of interesting geological and geomorphological structures on a small scale. As a consequence of the synclinal structure and the erosion processes, two cuesta escarpments of the Luxembourg Sandstone are exposed in the region, delimiting a plateau, whose north-western and south-eastern rims are only about 10 km apart. They form steps of more than 100 m, rising over the lower, slightly undulated landscape, mainly formed in Middle Triassic marls. The plateau was epigenetically dissected by rivers and creeks, exposing high cliffs at the valley slopes. Geomorphological forms like fluvial terraces, a meander shortcut, numerous rockfalls and slides tell this geomorphological story and thus the vividness of geological processes active especially during the Pleistocene.

Especially on the rock faces of the Luxembourg Sandstone, an abundance of sedimentary structures, such as cross-stratification, lenticular bedding, calcite concretions and others can be seen. Their visibility is increased by erosional processes, leaving more calcareous strata protrude from the more erodible sandy strata.







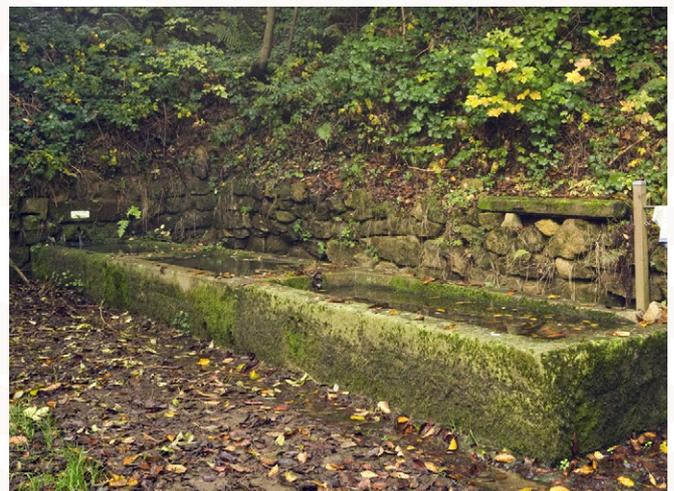
Honeycomb weathering, characterized by dissolution and re-crystallization of calcite, are observed on numerous outcrops.

The whole unit of the Luxembourg Sandstone is cut through by a nearly vertical, sub-orthogonal network of primary joints with an up to decametre-wide spacing. On the edges of the plateaus, where the rivers have cut through the whole sandstone body and expose the marly units beneath, the joints are generally widened by gliding or tilting, leaving small passageways (lux. "Schlëff"). Back-tilted slabs created caves. Lots of the slabs have toppled during the evolution of this landscape and the opening of the valleys, forming a sandy and blocky regolith on the slopes.

The joints also strongly influence the drainage system. Groundwater circulates through fractures and pores, accumulates at the base of the sandstone over the underlying, impervious marls and flows the dip direction to outlets or drains. The base of the sandstone is marked by large springs and diffuse

water outlets. One of the largest well even on the national scale, with a discharge of $> 3000 \text{ m}^3/\text{day}$, is located close to the hamlet of Müllerthal in the centre of the region. Smaller groundwater reservoirs form on top of marly interlayers within the sandstone unit or in dolomitic and calcareous beds inside the marly unity. Together, these reservoirs yield a broad spectrum of different ground waters with complex interactions. Due to the dissolution of the calcareous matrix of the Luxembourg Sandstone, probably also the limestone of the "Marls and Limestones of Strassen" on top of the unit, the groundwater is rich in Ca-carbonate. The formation of calcareous tufa can therefore be observed on several springs.

The genesis of mardels, small and often water filled depressions, are explained by dissolution of gypsum or limestone lenses or beds that were embedded in marly strata and the subsequent lowering of the surface. As a consequence of soil erosion processes in their surroundings, the mardels are refilled with quaternary sediments, making them highly interesting for palaeoecological studies.



The continuous long-term discharge and excellent filtering capacities of the Luxembourg Sandstone, and in addition, to a lesser degree, the springs pouring out of the thick dolomitic unit of the Upper Muschelkalk, allow a nearly fully self-sufficient drinking water supply of the region. The discharges of the springs pouring out of the Luxembourg sandstone aquifer are essential for the good ecological status of the rivers and creeks associated with ground water as the Black Ernz and the White Ernz.

Different geological strata, mainly sandstone and dolomite, were exploited in the Geopark region. They can be observed on many of the old buildings within the region and beyond. Dolomite was mainly used as quarry stone, while sandstone was also used as ashlar and worked into diverse forms.

These were an important economic factor in the past, as shown by a number of railway lines, that initially have been constructed for the transport of the quarried stones. Two quarries are still active today.

The region is also an archive of a valuable cultural heritage and rich in archaeological findings from all ages, going back to the Palaeolithic. Rock overhangs, caves and open joints were used as tem-

porary settlement areas, shelter and burial ground in ancient times. Rocky promontories and plateaus were preferred settlement areas, with many castles perched on them still visible today. Surface water was used to drive water wheels on grain mills, on stamp mills or to use bellows. Another energy supplier were the local forests, from which charcoal was produced and used to smelt bog iron ores from the surroundings in early blast furnaces.

Over the millennia, human influence changed the natural landscape into a cultural landscape. A close relation between geology and land use is still clearly visible today. On the marly and carbonate substrates of the plateaus and plains, fertile soils provide arable land, meadows and pastures, the exact use depending largely on soil moisture. Forests on this substrate forming a slightly undulated surface are mainly *Quercus-Carpinetum* forests. Towards the sandy edges of the plateaus where only a thin sandy soil cover exist, *Pinus sylvestris* becomes dominant. Where land use is extensive, rare plant societies worth protecting, like calcareous grasslands (with *Orchidaceae* or *Juniperus*), are preserved as relics of grazing on marly substrates. On sandy substrates, sites with dry grassland are



rare, while maize is the most grown crop under cultivation.

The sandstone landscape in the deeply incised valleys and the dolomitic landscape respectively, offer diverse habitats for a large variety of plants and animals (insects, different bat species, *Falco peregrinus*, *Bubo bubo*, ...), creating a remarkable biodiversity of international importance. The steep slopes are wooded, *Melico-* and *Luzulo-Fagetum* and, on slowly moving stony regolith, *Tilio-Aceretum*, being the most frequent and natural forest communities. Humidity is relatively high, allowing a huge number of ferns, mosses and lichens to grow on the thus shaded forest floor and on the rock faces. The region is considered one of the 50 most important regions of bryological interest in Europe. The small and narrow open joints ("Schlëff") are characterised by exceptional microclimatic conditions, humidity and temperatures are very constant during the year, cool in summer and warm in winter, and the even humidity levels – producing altogether oceanic climatic conditions – provide ideal conditions for the growth of highly specialized plants like the relict populations of the Tunbridge Filmy-fern *Hymenophyllum tunbrigense*, having one of its rare incidences on continental Europe here. *Ilex aquifolium* and *Trichomanes speciosum* are also found due to the atlantic climate in the region. The groundwater pouring out of the aquifers is important for the associated aquatic eco-

systems (e.g. in rivers) and groundwater-dependent terrestrial ecosystems (e.g. springs, calcareous tufa, mardels), which provide a habitat for specialized plants and animals.

Scientific research in the area

Geological and hydrogeological as well as geomorphological and geo-archaeological studies of the region have been undertaken by various national and international institutions and universities, and a large number of publications on botanical as well as archaeological studies exist. Studies with a focus on tourism are also carried out in the region. For more than 40 years, the region has been host to a large number of geological and geomorphological study trips and field internships of various universities. In 2005, the second international conference on sandstone landscapes took place in Luxembourg. The proceedings are published in RIES, C. & Y. KRIPPEL (2005): Sandstone Landscapes in Europe, Past, Present and Future. Proceedings of the 2nd International Conference on Sandstone Landscapes. - Ferrantia 44. - Luxembourg.

Selection of scientific publications on the region of the last 5 years:

- ADAMOVIČ, J., R. MIKULÁŠ & T. NAVRÁTIL (2015): Spherical and ellipsoidal cavities in European sandstones: a product of sinking carbonate dissolution front. - *Zeitschrift für Geomorphologie* 59, Suppl. 1: 123-149. - Stuttgart.
- ARENSDORFF, G. (2016): Bisher unbekannte Felsbilder zwischen Nommern und Angelsberg (Luxemburg). - *Bulletin de la Société Préhistorique Luxembourgeoise* 36-37.2014-2015: 69-96. - Luxembourg.
- BROU, L., M. COURT-PICON, J. DABDOWSKI & H-G. NATON (2016): Le gisement mésolithique d'Heffingen-Loschbour (G-D. De Luxembourg) – Bilan des études paléoenvironnementales depuis 2003. - *Bulletin de la Société Préhistorique Luxembourgeoise* 36-37.2014-2015: 173-192. - Luxembourg.
- KORPELA, K.M., E.-M. SAVONEN, S. ANTTILA, T. PASANEN & E. TATCLIFFE (2017): Enhancing wellbeing with psychological tasks along forest trails. - *Urban Forestry & Urban Greening* 26: 25-30.
- KORTE, D.J. (2017): Diagenesis of Luxembourg Sandstone. - BSc. Thesis T Delft University of Technology.
- KAUSCH, B. & R. MAQUIL (2018): Landscapes and Landforms of the Luxembourg Sandstone, Grand-Duchy of Luxembourg. - in: DEMOULIN, A. [ed.](2018): Landscapes and Landforms of Belgium and Luxembourg. Chapter 4. - Springer.
- MANGON, A. (2013/14): Le grès de Luxembourg et son emploi dans le patrimoine bâti. Géologie, étendue de son application et études de cas en vue de déterminer les causes des pathologies observées et de proposer des traitements envisageables. - Travail de fin d'études Université de Liege.
- SLOTBOOM, R.T. & J.M. VAN MOURIK (2015): Pollen records of Mardel deposits: The effect of climatic oscillations and land management on soil erosion in Gutland, Luxembourg. - *Catena* 132: 72-88.
- VAN MOURIK, J.M. & R.T. SLOTBOOM (in press): Palynological reconstruction of the effects of Holocene climatic oscillations and agricultural history on soils and landforms in Luxembourg. - in: KOOIJMAN, A.M., E.L.H. CAMMERAAT & H.A.C. SEIJMONSBERGEN [eds.](in press): The Luxembourg Gutland Landscape. - Springer.
- WERNER, J. & A. ARENDT (2016): Les sources de la région gréseuse du Luxembourg. - *Ferrantia* 74. - Luxembourg.

B2. Listing and description of the geological sites within the proposed Geopark

The natural and historical heritage of the proposed Geopark includes geosites and geomorphosites that are directly related to its geology or geomorphology. Some areas have an especially high geodiversity and are therefore classified as “geo-landscapes”. Nearly all of the sites are positioned along

existing and well signposted hiking trails. Only some of them are accessible directly by car or bus. The link to other natural and cultural heritage of the site is always made in the respective interpretation.

Geo-Landscapes



Hëlt – dolomitic landscape

The deeply incised river Sauer flows in a large meander around the Hëlt. The meander bend has been shortened artificially for the generation of hydroelectric power and the Hëlt is thus an artificial meander core. The north-western part of the hill is wooded. Here, a large landslide, caused by fluvial erosion on the foot of the slope, affected marls below dolomite as well as the dolomitic rock face on top. According to legend, a “White Woman” lives in one of the deep joints of the dolomite and appears sometimes in the wood. In former times, gypsum lenses in the marls underneath the dolomite were exploited. This north-western side of the location contrasts with its south-eastern side, where a nearly Mediterranean climate on the gentle slopes favours viticulture and the occurrence of dry grasslands with orchids. The slopes are subdivided by a system of dry stone walls, which are typical elements of the cultural landscape, constructed from local stones.

Degree of protection: ZPIN in process, Habitat Natura 2000



Noumerléen – sandstone cuesta with impressive weathering structures

Noumerléen (“rocks near Nommern”) is the name of a part of the northern cuesta of the Luxembourg Sandstone. The steep sandstone escarpment rises high above the slightly undulated plain on marls of the Keuper, its top being cut by the Palaeogene erosional surface. The Noumerléen provide a miniature image of the sandstone landscape with a high diversity of traces of its geological and geomorphological history (sedimentation and weathering structures).

Extraordinary occurrences of honeycomb weathering are visible on the rock faces. Springs pour out at the base of the sandstone, feeding small creeks. Human impact is visible by the frequent incidence of places of charcoal kilns or the well visible remnants of a Roman times refuge fort.

Degree of protection: ZPIN in process, Habitat Natura 2000



Wanterbaach-Siweschlëff – sandstone landscape (partly fully accessible)

A multitude of typical elements of the sandstone landscape are evident from the edge of the plateau of the Luxembourg Sandstone to the deeply incised valley of the Black Ern. On the top of the landscape, a scenic view over the valley of the Black Ern to the Beaufort plateau opens up, overlooking the steep slopes of the sandstone formation (often with pines growing on the thin and sandy soils and beeches on the sandy-loamy regolith), and the less steep slopes on marls of Lowest Lias and Keuper age (meadows). Individual sandstone towers were horizontally displaced by up to 1 m by gliding processes on the underlying marly substrate, creating systems of narrow walkable passages (“Schlëff”). Rotation and back-tilting of one single monolith led to the formation of a triangular cave. One of the typical large rock overhangs can be seen here. Ferns and mosses grow on the rock faces and on the forest floor. Rock climbing is allowed on a small part of the rock faces.

Degree of protection: ZPIN in process Habitat Natura 2000



Haupeschaach and Halerbaach

The valleys of the Haupeschaach and the Halerbaach are incised into the Luxembourg Sandstone and show the typical forms of such valleys. They have been formed by the erosional force of the creeks, which are fed by numerous springs, and show a V-shaped transverse profiles with sandy and blocky regolith at the foot of sandstone cliffs. Numerous structures related to sedimentation and weathering can be seen on the rock faces.

Degree of protection: classified as national monument, ZPIN in process



Champignon

The Champignon is a mushroom-shaped rock in front of the northern cuesta of the Luxembourg Sandstones. Its top is formed by a sandstone layer which is more resistant against weathering than its foot. It is an erosional remnant of the unit of the Luxembourg Sandstone and is situated on an exposed position with a good view of the surrounding, slightly undulated slopes of the landscape in marls of the Keuper. Polishing grooves, which are visible on some sandstones, are evidence of human presence, probably as early as the Neolithic period. The thin sand cover allows growth of heather, and a sandy dry grassland has formed here.

Degree of protection: within an area classified as national monument, ZPIN in process, Habitat Natura 2000



Tull and abandoned meander of the river Sauer

Until the end of the last glacial period (according to pollen analysis), when a meander cut-off shortened its course and left the cut-off meander and the meander core behind, the river Sauer flowed in a large meander around the hillock Tull. The western part of the abandoned valley is developed in dolomites and is therefore quite narrow, whereas the eastern part is developed in marls and, as a consequence of the softer rock type, is much wider. Fluvial terraces cover the Tull and its surroundings, telling the fluvial history of the region. A mineral water spring "Kefferbur", emerging from the "Schilfsandstein", was exploited in the early 20th century and building stones were produced in quarries in different strata, which today are abandoned.

Degree of protection: none

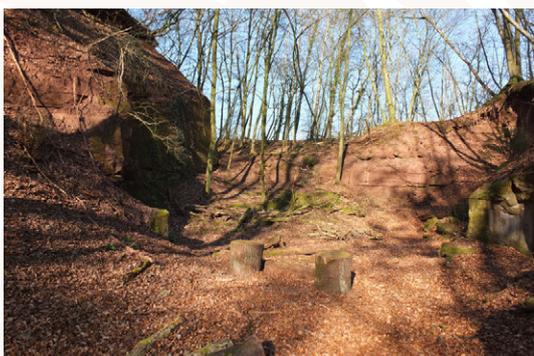


Butte and outlier

A small butte and an outlier are preserved in front of the southern escarpment of the cuesta of the Luxembourg Sandstone near Bech.

Degree of protection: partly Natura 2000

Geosites



Abandoned sandstone quarry Burermillen

Burermillen is the only location where red sandstone (Buntsandstein) was exploited in a small quarry on top of the Born anticline in the Sauer valley. Stones of the top layer of Buntsandstein strata were quarried here, transported by railway and used as ashlar and building stones.

Degree of protection: Habitat Natura 2000



Abandoned gypsum mine Rosport

Gypsum lenses were extracted in small mines. At the time, the gypsum was brought to the railway track at the foot of the hill using a gravity incline. Today, access to the cave is prohibited

Degree of protection: Nature Protection Law, Natura 2000



Abandoned sandstone quarry Beaufort

Between 1835 and the mid 1970s, Luxembourg Sandstone (of Lower Lias age) was exploited in quarries near Beaufort. The extracted sandstone was used for houses and bridges, as well as for ornaments like cornices and gravestones. It was transported by railway, which ran through 3 hairpin bends from the quarries at high altitude into the valley of the Sauer river below.

Degree of protection: Habitat Natura 2000, ZPIN in process



Abandoned millstone quarry Huellee

The artificial cave of the Huellee, as well as the nearby „Amphitheater“, were formed by the quarrying of millstones, for which one layer within the Luxembourg Sandstone Formation had suitable qualities.

Quarrying took place in Medieval times and probably already in Roman times. The typical round outlines of the millstones that were cut from the rock can be seen all over the walls and the ceiling. The millstones were used in the mills of the region and beyond.

Degree of protection: Habitat Natura 2000, ZPIN in process



Alkummer

A large part of the dolomite rocks, limited by the joint system, slid and tilted on the marly layer underneath in the direction of the valley and opened up a narrow passageway.

Degree of protection: Habitat Natura 2000



Gefallenleen

The landscape in the area of the Gefallenleen („fallen stones“) is the result of an enormous rockfall in dolomites of the Muschelkalk and sliding processes the marls below. A huge amount of large blocks of dolomite lie in front of the rock face, forming a highly irregular surface. A canyon forest has grown on this blocks.

Degree of protection: Habitat Natura 2000



Mardel

A mardel („Mardelle“ is a tiny maar) is a small hollow mould, which is at least temporarily filled with water. It is a typical form connected to dissolution of gypsum lenses or limestones from a marly subsoil. In places where the gypsum or limestone lenses were dissolved, the surface lowered. Mardels are a valuable archive of the history of land use, soil erosion and climate change. They provide rare habitats for special animals, such as the crested newt.

Degree of protection: ZPIN



Wollefsschlucht

The Wollefsschlucht formed when joints in the sandstone massif running parallel to the valley of the river Sauer opened up by sliding processes in the underlying marly substrate. In its most impressive part, large sandstone towers tilted up to 30° towards the slope, creating a small and in places deep passageway. The structure of the Luxembourg Sandstone can nicely be seen on the rock faces.

Degree of protection: ZPIN in process Habitat Natura 2000



Schéissendämpel

In the run of the river Black Ernz, at the picturesque Schéissendämpel, a well-known landmark of this region, a small waterfall has formed at the transition from the Luxembourg Sandstone to the marls beneath. The gravel carried by the water during high water has ground three tracks of water into the sandstone, from which the water falls. A stone bridge, dating from the very early time of tourism in the area with wooden railings spans the Schéissendämpel. It is adorned with imitations of fossils, as is typical for the (outgoing) age of Romanticism.

Degree of protection: ZPIN in process, Habitat Natura 2000



Kuelscheier

The Kuelscheier is a small passageway between two sandstone slabs, one of which slid several decimetres on the underlying marls. A well indicates the base of the sandstone, and thus the transition to the low permeable marls.

Degree of protection: ZPIN in process, Habitat Natura 2000



Calcareous tufa spring

At Consdorf in the valley of the Black Ernz, the water of a well, emerging from the upper part of the Luxembourg Sandstone, was artificially led over a rock face. The lime content of the water, originating from the dissolution of the calcareous cement between the quartz grains of the sandstone, is precipitated out of the water while it trickles over the rock face, which is overgrown with mosses. A thick layer of calcareous tufa has developed over time.

Degree of protection: ZPIN in process, Habitat Natura 2000



St. Mary's chapel, calcareous tufa

Calcareous tufa is the youngest solid rock of the Geopark. It originates from calcareous groundwater, emerging from carbonate sediments when the dissolved lime is recrystallized and thereby generates this rock with its very porous structure. In its fresh state, the rock is very brittle and soft, but it hardens as it dries out and can be used as a building stone. Not many deposits of calcareous tufa in the Geopark were worth working, and only isolated stones are present in larger buildings. In this region, St. Mary's chapel near Girst is a rare example of a small building that was constructed using only calcareous tufa.

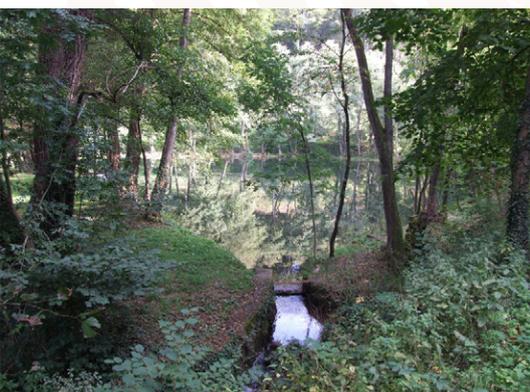
Degree of protection: none



Salt water spring

At Born, where the Buntsandstein sandstone aquifer rises above the level of the river Sauer, in times of low water discharges of the river, groundwater with high contents in salt and iron pours out from a number of springs. From the 16th until the middle of the 18th century, the salt of this springs were extracted through gradation.

Degree of protection: Habitat Natura 2000



Ponds of a former blast furnace

Ponds are rare in the landscape of the Luxembourg Sandstone. At Fischbach, one of the early industrial centres of the country, water was dammed to generate energy to run stamp mills and bellows that were used in the process of smelting of bog iron ore. Some blast furnaces were active in this area from 1768-1857. Nearly all remnants of the buildings are destroyed, only the canals, ponds, lots of scoria in the surrounding and a relic of one blast furnace have been preserved and are visible today.

Degree of protection: none

Educational sites



Salzmännchegaart

An educational presentation of the geology of the Geopark and of the whole Luxembourg is shown in an area behind the primary school in the village of Born.

Degree of protection: none



Aquatower

An exhibition on water and its sustainable usage is shown in the new water tower of Berdorf.

Degree of protection: none



Sources Rosport S.A.

Mineral water from the only natural spring in Luxembourg that yields natural carbonic acid, is bottled near the village of Rosport. The filling plant can be visited on appointment.

Degree of protection: none

Scenic viewpoints



Rippiger Kupp

The Rippiger Kupp is a part of the escarpment of the southern cuesta of the Luxembourg Sandstone, which in this location is combined with a large fault to form a fault scarp. Sandstone outcrops on the side of the escarpment, on the other side opens a vast view into the open landscape of Keuper marls.

Degree of protection: none



Roitzbachplateau (s. Wanterbaach-Siweschlëff)

This location is fully accessible and provides a scenic view into the deeply incised valley of the Black Ernz.

Degree of protection: ZPIN in process, Habitat Natura 2000



Héikräiz

On the plateau on top of the Luxembourg Sandstone outcrop the mostly agriculturally used "Marls and Limestones of Strassen". The location provides a 360 degree view, typical for these types of plateau. The area is deeply incised by rivers and creeks which have their origin in temporarily pouring springs related to the banks of limestone. The fossil oyster *Gryphaea arcuata* is abundant here and can be observed on several places on the surrounding fields.

Degree of protection: none



B3. Details on the interest of these sites in terms of their international, national, regional or local value (for example scientific, educational, aesthetic)

Geosite	Public interpretation	Scientific value	education	touristic	aesthetic
1 Hält	-	-	++	+	+
2 Noumerléen	+	+	+	+	+
3 Wanterbaach-Siweschléff	+	+	++	++	+
4 Haupeschaach and Halerbaach	+	-	++	++	+
5 Champignon	+	+	-	-	+
6 Tull and abandoned meander of the river Sauer	+	+	-	+	-
7 Butte and outlier	+	-	-	-	-
8 Abandoned sandstone quarry Burermillen	+	-	-	-	-
9 Abandoned gypsum mine Rosport	+	-	-	+	-
10 Abandoned sandstone quarry Beaufort	+	-	++	++	+
11 Abandoned millstone quarry Huellee	+	+	-	++	+
12 Alkummer	+	-	-	+	-
13 Gefallenleen	+	-	-	+	-
14 Mardel	+	+	-	+	-
16 Wollefsschlucht	-	+	++	++	+
17 Schéissendëmpel	+	-	+	++	+
18 Kuelscheier	+	-	+	++	+
19 Calcareous tufa spring	+	+	-	++	+
20 St. Mary's chapel, calcareous tufa	-	-	-	-	+
21 Salt water spring	+	+	-	-	-
22 Ponds of a former blast furnace	+	-	-	+	-
Educational sites					
23 Salzmännchegaart	+	-	++	+	+
24 Aquatower	+	-	++	++	+
25 Sources Rosport S.A.	+	-	++	++	-
Scenic viewpoints					
26 Rippiger Kupp	+	-	-	-	+
27 Roitzbachplateau (s. Wanterbaach-Siweschléff)	+	+	++	++	+
28 Héikräiz	+	-	+	+	+

B4. Listing and description of other sites of natural, cultural and intangible heritage interest and how they are related to the geological sites and how they are integrated into the proposed Geopark

It is easy to create a link between the geology of the region and its interesting natural and cultural heritage. Just like the geosites in the area, sites of cultural heritage are also provided with interpretation. They are connected to hiking paths and are often already part of the geosites and geolandscapes.

Archaeological and historical sites not integrated in geosites

The region is a valuable archive of human presence since the Palaeolithic period. Numerous sites of high archaeological or historical importance were recorded, dating from the Stone Age, Celts and the Romans, up to recent times. Although not part of denoted geosites, these sites are often related to geology, geomorphology, soil and water.

Loschbour:

In 1935, the oldest human skeleton, dated to the Mesolithic, was found under a rock overhang with calcareous tufa at this site.

Tumulus/Grave mound Altrier:

A chieftain's tomb of Early Latène period in an exposed position at the edge of the sandstone cuesta.

Aleburg Beaufort, Aleburg Noumerléen:

Two of many refuge castles perched on the rock ledges of the Luxembourg Sandstone. The incising rivers and creeks created areas on the edges of the plateaus, where three sides are protected by vertical cliffs in the sandstone, the 4th side was protected by ramparts.

Medieval and Renaissance castle of Beaufort:

Dating back to the 11th century, the castle was built from local sandstone. The preserved ruins belong to Luxembourg's national cultural heritage, as does the nearby Renaissance castle (built 1649), which has never suffered any severe damage. It is situated in the valley of the Haupeschaach (s. above).

Castle Larochette:

The castle is perched on a sandstone promontory, high above the valley of the Black Ernz and the





village of Larochette. At the end of the 16th century, the castle burned down and has been a ruin ever since. Restoration of some buildings took place in the 1980s. The access way to this site leads through a prehistoric rampart.

Echternach:

The old buildings of the town (abbey, churches, city wall, ...) were built with local stones. Lots of them can be observed along the cultural walk Via Epternacensis.



Dancing Procession Echternach:

Every year on Whit Tuesday, thousands of pilgrims and spectators take place in this unique cultural phenomenon in honour of St. Willibrord, the founder of the abbey of Echternach. This Dancing Procession was recognized as Intangible Heritage by the UNESCO in 2010.

Christnach:

Christnach is considered a model village for the region, with its beautifully conserved rural architecture. Many of the manorial farmhouses in the village were skilfully restored.



Stone polish Nommern:

see above (Champignon)

Museum of Prehistory "Hihof":

This museum with its large number of exhibits is dedicated to the technical evolution of stone tools and weapons from the Paleolithic, spanning a period of more than a million years by many exhibits.

Roman Villa Echternach:

Excavated in 1975, the manor house of this villa – one of the largest and richest rural properties in the surrounding areas of Roman Trier (Augusta Treverorum) – can be inspected. Basements, cellars and ornamental ponds were preserved or rebuilt using local sandstone. A Roman garden and a small information centre provides insight into the daily life in a Roman villa.



Tudor-Museum Rosport:

This interactive museum is dedicated to scientific research in general and to the work of Henri Tudor, the inventor of a lead accumulator to store energy in particular.

Heringer Millen, Müllerthal:

The Heringer Millen is one of the restored mills of the Mëllerdall region. The mill-wheel is operational and can still be activated. Activities for children (e.g. From Wheat to Bread, including baking courses) are offered here. A tourist information centre is available in the Heringer Millen.



Botanical sites not integrated in geosites

The plant communities growing in the region of the Nature- and Geopark are closely related to substrate, soil properties, and landscape (exposition, slope position) and thus to geology (see above).

Ravine forest, where a great variety of **ferns and mosses** grow on the stony regolith in the deeply incised valleys of the Luxembourg Sandstone. The forests „Schnellert“ and „Saueruecht“ are forest reserves, where the natural development of the forests is supported.



Orchids and **dry grassland** on marly and carbonatic subsoils can be found in different places in the Geopark. Orchids are didactically presented at the site „Deiwelskopp“ near Moersdorf, but occur at other places too (s. Hëlt).



Sandy dry grassland are rarely developed on sandy soils of the Luxembourg Sandstone.

Small **bogs** exist where marly substrates in flat slopes prevent infiltration or direct surface runoff of rainwater, as is the case in mardels on marly substrates or where marly interlayers in the Luxembourg Sandstone are exposed, as is the case at „Ripsmuer“.



Orchard meadows are typical elements in the cultural landscape and often related to poor marly soils.

C Geoconservation

C1. Current or potential pressure on the proposed Geopark

Water is one of the most important natural resources of the Geopark. Drinking water is almost entirely extracted from groundwater. A large number of surface water bodies form aquatic biotopes and have an important influence in forming the landscape.

A number of factors increase the risk of **groundwater overexploitation**:

- » The consumed amount of drinking water fluctuates considerably during the year. During the summer months, the consumption is notably higher due to the large number of tourists visiting the region and due to the household level.
- » Based on a faster regional development, a current local population rise of 64 % is possible if all space dedicated to new housings would be used.
- » Commuters to the region contribute to an increase of water consumption.

The **quality of the drinking water** in terms of its chemical and microbial properties has to be guaranteed by the water supplier. The presence of nitrates and metabolites of pesticides in the groundwater in particular already affects the quality of the drinking water. Consequently, the groundwater body of the Lower Lias is classified as being in a bad status. Drinking water protection areas are defined around the springs used for drinking water, bring certain restrictions concerning land use. The process of delimitation is currently taking place in the municipalities of the Geopark. The staff of the Nature Park is eventually going to manage the water protection measures that will need to be applied.

The **quantity of surface water** must also be guaranteed in the long run, especially during the summer months, to maintain sufficient low water discharge through the creeks and rivers and to protect the quality of the aquatic habitats. The extractable





amount of drinking water has therefore to be limited at each spring. Likewise, the direct extraction of surface waters that are used for irrigation or watering cattle has also to be limited. Measures to reduce the consumption of drinking water may be introduced by the municipalities in collaboration with the national Water Management Agency. It is not possible to fully replace the amount of extracted water with water that is led back from sewage-treatment facilities. The capacities of existing and planned water treatment facilities have to be adapted to the projected increase in population. In addition, all consumers in the region have to become connected to modern sewage-treatment facilities (e.g. campsites).

An important natural risk in the region is the **flood-ing** of rivers, as many settlement areas lie at the valley bottoms. Flooding is seen as a consequence of ground surface sealing and riverbed straightening, and might increase with a predicted increase of heavy rainfalls during the summer months due to climate change. This requires decentralised rain-water retention along streets and in areas of new housing developments. Parts of the wetlands along the river White Ernz have been restored and are now designated for a future natural development ("zone protégée d'intérêt national"). Retention areas have also been created along the river Sauer. Further restoration measures have to follow.

Another risk to natural resources is **soil erosion**. One of the consequences of surface run-off is the loss of cultivated soil. Suitable agricultural measures have to be adopted in order to reduce soil erosion and to maintain soil functions. In case of flooding, eroded soil particles pollute the creeks and rivers with organic and inorganic load and may deteriorate aquatic habitats.

To minimize **soil sealing** it is important to prevent an excessive development of new buildings,

especially in areas that are designated for the re-generation of groundwater and of fresh air. In forests, tracks and trails have to be protected against small-scale erosion. Old stone staircases, typically found on tourist hiking trails in the sandstone and dolomite landscapes, are monitored regularly to avoid deterioration and deformation. Cross-country mountain-biking and hiking is prohibited to further alleviate potential ecological risks.

An extensive network of hiking trails exists in the forest and passes most of the outstanding rock formations. **Spectacular and outstanding habitats** on the rock surfaces need to be protected. The mechanical abrasion of protected ferns and mosses by hikers walking through small passages within the rocks has already been counteracted by closing public access to some areas. As geo-tourism becomes more popular, the rising number of visitors can cause an overstrain of well-known attractions and car parks at peak times. The risk of habitat destruction caused by rock climbers is reduced through delimiting the area where this sport can be practised. Habitats can also be destroyed by thoughtless geocache hiding spots. Sometimes, unofficial information about "adventure tourism" into protected caves or the installation of non-official campsites is spread through Social Media. The destruction of pre-historical or historical petroglyphs by modern graffiti or the destruction of other archaeological sites by "treasure hunters" are a problem.

Differences in interests between **nature conservation and geological or archaeological activity** can be a source of conflict. If due care is not taken, valuable archives of natural or cultural history may be destroyed in an effort to enhance the ecological value of a site (e.g. mardels).

The region is also subjected to a number of **further pressures** and general problems:

- » Increasing private mobility in the region and beyond create air and noise pollution.
- » The development of dormer villages with modern residential buildings resulting in the residents loss of their regional identity.
- » The destruction of historic building stock and its replacement with modern buildings in the villages.

- » The possible increase of gravitational mass movements as a consequence of increasing building operations or the predicted climate change.
- » The need of age-related rehabilitation and closing of hotel accommodations in the region followed by the loss of jobs.
- » Littering and vandalism of existing infrastructures.



C2. Current status in terms of protection of geological sites within the proposed Geopark

Palaeontological excavations and excavations for historical, pre-historical and other scientific purposes, are only permitted by authorisation of the responsible Minister.

- » Loi du 21 mars 1966 concernant
 - a) les fouilles d'intérêt historique, préhistorique, paléontologique ou autrement scientifique;
 - b) la sauvegarde du patrimoine culturel mobilier

Some objects directly related to geology (e.g. Hupeschaach and Halerbaach, Champignon) are, alongside many buildings built of regional and local stones, classified as **national monuments** and are therefore protected by law. These sites must not be destroyed or removed, neither in parts or in full without a ministerial authorisation. The list of protected objects is not exhaustive.

- » Loi du 18 juillet 1983 concernant la conservation et la protection des sites et monuments nationaux.

Some **biotopes related to geology** such as small ponds (mardels), springs, dry grassland, heath and peat bogs. These are protected by the Luxembourgish conservation of nature and natural resources act and must not be reduced, destroyed or changed.

- » Loi du 19 janvier 2004 concernant la protection de la nature et des ressources naturelles.

Furthermore, several areas covering a total of about 4.9 km² of the Geopark are designated as **protected areas of national interest** ("zones protégées d'intérêt national"). A further 40 km² are in planning, with 3.5 km² already in an advanced stage of the regulation procedure. Efforts are made to complete the designation process by 2021. Protection is primarily related to flora and fauna habitats, and thus indirectly to geology, but large parts of protected areas are identified under the aspect of landscape or the occurrence of rock faces.

Prohibited activities in these areas include:

- Activities susceptible to modifying the soil or the subsoil: excavations, drillings, earthwork, notable removing of the topsoil, digging, back-filling, the extraction of material and the depot of soil/earth, waste or any other material.
 - Construction work that is susceptible for modifying the system of surface or underground water, such as drainage and the maintenance of drainages, changing of the course of the creeks, the reduction, the destruction or the deterioration of biotopes such as sources, creeks, rock faces or regolith.
- » Loi du 19 janvier 2004 concernant la protection de la nature et des ressources naturelles.

The rock faces of the Luxembourg Sandstone are integrally protected as habitats of **lichens, mosses and ferns**.

- » Règlement grand-ducal du 8 janvier 2010 concernant la protection intégrale et partielle de certaines espèces de la flore sauvage.

Nearly all of the protected areas are part of the **Natura 2000** network, a network of nature conservation areas of the European Union (Habitat directive and Birds), which comprises an area of about 42 % (107 km²) of the Geopark region. Lots of the Natura 2000 habitats are connected to geology, like

canyon forests and other forests on scree and regolith, alluvial forests, neglected grasslands, (juniper) heath, sources with calcareous tufa, vegetation on siliceous or calcareous rocks or regolith and touristically unexploited caves, which are therefore protected.

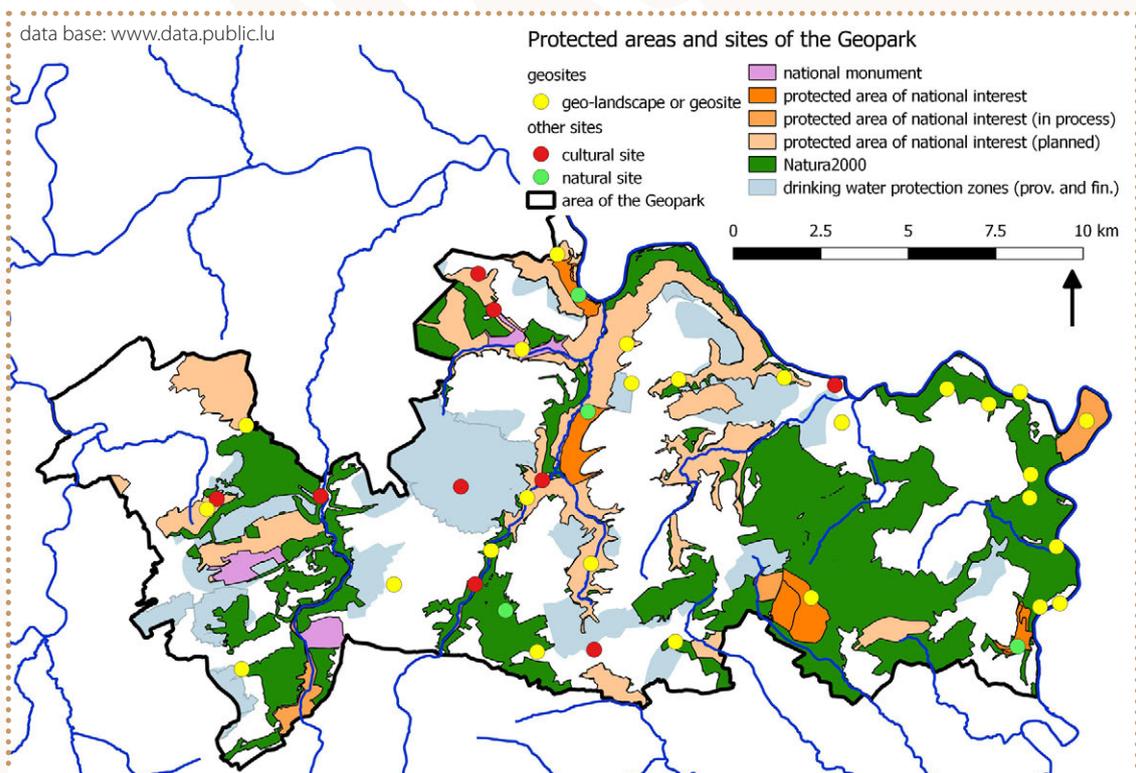
The **protection of surface and ground water** as well as their management is regulated by law and by several European directives (e.g. 2000/60/EG). One objective is the protection of surface and ground water against deterioration and the subsequent improvement of water quality. To this purpose, a management plan was established that details a catalogue with measures concerning the aspects of agriculture, hydromorphology and sanitary engineering as well as the delimitation of drinking water protection areas.

- » Loi du 20 juillet 2017 modifiant la loi modifiée du 19 décembre 2008 relative à l'eau.

Règlement grand-ducal du 28 juillet 2017 portant création de zones de protection autour du captage d'eau souterraine Weilerbach et située sur le territoire de la commune de Berdorf.

Règlement grand-ducal du 28 juillet 2017 portant création des zones de protection autour des captages d'eau souterraine Schéissendëmpel 1, Schéissendëmpel 2 et Härebur 1 et situés sur les territoires des communes de Waldbilling et de la Vallée de l'Ernz.

Règlement grand-ducal du 28 juillet 2017 portant création de zones de protection autour du site de captage d'eau souterraine Meelerbur et situées sur le territoire de la commune de Berdorf.



C3. Data on the management and maintenance of all heritage sites (geological and non-geological)

The Möllerdall Geopark maintains a **database for all heritage sites**, recording their status. Sites that have not yet been selected for promotion to the general public are also included. This database facilitates the management of the sites and can easily be expanded with new sites. All points of interest are identified by their coordinates. The use of geographical information systems (GIS) allows a straightforward creation of maps.

To **prevent misuse and the destruction of the different heritage sites**, the Möllerdall Geopark communicates and illustrates the general acceptable behaviour in nature via leaflets and on site panels.

Most sites are connected by the Mullerthal Trail (a 112 km hiking trail within the region, awarded "Leading Quality Trails – Best of Europe" in 2014 and 2017), as well as shorter regional trails. Only a small number of heritage sites are not directly connected to a trail. The trails are an effective and well received measure of visitor direction; the official starting points can easily be accessed by public transport.

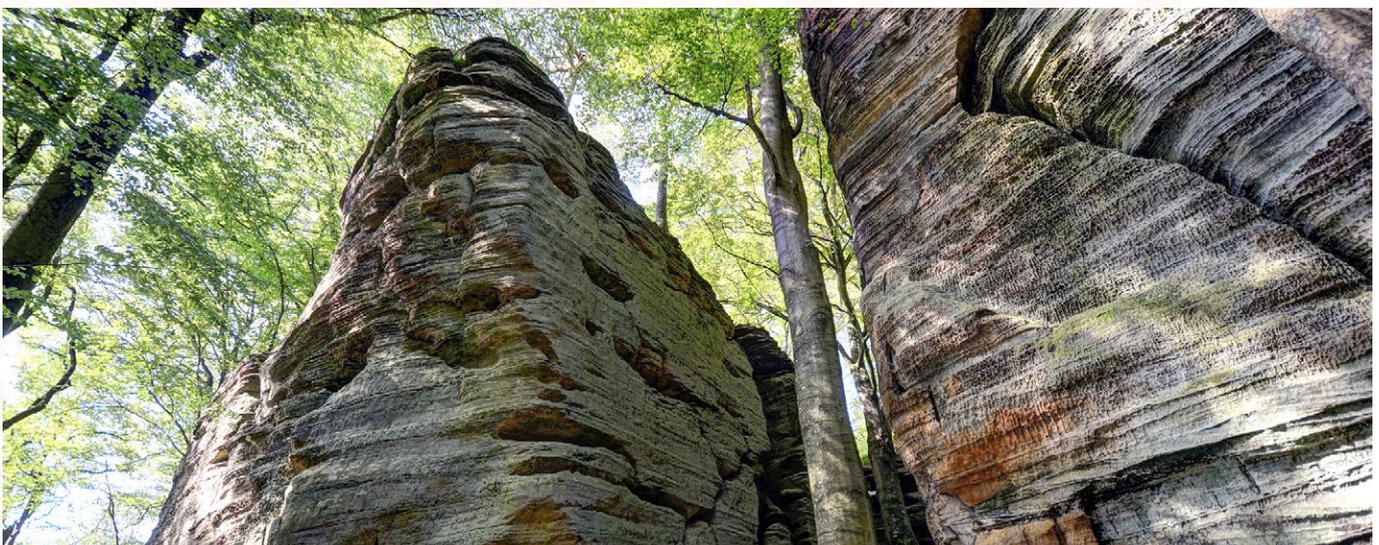
Altogether, the region greatly benefits from the maintenance of its heritage sites through the **excellent cooperation of all active stakeholders**. The Regional Tourism Organisation (ORT-MPSL) is responsible for the quality management (hiking infrastructure, way marking and damage repair) of regional and local hiking trails. Together with the local tourist associations and the staff of the Administration for Nature and Forest (ANF), the Regional Tourism Organisation guarantees the accessibility of the hiking trails through the effort of job-creation schemes for

unemployed people. The ANF inhibits the process of natural succession in abandoned quarries by regularly clearing trees to maintain the rock surfaces.

Furthermore, the ORT-MPSL is permanently (365 day / year, 24 / 24) collecting data on the time and directions that visitors hike on the Mullerthal Trail. This data is used for **permanent quality enhancement, visitor management and marketing perspectives**. On a regular basis (every three years), the quantitative data is supplemented by a qualitative visitor survey.

The geo-landscapes encompass many interesting smaller sites such as sedimentary or weathering structures and stone polishes. Currently, only one of many smaller sites has been identified for visitor access, based on scientific criteria. The other smaller sites remain protected by not being exposed to the public. By re-routing or even closing hiking trails where necessary, the cooperation of scientists and tourism agencies in the region has led to the protection of rock surfaces and narrow passageways with a special microclimate and home to rare species of ferns and mosses.

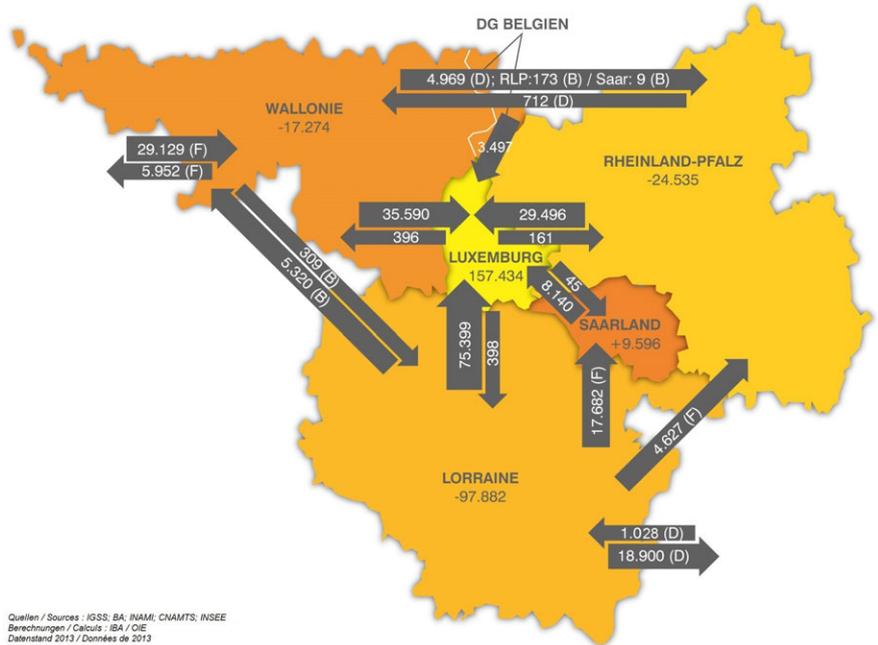
The government co-finances the maintenance of protected habitats, some of them related to geology, through a number of specific programmes (e.g. areas protected by NATURA 2000). The responsibility for the regional co-ordination of these programmes lies with the Biological Station of the Nature Park Möllerdall - the management structure of the Geopark. Comparable programs are in place for water protection areas and forest management.



D Economic Activity & Business Plan (including detailed financial information)

D1. Economic activity in the proposed Geopark

In the framework of the "Greater Region", the Grand Duchy of Luxembourg is the country with the most extraordinary dynamic of development and can be regarded as a transnational economic driver. An important element is the job market with an increase of labour supply, a persistent growth of its population through immigration and large transnational fluxes.



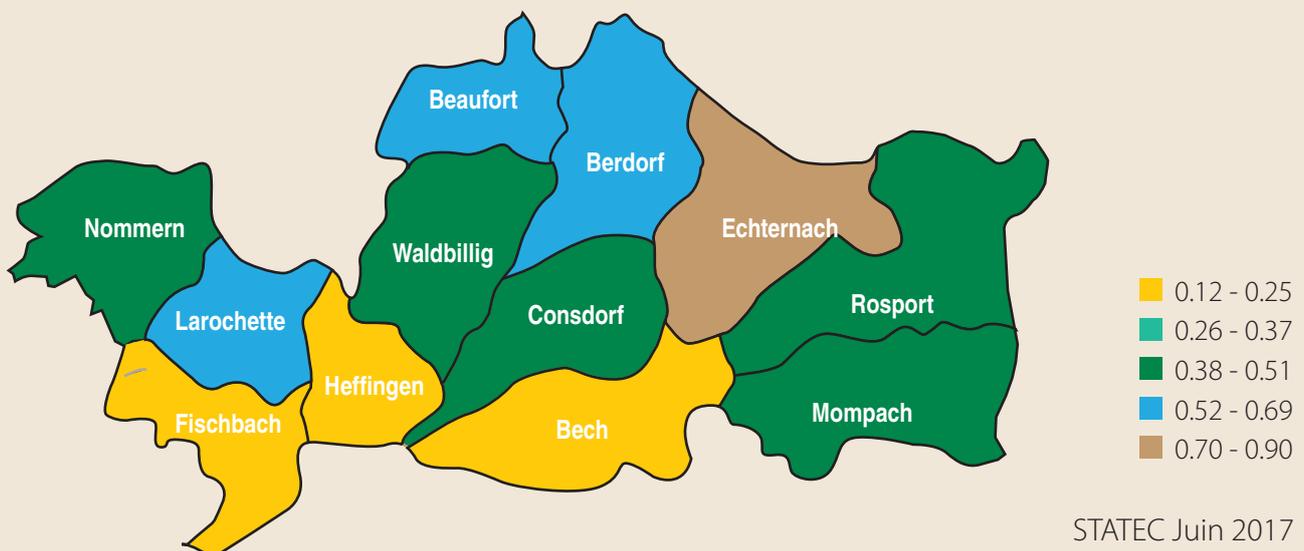
<http://euregio.lu/de/information-aux-citoyens/>

International motorways pass the region in the East (A1/E44/64) and in the West (A7). The road from the City of Luxembourg to Echternach (N11) is classified as a European major road (E29) and passes through the Mëllerdall Geopark from NE to SW. Several larger national roads also cross the area, from SE to NW (N14: Grevenmacher – Diekirch) and along the river Sauer (N10: Wasserbillig – Diekirch). Smaller national roads assist in further connecting different parts of the area.

The following map shows the **social-economic index** in the area of the Geopark. It is calculated by taking into account factors as:

- » The number of single-parent households;
- » The median income per municipality;
- » The number of people on minimal wage;
- » The rate of unemployment;
- » The number of people with lower income (workers).

Socio-economic index



Referring to area, agriculture and forestry are important factors, although only < 5 % of the employees work in these sectors. Most employees work in service companies and industrial enterprises. Tourism, an important economical factor, is essential for the job market, even though the relevant workspaces suffer from seasonal fluctuations. The unemployment rate in Luxembourg is 6.4 % (2017). Overall, around 900 companies are based in the region. A regional non-profit association has been founded in 2011 to promote the marketing of regional products ("Mëllerdaller Produzenten"). A number of fruit varieties grown on local meadow orchards are distilled into well-renowned spirits. Several food producers sell their products via direct marketing, others sell them through grocery shops in and outside the region (e.g. Millermoaler in Hinkel, Epicerie am Duerf in Schrondweiler, Moulin Dieschbourg in Echternach), at local tourist offices and at local markets.

A **label for regional producers** is under development. Regional timber is marketed as "Holz vun hei" ("local timber").

Small businesses that cater for everyday needs are present in most municipalities, a larger number can be found in Echternach, the area's regional and economic centre, with a large number of shops in the town centre and smaller industrial areas dotted around town. Echternach is also home to an economic activity zone of regional and national importance, hosting several state-of-the-art-technology companies.

At the end of the 19th and in the first half the 20th century, the large number of **quarries** in the region were a driver for regional development and led to the construction of several, now decommissioned railway lines. Similarly, all but two still operating quarries have since laid down their activities.

Different types of **renewable energies**, most notably wind energy (56 %) and water power (35 %), are produced in decentral locations within the area. Wood chip plants, solar equipment and biogas plants complete the list, while the (former) mills of the region create further potential.

Various institutions provide education and further education. Eleven primary schools for pupils aged 6 - 12, a grammar school with various specialized branches of education and a music school exist in the region.



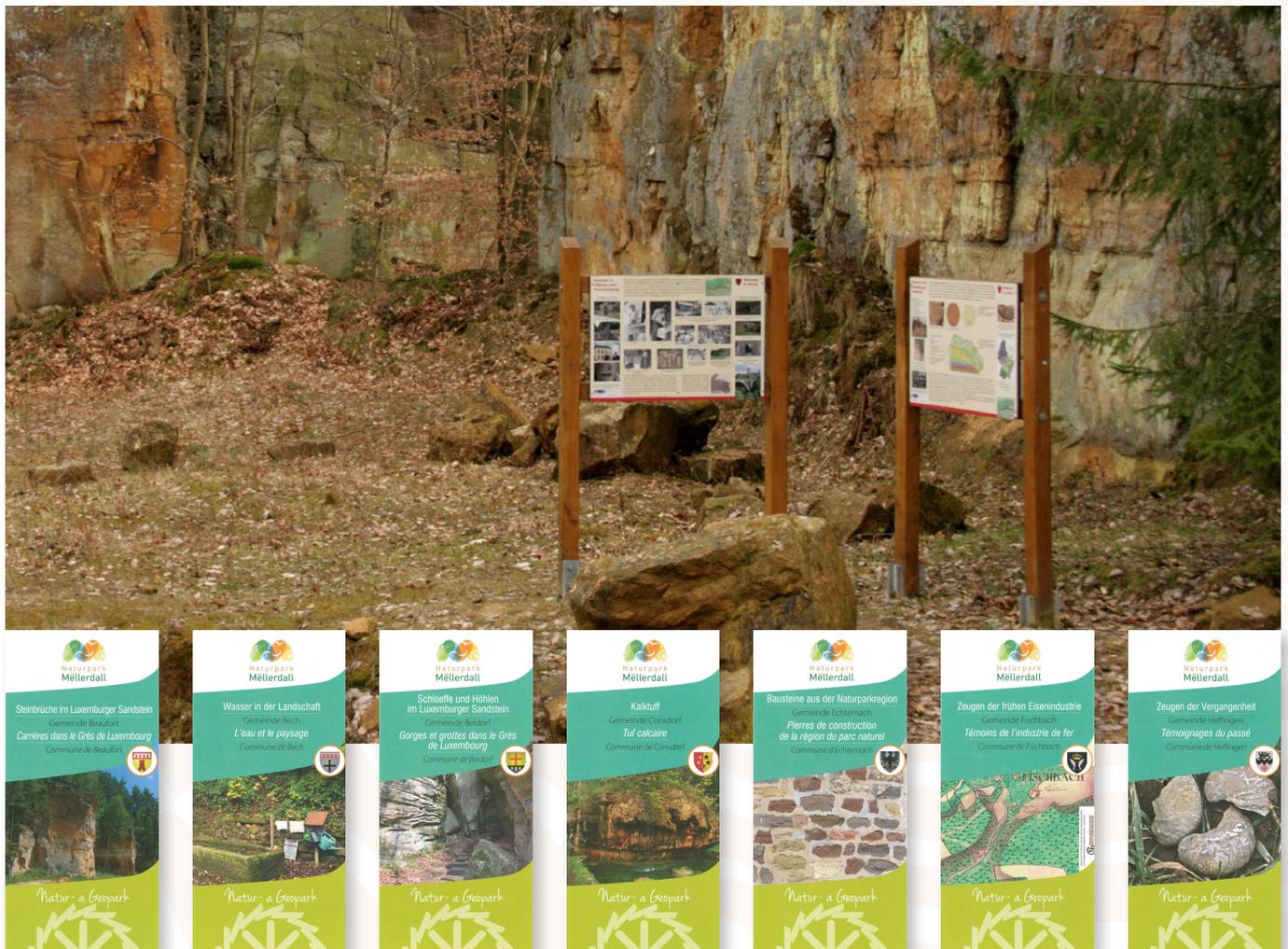
D2. Existing and planned facilities for the proposed Geopark (e.g. geo-education, geotourism, tourism infrastructure etc)

The staff of the Nature Park and the Mëlldall Geopark provides a great variety of specialized knowledge on nature and landscape. Information about the region is collected in a **digital documentation centre**. This concentrated knowledge provides the scientific and practical foundation for interpretation work (interpretative panels, publications, exhibitions, public relations) and for the park's advisory role in sustainable regional planning. The direct contact of the team with national institutions facilitates integrative decisions on the conservation of geo-heritage or natural and cultural sites.

The Geopark presents most of the sites of the region to the public in form of information panels at their location, on leaflets, brochures or through digital media. A small number of important themed walks, especially on the use and protection of water and archaeology are planned. **Various printed publications** with a focus on plain language have already been developed and are for the biggest

part available in at least two languages. Scientifically accurate but easy to understand information on geology for the different multiplier has been published in printed form. Furthermore, a map showcasing the infrastructure, hiking trails and heritage sites exists, and shows access to sites that are not directly connected to hiking paths. An implementation of the information into the national Geoportal (www.geoportal.lu) is planned.

The ORT-MPSL undertakes some of the (national and international) **marketing of geo-touristic products** (hiking maps, presence at international fairs, organisation of press and blogger trips to the region) to promote the geological heritage. While the trails are accessible all the year round, the opening times of most of the tourist offices and museums are limited from November to March. The staff at the local tourist offices is briefed about the possibilities and the products of the Geopark on a regular basis.





An **exhibition on geology and water** is installed inside the Aquatower in Berdorf. Information on the region's geology can be found in the "Salzmännchegaart" in Born, which is a permanent installation open to the public and comprises different geological exhibits, such as a geological cross-section of the region and a theatre, built with various Luxembourgish building-stones. Other institutions such as the prehistoric museum Hihof and the Roman villa in Echternach also present the history of the region. The Tudor museum in Rosport is specialized in the history of electricity and science.

A **travelling exhibition on soils** is shown throughout the region. Future plans for the region include a topographic model showing the geological strata of the region (planned for 2018), a movie on the evolution of the landscape and a general information centre about the area of the Geopark (currently in discussion).

The staff of the Nature Park and Mëllerdall Geopark provide **guided tours on culture, nature and geology** for various target groups such as school classes or tourists. Other organisations such as the ANF, the ORT-MPSL and the Aquatower also provide



guided tours. The Nature Park Mëllerdall and the Mëllerdall Geopark are engaged in offering certified training courses for guides, organized on national and regional levels. Moreover, talks on the geology of the region, including scientific results, will be planned on a regular basis in the future.

A **geo-box with experiments on geology** (minerals, stones and their properties, sand as a water filter, the formation of the geologic strata and the landscape) can be borrowed from the Geopark. Further experiments are in preparation. Different educational games providing geological information (jigsaw, "old maid") for the youngest visitors are available. Interactive games on sedimentation and "memory" will be integrated on the website.

The **national education event called "Science Festival"** is organized every two years by the Museum of National History in the City of Luxembourg and offers a perfect platform for geo-education. A regional "Day of Geosites" is planned for 2018 in the area of the Geopark.



D3. Analysis of geotourism potential of the proposed Geopark



The region has been developed as a tourist destination since the end of the 19th century due to its impressive sandstone landscape. The first hiking trails were installed in “Luxembourg’s Little Switzerland” as early as 1879. In the active regional memory, the caves of the region still play a role as shelter during World war II.

The ORT-MPSL, established in 2007 as a non-profit organization, reunites municipalities and (local) tourist organizations. Some of its responsibilities include:

- » the development and promotion of the Mullerthal Region – Luxembourg’s Little Switzerland as a tourist destination,
- » the development of a regional tourism concept and the creation of new tourism products in accordance with the national marketing strategy.

The ORT-MPSL provides a structure for the marketing of geo-touristic products, which are developed in cooperation with the staff of the Geopark and the Nature Park.

The network of national and local hiking trails managed by the ORT-MPSL is well signposted and passes along most of the geosites. 100,000 visitors annually hike on the Mullerthal trail. The region has a need for additional touristic concepts in order to broaden its offer to new target groups such as eco-tourists, amateur geologists and visitors interested in edutainment programs. New geo-sites along the trail still need to be highlighted (through information panels, digital applications etc.) Some scenic views and rock faces in the area, that used to be famous around 100 years ago for their view and beauty, have become overgrown and will need to be restored.

In addition to the hiking trails, some cycle paths exist, they are located mostly along the rivers and on abandoned railway lines. A few paths are specially designed for mountain bikes. A large number of camp grounds is scattered around the region, while other types of accommodation are mostly located in the central part of the area (Beaufort, Berdorf, Echternach, Consdorf, Waldbillig), along with other leisure facilities.

The development of geo-tourism is scheduled in the master plan of the ORT-MPSL (valid until 2021) and in the national promotion strategy “Luxembourg for tourism” (as “active experience in nature”). Being an important connection between economy and ecology, these strategies will contribute to a sustainable structural development of the region.

A **regional geo-tourism concept** will be developed in several stages, including:

- » an adapted marketing strategy for the tourist destination “UNESCO Global Geopark and Nature Park Mëllerdall”;
- » the identification of needs in terms of organization, networking and utilizing synergies with other actors in tourism (hotels, campsites, holiday flats, restaurants, regional food producers, tourist attractions, tourist information offices)
- » an operational action and an evaluation plan (“Geo-tourism Masterplan in the Mullerthal Region - Luxembourg’s Little Switzerland”).

To achieve the above mentioned objectives, a half-time position dedicated exclusively to the development of geo-tourism in the area will be available from 2018 onwards. Additional financing instruments exist in the 5-year planning of the Ministry of the Economy and the regional LEADER-LAG (valid until 2021).

D4 Overview and policies for the sustainable development of:

- geo-tourism and economy
- geo-education
- geo-heritage

The most important aspect for the sustainable development of the region is the cooperation of the different regional stakeholders from the economical, ecological, touristic and social sectors, working together as partners and in close contact with the national authorities. The sustainability is guaranteed by the long-term structure of the Geopark and the Nature Park and the organizations working in the same field. "Geology and archaeology" is incorporated in the current strategy of LEADER, and allows the financing of some Geopark-projects (economic, education, heritage). Regular evaluations of activities are a basis for re-examinations and a measure of success.

When possible, the Nature Park and the Mëllerdall Geopark work with local enterprises (graphic/design, transport, catering etc.). The Nature Park Mëllerdall will accompany the designation and the development of a new industrial zone in the region.

Geo-tourism and economy

Guiding visitors on well signposted trails is a good way to prevent the extensive destruction of



valuable areas. The hiking trails in reach of car parks and **bus stops** and maps and signs with information about access to the trails are in place. Information on public transport is easily accessible via the national website www.mobiliteit.lu (which is also

linked on the regional websites). The ORT-MPSL regularly publishes a leaflet on mobility in the region. Current projects, co-financed by Interreg VA and LEADER are aimed at highlighting fully-accessible natural and cultural experiences along some of the hiking paths and promote the installation of disabled-friendly access to local tourist offices. Local tourist offices are working on improving networking among themselves and are developing ways of digitizing (geo-)touristic information.

All published media is printed on **FSC-certified paper**. A **Code of Practice** for appropriate behaviour in the forests (Däi Bësch – Mäi Bësch, "my forest – your forest") was awarded with the 2nd place of "Eco award" of the European Ramblers' Association in 2014.

Some interpretative media of heritage sites already existed prior to the founding of the Geopark. A **corporate design for all interpretation media** is currently being discussed in the region. It is planned to limit the number of interpretative site panels to reduce the impact of these panels on the landscape. The focus is directed towards digital media such as well-directed campaigns to develop geo- and earth-caches (in compliance with environmental protection issues), the use of QR-codes and other technical offers like mobile apps with short movies, augmented reality or audio-guided tours. The aim is to fascinate the visitors e.g. by telling the local myths and legends behind the names of the rocks.





In 2008, the regional center **Echternach** was awarded by EDEN (European Destination of Excellence, an initiative promoting sustainable tourism development models across the EU) status. Through the selection of destinations, EDEN achieves the objective of drawing attention to the values, diversity and common features of European tourist destinations.



The **Heringer Millen** houses one of the local tourist offices and it is also a Best of Wandern test centre for hiking clothes. The mill from the 17th century has been restored and can be visited. The old mill wheel is still turning, and traditional mill bread is baked in-house in an ancient stone oven, teaching groups to learn about an important traditional craft work.

Founded in 1897, the regional grain mill, **Moulin Dieschbourg** in Echternach is still grinding local cereals using water power and processes them alongside regional conventional and biological agricultural products (Bio / organic and Demeter). The mill also roasts fair trade and organic Arabica coffee beans in their own roaster. The mill can be visited by appointment.



The **three youth hostels of the region** (Echternach, Beaufort, Larochette) as well as some camping facilities are certified with the Luxembourgian Eco-label, which is awarded by the Ministry of the Economy and the Ministry of Sustainable Development and Infrastructure. The Eco-label certifies for sustainable management of the accommodation infrastructure.

The **production of geo-souvenirs** such as pieces of recycled drilling cores (coming with a certificate of authenticity and details of place and depth, used in restaurants as menu/card holder) or culinary offers ("edible stones") are still planned for development and might help in integrating local (touristic) enterprises, regional producers and people working in national programs for the unemployed.

Geo-education

The long-term sustainability of educational subjects is assured by the **teaching mission of the ANF and the Nature Park and the Geopark** itself. Regional themes as well as topics on sustainability and competence-building are implemented in the curricula of different types of schools.

Several stakeholders offer extracurricular learning activities in the region. The Aquatower asbl and Sources Rosport S.A., the only enterprise bottling natural sparkling mineral water in Luxembourg, offer information on **guided tours about different aspects of drinking water in the region**. The staff of the Nature Park and Geopark offer guided tours for school classes and adults. The Mëllerdall Geopark is committed to the further education of teachers and tourist guides, with the aim to provide them in the medium term with the geological knowledge to carry out tours by themselves.

In a pilot study of the Geopark, to test the possibilities of **education for sustainable development**, materials for primary schools were produced, providing easy-to-understand information on selected hiking paths. In the medium term, every primary school of the region will be provided with detailed



material that can be used on a path starting at or near by the school to use with children of different age groups. In a first stage, ideas for children 10 - 12 were developed in cooperation with an educational scientist, which included observing and measuring stones, landscape, soils, vegetation and water and making simple connections of the ecosystem and history. These materials, like the geo-box, will be made available to teachers as part of further education programmes on a national level.

Contact with secondary school teachers has been made, to engage children older than 12 in the intensification and expansion to a more scientific approach (measure, analyse) and more complex sustainability topics like water conservation and climate protection measures (also within the LIFE project ZENAPA). Further planning will be made on the topics of the protection of natural and cultural

heritage and the deeper knowledge on ecosystem processes. Another example of an activity in this sector that is not just aimed at pupils is the showing of the film "demain" ("tomorrow") by the Nature Park.

At medium-term, these activities will contribute to the systematic **creation of a "nature park school"**, a concept that is developed with the two other Nature Parks in Luxembourg.

Cooperations with international universities are being prepared. University students as well as pupils can spend their internships in the Nature Park and in the Mëllerdall Geopark.

GEOLOGIE | GEOLOGIE

Dolomit, Kalkstein und Gips in der Region Müllerthal

Die Flüsse der Trias- und Jurazeit transportierten nicht nur Feststoffe wie Kies, Sand und Ton in die damaligen Meere, sondern auch im Wasser gelöste Stoffe. Bei der Verdunstung des Meerwassers in vom offenen Meer abgetrennten Lagunen kristallisierten daraus nacheinander verschiedenen Minerale, sobald deren Löslichkeit überschritten war. Während der Jurazeit füllte nur das Karbonat-Kalzium (CaCO₃) aus dem Meerwasser aus, in der Trias nur das Karbonat-Dolomit (CaMg(CO₃)) und in der Keuper- und Muschelkalkzeit auch Sulfat, vor allem Gips (CaSO₄ · 2 H₂O). Der Kalkzettel bildet meterdicke Kalksteinbänke, in denen viele Fossilien vom Leben im Jura Meerzeugen. Besonders die sogenannte Teufelskralle (Auster) ist in den

Dolomie, calcitaire et gypse dans la Région Mullerthal

Les rivières ne charriaient vers les mers, aux temps du Trias et du Jurassique, pas seulement des particules solides comme les graviers, sables et argiles, mais également des éléments dissous dans l'eau. Lors de l'évaporation de l'eau de mer, dans des lagunes isolées du large, cristallisaient, quand la solubilité des éléments était dépassée, des carbonates et sulfates. Dans les mers du Jurassique ne cristallisaient que de la calcite (CaCO₃) alors que de la dolomite (CaMg(CO₃)) se déposait dans les mers du Trias. Du gypse (CaSO₄ · 2 H₂O) se formait dans des lagunes des mers du Keuper et du Muschelkalk (période du Trias). Les minéraux se déposaient sous forme de boue sur le fond en incorporant des restes de la vie marine. Les bancs de calcite du Jurassique de l'assise des «Marnes

„Mergeln und Kalken von Straßen“ in sehr großer Zahl zu finden. Dolomit bildet mit eingelagerten Mergelsteinen ein Gestein gleichen Namens, dessen Schichtpaket in der Region bis zu 55 Meter dick ist. Mehrere Meter mächtige Gipsinseln lagern in den sie umgebenden Mergeln.

et Calcaires de Strassen“ sont d'épaisseur métrique et renferment de nombreux fossiles tels des huîtres (griffes du diable). La dolomie forme avec ses intercalations de marnes une unité rocheuse épaisse de quelques 55 mètres. Des lentilles de gypse de quelques mètres d'épaisseur sont intercalées dans les unités marnaises.

Dans la région Mullerthal, la dolomie et le gypse ont été exploités en tant que matériel de construction. La dolomie, une roche dure et dense, est exploitée encore aujourd'hui dans une seule carrière à ciel ouvert et est utilisée comme pierre de taille et ou dans la construction routière. Elle ne se prête guère à des utilisations comme pierre d'ornementation. Du gypse était exploité en carrière souterraine. Les calcaires et dolomites ont été utilisés dans le passé et depuis l'époque romaine pour la production de chaux. Il y a certainement de nombreux restes de fours à chaux dans la région. Leur découverte se fait le plus souvent par hasard.

Des informations sur des anciennes carrières ou fours à chaux de la région seront très utiles pour compléter les banques de données sous-sol et seront acceptées avec remerciements info@geologie.lu.

Autoren: B. Kausch/R. Maquill

Wenn Sie Informationen über weitere Brennöfen oder Steinbrüche in der Region haben, freuen wir uns zur Vervollständigung unserer Daten über Rückmeldung, gerne über info@geologie.lu.

19

Geo-heritage

The fixed structure and the opportunity to act on a regional level without ignoring the national level is given by the **close cooperation of different bodies** of the Luxembourgish government: the Geological Survey of Luxembourg (SGL), the Museum of Natural History (MNHN), the National Archaeological Research Centre (CNRA) and the National Service of Sites and Monuments (SSMN). Parts of the geo-heritage might be identified as **“national monuments”** and can thus be put under existing legal protection. The regional database with geo-sites will be further completed and further research, in cooperation with national and international scientific institutions, will provide opportunities for the inclusion of additional sites.

Projects on **water and nature conservation**, carried out by the staff of the Nature Park and the Geopark, often help to create public awareness on the necessary protection of the geo-heritage through communication measures. The degree of protection of the different sites is communicated via leaflets and panels. The common agreement to include the Geopark within the structures of the Nature Park is a strong and clear statement for the protection of the geo-heritage besides the objectives of preservation and restoration of the high-value natural and cultural heritage of the region.

D5 Policies for, and examples of, community empowerment (involvement and consultation) in the proposed Geopark

The development of the Nature Park in a **bottom-up approach**, with its strong involvement of local and regional organisations, provides evidence for its strong integration in the regional community. A public call for project ideas was put out to everybody. A large number of the projects that were handed in include the natural and cultural heritage of the region. About half of them have already been coordinated in direct contact and agreement with local authorities by the Nature Park and the Geopark. Public involvement remains one of the strategies of the master plan of the Nature Park to strengthen regional identity.

As members on the advisory committee and the committee, community representatives are an integral part of the structure of the Nature Park and the Geopark.

Information leaflets on activities are distributed to all households and can be downloaded on the website of the Nature Park and the Geopark. Activities on the different segments of sustainability are offered by private people, local handicraft enterprises, restaurants and public stakeholders. Many projects demand the active involvement of local people, thus allowing the transfer of knowledge

between experts and the involved public.

Several local newspapers (local LEADER-Group and the Naturpark³) in which topics on geology are published are distributed in the region on a regular basis.

The training of local people as walking guides is planned.



D6 Policies for, and examples of, public and stakeholder awareness in the proposed Geopark.

Several **networking-groups of active stakeholders** exist already or are established on a project basis, for example:

- » The working group for geology,
- » the working group for climate change (LSC ZENAPA) and
- » the working group for education.

Where necessary, projects include further regional and national stakeholders.

The **visibility of the Geopark** is assured:

- » by signs, which are erected at the main roads entering the area and showing the logo of the Park;
- » by touch screens in the tourist offices;
- » by panels communicating the projects of the Nature Park and the Geopark (e.g. community gardening, ecological projects, dry stone walls);
- » by websites and social media;
- » in information booklets of the municipalities, distributed to every household.

The Geopark takes part in various events in the region, as the annual **Millefest** and the **Season Opening of the Mullerthal Trail**, where geological tours are offered on a regular basis. On the national level, the Geopark participates in events like the **"Heritage Days"**, providing information on specific topics and their links to geology. A supplementary regionally annual event, a **geosite-day** as it is celebrated in Germany ("Tag des Geotops") or the celebration of the **World Water Day** (which was already carried out by the Aquatower asbl) is intended in the master plan of the Geopark, moving between municipalities and integrating local communities.

An exhibition called **"Nature's Luxembourg"**, displaying astonishing photographs on the nature and geology of the three Luxembourgish Nature Parks by the famous photographer Raymond Clement, is currently shown at different places.



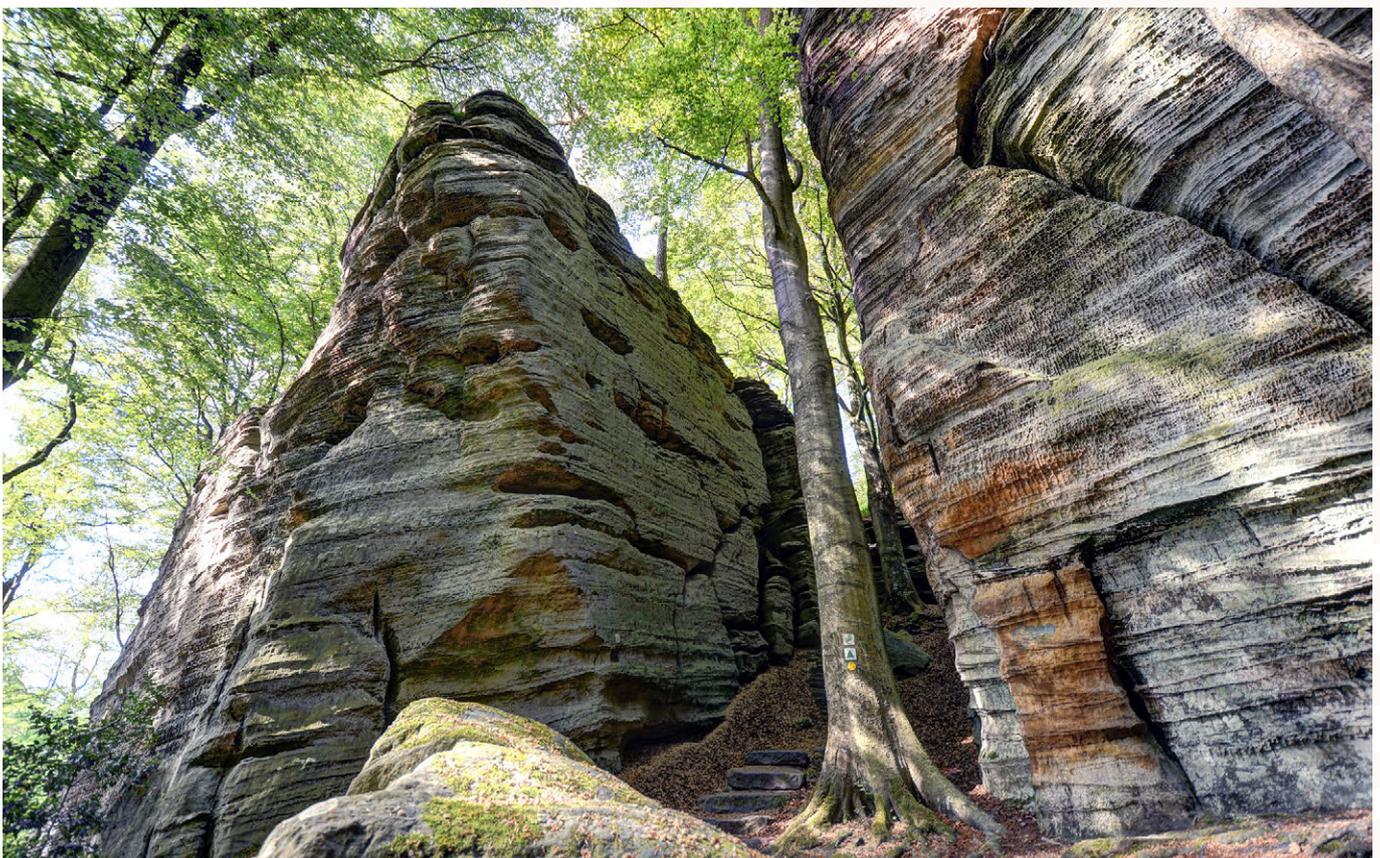
E Interest and arguments for becoming a UNESCO Global Geopark

The region of the Mëllerdall Geopark is part of a particular small-scaled cuesta landscape formed in Mesozoic sediments. Plateaus in sandstone and dolomites, deeply dissected by rivers and creeks, alternate with gently undulating hillsides in marly substrate.

The sandstone landscape of the **Lower Jurassic Luxembourg Sandstone** in the centre of the synclinal structure is extraordinary for Western Europe. Two sandstone escarpments only 10 km apart rise more than 100 m above the hillsides, which consist of Triassic marls. The plateau of the Luxembourg Sandstone is deeply dissected by the epigenetical incision of rivers and creeks, exposing sandstone cliffs on the valley slopes. The high geodiversity is evident in diverse geological structures on the rock faces and geomorphological forms at the edges of the plateaus. These are an impressive testament of the geological and geomorphological history of the region and provide a textbook of sandstone formation, weathering, erosion and geomorphology, which is influenced by the alternation of hard and soft rocks with related forms and processes.

The rocks provide the basis for the evolution of the cultural landscape elements in the region since the stone-ages. They influence the close relationship between topography, groundwater, building stones, settlement activities, land use and the highly diversified flora and fauna with rare and worth protecting species. The sandstone formations with their typical erosion features, the dense canopy cover and the multiplicity of habitats, contribute to an extraordinary biodiversity. Exceptional microclimatic conditions at the vertical rock faces and in small and narrow open joints which tend to mimic the oceanic climate of the European Atlantic fringe offer life conditions for a **great number of rare and often relict species of ferns, mosses and lichens.**

Due to the long-term continuous discharge and excellent filtering capacities, the region of the Geopark is nearly self-sufficient in the supply of drinking water, and the rivers and creeks are valuable biotopes. Thus, the protection of the water quality is very important. Due to its bizarre rock formations, the region has touristically been promoted since the last quarter of the 19th century as „Luxembourg’s Little Switzer-



land". The rock formations are easily accessible via numerous hiking trails.

The Geopark allows to increase the value and promote the geo-heritage of the region and, within the management structure of the Nature Park and together with the partners of the Geopark, to sensitize local people and stakeholders as well as tourists to the rich natural and cultural heritage of the region. Structured offers for education on sustainable development for local pupils and people, the development of geo-tourism, the execution and support of projects of sustainable regional development and the inclusion of local enterprises are made possible thanks to the close cooperation of governmental, municipal and private stakeholders in the Geopark.

An increase of the awareness of the value of the heritage means a better general protection of the geo-heritage. This opens – on a higher administrative level – the opportunity to achieve a better legal protection for geo-heritage sites, e.g. by the designation of national monuments or protected areas of national interest. Numerous projects involving local people help in strengthening the regional identity.

Since guidelines for a national Geopark do not exist in Luxembourg, a membership in the UNESCO Global Geoparks network would help to structure the Park's own objectives and to learn from other's best practices. It would also raise the national and international value of the Mëllerdall Geopark and enhance the awareness of the different stakeholders (e.g. tourism, education, scientific community, government) of the necessity to protect Earth's geodiversity.

The status of UNESCO Global Geopark would be a final approval for the legally consolidated objectives of sustainable regional development of the Nature Park. It would allow to improve the transmission of the knowledge on earth's evolution and about the interactions of the ecosystems to our children. For Luxembourg, the recognition as a UNESCO Global Geopark would be the first environment-related UNESCO award of the country. The Luxembourgish government is very aware of the high importance of the 2030 Agenda for Sustainable Development. The objectives of the Nature Park Mëllerdall and the Mëllerdall Geopark resemble in many points to the 17 sustainability goals. Thanks to the efforts of all stakeholders, the region can actively help to reduce its footprint.



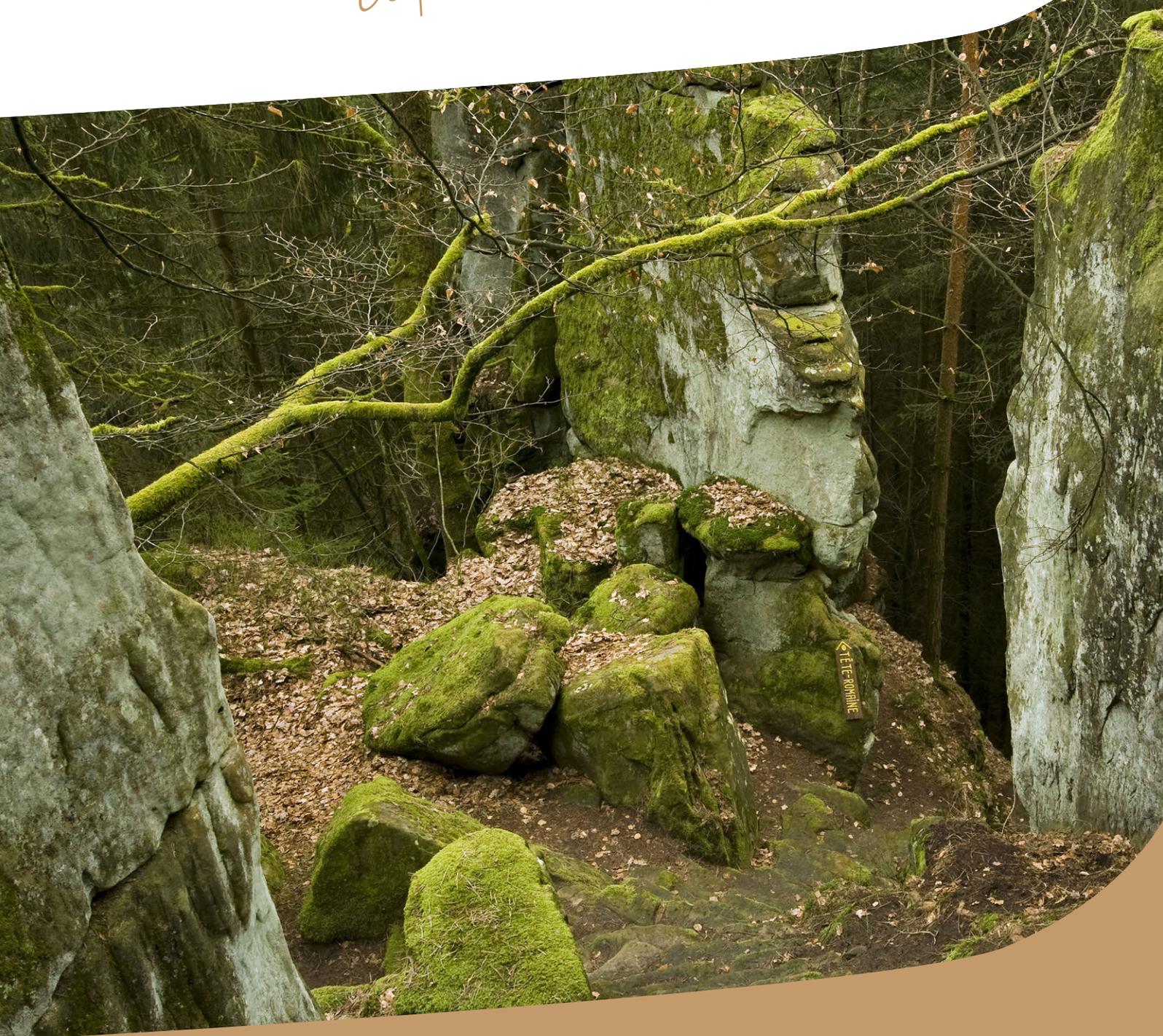


Naturpark
Mëllerdall
Geopark



LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère du Développement durable
et des Infrastructures

Département de l'aménagement
du territoire



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