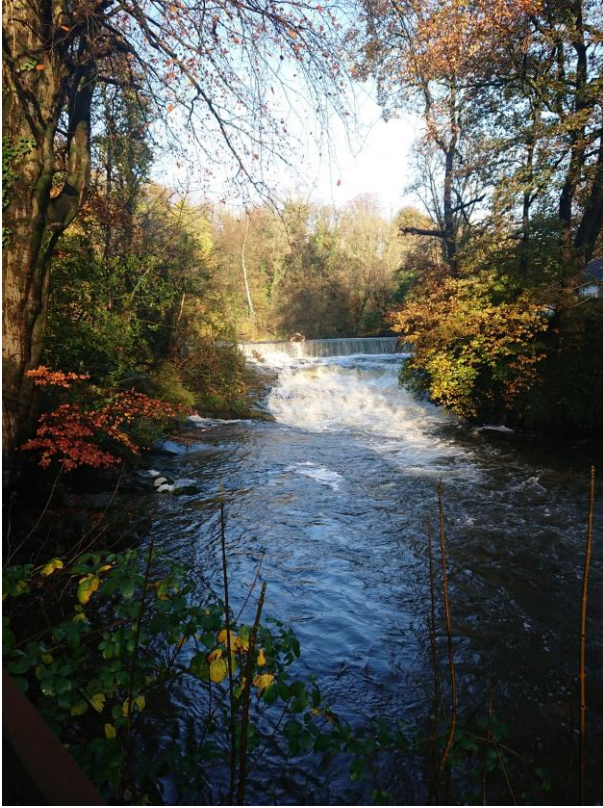




THE EVOLUTION OF A LOCAL PHYSICAL LANDSCAPE

PHYSICAL LANDSCAPE

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Introduction

This report aims to assess the various notable physical and anthropogenic impacts of the location site to provide a more in-depth understanding of the area itself along with any appropriate conservation or land management work that may be required. By examining the evolution of the physical landscape, organisations should therefore be able to make more informed decisions that better suit the overall needs of the environment. The greater surrounding area has a notable physical landscape history, and the local area has an equally notable anthropogenic influence. As the location site covers so large an area, a single image capturing it in full is impossible, so images from various locations have been taken for reference.

Location

The area that has been chosen for evaluation follows approximately 2.5 miles of the Lower Clydach river until it meets the River Tawe. The site begins from the meeting point of the Lower Clydach river and the Tawe river in the village of Clydach itself, following the former along a bridlepath up the edge of the U-shaped valley until it reaches Cwm Clydach, an RSPB site which was designated in 1986 (RSPB, nd). This site was initially known for a single breeding pair of red kites, though observation has shown that numbers have since increased, and more breeding pairs are now thought to be in the area. In addition, there is an abundance of buzzards, dippers, grey wagtails, kingfishers, spotted flycatchers, and redstarts (RSPB, nd). Prior to designation, the area was a colliery known as Clydach Merthyr Colliery (or locally as Nixon's mine) from 1863 up until coal production was stopped in 1961 and it was then used for ventilation and pumping for the nearby Graig Merthyr Colliery until 1978 (Paterson, nd). As can be seen in Figure 1, there were several entrances (the true figure isn't highlighted in the image, just those located in this area) grouped quite close together with a separate mine a little further down the valley.

Dense woodland surrounds the location on one side; beech woodland covers the base of the two hills that the site runs around, namely Mynydd Gelliwastad and Tor Clawdd. The nature of this type of woodland leaves little in the way of grass at the location site, but plenty of decomposers to take advantage of the carpet of leaf fall. There is also an established issue with invasive non-native species in the area, namely Japanese Knotweed (*Reynoutria japonica*) and Himalayan Balsam (*Impatiens glandulifera*) (Wales Online, 2004). On a recent trip a discovery was made of some Western Skunk Cabbage (*Lysichiton americanus*), however since reporting this to the RSPB it was removed within a matter of days to protect the river.

The hillside is well-draining, but the bridleway and route that was followed is not; constantly at risk of flooding, it is currently maintained by both the RSPB at the Cwm Clydach site and the Clydach Community Council for the remaining portion of land (starting approximately from the top end of Fossil Area 2 and down into Clydach in Figure 1). As water runs down the hillside and out from remaining or broken culverts, paths become inundated with water and in heavy rain are impassable in some sections. Evidence of earlier problem solving rather than preventative measures can be seen further towards the village that have now failed, such as piling loose dirt banks without any solid structures to keep them in place; however, current work has shown that they are now working

closely with the RSPB on proactive and preventative flood treatment measures to create a safer
bridleway for public access moving forward.

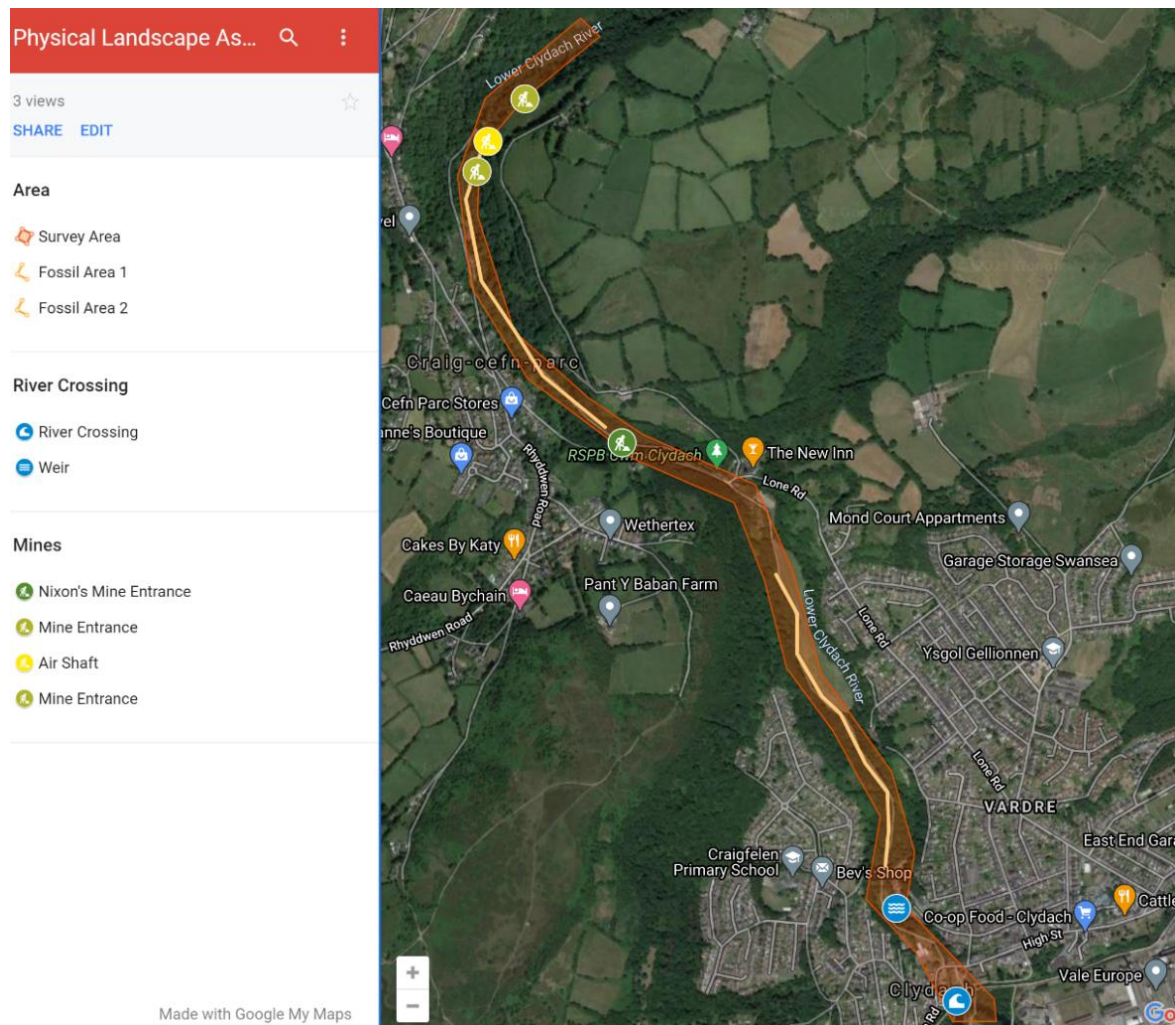


Figure 1: Location map and key, image author's own 2021

The site also shows signs of quarrying taking place (as seen in Figure 2), though no official records can be found to show when. Local village tales like to tell of workers building stronger houses than had been provided for them (Clydach Historical Society, nd), however as with most of these stories a pinch of salt is also recommended. The exposure of the rock does however provide evidence of the geological features of the area, so whilst the timeline of the quarrying is unknown it has at least left unearthed something useful.

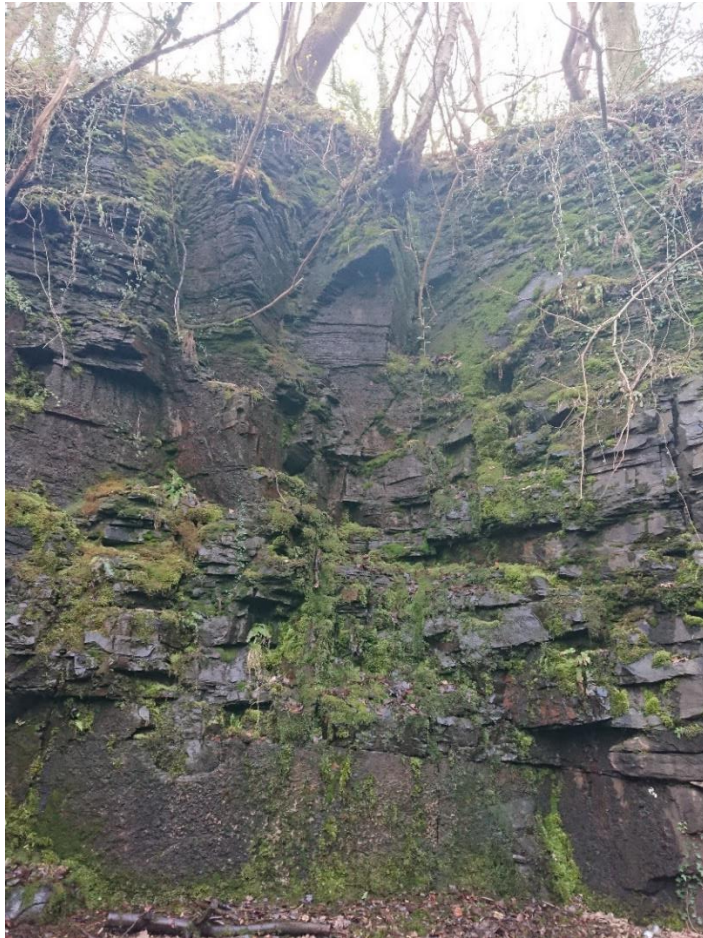


Figure 2: Evidence of pennant sandstone quarry site along bridleway, image author's own 2021

Geological

The Cribarth fault, or 'Cribarth Disturbance' (The Geological Society, 2012) is a transform fault approximately 16 miles further up the Swansea valley from the location site that branches off the main vault line running up the neighbouring Neath valley. This ridge appears as several tight anticlines, the main ridge being limestone flanked by gritstone (Fforest Fawr Geopark, 2011). The entire area was extensively quarried in the nineteenth century and this has naturally then fed down the valley into the location site.

The geological formations from the fault lines can be traced partially down through Swansea valley and the location site itself even though the rock type itself changes; the gritstone and limestone found higher up towards Cribarth is not found at the location site. As can be seen in Figures 2 and 3, the rock type has change and is now pennant sandstone, showing that a fault line will continue regardless of the rock type and finding no resistance or deviation in route.



Figure 3: Quarry site off bridleway at location site, image author's own 2021

The alteration of the rock type in itself however is not surprising; as can be seen in Figure 4, the rock type can change in a relatively small area, and the location site itself has three different formations (though all still falling under the umbrella of sandstone) (British Geological Society, 2021). This map shows the presence of mudstone and siltstone in the green and yellow areas, with the latter also holding more recent alluvium deposits, and older glaciofluvial ice contact deposits in the pink areas which just touch the bottom of the location site.

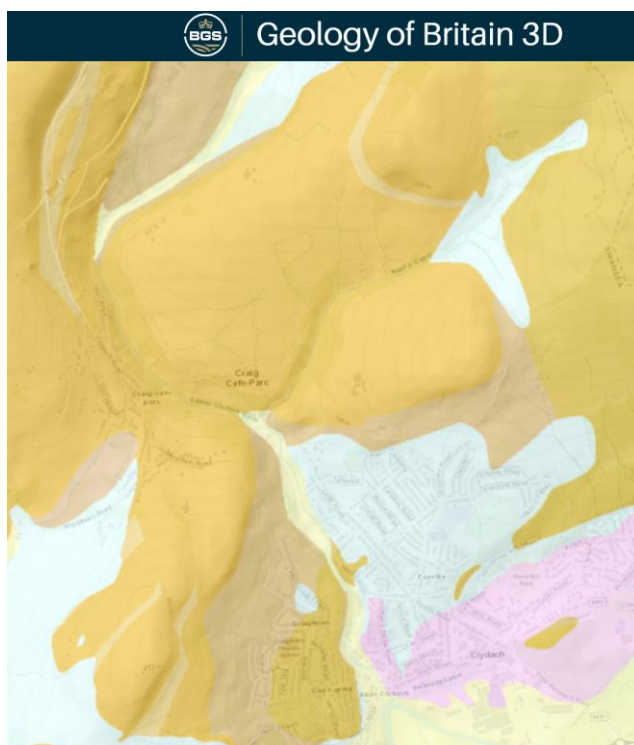


Figure 4: Geology map of Britain, BGS 2021

A series of trips through the survey area also highlighted that two sections were particularly fruitful for fossils. The first fossil seen in Figure 5, a bivalve, was the rarer of the three examples, though not unusual for the area. Found slightly further away from the riverbank, it is likely that anthropogenic development and movement over time will have accounted for this shift.



Figure 5: Bivalve fossil found in local area, image author's own 2021

The second fossil in Figure 6 was the *Alethopteris serlii*, found in the Lower Clydach river itself up in the area marked as 'Fossil Area 1' in Figure 1. Commonly found in coal seams and formed in the carboniferous period (Kent Geologists' Group, nd), plant fossils such as these are stamped between layers and can easily be pulled apart, though are very fragile.



Figure 6: *Alethopteris serlii* found at location site, image author's own 2021

The third example of fossils in the area (see Figure 7) was the *Stigmaria* fossil, which forms the root of the Lycopsid tree (Fossilmall, 2021). These are more widely known as making up the coal seams that we traditionally searched for, so large chunks of these fossils were in abundance both in Fossil Area 1 and in Fossil Area 2 in Figure 1.



Figure 7: *Stigmaria* fossil root of Lycopsid tree found at location site, image author's own 2021

Glacial

The glaciofluvial ice contact deposits shown on the map in Figure 4 provide further information for evidence found of the glaciation at the location site. The riverbed is littered with different rock types which is typical of glacial flow (as can be seen in Figure 8).



Figure 8: Glacial deposit at location site, image author's own 2021

The path of the Swansea valley is the route of glacial flow, ending in Swansea Bay (The Geological Society, 2012). Most notably, slightly outside of the location site is a moraine with geological SSSI status in the neighbouring Glais area, separated by the River Tawe. Large rocks of various composition have been deposited in the area and have been found in the riverbed nearby. These will have originated in the Brecon Beacons, and include old red sandstone and carboniferous limestone (Waters, et al., 2005). This glacial flow will have carved out the U-shape of the valley, which will have originally been one larger ice sheet at Craig-y-Llyn (Natural Resources Wales, nd). This broke into several lobes, which slowly broke down into smaller glaciers again along the Nedd, Tawe and Afan valleys (Evans, et al., 2005). Evidence of the Tawe lobe exists in the moraine in neighbouring Glais, of which deposits sit in the Tawe where at the bottom of the location site. This moraine is the only part of the location site with any kind of status as an SSSI for its geological interest (European Environment Agency, 2021), though there are no conservation notes on or maintenance requirements on the area other than no building or development.

Anthropogenic Changes

When assessing the evolution of a physical landscape it is imperative to note the anthropogenic impacts that have occurred as these changes still form a measurable aspect of the evolution of the landscape.

Clydach Merthyr Colliery

Openly operating from 1863 until 1961 and then used for air venting until 1978, the Clydach Merthyr Colliery, or 'Nixon's Mine' (see entrance in Figures 9 and 10), was known for high-quality coal with low ash content (Swansea University Archives, nd) and before its official closure by the National Coal Board, it was estimated to produce an annual output of 115,000 tons. It was also notable for two other reasons- as it was virtually gas free, carbide lamps were commonly used, and also had an underground blacksmith shop and boilers to raise steam for the haulage engines (Paterson, nd).

The mines were renowned for having a strong sandstone roof and needing little in the way of support; however, from carving into the rock, the mining process has resulted in the landscape now being unstable in places. Evidence of mining activity is littered across the location site with remnants of buildings, blocked entrances, machinery, and most notably changes to the soil profile and water quality here heavy metals are now present.



Figure 9: Nixon's Mine entrance, Paterson 1970



Figure 10: Nixon's Mine entrance, image author's own 2021

Upon closure and the site being taken over by the RSPB, all historical mine remains are now being maintained by the Coal Authority (GOV UK, 2021). As can be seen in Figures 11 and 12, this can range from fencing off areas and leaving signs to warn the public of unstable ground to blocking off more obvious entrances entirely. Where some of these have also fallen into disrepair or have been damaged by the public, common pipistrelle bats (*Pipistrellus pipistrellus*) have started now started to roost in the tunnels (such as Figure 12).



Figure 11: Sealed mine entrance, image author's own 2021



Figure 12: Sealed mine entrance, image author's own 2021

Mond Nickel Refinery

Whilst not within the location site, the Mond Nickel Refinery was built in nearby Clydach village in 1902 (see Figure 13) and still currently operates as Vale Refinery. Whilst the refining process was profitable to the village, there were concerns from farms about pollution from copper damaging vegetation and livestock up to one mile away (Ashton, 1972). Until the process was improved over a number of years, nickel dust was observed to be blown over the area, affecting the health of the population. The quantities absorbed by food, inhalation and drinking water would have been too low to negatively impact human health but could still have affected smaller animals and whilst some species of nickel can positively influence plant growth certain compounds also have toxic effects (Schaumlöffel, 2012).



Figure 13: Mond Nickel Refinery, Britain From Above 1931

Soil Profile

Originally the area would have been ancient woodland, and so the soil profile would have been extremely valuable; hugely complex and diverse, this type of soil profile would have housed a large portion of life-supporting ecosystem services provided by the soil's biotic community, found in the rhizosphere (Woodland Trust, 2016). Losing soils of this quality is a serious issue, though the extent of this wouldn't have been understood when mining development started towards the end of the 19th Century.

Taking the natural and anthropogenic influences into consideration, the soil profile of the location has experienced significant negative change in a relatively short period of time. Areas will have remained dry and well-draining to maintain the established beech woodland in the upper regions, however further down towards the river (as can be seen in Figures 14 and 15) will be contaminated with heavy metals from the coal mining (Guo-li, et al., 2008). Areas that have been cleared of beech and planted with alternative species to encourage phytoremediation are still struggling and seeing little in the way of positive results.



Figure 14: Section of riverbank at location site, image author's own 2021



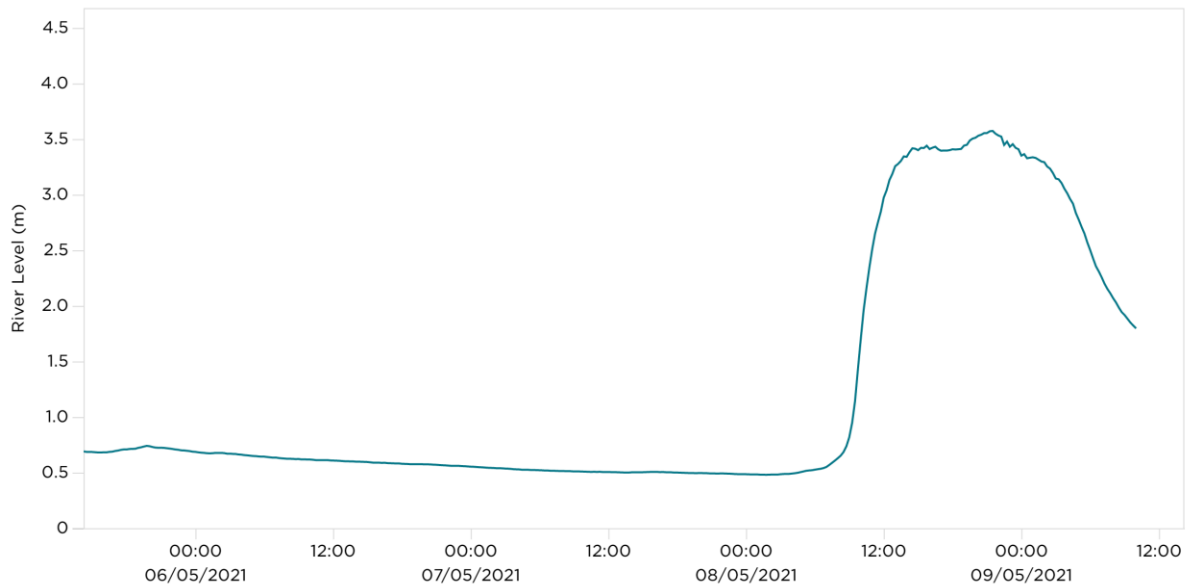
Figure 15: Collapsing riverbank at location site, image author's own 2021

Conservation

Notably there is an issue with flooding not only in the location site but in the village itself; in heavy rain roads are frequently closed and residents are forced to use old mountain roads to get out of the village and small businesses have experienced flood damage several times on an annual basis. By looking at river levels for the nearest river station after a day of moderate rainfall in Table 1, it is clear that water levels can rise significantly in a short period of time; a large meander of the Tawe with a natural flood plain is where the Lower Clydach flows in but is also where the main road though the village now runs, along with the canal. As a result, this flood plain is now drastically shorter and the resulting influx of water in heavy rain flows into the buildings and road. The same problem happens slightly further upstream at Mond Golf Club where the meander overflows into the club grounds and the main road (Wales Online, 2021). Therefore, from a conservation

perspective, continuing with soft engineering techniques such as regular planting and coppicing to protect the riverbank along the location site would reduce the risk of erosion and flooding. Further downstream into the village this is obviously harder with the structures in place, however effective land management would allow for some relief; the land adjacent is used by the village youth rugby team. By removing concrete walls built to protect the fields from flooding, this space could be used as a new flood plain and the rugby team be relocated, however it is understandable that there would be a reluctance for a plan such as this to be acted on given the cultural importance of the sport and old training grounds.

Table 1: River levels from Tawe reading at Ynystanglws, NRW 2021 (Natural Resources Wales, 2021)



Important indicators for environmental change, the evidence of a variety of fossils in the area is important for conservation of the area. Notably these would not have to be removed, but slope stabilisation to protect the riverbank after the extensive coal mining is required. Trees that have been planted in in the years since the site closure also need frequent coppicing to ensure they do not grow beyond the ground's capacity; with the soil profile changed from the mining, the ground around the riverbank is still quite loose and unable to support larger trees, meaning large sections have collapsed under their weight in recent years. Frequent coppicing will protect the riverbank, the shale and fossils in the river itself, encourage new shoot and decomposer growth (encouraging soil remediation), provide habitats for burrowing animals, which will in turn encourage more predatory birds back into the area. As can be seen in Figure 16, without regular maintenance, the riverbank can easily collapse and so work is still required to stabilise the area to make it both a sustainable habitat and a viable recreation space. Arguably there may eventually come a time where the needs of one will outweigh the other, but assessments on biodiversity and prolonged conservation efforts would need to be considered for an effective decision to be made in that instance.



Figure 16: Further collapsing riverbank at location site, image author's own 2021

The higher land at the site is an established natural beech woodland, suggesting a longstanding dry and well-draining soil profile (Johnson & More, 2006). Similarly, with an ancient/beech woodland, the increased leaf fall results in less grass but an increase in decomposers, such as glistening ink caps (*Coprinellus micaceus*) seen in Figure 17. For an area that is recovering from the mining industry and the traditional nickel refining process, encouragement of these decomposers is vital for remediation of the soil profile; working in tandem with phytoremediation as a method to remove heavy metal from the soil (Desai, et al., 2018), mycoremediation is both a cheap and effective tool (Akhtara & Mannan, 2020). The issue remains that remediation of ancient woodland soil profile is incredibly difficult work; it takes generations to restore with little interference, but with constant coppicing and land management required to keep the site open for public use, this is at odds with this basic need. Land managers will need to accept that the soil will likely never be fully restored, but it can at least be remediated to an acceptable level with continued soft engineering.



Figure 17: Glistening inkcap (*Coprinellus micaceus*) on a beech stump, with Himalayan Balsam (*Impatiens glandulifera*) in the background at location site, image author's own 2021

Conclusion

This assessment of the evolution of the physical landscape has shown that knowledge of how the environment used to be and its steady change over time would benefit conservation efforts. To effectively manage what is there, an understanding of what has occurred previously is necessary; without prior knowledge of any potential hazards or damage, any appropriate defence measures or conservation efforts would be based on missing information and not necessarily suited to the needs of the environment. In the case of the location site specifically, the anthropogenic impacts have influenced areas such as the soil profile to such an extent that knowledge of its evolution is vital to understand that it previously held ancient woodland status and could possibly still hold pockets of valuable soil data; with this information, conservation efforts can be focused in this area in addition to flood defence to protect the riverbank and village itself.

References

- Akhtara, N. & Mannan, M. A.-u., 2020. Mycoremediation: Expunging environmental pollutants. *Biotechnology Reports*, 26(n/a), p. n/a.
- Ashton, W. M., 1972. Nickel Pollution. *Nature*, 237(n/a), pp. 46-47.
- Britain From Above, 2012. *View of Mond Nickel Works*. [Online]
Available at: <https://britainfromabove.org.uk/image/wpw037144>
[Accessed 24 04 2021].
- British Geological Society, 2021. *Geology of Britain*. [Online]
Available at: <https://mapapps.bgs.ac.uk/geologyofbritain3d/>
[Accessed 05 05 2021].
- Clydach Historical Society, nd. *Clydach History*. [Online]
Available at: <http://clydachhistoricalsociety.org.uk/>
[Accessed 05 05 2021].
- Desai, M., Haigh, M. & Walkington, H., 2018. *Phytoremediation: metal decontamination of soils after the sequential forestation of former opencast coal land*. [Online]
Available at: <https://radar.brookes.ac.uk/radar/file/5a00b7f9-2585-4351-9203-80b7050a6079/1/Phytoremediation%20-%202018%20-%20Desai%20Haigh%20Walkington.pdf>
[Accessed 09 05 2021].
- European Environment Agency, 2021. *Glais Moraine*. [Online]
Available at: <https://eunis.eea.europa.eu/sites/139369>
[Accessed 10 05 2021].
- Evans, D. J. A., Clark, C. D. & Mitchell, W. A., 2005. The last British Ice Sheet: A review of the evidence utilised in the compilation of the Glacial Map of Britain. *Earth-Science Reviews*, 05, 70(3-4), pp. 253-312.
- Fforest Fawr Geopark, 2011. *Cribarth*. [Online]
Available at: <https://www.fforestfawrgeopark.org.uk/enjoying/places-to-go/caves-and-kilns-delving-into-the-wild/cribarth/>
[Accessed 24 04 2021].

Fossilmall, 2021. *Stigmara*. [Online]

Available at: <http://www.fossilmall.com/Stonerelic/western/wpf9/wpffossil9.htm>
[Accessed 10 04 2021].

GOV UK, 2021. *Coal Authority*. [Online]

Available at: <https://www.gov.uk/government/organisations/the-coal-authority/about>
[Accessed 09 05 2021].

Guo-li, L., Da-xue, L. & Quan-ming, L., 2008. Heavy metals contamination characteristics in soil of different mining activity zones. *Transactions of Nonferrous Metals Society of China*, 18(1), pp. 207-211.

Johnson, O. & More, D., 2006. *Collins Tree Guide*. 3 ed. London: Harper Collins.

Kent Geologists' Group, nd. *Planta*. [Online]

Available at: <http://www.kgg.org.uk/alethopterish.html>
[Accessed 10 04 2021].

Natural Resources Wales, 2021. *River levels, rainfall and sea data*. [Online]

Available at: <https://rivers-and-seas.naturalresources.wales/Station/4134?parameterType=1>
[Accessed 09 05 2021].

Natural Resources Wales, nd. *South Wales Valleys*. [Online]

Available at: <https://naturalresources.wales/media/682625/nlca37-south-wales-valleys-description-1.pdf>
[Accessed 09 05 2021].

Paterson, I., nd. *Clydach Merthyr Colliery*. [Online]

Available at: <http://www.welshcoalmines.co.uk/GlamWest/Clydachmerthyr.htm>
[Accessed 27 03 2021].

RSPB, nd. *Cwm Clydach*. [Online]

Available at: <https://www.rspb.org.uk/reserves-and-events/reserves-a-z/cwm-clydach/>
[Accessed 27 03 2021].

Schaumlöffel, D., 2012. Nickel species: Analysis and toxic effects. *Journal of Trace Elements in Medicine and Biology*, 26(1), pp. 1-6.

Swansea University Archives, nd. *Clydach Merthyr Colliery*. [Online]

Available at: <https://archiveshub.jisc.ac.uk/search/archives/2fafa12d-89f5-3c0c-8a7b-08a69f9d7933>
[Accessed 10 04 2021].

The Geological Society, 2012. *Swansea Bay*. [Online]

Available at: <https://www.geolsoc.org.uk/GowerTour1>
[Accessed 24 04 2021].

Wales Online, 2004. *Now conservationists fight Himalaya plant*. [Online]

Available at: <https://www.walesonline.co.uk/news/wales-news/now-conservationists-fight-himalaya-plant-2426558>
[Accessed 09 05 2021].

Wales Online, 2021. *The road that has to close every time there is flooding*. [Online]

Available at: <https://www.walesonline.co.uk/news/wales-news/road-storm-closes-flooding->

swansea-20303986

[Accessed 09 05 2021].

Waters, C. N. et al., 2005. Urban Geology of Swansea and Port Talbot. In: B. G. Survey, ed. *Urban Geology of Swansea and Port Talbot*. Cardiff: National Museum of Wales, pp. 7-22.

Woodland Trust, 2016. *Secrets of the Soil*. [Online]

Available at: <https://www.woodlandtrust.org.uk/media/1754/wood-wise-secrets-of-the-soil.pdf>

[Accessed 09 05 2021].