Geomorphological Hazards and Cultural Heritage

The example of the Sanctuary of Senhora da Peneda in Arcos de Valdevez Municipality
The Sanctuary of Senhora da Peneda
The Sanctuary of Senhora da Peneda

1 - Pórtico (Portico) with the royal arms and Latin inscription;

2 - Largo do Pórtico (Square of Portico), where the statue of Angel Gabriel can be admired (facing the image of N.ª S.ª da Encarnação);

3 - Twenty chapels in nine flights of stairs;

4 - Terreiro dos Evangelistas (the Yard of Evangelistas);

5 - Grande Terreiro (the Great Yard);

6 - Virtue staircase;

7 - Temple.
1800

Given the amount of the expenses it is possible to observe/deduce great activity in the Sanctuary due to a violent thunderstorm and rainfall/queda de água. The reports of the time refer many times extensive expenses “caused by the diluvium/flood”, namely the destruction of walls next to the sanctuary, caves and holes which became visible in the ground, blockage in aqueducts, obstruction of wells, destruction of the quartel (quarter where the pilgrims and workers were lodged), roads, pavements and bridges.

“It is presumed that it was the massiv stream of water that exceeded the capacity of the aqueduct under the quarter or obstructed, destroyed the quarter and flew uncontrollably among the chapels down to the pórtico” (ARIEIRO, José B. C., 1996)
Record of Disasters in Serra da Peneda

1821

A great amount of money was spent in the new quartéis (quarters) on the way down from Meadinha, which the rains and the thunder had destroyed.

1884

It is reported that the retaining wall of the temple yard to the west of the building collapsed.

1886

A violent thunderstorm caused three cliffs to collapse over the temple (the building of the temple is nowadays the hotel) destroying the entire wall to the west side of the building, the balconies and the retaining wall.

1896

Reconstruction of the wall supporting the temple yard, part of the aqueduct and the barracas (quarters), that the thunder and the water had again destroyed.
Record of Disasters in Serra da Peneda

Hydroelectric Power Station

1946

In order to attempt to solve the serious problem of electrical light in the Sanctuary and precincts, a “generator hydroelectric power station” was built.

1947

Due to the Autumn floods, this dam broke in the morning of 31 October; the flooding caused great damages to the building owned by the Sanctuary, including the hotel, which was completely destroyed. The flooding also caused the death of one worker.
Rockfall Hazard

Water flowing over the rock fractures
Rockfall Hazard
Rockfall Hazard
Average Annual Rainfall between 1930 and 1960

High amount of rainfall recorded in the meteorological stations near the study area, in the previous days of the disaster in Peneda.

Rainfall peak occurred in 30 e 31 October
Average Annual Rainfall between 1930 and 1960
High amount of rainfall in the study area between 1930 and 1960.

Annual rainfall records are normally high in this area; there are records of very elevated rainfall peaks, as it happened, for example, in the hydrologic year 2000/2001, amounting 6693.50 mm in Tibo da Gavieira and 5082.30 mm in Peneda.
News reports of the Flood and Rockfall of 1947

“The massive dam of River Peneda was destroyed by violent torrents which resulted in the death of a mason worker, put in danger several other people, and caused some huts to collapse while destroying the crops”

“(…) The dam did not resist now the violent torrents of the last rains and after breaking its massive wall the flow of water fell down from great height rushing overpoweringly at the underlying fields, destroying also some huts and humble houses, as well as a hostelry of the sanctuary – which was partially destroyed.

Dragged by the violent fall, António Rodrigues, mason, (…) who was working there (…). The body of the unlucky worker was dragged at a considerable distance, until the end of the staircase of the temple of the Sanctuary. (…)

The unexpected and alarming disaster took place yesterday in the early hours of the morning (5am). The water caused the fall of enormous rocks and great amounts of sand and land (…).”

(O PRIMEIRO DE JANEIRO, 1 November 1947)

“A dam broke in Serra da Peneda the water caused damages of several thousand contos (portuguese monetary unit of the time)”

“(…) Yesterday’s events constituted an unpleasant, disastrous and fatal surprise. At 5 am the dam broke. There was a loud noise, which echoed over the hills, alarming the local and the neighbouring populations.

The water accumulated in the dam started flowing, untamed in an abnormally high stream flow frenetic, like a real torrent – flooding the land and the houses. The so-called quartéis, where the pilgrims on journey rest, were destroyed.

A great part of the hotel was affected, and was partially destroyed. Beams and floors were destroyed by the water, which heaped up in the largo do Pórtico; the Passal and the fields were completely flooded, destroying walls and roads, which became impassable.

The most impressive is that as a consequence of the dam break the area resembles a large river. All the chapels of the Sanctuary and even the temple itself may fall into ruins. The sight of the entire area is calamitous. (…) The damages are extensive and the losses even greater. The losses are estimated in several thousand of contos.

(JORNAL DE NOTÍCIAS, 1 November, 1947)
News reports of the Flood and Rockfall of 1947

“The disaster of Peneda caused serious damages to dozens of farmers

The entire village protests blaming the fragility of the construction work of the dam of Alto da Meadinha”

From the top of Meadinha fall over the village of Peneda, during the entire year, the open waters of the mountains above this mountain. The Brotherhood, which is responsible for all the works carried out there, in order to prevent floods, had ordered the construction of a tunnel, equipped with a drainage pipe, to drain the water until the brook (...).

On Thursday morning – at exactly 5.20 am – the dam, concluded three months ago, broke under the pressure of the water, which destroyed, with a loud noise, the entire central part of the construction. The flood of water joined the water of the brook. What had previously been a simple water fall, easily tamed in a drain pipe, well protected under the ground, turned into a devastating, violent, wailing sea. The water roared like the waves of the ocean during the great storms.

The abnormally high stream of water was suddenly discharged by the main pipe. The first surge, more violent fell loudly over the central part of the Grande Hotel (...). The other surges entered the sub-soil but without any possible drainage sprang violently lifting rocks, destroying small houses, destroying part of the staircase (...).

With its savage violence, they dragged, destroyed everything. (...) The water on reaching the yard built mid-stairs did not quiet. The stream became even higher and more violent. They dragged António Rodrigues, mason worker, from his cabin (...) down the staircase, like a feather. (...) found in the front of the staircase more than 300 meters away from the place he went to sleep in. (...)

The dam contained eighty thousand water pipes (40 million litters), from a brook which springs is two km away from the Alto da Meadinha (...).

(JORNAL DE NOTÍCIAS, 2 November 1947)
News reports of the Flood and Rockfall of 1947

“The catastrophe of Peneda

It is not clear that the official authorities knew about the existence of the dam”

“(…) The water which flew agitated down the arid mountain flooded, inundated the arable soils, destroying everything as if the soil had become dislocated. The look of the place, inside and outside the area of the Sanctuary, is of desolation and ruin. Men cry the loss of their goods, all the work of one year lost, the hunger of their homes and, in many cases, the destruction of their own homes”.

JORNAL DE NOTÍCIAS, 3 November 1947

“The dam of Serra da Peneda broke

destroying several buildings and causing injuries and one death”

“(…) a small dam had been recently inaugurated (...). It was that same dam that was not able to hold the pressure of the water and which broke unexpectedly yesterday.

The stream flow, descending the mountain vertiginously, caused extensive damages in the area and great alarm among its inhabitants, precisely because the dam broke in the early hours of the morning.

(…) the waters had destroyed the hotel located there, the great houses that sheltered the pilgrims, which the population calls quarters, one of the small chapels of the sanctuary and several houses.

(…) it is believed that the damages are extensive.

Among the inhabitants, and according to the same source, several people suffered injuries and one man died. (…)”

(O COMÉRCIO DO PORTO, 1 November 1947)
News reports of the Flood and Rockfall of 1947

“The water of the broken dam in Serra da Peneda caused one death, destroyed several houses and rendered the crops useless”

“(...) And when it was least expected (...) the dam broke.

The scene, compelling and impressive, is almost indescribable. It was 5 am – it was still dark – and the few people who spend the night in the hotel and in the rest of the properties owned by the Brotherhood were waken up by the dreadful, terrible sound of the collapsing walls, the rolling cliffs, of fall of the waters.

Within minutes, the low lying lands were flooded; the fields were turned into lakes and it was possible to see the roofs of disperse houses emerging from the water and under which the distressed inhabitants screamed desperately.

At dawn the sight was devastating. The hotel was partially destroyed; the fields submersed; some chapels of the sanctuary threaten to fall into ruins; the quarters of the pilgrims suffered cracks. Disturbed by a mist of tragedy, the peace and tranquility turned into deep, mourning sadness, with the strange symphony of grieves of the injured and of those who had miraculously escaped and who had greatly suffered and endured minutes of incertitude, lost their possessions, the population remained during a long time scared, terrified, clinging to trees.

(...) The debris of the buildings were founded far away, proving the violence of the water from the dam, and transforming the place into a large river, giving the area a desolating look. (…)
Photographs of the 1947 Flood and Rockfall

View of the yard of Peneda after the terrible flooding

Jornal de Notícias, 2 de Novembro, 1947
Photographs of the 1947 Flood and Rockfall

To the left - front of the staircase of Senhora da Peneda;
To the right - overview of the destroyed quarters

Jornal de Notícias, 2 de Novembro, 1947
Photographs of the 1947 Flood and Rockfall

Detail of the destruction caused by the disaster in a part of the hotel

Jornal de Notícias, 3 de Novembro, 1947
Simulation of the flooded area in 1947

Flooded area in 31st October 1947
Simulation of the flooded area in 1947

This could be part of the flooded area in case a similar event takes place. Taking into consideration the fact that nowadays more tourists visit the area and more people live there, the area is more vulnerable to such disasters, thus, the higher is the risk.
Risk of a new break of the dam

Assuming that the rainfall amount in this area is very high, the water reservoir is, thus, extremely full in the rainy months. The rainfall flow transports sediments (rocks and sand) which are deposited in the water reservoir, silting up the dam and reducing the water reservoir storage capacity. Consequently, the dam structure is pressed, and the risk of a new break is always present.
Risk of a new break of the dam

Dam
(August, 2006)