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The Neverlake: Water and Land Management in a Dry and Soilless Place: A Micro Case in the Long Run (Classical Karst from the Seventeenth to the Twenty-First Century)

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Presentation of the Research Question and Štanjel

In recent environmental history, humans are a necessary and decisive factor, while nature is an active subject in it. This immediately raises the fundamental question of the environmental and social sustainability of the use of natural resources by human communities in the long run. In the social sciences, as well as in historiography, the question of whether collective forms of exploitation can be sustainable has been present at least since the publication of Hardin's article on the 'Tragedy of the Commons' (1968), in which he gave his well-known negative answer. Numerous researches have attempted to confirm or refute this assumption, including the famous study by Elinor Ostrom (1990), which shows that effective and sustainable methods of managing 'common pool resources' are possible, provided that adequate institutional frameworks are enacted among the direct users. Along these lines, Jesper Larsson (2016) has recently emphasized the importance of mutual control and dispute resolution among beneficiaries of the commons as important levers for ensuring the sustainability of its use. Anthropological studies also refute the assertion that peasants would be unable to manage natural resources sustainably. James Scott (1998) argues that 'vernacular knowledge of local ecosystems', based on practice and experience, can ensure even better

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environmental and social sustainability than modern forms of use. Diego Moreno (1990), combining historical, geographical and archaeological research methods, affirms that forests, especially in the Mediterranean, should not be considered simply as natural phenomena subject to human exploitation, but that historically they are 'an artefact and must be studied as such'. This does not mean that trees are just part of the scenario in the theatre of history, but rather, as Oliver Rackham (1996, 298) says, actors, and each of them has their role.

With its long history in the relationship between man and the environment, the Mediterranean region – and the Karst within it – represents an ideal observatory to address these issues, as it is a particularly fragile and sensitive environment, which at the same time represents the archetype of all Karst areas in the world (Grove and Rackham 2001). The concept 'Karst' itself, referring to all karstic phenomena, environments and landscapes in the world, is named after the Classical Karst, where our research is located.

In recent decades, both karst and the Karst have attracted more scientific attention from geographers than from historians. To underline the specificity of the anthropization forms of the karst areas, Jean Nicod (1987) proposed the concept of 'agro-karstic landscapes'. Giorgio Valussi (1965) placed the karst landscapes in the 'landscapes of effort', that is, in the environments that require continuous effort from humans to be inhabited. The landscapes of the Mediterranean and sub-Mediterranean karst areas share a number of characteristics and elements. One of them is the agricultural use of the depressions of the land where the earth accumulates. Another is the existence of particular water collection systems, necessary due to the combined effect of climatic and geomorphological conditions (Nicod 1987, 107).

The same is true for the Classical Karst. In order to be cultivated, *dolines* must be considerably adapted, which is why the dolinas converted into cultivated areas were called 'worked dolines' (Gams, Lovrenčak and Ingolič 2001, 228). There were also artificial ponds, often created within the dolines in the ground made impermeable by the overlay of stone and clay layers, and fed by rainwater (Pagnini 1966, 117, 125, 133; Moritsch 1969, 130–1; Pagnini Alberti 1972; Belingar 2007). Moreover, due to its geomorphological characteristics, the soil is particularly exposed to the erosive action of atmospheric agents (wind, rain, snow, ice), and deforestation accelerates these processes (Gams 1991a, 1–3; Gams 1991b, 9, 15–6).

The Karst represents an exceptional example of the relationship between man and the environment, as it poses particular problems and challenges to humans and their activities. It is a rather inhospitable land for humans, because there is a lack of land suitable for food production, and in addition, the surface is very rocky and surface water is lacking. Nevertheless, it has always been populated, and over the centuries and millennia humans have adapted it to the needs of agriculture, animal husbandry and viticulture. Precisely because of the special challenges it poses to humans, the Karst is an example of a completely transformed living space, where it can be said that every square metre bears the marks of human adaptation. The best known and most expressive elements of the Karst cultural landscape are man-made dry stone walls, cultivated dolines and, last but not least, ponds for collecting and storing rainwater (Panjek 2015).

In this article we deal with the topic of water resources management in the Karst, but in a somewhat unusual way, as we deal with a seemingly strange case. Our work stems from the discovery of an archival document from the seventeenth century, which testifies that a small lake near the village of Štanjel was drained by its inhabitants. Where is the logic in people draining one of the few water sources in the proverbially dry Karst? This is the main question of this paper, and the search for an answer takes us into historical and geographical waters. Our approach to this topic is inspired by Satoshi Murayama's concept of 'Living Spaces', which is in fact much more than a concept, but rather an interdisciplinary approach to taking a long-term, holistic view of human-environment relationships, linking the past to the present and possibly to the future. Based on our findings, in the concluding sections we first address the social and economic factors that influence the environmental adaptation initiative and its livelihood outcome by discussing the initiators of the revealed water management model. Finally, we address what natural and environmental factors influence the outcome in terms of sustainability and change by proposing some hypotheses on the reasons for the area's gradual deterioration.

Historically, Štanjel is a particularly interesting settlement with a strategic location, controlling one of the passages between the hinterland and the Adriatic coast. The hill on which it is located (312 m) was first settled in prehistory and then again in antiquity (a hilltop site, Roman); in the Middle Ages a tower was built on the top of the hill. It is believed that on the slope at the base of the tower a settlement gradually developed on

man-made terraces. It was mentioned for the first time in 1331. The settlement, with its characteristic long rows of houses along streets, was surrounded by walls towards the end of the fifteenth century, at the time of the Turkish invasions. Thus, in addition to its defensive hilltop location, Štanjel was further fortified. After the walls were extended in the last decades of the sixteenth century, Štanjel became 'a small fortified town with a modern Renaissance wall' (Sapač 2011, 246–9, 282; Medvešček 2019, 7–8 and 13).

The Rocks and Surfaces Around Štanjel

The Karst is a low Dinaric plateau composed of limestones and dolomites, most of which date from the Cretaceous; there are also carbonate rocks from the Paleogene. The karstified plateau, which has the characteristics of a plain in the central part, extends in a northwest-southeast Dinaric direction and covers an area of about 440 km² (Kranjc, Bijuklič, and Žalik Huzjan 1997). The Karst is surrounded on all sides by Eocene flysch rocks, except in the west, where it sinks under the Quaternary sediments of the Soča River as part of the Friulian plain.

The rock composition also varies greatly near Štanjel, where mainly limestones of different ages alternate in a small area. On the surface, Eocene transitional beds with limestones, marly limestones and marls appear. In the lower part of the slopes in the direction of the Branica River we also come across some Eocene flysch rocks which otherwise make up most of the hills in the Branica River basin. The area is cut by a very important fault in the Dinaric direction, the Raša Fault, and by the somewhat less important Lukovica Fault in the same direction (Jurkovšek, Tešović, and Kolar Jurkovšek 2013).

The surface around Štanjel does not have the characteristics of a karst plain; its shape is more reminiscent of hills. This is also reflected in the conspicuous absence of dolines, as very few can be seen in the surroundings of Štanjel. Compared to the neighbouring flysch hills of Vipavska brda in the north, the relief of the hills around Štanjel is not as dissected, due to the permeable carbonate rock. Intense fluvial-denudational geomorphological processes take place in the hills of Vipavska brda, dissecting the surface into a network of valleys and intermediate ridges. In the limestones in the Štanjel area, on the other hand, the predominant process of surface formation is corrosion, which changes the surface by dissolving the rock, forming depressions of different shapes and sizes.

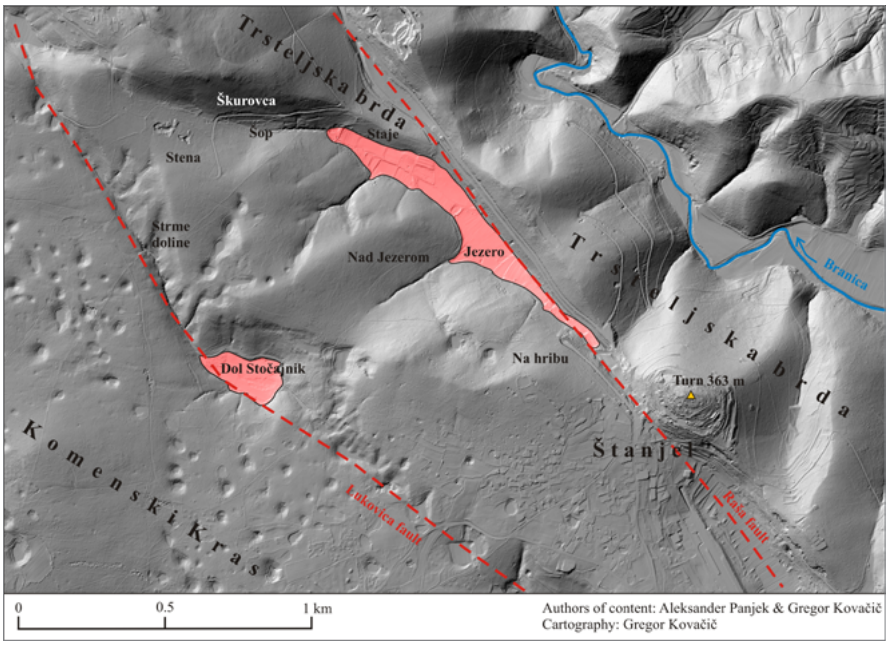

Figure 1 View of the Surface Around Štanjel Indicating the Two Dolines Jezero (Lake) and Stočajnik, and the Raša and Lukovica Faults

Author Gregor Kovačič (map and content) and Aleksander Panjek (content).

Also characteristic of the Štanjel area is the presence of smaller and somewhat larger, more rectilinear erosion gullies (ravines) on the slopes, characteristic of the entire northern edge of the Karst, which descends relatively steeply into the Branica valley and further west from Trstelj Hill (643 m) and the surrounding hills into the Vipava valley, as well as the northeastern edge of the Karst, which descends steeply into the Raša valley. A special relief feature of the Štanjel area are two somewhat longer systems of erosion gullies ending in dolines. Their bottoms are about 100 m higher than the bottom of the Branica valley in the case of the 'Neverlake' area, and 150 m higher in the case of the Dol Stočajnik area. Both systems are clearly visible in the digital elevation model (figure 1). In the present article, the discussion focuses on the 'Jezero/Neverlake' area.

This raises the question of when and how these landforms were formed and whether they are still being formed today by erosional-denudational processes, since corrosion is undoubtedly the predominant process of surface transformation.

The erosional relief forms on the slopes of the northern edge of the Karst, i.e. also in the vicinity of Štanjel, were formed in a younger geological period, probably in the last 2 million years, when the surface of the neighbouring flysch area north of the Karst lowered significantly (Radinja 1974, 21–33). This lowering is the result of the lower resistance of flysch rocks to denudation processes, which means that the surface on flysch rocks lowers much faster than the surface on carbonate rocks (limestones and dolomites). Various measurements have shown that under current climatic conditions, the surface on the Karst plateau lowers at a rate of 20-100 mm per 1000 years (Cucchi, Forti and Ulcigrai 1994, 55–62; Gams 2003), while the denudation rate on flysch rock is 400-5000 mm per 1000 years (Zorn 2008).

The above-mentioned difference in the resistance of the rocks to factors related to surface lowering has caused the valleys in the northern flysch area of the Karst to deepen and move to a lower position compared to the plateau. This caused the surface waters of the northern part of the Karst to change their course toward the lower flysch area; the fluvial erosion caused by the streams began to form erosion gullies on the northern slope of the Karst plateau. As long as the area was covered with flysch, smaller intermittent surface waters flowed from this edge towards the Branica, Raša and Vipava valleys. After the flysch was eroded in the upper part of the Trsteljska brda hills and on the northern slopes below, a series of erosional gullies emerged as inherited fluvial-denudational landforms on carbonate bedrock; in the case of the Vrpoljska brda hills in the south of the Karst, Uroš Stepišnik (2011) came to the same conclusion. The inherited landforms on the northern marginal slope of the Karst prove that there was a major flysch thrust sheet in this area, which was eroded (denudated) in the course of geological history.

'Neverlake' Near Štanjel: Physical-Geographical Aspects

The main subject of interest is the area in the immediate vicinity of Štanjel called 'Jezero' ('Lake'). It is a doline of a distinctly elongated shape, running in a northwest-southeast direction, located about 1 km northwest of Štanjel. The longer axis of the doline measures 1,160 m, while the shorter axis of the widest part of the doline measures only 161 m. Thus, the doline's shape resembles a valley, but it does not meet the geographical criteria for this relief shape, since it is a depression closed on all sides. The circumference of the doline at the edge of the relatively flat bottom with the surrounding hillslopes is about 2,600 m; its area is just under

0.1 km² (10 ha). The northwestern edge of the doline is at an elevation of about 250 m, while the southeastern edge is about 10 m higher. The deepest point of the Jezero doline is at an elevation of 219.8 m on the ponor, while the 'Neverlake' itself is about 2 m higher.

Six erosional gullies extend into the doline. The longest gully descends from an elevation of 393 m, is about 800 m long, and has a stream gradient of 17.9 percent. Where it exits the doline, it has formed an alluvial fan, i.e. a fan-shaped rubble-gravel-sand fill, on which people have created cultivable land. The erosion gully extends noticeably deeper into the slopes of Stena in the south and Škurovca in the north. The deepest part of the erosion gully is about 500 m long. As can be seen from the geological map, a minor fault (Jurkovšek, Tešović, and Kolar Jurkovšek 2013) runs along the axis of the above-mentioned gully, which certainly influenced its formation and depth. The blocks that shift along the fault planes fracture the rocks. These fractured rocks are more susceptible to erosional-denudational processes than solid rocks, which means that vertical erosion can deepen the gullies or valleys faster and that the corrosion process is stronger in the fractured carbonate rocks. The stream-gradient of the erosional gully becomes much lower as it enters the doline; at a distance of just over 500 m from the 'Neverlake' it is only 5.7 percent and toward the ponor it is even less (4.4 percent). A little further south, an erosion gully about 400 m long with a 21.2 percent slope enters the upper part of the doline; still further south is a 350 m long erosion gully with a 20 percent slope (called the 'Nad Jezerom' ('Above the Lake') area). On the basic topographic map of this area at the scale of 1 : 5,000, an intermittent watercourse is marked. Three smaller erosion gullies extend into the doline from the south.

The formation of the Jezero doline with its associated erosional gullies can be explained as the inherited remnant of a system of a larger valley and lateral erosional gullies from the pre-karst phase of the area, before the flysch thrust sheet was removed by erosion and corrosion. At that time, surface waters were still flowing from the edge of the Karst near Štanjel towards the river basin of the predecessor of today's Branica, or perhaps Raša, river. After the flysch thrust sheet was eroded, the depression of the valley in the area of today's 'Neverlake' and the associated erosion gullies lagged behind the lowering of the Branica valley, so that the valley was cut off and hung over the bottom of the Branica valley. It is likely that, at least in the early stages, a larger amount of gravel composed of carbonate and flysch remained in the depression. This gravel ac-

Figure 2 Gregor Kovačič Next to the Ponor in the Lowest Part of the Jezero doline
Author Aleksander Panjek

celerated the corrosion of the carbonate bedrock and thus influenced the deepening and widening (flattening of the bottom) of the doline. The efficient deepening of the doline was undoubtedly favoured by its location on the axis of the Raša Fault, where the carbonate rock in the bedrock is more fractured compared to the surrounding rock. Material transport in the northwestern part of the doline must have been considerable, at least in the initial phase of formation, as surface water created a well-shaped

Figure 3 View of 'Neverlake'
Author Aleksander Panjek

alluvial fan of boulders and gravel. The erosional gullies are therefore inherited forms of fluvial denudation, completely cut into the carbonate bedrock. The main ponor at the bottom of the doline is a small depression with a diameter of 4 m and a depth of 1 m (figure 2). We can only guess at the direction of subsurface drainage from the ponor, but it is likely that it flows underground to the northwest, to the Timavo River karst springs on the western edge of the Karst, just as most of the infiltrated rainwater in the Karst does.

Although today the predominant process of surface transformation in this area is corrosion, man-made structures from the past indicate periodic torrential activity. Torrents sink into sediment-covered ponors at the bottom of the doline. The water retained in the lowest part of the doline on such occasions and the resulting swampiness undoubtedly gave the doline its name – 'Jezero' ('Lake') (figure 2 and 3).

'Neverlake' Near Štanjel: Historical Accounts

The landlord of Štanjel, Johann Philipp von Cobenzl, who was also *vizedom* (representative of the Archduke) in Carniola, addressed a petition

to Archduke Ferdinand II of Habsburg in December 1606, asking that Štanjel be taken out of the dominion of Rihemberk manor, transformed into an independent manor, and granted to him. Although his petition was granted, there were complications that finally led us to the subject of this research.

When a new land register was created a few decades later, when the Rihemberk manor was sold to the noble house of Lanthieri, the Štanjel area was accidentally listed in it. The commissioners appointed by the Inner Austrian Court Chamber to estimate the revenues of the manor, who also paid attention to the increased levies compared to the past, recorded 55 gardens in Štanjel. Since this was a new development, the commissioners added a note in their appraisal stating that these 55 small gardens in the community of Štanjel had been acquired through the draining of a small lake 16 years earlier and the land had been divided among the subjects (StLA, IÖHKS, K. 90, H. 11, f. 29–33). This appraisal is dated 1624; the information it contains allows us to date the draining of the 'small lake' at Štanjel precisely to 1608. How does the draining of the lake logically fit into the description of the local agricultural and climatic conditions that Philip of Cobenzl himself had outlined two years earlier (1606) in his petition to the Archduke to acquire the dominion? Very little soil and a great deal of rocks, too much bora wind and not enough water – this image of the Karst corresponds to the widespread conception today:

A barren, wild and stony world, without any natural element apart from the gusty bora wind; where there is not an inch of land lengthwise or breadthwise on which a plough could be placed to sow a handful of grain. There are no more than two inhabitants who are able to survive on their crops for four or five months; all others, like the poor cottagers and day labourers, and very few of them I might add, are able to survive on their grain for 14 days, having to acquire the rest elsewhere. There is only one whole farm among all the people. The gardens from which the community or manor of Rihemberk receive levies are nothing but bare rock and the soil has to be brought there with great effort; the poor people grow vegetables there but rarely cultivate anything useful on account of the arid climate and strong winds. (Panjek 2015, 21)

We already published this two decades ago (Panjek 2002), but the question of how sensible it was to drain a lake in an environment where there is a proverbial lack of water sources remained unanswered until we met a resident of Štanjel, Mr Jožef Švagelj. He pointed out to us an error he had noticed in the way the functions of dry stone walls and forms of wa-

ter management in the Karst were treated in our recently published book on the history of the Karst cultural landscape (Panjek 2015). In 2016, we arranged an excursion to Štanjel; he accompanied us there and showed us the area that the locals call 'Jezero' ('Lake'), especially the remains of walls in two adjacent ravines and the traces of a stone canal and a well in the area of the valley. At that moment it became clear, or rather it was only logical, that the 'Lake' of Štanjel that Mr. Švagelj showed us was the same 'small lake' that had been drained in 1608 and converted into 55 gardens.

On this basis, we have also examined other historical and cartographic sources. First, we will present the main findings in chronological order, which we arrived at by using different types of sources. Then, in the concluding section, we will give a general explanation in which geographical methods will also be used.

The original land register of the 'community and *tabor* of Štanjel in the Karst' (*Sup und Tabor Sanct Daniel, am Carst gelegen*, acquired by Johann Kaspar von Cobenzl) from 1631 contains two separate lists of those who owned some land and those who only paid dues on hearths (houses; ASGO, AC, AD, b. 199, fasc. 511). Since the community of Štanjel also included some of the neighbouring villages, it is not possible to determine with certainty which and how many of the named householders were the heads of households in the settlement (*tabor*) of Štanjel. Considering the fact that the land register mentions a total of 154 people who were obliged to pay land and/or house dues, it is very likely that the draining and division into 55 gardens affected only members of the Štanjel settlement and not of all villages.

The next step in time takes us two centuries into the future, to the Franciscean cadastre. The maps of the cadastral community of Štanjel, made in the 1820s, show a watercourse at the exit of the ravine at the northwestern end of the 'Neverlake' *doline*, marked in blue. This is followed by a reservoir and canal that runs down the centre of the doline and ends before reaching the lower section. The only marked body of water in the lower part of the valley is a karst pond. The remaining land is farmland. These maps from the Franciscean cadastre show that at that time (1820-30), the upper part of the system (canal-reservoir-canal) was still in operation, while the canal in the lower part of the doline had already been levelled and converted into fields, leaving the reservoir in the form of a karst pond (ASTs, CF, *Mappe*, S. Daniele (Štanjel), 427b).

LiDAR images of the slope on the northwestern edge of the valley clearly show a fairly extensive system of cultural terraces (figure 7). Since they are not recorded in the Franciscean Cadastre, they must have been built and arranged at a later date, certainly after 1825.

Jožef Švagelj will take us through the changes that have taken place in the area of 'Neverlake' from the twentieth century to the present day in his own words, which vividly describe the area and its use.

> This cultural landscape, the 'Lake', has changed its appearance three times in my lifetime. Before 1960, it was about self-sufficiency. The bottom was covered by fields of corn, with beans in between; *cuke* (zucchini) were spreading onto the mowed meadow; cabbage plots were located by the karst pond. Potatoes were grown on the higher built terraces in Klanec and Staje; after they were dug up, beetroot and kale were grown there. We also had four rows of the Isabella grapevine (*smrdljivka*). We took our cows to graze on the Strma dolina commons above the 'Lake'. We watered the livestock at one of the many karst ponds. The livestock couldn't get to the cultivated land because it was enclosed by dry walls, with thorns on top. An old pine forest grew around the 'Lake' in the area called 'On the Hill'; the hill Vrhec was just forested with pines, while the slope 'Silent Side' still has the same oak forest on the sunny side.
>
> The place changed its appearance after 1960 when the young people found jobs and the old people were retiring. A new pine forest grew on Vrhec and the commons where we used to graze was occupied by self-sown pines. The fields were gone; only a patch was left here and there. The bottom of the valley changed from corn fields into a meadow that provided hay and second-cutting hay. The fodder was fed to cattle in the barns for a year; a man called Fonze continued breeding bulls the longest. The fields on the higher terraces were planted with grapevines. They were mostly cultivated by pensioners who also liked to socialize there. They were guaranteed to find company there in nice weather. At first, the vines were treated with blue vitriol using water from the newly made concrete troughs, and later on with machinery purchased with non-farming income. A man named Beber planted basket willows at the karst pond so you could see the sign 'NAŠ TITO' (OUR TITO) from the road. This new cultural landscape with vineyards was used for entertainment or socializing.

> Today, or let's say for the past twenty years, the 'Lake' is becoming an increasingly overgrown 'cultural' landscape. It's surrounded by a forest; shrubbery is penetrating the built terraces; meadows can still be seen at the bottom. Once or twice a year, larger machinery is used to mow and transport the grass to an unknown farm – all in a single day.
>
> There are no more cattle in Štanjel. There are no people in the 'Lake' during the day; perhaps at night, a hunter or two is on the lookout for game. The deer, roe deer or wild boars are its new masters. People treat nature like plunderers. The first pines were felled on Vrhec. It's only a matter of time before the forest overgrows the 'Lake'.
>
> One more thing! The dolines Jezero (Lake) and Stočajnik contain something I've never come across before in any description of the Karst. According to the stories of ancestors, the dry stone walls were there to reduce the force of torrents and prevent rocks from being deposited on fields. However, they did allow soil to be deposited on the flooded bottom of the valley. Water-induced soil erosion on the barren Karst was a major problem once. I want to show these systems for defence against water damage before I forget them, but there's no one to show them to. (Jožef Švagelj, email message to author, 1 Februar 2016)

As mentioned above, this appeal aroused our interest in the drained 'small lake' of Štanjel, which led to student research and finally to the present scientific article, in which we try to sketch in an interdisciplinary way the four-hundred-year-old relationship between humans and environment in this incredibly interesting patch of the Classical Karst.

Water Regulation System and its Results: Water and Soil

This interpretive section of this chapter draws on geographic knowledge, historical and oral sources, and the results of a detailed analysis of the LiDAR image of the 'Neverlake' area. The information obtained is synthesized into a coherent reconstruction of the construction activities associated with draining the lake, the initial reasons and results, and the subsequent changes over time. The northwestern, i.e. largest, erosion gully that opened into the Jezero doline was regulated in the lower part by enclosing its left side with an embankment made of gravel; on its right side, a dry stone wall was built, creating a canal for the running water (fig-

Figure 4 Regulation of the Erosion Gully, Northwest of the Jezero doline
Author Gregor Kovačič.

Figure 5 The Canal of the Intermittent Torrent Runs Along the Middle of the Rubbly-Gravelly Alluvial Fan
Author Gregor Kovačič.

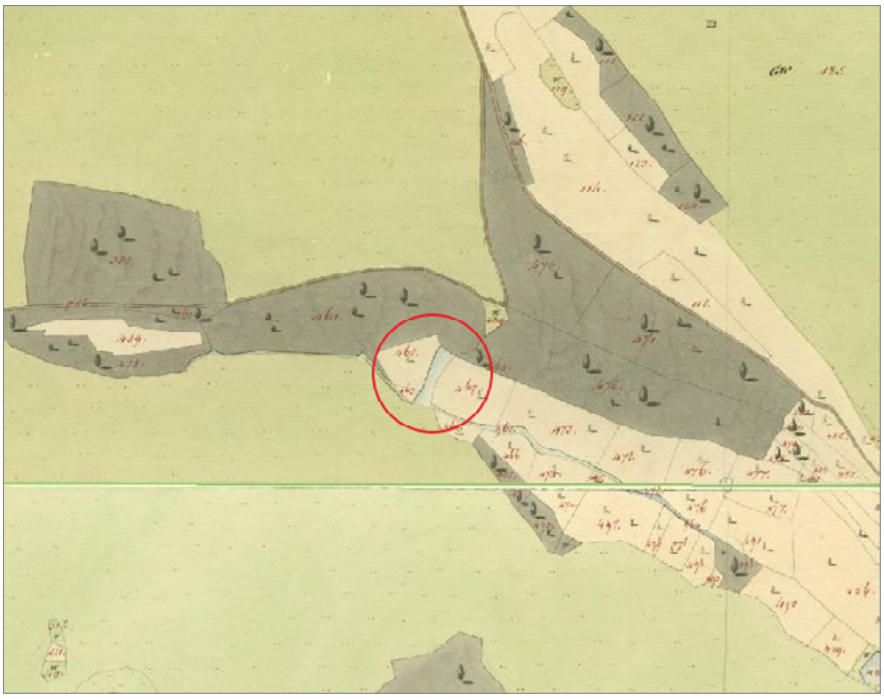

Figure 6 Anti-Erosion Barrier in the Northwest Part of the Jezero doline

Source Processed details by Gregor Kovačič of the map in the Franciscean Cadastre; ASTs, CF, *Mappe*, S. Daniele (Štanjel), 427b.

ure 4), which flowed in a controlled manner into the northwestern part of the doline bottom. At the very northwestern edge of the doline, they constructed a transverse erosion barrier to retain larger sediments that would otherwise deposit uncontrollably on the cultivable lands and reduce its fertility. The barrier is clearly visible in the shaded LiDAR relief and is also shown on the main topographic map at a scale of 1 : 5,000 (figure 8). The barrier reduced the erosive force of surface water, thereby reducing the effects of water-induced erosion of the soil that property owners occasionally faced. This barrier also acted as a more permanent reservoir, as it is clearly coloured blue in the Franciscean Cadastre (figure 6). An artificially constructed channel led off from the transverse barrier through which water drained toward the centre of the doline. The barrier did not impede the transport of fine-grained sediments, which the water washed along the canal into the lower part of the doline, increasing the fertility of the soil; the canal also served to supply water for irrigation

purposes. The canal runs through the middle of the alluvial fan (figure 5). Geomorphologically, by constructing the barrier, people have to some extent fossilized the existing alluvial fan that extends from the northwestern part of the doline towards its bottom and that was still active in earlier centuries. On the map in the Franciscean Cadastre the transverse barrier is shown as a body of water because the water was retained behind the embankment; when there was no water, the land was soggy (figure 6).

Also interesting is the regulation of the torrent that flows from the area 'Nad Jezerom' ('Above the Lake') into the doline. Here, too, the lower part of the erosion gully from the lower, downstream side was enclosed with a dry stone wall to a distance of about 160 m to prevent the water from overflowing and depositing sediments on the bottom of the doline. With the help of the dry stone wall along the riverbed, a kind of artificial levee was created, which diverted the water from the erosion gully to another reservoir, probably created in the smaller area still called 'Jezero' ('Lake'); the Franciscean Cadastre shows only one body of water in this area, namely a karstic pond without an inlet (unlike the northwestern part of the valley). The downstream bank of the lake was also artificially raised to prevent the water from overflowing into the lowest part of the doline where a ponor is still located today. The reconstruction of all the above-mentioned works is shown in figure 8 as a comprehensive regulatory system.

In this way, instead of flooding a larger area, the water was directed and dammed in a much smaller area. The area has kept the name 'Lake' until today, in memory of its predecessor. The older lake was probably much larger and occasionally flooded a larger section of the doline because it was fed by two torrents at two different ends of the doline. If this had not been the case, the use of the term 'drainage' in the seventeenth-century document would have made no sense; even less sense would have been the construction work, the remains of which can still be seen in the field four centuries later.

These construction works can be interpreted as the works to drain the lake in 1608. Their purpose and results, based on the reconstruction mentioned above, have proven to be much more complex than simply draining the lake; due to its connection with torrential tributaries and the existence of a ponor at the bottom, the lake can reasonably be classified as a seasonal flood lake. The issue was not just drainage, but regulation and management of the water and land use. Considering that the original land was occasionally flooded to varying degrees and for varying lengths of time, was more or less marshy, and that the torrents deposited larg-

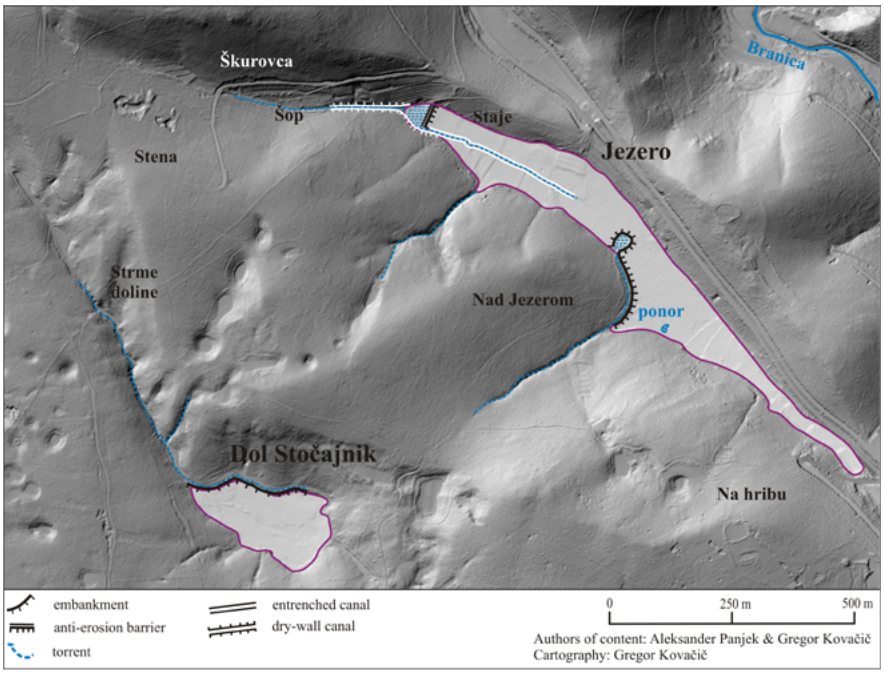

Figure 7 Reconstruction of the Water Regulation System in the Neverlake' Area of Štanjel

Source Processed LiDAR detail by Gregor Kovačič.

er gravel on it in addition to useful sediments, the use prior to regulation could only have been marginally agricultural. It is much easier to imagine the area of the 'old lake' as a place intended for grazing, mowing and watering livestock.

With the construction works, which logically combined the existing local knowledge and techniques for the construction of dry stone walls and artificial reservoirs (karst ponds), they achieved two important results at the same time. In the Karst in general, and in Štanjel in particular, there was a shortage of cultivated land and water, especially during periods of drought, which is also evident from Lord Cobenzl's vivid description. By regulating the area of the old lake and draining it, Štanjel gained new high-quality cultivable land on unusually fertile land destined for gardens, with each household in Štanjel getting its own – so it was a form of hydromelioration. On the other hand, they enriched the quantity of this resource by providing a permanent and abundant supply of higher quality water. The water was no longer swampy, muddy and seasonal,

but was stored in reservoirs throughout the year and was therefore cleaner. It was available for irrigation or watering the gardens (e.g. the canal), for watering the livestock and probably also for human consumption. So we are witnessing a very interesting case of adaptation of the karst environment through water regulation and the acquisition of new cultivated land, maintaining and improving the availability and quality of water.

As the maps of the Franciscean Cadastre show, the seventeenth-century built elements just described were only partially in use in the first decades of the nineteenth century, especially at the higher northwestern end of the doline; the canal that conducted water into the new, smaller artificial lake had apparently dried up, and the lake itself had shrunk to the size of an ordinary karstic pond. The cadastre provides us with a few other insights and conclusions. By 1820, the dried-up bottom canal had lost its function to the extent that the last section of its bed, which no longer steered the water into the small artificial lake, was converted into farmland. Three parcels of land can be seen there – one with a field, one with a meadow and one covered with a coppice of deciduous trees. The lands at the mouth of the (now former) canal were mostly meadows; fields can be seen only at the edge of this lowest part of the doline. It can be assumed that the water infrastructure at this end had decayed, the walls were breached, and the torrent began to flow out of the gully onto the land again, making cultivation impossible.

By combining the cartographic and written parts of the cadastre, we have tried to determine as accurately as possible the extent and actual location of the area we are talking about. For this purpose, based on the maps, we made a list of the plots located at the bottom of the doline. After comparing LiDAR surface images and photographs with field observations, we removed from the list any plots that were on the slope surrounding the doline, which were often crop terraces or woodlots. We did this because we felt that these plots were not part of the area of the old 1608 flood lake and drainage. In this way, we arrived at a total area of 8.1 ha, which should correspond to the largest former floodplain in the doline. The draining of the lake resulted in a somewhat smaller area, since part of the area was occupied by water infrastructure: the upper canal with a reservoir that continues into a smaller canal towards the centre of the doline; a new small artificial lake – later a karstic pond with a meadow around it, which was probably part of the lake in the past; and the area of the lower canal that roughly overlaps with three plots of land that were on the same line at the time of the Franciscean Cadastre. This water regulation infra-

Table 1 Largest Owners of Arable Land in the Area of the Drained Lake (1822)

Landowner	Number of plots	Surface area (ha)
Coronini Michele (Dominion of Štanjel)	5	1.1
Beneul Jožef	1	0.9
Brusatti Gio. Battista	4	0.8
Švagelj Ivan	3	0.5
Švagelj Jožef	2	0.4
Jerič Anton	1	0.3
Beber Marjeta	2	0.3
Jakomin Frančišek	1	0.3

Source ASTs, CF, *Elaborati*, S. Daniele (Štanjel), 659/2, Protocollo proprietary.

Table 2 Intended Purpose of Lands in the Area of the Drained Lake (1822)

Intended purpose of land	Number of plots	Surface area (ha)	Surface area %
Field with grapevines	18	4.6	60.5
Field	15	1.9	25.0
Meadow	8	0.9	11.9
Pasture	1	0.1	1.3
Coppice	1	0.1	1.3
Total	43	7.6	100.0

Source ASTs, CF, *Elaborati*, S. Daniele (Štanjel), 659/2, Protocollo particelle fondi.

structure, which served drainage purposes (minus the area of the two canals where they incised higher into the two gullies), covered just under 0.5 ha of land. Based on this calculation, the newly acquired agricultural lands covered a size of 7.6 ha (a rough estimate based on the situation at the beginning of the nineteenth century). The above values show that – given the karst conditions – it was a large floodplain (the old lake), that the infrastructure they built, including water areas, was quite extensive, and that the newly acquired area of cultivable land was quite large. This explains why, at the time of the Franciscean Cadastre, the locals called this area 'Polje' ('Field'), as shown by the place names 'Nad poljem' ('Above the Field') and 'Potok na polju' ('Stream in the Field') for the upper canal.

The list of plot owners provides us with information that complements our understanding of the drainage process. Namely, the then owner of the manor of Štanjel is mentioned as the owner of six plots of land. It is not very likely that the lord of the manor bought or sold parcels of his own manor;[1] therefore, we can assume that the situation from the early

1 Except, e.g., if a peasant repaid tax debts, in which case they would prefer to find another buyer and receive money instead.

nineteenth century reflects the drainage agreement concluded between Cobenzl, the lord of the manor, and the people of Štanjel. There were 1.2 ha of 'lordly' plots, and a total of 6.4 ha of 'peasant' plots. If we divide the area into 55 shares, as evidenced by the seventeenth century source, we find that each householder in Štanjel received 1,163.6 m² of arable land after the drainage and regulation of 1608. We also note that the share of the landlord – if our assumptions are correct – was almost exactly as large as the 10 shares of the peasants. This would mean that the drained area was actually divided into 65 shares, 10 of which belonged to the landlord and 55 to the families of the Štanjel inhabitants. Even if this were the case, the size of the individual shares is surprisingly large, especially considering that our seventeenth century source defines them as 'small gardens'. In the Karst, about a thousand square metres of arable land is quite a lot – especially if it is a garden, because that would be enough to cover the needs of an average family for garden crops.

Given the fragmentation of agricultural land, it is another small surprise that the total number of agricultural plots at the time of the Franciscean Cadastre was less than when they were first divided (43 in 1830 compared to 55 in 1608).[2] Over the course of two centuries, the number of landowners also decreased, from 56 (55 plus landlord) to only 22 (20 plus landlord, plus community). In 1822 the then Lord of Štanjel, Michele Coronini, owned the largest share of farmland; however, one of the largest owners of farmland in the area of the Lake (Jezero/Polje) was also the then Mayor of Štanjel, Jožef Švagelj (table 1).

At the time of the Franciscean Cadastre, 85.5 percent of the total area of the doline consisted of fields with or without grapevines (table 2). One wooded plot was located at the mouth of the upper canal ('Potok na polju'). All grassy plots were located in the lowest part of the doline, opposite the mouth of the lower stream, where the water regulation system deteriorated. This cannot be a coincidence and indicates that the abandoned protective walls had a negative influence on the intended use of the plots.

This state of affairs corresponds to that of the late nineteenth and early twentieth centuries, to which we can date the reports of Jožef Švagelj's 'ancestors'; according to him, in the meantime, the water infrastructure had collapsed in the western part of the valley as well. The only role that the walls seemed to play at that time was to mitigate 'the force of tor-

2 ASTs, CF, *Elaborati*, S. Daniele (Štanjel), 659/2, Protocollo particelle fondi.

rents' and to prevent 'rocks from being deposited on fields', while allowing 'soil to be deposited on the flooded bottom of the valley'. The bottom of the doline was thus flooded again and the water was merely contained, no longer directed and stored. On the other hand, quite extensive cultivated terraces had been created on one slope, testifying to another great and final effort to increase the arable land, which can be dated to the second half of the nineteenth century. Half a century later, after the Second World War, the water infrastructure was no longer operational or serving its purpose; now it is only a memory. Part of the area was used as grassland, the rest of the karst pond was planted with willows, which gradually dried it up completely. Agricultural activities were becoming less a secondary activity and more a marginal, almost leisure activity. Today, hardly any traces of cultivation can be seen; most of the area is devoted to mowing or hunting game. It could be said that this marks the end of a four-hundred-year cycle, with land use returning to its original form before the waters were regulated. The only difference is that the lake has disappeared – both the big lake and the small lake. In short, over the centuries (mostly during the last century and a half, and especially the last five decades) we have witnessed a gradual and then accelerated deterioration of the water regulation infrastructure, its purpose, and its efficiency. This has led to a parallel process of decay of a highly interesting and, according to what is known so far in the literature, original and rare cultural landscape in the Karst, which is (unfortunately) almost extinct in the present.

Although the above reconstruction is partly based on assumptions, it is nevertheless also based on quite solid documentary evidence that allows us to defend this description of human adaptation and use of the environment in the last four centuries. There are, however, some unanswered questions that we can only partially answer at the moment and that can be summarised in two groups of problems. The first group concerns the possible impact of climate change and undisputed environmental changes on the historically documented curve of the Štanjel 'Neverlake'. The second group relates to the identification of the initiator or initiators of the ingenious and efficient water regulation system in the area of the lake.

Question About the Initiators of the Regulation of 'Neverlake': The People of Štanjel or the Landlord?

In this section we will look at the social and economic factors that influenced the environmental adaptation initiative and its outcome in terms

of sustenance. All the above-mentioned regulatory works in the Jezero doline indicate that the inhabitants of Štanjel had to deal with torrential floods, the deposition of gravel and water-induced soil erosion before. These natural processes must have occurred often enough that at some point people decided to regulate the waters in order not only to reduce the negative effects of flash floods, but also to improve the quality of the soil and turn it into gardens. We assume that a lake existed in this place at least around 1600, which probably flooded the area occasionally, was fed by torrents and covered a larger or smaller part of the doline.

The question arises who took the initiative in 1608 to regulate and drain an intermittent flood lake in Štanjel. Was it the people of Štanjel or Count Johann Philipp von Cobenzl? We have proved and established that it was not a small intervention, but an extensive constructional and technical achievement, in which they protected about 8 ha of land from flooding by building about 5,000 m2 of water infrastructure with excavations, embankments and dry stone walls, which continue into the two gullies and are not included in the above figure. Since the written sources do not directly answer our question, we have to collect the scattered evidence and reconstruct the circumstances to reach some conclusions.

In whose interest was it to regulate the Štanjel lake and why? As we have learned from Cobenzl's letter to the Archduke, the inhabitants of Štanjel lacked cultivable land to such an extent that the vast majority of households in the settlement were unable to feed themselves from their own produce. This statement is confirmed by the perusal of the Štanjel land register from 1634, which does not mention the size of the lands of the individual subjects, but from which it is clear that there were only a handful of farms worthy of the name. Moreover, the regulation works were carried out towards the end of a long period of rapid demographic growth, both in the wider area and in Štanjel in particular (figure 8). Thus, the inhabitants of Štanjel would have enjoyed additional, high-quality arable land. High-quality surface water was certainly not abundant, although there was more of it than might appear at first glance. They could use the floodwater in the 'Neverlake', but its quantity fluctuated, and since it was flood-related, it could not be suitable for human consumption, although it could be suitable for livestock. In view of the above, it can be undoubtedly stated that the regulation of the floodwater, which provided up to 8 ha of additional high-quality cultivable land and a better quality and more permanent water supply, was undoubtedly in the interest of the Štanjel population. From Cobenzl's point of view, the regulation

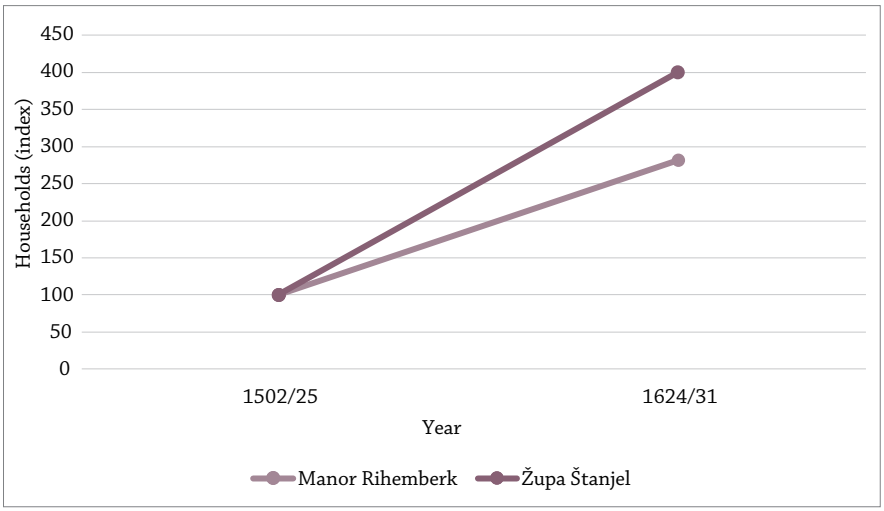

Figure 8 Demographic Growth in the Rihemberk Manor and in the Štanjel župa (index 1502 = 100)[a]

Note a) Estimates based on the number of households (hearths) and holdings in land registers. The 'župa' is a larger unit of rural self-government, which in this case includes Štanjel itself and some surrounding hamlets

Source Elaboration of data from ASGO, AC-AD, b. 199, fasc. 511; AS 1, VUK, š. 105, fasc. Lit. R XI-1; StLA, IÖHKS, K. 90, H. 11, f. 29–33

of the lake had only positive effects, as it improved the living conditions of his subjects and, at the same time, increased their taxes, as they also had to pay dues for the new gardens.

What was Johann Philipp von Cobenzl like in those days and did anything special happen in Štanjel? In the years before and after he asked Archduke Ferdinand for the lordship over the community and *tabor* of Štanjel and received the assurance that it would indeed be granted to him (1606-1607), Cobenzl showed great zeal in improving the appearance of the town, especially its most important buildings, i.e. his castle and the church. He had the family tomb in the town church renovated in 1603. At the beginning of the seventeenth century, Philipp von Cobenzl also finished the already started project of reconstruction of older buildings into a Renaissance mansion. The works were probably started in 1607. At that time, on his initiative, the Štanjel bell tower was also built; the construction works were finished in 1609. The construction of the new bell tower was led by Master Melichar Fabian, who perhaps also led the construction of the new wing of Štanjel (Premrl 2007, 13, 52–3; Sapač 2011, 255, 285–8).

All the zealous construction works that took place in Štanjel on the initiative of Philipp von Cobenzl, i.e. the family tomb (1603) and especially the renovation of the mansion (1607) and the finished construction of the bell tower (1609), thus took place around the same time and partly at the same time as the draining of the 'Lake' in Štanjel (1608).

In addition to the positive results of the works, several other circumstances support the possibility that the initiative originated within the local community. Before draining and parcelling into individual shares, the floodplain most likely had the status of collectively owned communal land, the use of which was regulated by the community of the *tabor* of Štanjel. Therefore, it can be assumed that the local community had to at least agree with the change of use, and the landlord (Cobenzl) also had to agree with this change. The construction technique of the works carried out indicates the use of the traditional Karst dry stone wall construction method, which speaks for the involvement of local knowledge and labour. However, it cannot be ruled out that more complex construction skills were used, possibly by Master Fabian, who was simultaneously building the new Štanjel bell tower.

To sum up, the draining of the intermittent flood lake benefited the landlord and the community of Štanjel; the timing of the project coincided with the demonstrated initiative and zeal of Philipp von Cobenzl in Štanjel; and the works must have been carried out in agreement and cooperation between the two sides. Whose idea it was originally, who designed the regulatory system and technically managed the project are questions that have remained unanswered so far.

Question About the Reasons for the Disintegration of the System: Climate or Anthropogenic Environmental Changes?

Last but not least, we will address the question of what natural and environmental factors influenced the outcome in terms of sustainability and change. In order to form hypotheses about the decay of the system and to assess their credibility, it would be useful to mention some other cases and the wider circumstances. The 'lake' discussed so far was not the only one of its kind in the Karst.

Near Štanjel there was another area where the water flooded the land. The area is called 'Dol Stočajnik', which can be seen in figure 7 southwest of 'Jezero' ('Lake'). The larger Štanjel farms had cultivable land there; as a document from 1606 or 1607 testifies, they were 'now being created on the communal land called Stočajnik' ('*auf der gemain von neuen gemacht*

Stattschounikh genannt'; StLA, IÖHKS, K. 90, H. 14, ff. 41–73). These farms were owned by the Špiček brothers at that time. Chronologically, this adjustment was carried out only a few years before the draining of the 'Lake'. There, too, the regulation works were carried out in the form of dry stone wall construction (figure 7). The fact that the area of Stočajnik was previously communal land is consistent with and supports the above interpretation that the area of the 'Lake' was collectively used before its draining. However, there are two notable differences. First, the goal of water regulation in Stočajnik was to create arable land for a single family, while the 'Lake' was collective property that benefited the entire community. It is difficult to say how this affected the forms of labour; however, it can be deduced that the community must have had a say in Stočajnik as well, since they had given up collective use of the area. Moreover, the successful regulation of Dol Stočajnik may have inspired a similar initiative at the 'Lake'. Second, as evidenced by the Franciscean Cadastre, there was still cultivable land in the entire regulated area in Stočajnik in the early nineteenth century.

Another similar example is the mill in the village of Rodik. The map in the Franciscean Cadastre shows a larger channel there, accompanied by the place names 'Pod Jeserom' ('Below the Lake') and 'Jeseron' ('Lake'). There is no lake visible, but the land is parcelled out in the shape of a lake, which apparently disappeared in the early nineteenth century. On the cadastral map, a reservoir is marked by the above-mentioned channel, next to which there are two building plots. One of them bears the name 'Stari mlin' (Old Mill), which means that a mill once operated there. From this we can conclude that at the time of the creation of the Franciscean Cadastre there was less water in this area than in the more remote past. We can find out what kind of watercourse it was from the list of plots, because the above-mentioned channel has its own cadastral number and belongs to the group of 'ponds and drainage channels' (*Lach und Ableitungs Gruben*). So, the channel that starts at the reservoir next to the 'old mill' is a drainage or water channel, which is definitely the result of artificial water regulation in the area once occupied by a 'lake' (figure 9). This old mill is also mentioned in the folk tradition:

The Sirk House was once called Pri Malnih [At the Mills] as the Sirk family was a family of millers. […] The Sirk family built the dam and operated the mill during heavier rainfall, when the stream Pod koriti had a stronger flow. There was no water in the summer during drought, and the mill did not operate then. That is why the people of Rodik came up with a

Figure 9 Area of the Old Mill with an Artificial Reservoir, Canal and Former Lake

Source map by Nataša Kolega – Rubin d.o.o, processed details from the Franciscean Cadastre; content by Aleksander Panjek.

teasing ditty: The Sirk mill mills little by little; when there's a drought it listens, when there's rain, it pounds. Today, all that is left of the Sirk mill is the place name Pri malnu [At the Mill]. (Peršolja 2009, 39–40)

Thus, the folk tradition confirms the existence of the mill and the construction of an artificial reservoir with a dam; however, the longer canal and the even older lake are no longer mentioned in the above account. Based on the above, it can be hypothesized that by damming the (seasonal, perhaps torrential) waters that formed the (intermittent) lake, the water was regulated to allow at least the seasonal operation of the mill and prevent the flooding of the land (a canal instead of the earlier 'lake'). In this way, the land could be cultivated without losing the water resources (the water remained in the canal; Panjek 2020). There is no information about when the mill was built; analogously, we could date it to the time when similar regulation works were carried out in Štanjel.

The first thing all these examples have in common is that regulation improved the use of rainwater and at the same time created new cultivable land – even a mill in the case of Rodik. Another commonality seems to be that there was more surface water in the Karst in the early modern period than in the first half of the nineteenth century. This is the first starting point for our hypotheses.

Is it possible that the partial disintegration of the regulatory system at the 'Lake' in Štanjel was the result of reduced interest in tillage, so that the demanding collective maintenance work was abandoned? This possibility seems highly unlikely, because the period between the eighteenth and nineteenth centuries was a time when cultivable lands were expanded due to the increasing demand for foodstuffs from the growing city of Trieste. It is true that Štanjel was cut off from the new road connections to this port city, but the survival of farmland in Dol Stočajnik proves that the local population still found tillage interesting enough. A similar case is the abandonment of the mill in Rodik at the beginning of the nineteenth century, when the building was still called 'old mill' but its owner was not categorized as a miller. This does not indicate a diminished economic interest in this activity, because in the meantime a newer mill was built on another watercourse in a neighbouring village. So the old mill was not abandoned because it was no longer needed, but rather because there was not enough water.

The last circumstance that deserves mention is related to the changes in the environment and cultural landscape in the Karst between the sixteenth and nineteenth centuries. There is an age-old question about the

history of the Karst forests, which largely coincides with the question of their degradation and their later artificial reforestation. The traditional interpretation is based on a degradationist narrative rooted in eighteenth- and nineteenth-century policies and forestry science. Particularly in nineteenth-century sources, we read that the Karst was bare and stony and that this was the result of unsustainable exploitation through deforestation and overgrazing. In contrast, the forest and pasture land use system of early modern peasants shows how the inhabitants did not destroy the forests and trees, but instead used them. Each individual tree was there for a specific purpose. Peasants determined their use based on the characteristics of the karstic terrain, climatic conditions, and their experiments with the capacity of vegetative species. They felt that a 'real forest' was not economically justified in the Classical Karst, and so only those trees necessary to meet domestic and agricultural needs were allowed to grow. Coppice was the preferred form. It has also been demonstrated that there is no real evidence that the Karst was ever covered with forests in historical times, at least not since Roman times or even earlier. Nevertheless, it can be noted that forest cover decreased and became sparser in the period from the early sixteenth to the mid-eighteenth century (Panjek 2018), when artificial reforestation began. This is also true for our case study. Although we do not have precise microlocal evidence for Štanjel, we can assume that in the period between the regulatory works on the 'Lake' (around 1600) and those on the hill above the lake in the first decades of the nineteenth century, the tree coverage decreased. Could this serve as a starting point for understanding the partial decay of the system?

In conclusion, we can put forward two hypotheses about the reasons for the disintegration of the regulatory system at the 'Lake'. First, the climatic conditions or, more simply, the precipitation regime, had changed, which means that in the early modern period there was more precipitation and it was more evenly distributed throughout the year. We know that this was not the case in the nineteenth century thanks to the Franciscean Cadastre, which speaks of heavy and short-lived seasonal rains that washed the soil away from cultivated land. The existing knowledge of the climatic history of this area does not provide sufficient basis for this hypothesis. Second, the reduction in tree density opened up more and more land that was not protected from rainfall-induced erosion, making it more exposed to erosional processes. In the first phase, this resulted in more eluvium being washed away from the slopes of the

catchment area of the torrents flowing into the 'Lake', leaving more sediment at the bottom of the doline mentioned above. Since the erosional processes in the drainage basin of the torrents were much faster than the eluvium-forming processes on the carbonate bedrock, the eluvium cover was completely removed and rainwater was able to flow freely into the underground. As a result, surface runoff decreased significantly and water did not flow into the doline as often as before. Under this scenario, it would have become increasingly difficult to contain the torrential water in phase one, and there would not have been enough water in phase two to make the system functional. Therefore, it was partially abandoned.

Both possible explanations remain unproven hypotheses for the time being. It should be added, however, that the two are not mutually exclusive.

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