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Seasonal Karst Lake Cerknica (Slovenia) – 2000 Years of *Man Versus Nature*

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Abstract

The Roman geographer Strabo (63 BC – 21 AD) was probably the first to mention Lake Cerknica (Cerkniško Jezero) and the first printed record was published in 1537 (G. Leonberger). The early authors (16th–17th C.) just admired it. The next phase can be called the research one. Authors of the 18th century tried to explain the lake's hydrographic regime. With the rise of physiographic movements, the first proposals to change the regime, i.e. to dry up the lake, appeared. Many projects have been suggested; a lot of research and even some practical works were done until the middle of the 20th century. No project was fully implemented because of fear of flooding the capital, Ljubljana. After World War II, the situation changed. Instead of draining the lake, it was proposed to make the lake permanent. The first experiments were not successful and in the 1980s attitudes towards the lake changed. Green and environmental movements prevailed and work began to protect the lake as a natural phenomenon.

Keywords: polje, engineering works, karst research, history, Slovenia, Cerknica.

Lake Cerknica (Cerkniško Jezero) is the part of Cerknica Polje (Cerkniško polje), which is regularly flooded – a seasonal lake. It lies in the central part of the Slovenian Dinaric Karst in the tectonic depression along the Idrija Fault, one of the most important tectonic lines in Slovenia. There are four other poljes in the same depression besides Cerknica Polje: Babno Polje and Loško Polje at a higher elevation (600–800 m a.s.l.) and Planinsko polje and Logaško Polje at a lower elevation (450–400 m). Cerknica Polje lies in Jurassic and Cretaceous limestone with less karstified Triassic dolomite in the centre of the lake bed. Lake Cerknica receives its water from higher lying poljes as well as from the neighbouring karst plateaux. The more or less flat bottom of the polje covers an area of about 38 km^2.

The highest water levels occur with the rainfall maximum (November–December) and with melting of the snow cover (March–April). The lake is full at these times and can cover up to 27 km^2. During high summer (July–September), the water remains just in the lowest part of the polje or dries up completely. Between these two extremes, the water level (and the area of the lake) varies according to the weather. The long-term average water regime is a lake for 10 months of the year (but not at maximum level) and the bed completely dry for 2 months (Kranjc, 1986).

Over the years, people have organised their life, work and land-use in response to the water regime. Throughout the cold part of the year, the lake was used for fishing and the transport of timber (by water or over the ice), while during the dry period, the bed was used for pasture and reeds and rushes were harvested as litter for animals.

In karst countries poljes are a sort of green oasis with water, soil and vegetation. It is therefore not surprising that from the beginning of settlement in karst lands people have had close relationships with poljes. Numerous examples of poljes can be found in the works of ancient authors. Herakles' third work, to chase the bronze birds of Stymphalia Swamps, is set in Stymphalia Polje. People began to drain Lake Kopais (a polje) in Beotia as early as the 13th century BC. A 25 km long and 40 m wide canal was dug to the "Great Katavothron (=ponor)" for this purpose (Schneider & Höcker, 1996).

The Roman geographer Strabo (63 BC – 21 AD) first mentioned Lake Cerknica (Arheološka najdišča Slovenije, 1975) and there are some indications that the Romans started to drain the polje. The first printed record of Lake Cerknica is a poem by a young German student from Regensburg, Georg Leonberger, written in 1537 (Shaw, 1994). G. Wernher (1551) described Lake Cerknica more realistically. His book was dedicated to Sigismund Herberstein (1486–1566), a native of Vipava and a diplomat at the Vienna court. Wernher's remark "…I will describe it from what you yourself have written…" is very interesting. It means that Herberstein himself had already published, or at least described in a written form (letter to G. Wernher?), Lake Cerknica before 1551. But this description has yet to been found (Shaw, 1994a). The period of these early descriptions can be called the "admiration" one. The authors admired the lake, its "miraculous" appearance and disappearance, its abundance of fish when a lake and its fertile land when dry. They did not care why this was so nor where the water came from.

The second phase can be called the "research" one. The scholars did not just describe Lake Cerknica and admire it, but tried to explain its unusual behaviour. One of the first and maybe the best known is A. Kircher, "near-legendary Jesuit polymath" (Cutler, 2004, p 67), who published his book *Mundus subterraneus* in 1665. To explain the phenomena of large karst springs he invented

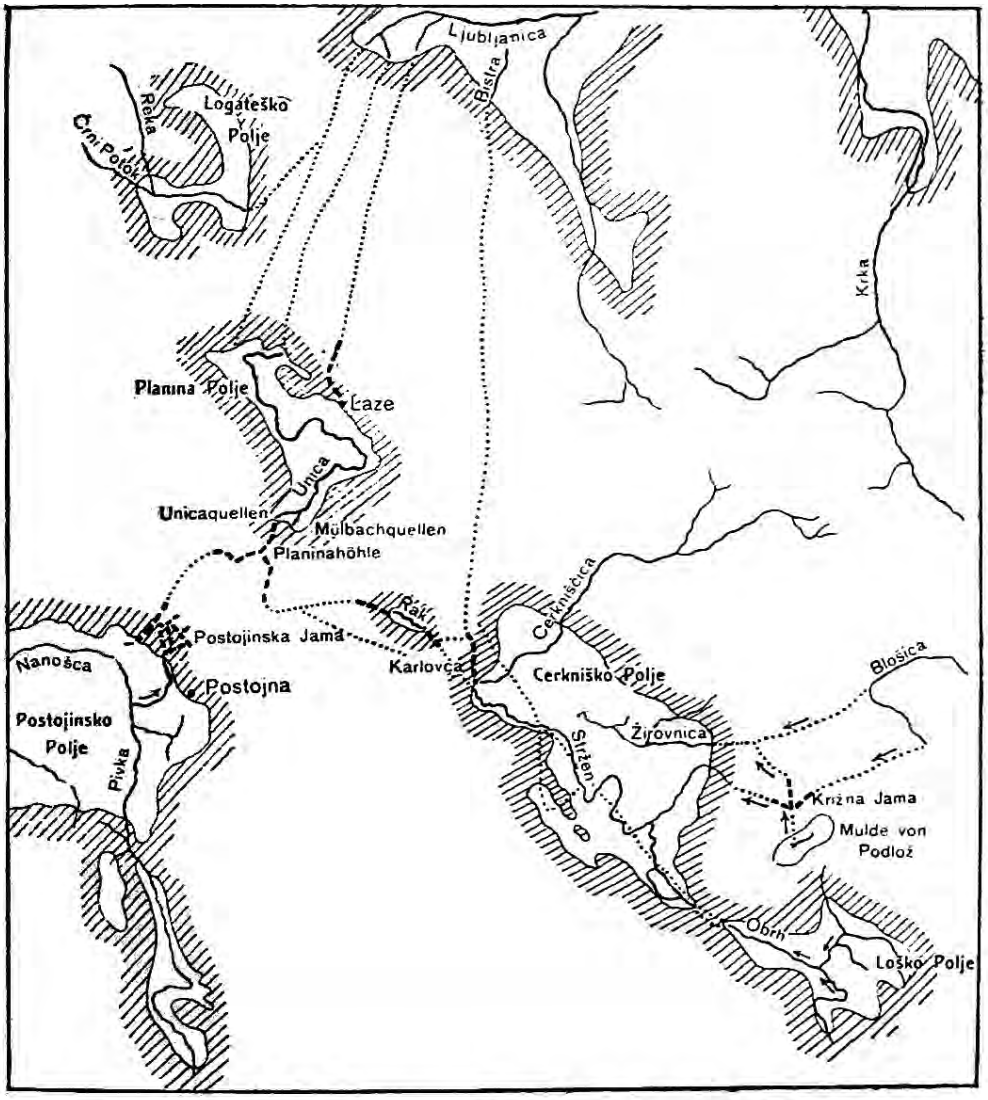

Fig. 1. — *Ober- und unterirdische Flussläufe im Gebiet der Innerkrainer Kesseltäler,* 1 : 300 000

Figure 1: Location of Cerknica Polje and its hydrological relationships with neighbouring poljes, after Löhnberg, (1934).

the theory of *hydrophilatia*. These are underground reservoirs in the mountains, filled by pumping up water from the sea through underground channels and siphons (Kircher, 1678). He used Lake Cerknica as an example of this idea.

The next important researcher was J. V. Valvasor who became a member of the Royal Society of London because of his explanation of the hydrological functioning of Lake Cerknica. He knew Kircher's theory well, but he did not agree with it. Valvasor published a more elaborate explanation in his topography of Carniola[1] in 1689. He invented five additional underground lakes to explain not just the filling and emptying of the lake, but also the order in which different springs or different ponors start to function. According to him, they were at different levels and connected by underground conduits and siphons. This seems to a modern researcher unnatural and even ridiculous, but if we compare his views with Kircher's, who was the great authority of the time, they are much less fantastic. Valvasor was an accurate observer of nature and he did not succumb to views of "a giant among seventeenth-century scholars" (Cutler, 2004, p 68). Valvasor also cites Kircher, but at the end of XLVI chapter of Book IV he states: "By my opinion it is no need to take into the account the oscillation of sea or its connection by underground channels..." (Valvasor, 1689, p 630). If we use instead of Valvasor's "underground lakes" a modern term of aquifer, his views are not so far from the modern ones. Valvasor's topography includes tens of pages dedicated to Lake Cerknica.

Half a century later Valvasor's Carniolian compatriot F. A. Steinberg (1758), who lived many years in a manor on Cerknica Polje, published a whole book related to Lake Cerknica. He described the life and farming on the

1 The Duchy of Carniola was hereditary (core) land of Austria and the part of the Austro-Hungarian Empire that included much of what is now the territory of Slovenia.

Figure 2: W. Putick and his team carry out hydrological and speleological research at the end of the 19th century.

polje and a great part of the book touches the question of hydrological function. His views are much nearer to Valvasor's than to Kircher's. His illustrations show numerous experiments he carried out to prove his views. Maybe it is not emphasised but it is important to note that the illustrations showing his experiments depict rain. So according to him, rain is the main factor filling up the lake.

It was J. A. Nagel, head of the Emperor's cabinet of rarities, who definitely stated that intermittence of the lake is due to precipitation. Nagel was sent to Carniola to see and report on the truth of the curious phenomena in Carniola and to bring back some rarities for the Emperor's collections. He decided that the changes in the water level in the lake are not due to precipitation only, but explained and showed by a sketch, that the ratio between water input and output is crucial. When the input is bigger than output (outflow), the polje is flooded and vice versa. Nagel's (1748) report remains in the form of a manuscript, deposited in the Emperor's library, and had practically no influence on contemporary and subsequent scholars.

The Jesuit scholars, brothers Gabriel and Tobias Gruber, came to the same conclusions as Nagel but T. Gruber (1781) published their ideas. In addition, they said that precipitation in the basin should be measured to find out the details of the intermittence mechanism.

The scholars of the second, research, period tried to find out the reasons for intermittence: from Kircher's fantastic underground conduits pumping sea water up into the mountains to Gruber's more realistic views about the role of precipitation.

The 18th century saw the rise of enlightenment and of physiocracy[2]. This is the third phase of research on Lake Cerknica, which can be called the "applied" or "utility" phase. This phase ended only 30 years ago. A typical representative from the beginning of this period in Carniola was B. Hacquet, who was also the predecessor of modern karstology. His views upon the functioning of Lake Cerknica were similar to Nagel's and Gruber's. However, there was a big difference. The first volume of his *Oryctographia carniolica* (1778) contains quite a long chapter on Lake Cerknica. Parenthetically he mentions that he made a three-month "economical[3]" travel across the Inner Carniola (Notranjsko) "Kesselthäler" (=poljes) with the aim of finding a measure to prevent the flooding. He presented his views about the problem in a lecture to the members of the Agricultural Society of Carniola at Ljubljana. We do not know if the lecture was ever published, and it is not known what measures he proposed to solve the question. In any case, B. Hacquet is the first person known by name that made such a proposal, but the proposal itself remains unknown.

As population and agricultural pressures increased, so did demands to increase the extent of arable land. All eyes turned towards the flat bed of Cerknica Polje with its relatively deep sediment and soil. Suggestions,

2 "Physiocratic" derived from Physio- (Greek, Physis = nature) meaning "pertaining to nature". "Physiocracy: Government according to a natural order, taught by Francois Quesnay (1694–1774), founder of the physiocrats" [Concise English Dictionary]. Physiocrats (in Austria) tried to develop better agricultural methods, they formed "Agricultural Societies".

3 "Economical". In "Austrian" German of 18th century "economic" means "agricultural". Hacquet's voyage was to find out how to drain poljes to use them for agriculture.

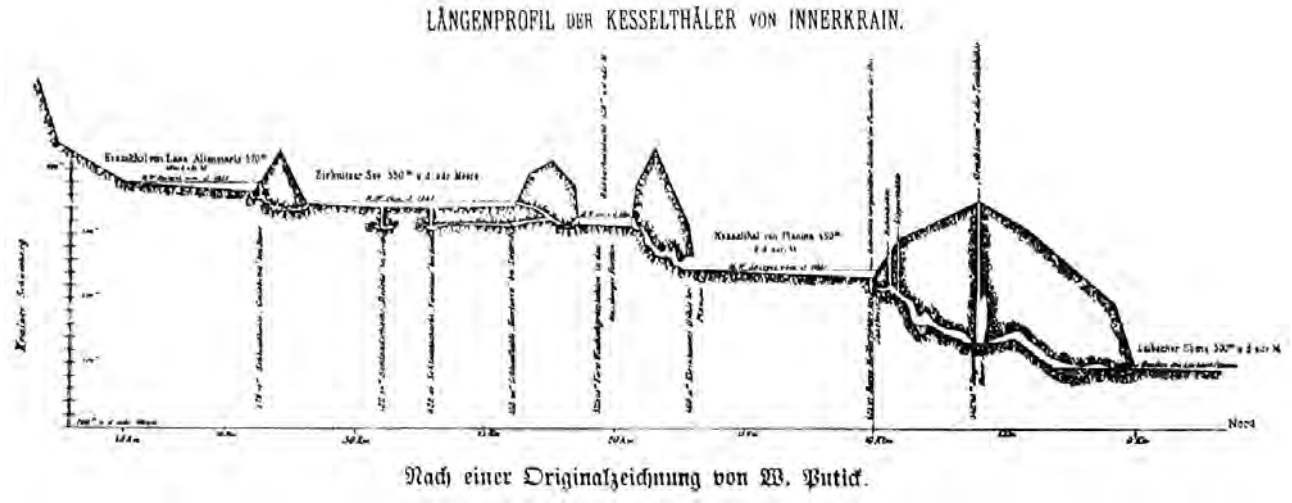

Figure 3: Longitudinal section of poljes, from Putick (1889).

proposals, and plans for its development and draining became more frequent. Both individuals who acted from their own will and interest, such as B. Hacquet, and the authorities became involved. In the beginning, these were mostly local but as we will see later, in the end the ministry from Vienna interfered. One of the first officials to become involved was A. Schaffenrath of Postojna, a district engineer, known above all for his pictures of Postojna Cave and his work in its development. He made a proposal in the first decade of the 19th century but nothing came from it (Kranjc, 2002).

A. Schmidl, the author of a famous book (1854) on caves and karst of Carniola that gave him the flattering name the "father of modern speleology", also made a proposal in the middle of the 19th century. As with Schaffenrath's proposal, nothing came from it. The same happened to the next plan of R. Vicentini (1875), although he took into account not only Cerknica Polje, but also upper and lower lying poljes, including Ljubljansko barje (Ljubljana Moor). The main reason was the fear of Ljubljana inhabitants that their town would be flooded more frequently and that the water would reach higher levels, if the poljes lying in the upper basin of Ljubljanica River drained faster.

F. Kraus, a geographer from Vienna, tackled the problem from a different point of view. He was one of the founders of the first speleological society, Verein für Höhlenkunde. One of the aims of this society was the study of Carniola's poljes to find ways to drain them. He studied the floods himself (Kraus, 1894), he organised a sort of net of field observers and succeeded in persuading the Vienna Ministry to engage and pay a young forestry

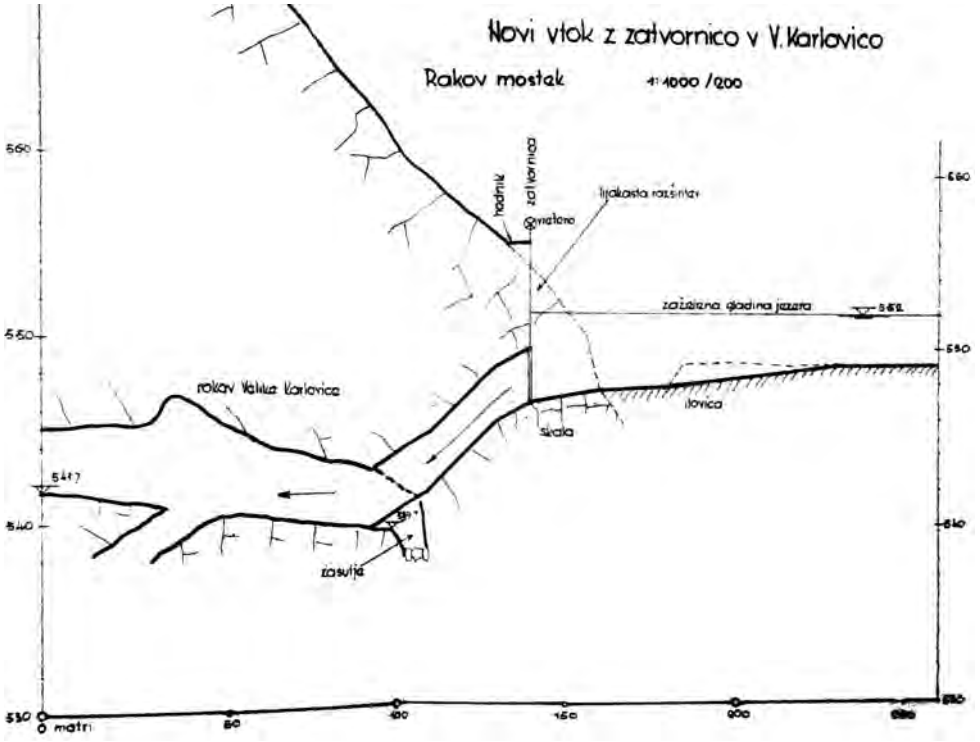

Figure 4: Section from Jenko (1965) showing tunnel connecting polje bed to the ponor cave Velika Karlovica.

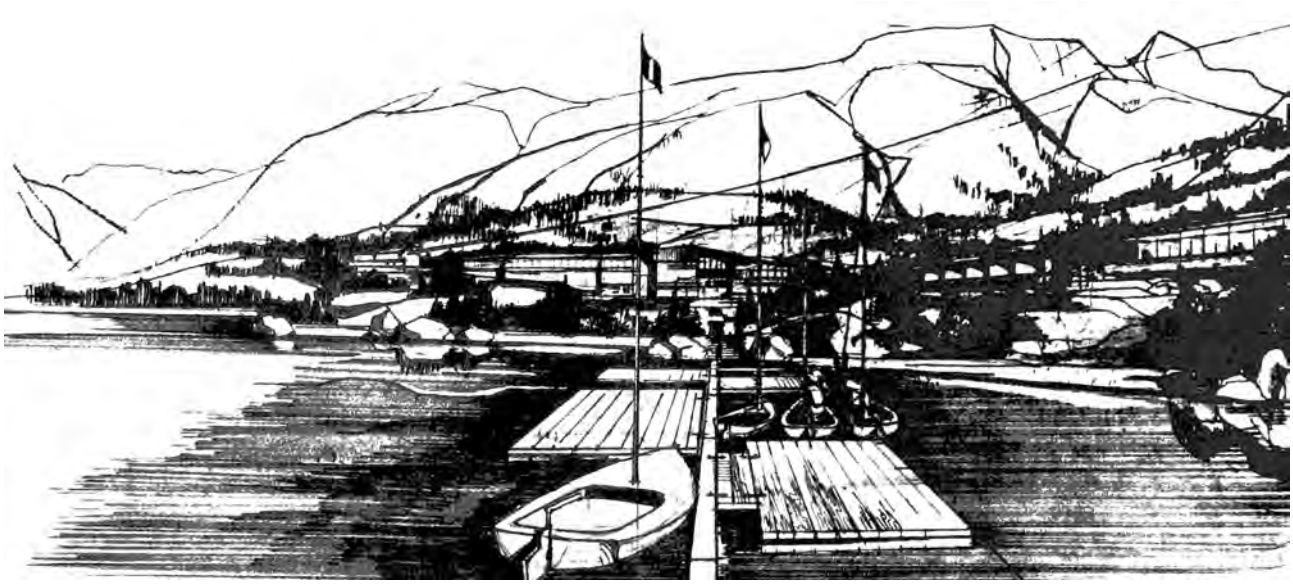

Figure 5: Yacht harbour (marina) planned at the foot of a hum. Architectural sketch of proposal from Berdajs et al. (1972).

engineer to study the problem seriously. This engineer was W. Putick who dedicated three years to these studies, mainly working in the field. The result of his research was a project with the noteworthy title "Harmless high water drain of kettle-valleys in Inner Carniola" (Putick, 1888). The project took into account the whole system, Loško Polje above Cerknica Polje and Planinsko Polje downstream in the background of the springs of the Ljubljanica River. The water from all these poljes rises in the Ljubljanica Springs. Nevertheless, Ljubljana, the capital of Carniola, interfered again. Only some elements of the project were implemented particularly on Cerknica Polje. The effects on Cerknica Polje were that the dry period was a little longer, the flood (lake) period shorter and the highest water level did not reach quite as high as before. Otherwise, the lake functioned as it did before.

A few decades later, in the 1920s the locals organised a "water co-operative" which was responsible for more drainage work following Putick's previous designs. With public funds, they straightened some streambeds, put a wooden grill (rake) in front of the swallow-holes, and lowered entrances to the main ponor caves by 2.5 and 1.2 m respectively. They blasted some siphons and they cleaned and enlarged some minor swallow-holes. They regulated (straightened) the beds of the main stream across the polje and its tributaries, for a length of nearly 8 km. There were some positive (in terms of the plans) results, but the lake was far from being drained completely:

- catastrophic floods were moderated,
- middle and high water levels drained faster,
- "sweet" grass began to grow on the ameliorated lands (Jenko, Mrak & Čadež , 1954).

During the driest period, however, agricultural fields were still not possible on the alluvial bed.

There were two more projects for draining the polje. A. Hočevar (1940) simply proposed an amelioration of floods in time and area. Tortolino's (1943) "General Plan of use of the Rivers Unica, Pivka, and Vipava, from Planina to the Sea" (regional) plan, made under the Italian occupation, proposed complete drainage.

Completely opposite projects, proposing to make a permanent lake instead of a periodical one, appeared relatively soon. In Vienna, F. Schenkel (1912) published the book "Karstgebiete und seine Wasserkräfte" (The Karst region and its water forces). He proposed converting Cerknica Polje into a reservoir. During World War II, two similar projects were developed at the Ljubljana faculty. One proposed that the accumulation lake should cover 1100 ha.

After World War II, private agriculture was increasingly neglected and other branches of the economy came into favour. V. Šlebinger's project proposed a small accumulation lake, dams, a surface channel, regulated underground outflow and a small hydropower station on Cerknica Polje. In a study by F. Jenko et al. (1954), the authors stated that the results of the previous works were insignificant. They planned major works: two accumulation lakes, a hydroelectric power station, and a drained (ameliorated) bed of the polje itself with an area of 2400 ha. The proposed works included a grout curtain under Cerknica, a surface drainage channel along the polje and a tunnel between Cerknica Polje and the lower lying Planinsko Polje.

But things changed. In 1965, F Jenko wrote in the introduction to his next plan that regulation and amelioration of 3000 ha of the Cerknica Polje bed would be too expensive and uneconomical. Therefore, he proposed his "Project of the permanent Cerknica Lake" (Jenko, 1965). The implementation of this project would develop tourism and fishery, and equalise the Sava River regime. Regarding the degree of permanence, three

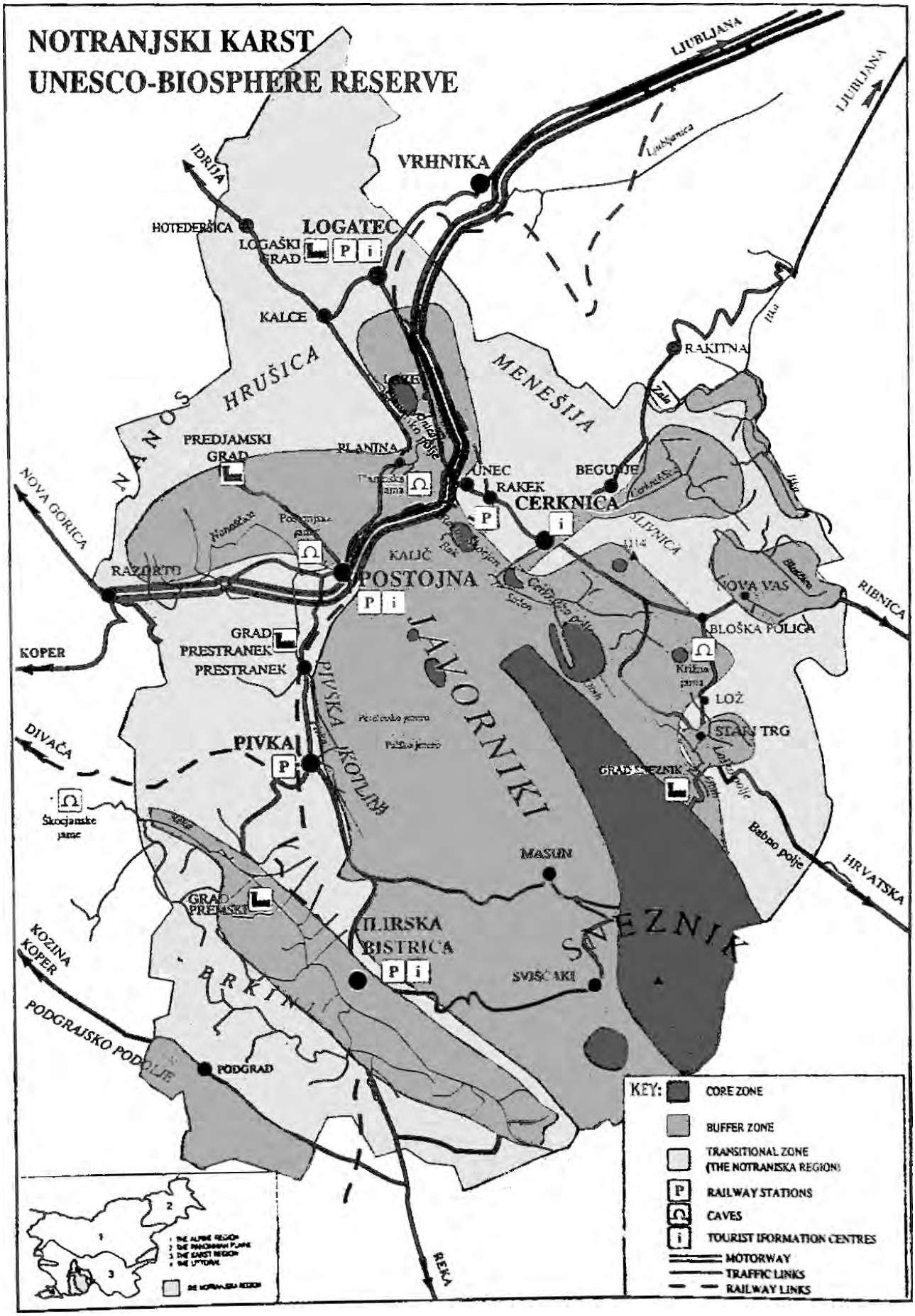

Figure 6: Lake Cerknica “Man and Biosphere Reserve” proposal, from Berce-Bratko (1994).

variants were foreseen: the lake would dry every 5 years for 1 month on average; the lake would dry once in 30 years; and complete "stabilisation", which meant a real permanent lake.

Numerous objections arose from different specialists and Jenko's project changed into "3-years experimental closing of swallow-holes". Some ponors were blocked completely, the lower part of the entrance to the main ponor cave was dammed by a concrete wall, a 30 m long tunnel, 3.7 m in diameter, connected the lake with the inner part of the swallow-holes. To regulate the runoff, a 4 m square gate-valve was constructed at the end of the tunnel. An impact on the water regime of the polje was achieved, but not a fundamental one: despite all these works, the lake dried up!

Despite this unsuccessful experiment, Cerknica Polje was included into "The Upper Adriatic Project" (Berdajs & Kern & Lesourne & Orožen Adamič & Rossi Crespi, 1972). This envisaged a tourist zone with 1000 tourist beds and tourist-facilities like bathing, boating, sailing, motor-boating, hunting, fishing, skating, skijoring[4], etc.

All the facilities and constructions required a permanent lake. In case the lake did dry out, navigable channels were to be excavated in the lake bed and pontoon swimming pools were planned. However, the project remained just a project on paper.

In 1983, Breznik was the author of the last accumulation lake project. He stated in the introduction that flooding could not be prevented without damaging land downstream. The nucleus of the project would be a dam and grout curtain across the polje bed to separate the inflow side from the outflow (ponor) side. At that time a perception of the necessity of nature protection and safeguarding developed, the "green" movement started and a trend towards "renaturalisation" of the polje appeared. Breznik's project was rejected without a lot of opposition.

Daily reports in the newspapers show that nobody was satisfied with the lake as it was. Here is an example from the hydrologically normal year 1985. In spring, the lake was full. According to the newspaper reports, the water caused great damage to infrastructure (roads, cart tracks) and to farmland. In summer, when the lake dried up, there was great damage again, this time to fishing societies. This clearly shows that Lake Cerknica was regarded as being more harm than good, as a noxious phenomenon. Regretfully, Valvasor seems to be the last person who admired the lake and praised its abundance of fish when there was water and of grass and game when it was dry (Kranjc, 1987).

4 Skijoring is skiing on flat land while being drawn along by horses.

5 Local government area.

During the 1980s, people began to talk about the "primary" state and regime of the lake, which is also difficult to attain after centuries of human interference. At the same time, protection measures were envisaged. At the beginning of the 1990s the idea of the "Notranjski (Inner Carniola) Karst - UNESCO Man and Biosphere Reserve" was born (Berce-Bratko, 1994). The central part of the lake would belong to the central or core zone. Then the idea changed into the "Notranjski natural park". Both ideas failed.

Lake Cerknica is now protected as a regional park, but just within the limits of the Cerknica commune[5]. The major part of its recharge area is out of the park, and unprotected. As far as its water regime goes, one must be glad to be able to say that Lake Cerknica remains a typical intermittent lake. During autumn and winter-spring it is a lake, full of water, while during the summer drought it is dry, just like it was 2000 years ago when people tried to change it for the first time.

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