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Antioch Iron Gate \ Antakya Demir Kapi Türkiye

Technical Report

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Further details of persons associated with the project are given in Appendix 1.

1. Summary

The Iron Gate is an exceptional monument which reflects the long history of ancient Antioch. It was completed in its present form in 550 AD as an important part of the basic infrastructure of the city's defensive walls. It incorporated a gateway, an aqueduct and bridge and a flood protection dam. This structure has considerable heritage and technical interest and is set in dramatic terrain above the Orontes plain and the city of Antioch, now modern Antakya.

The present state of the Iron Gate is very fragile and further deterioration due to natural forces of erosion, aided by earthquakes and floods will soon result in its effective destruction. It is only a vestige of its original structure, and the adjacent walls have mainly disappeared. It could have considerable specialist tourism interest if restored properly and then promoted together with other local heritage assets.

The context of the terrible 2023 earthquake must be kept in mind during discussions and decisions on investment in the Iron Gate and the Authorities must set their priorities for any action within this framework.

In order to advance the Iron Gate's global rehabilitation in an effective manner the following main points should be considered (more details are given in the Report):

- The actions need to be coordinated and managed between the numerous entities involved or interested and a Project Coordination / Management Team should be appointed at an early stage, with appropriate funds and support.
- The initial data collection and technical studies currently under way need to cover all relevant aspects necessary to understand the existing state and condition of the structure and how best it could be improved immediately, in the short and longer term. The EIB Grant may be useful to help these activities, and still to be discussed.
- Particular attention should be paid early on to the flood risk and to restoring sound flow conditions at the bottom outlet. Further hydrological and flood studies as well as hydraulic checks on flow capacities are recommended.
- Particular attention should be paid to the safe access to and on the site and in due time to the security of the physical assets.
- The studies need to conclude with a Feasibility Report and recommendations for action with an urgent phase, followed by short and long-term proposals. These should include cost estimates and an action programme so that decisions can be made by the Authorities and potential financiers.
- Studies should be undertaken into the development of the regional tourism sector in particular to strengthen the local identity and its restorative benefits for the community and to the integration of all the city's heritage assets into the tourism offer.
- In due time, the responsibility for operating and maintaining the site should be designated and adequate funding allocated. The past neglect should not be continued.

This is a worthwhile, necessary and long overdue rehabilitation of a much neglected and distinguished architectural heritage monument. Immediate action, at relatively modest cost, is required urgently to prevent further damage in advance of a longer-term programme of rehabilitation. Numerous actions are needed on many issues and the key to success is that all these are firmly coordinated and managed and an early decision on this is strongly recommended.

2. Purpose and Location

The purpose is to stabilise and protect the ancient structure of the Iron Gate, part of the Byzantine city walls of ancient Antioch. A more extensive restoration should be envisaged in the medium term to enhance the heritage value of this important structure.

The Iron Gate is located approximately 2 km east of Antakya city centre, in south-east Türkiye. It sits above the city in a deep valley of the Parmenios River (now termed the Hacıküriş Stream) between two mountain peaks named Silpius and Staurin.

Antakya is the modern name of the ancient city of Antioch which was a dominant city in the eastern Mediterranean from its foundation in the 3rd century BC through the Roman and Byzantine periods and even later, with a rich history and heritage.

3. Context

3.1. Background

In 2024, Europa Nostra Türkiye nominated the site to the 7 Most Endangered Programme. The Advisory Panel of the Programme commented: "*The city of Antioch suffered heavy damages from an earthquake in 2023, which killed at least 30,000 people in Antioch alone and most of the remaining survivors scattered throughout Türkiye. Despite these devastating consequences, the Iron Gate resisted to stand strong and, although there is neither immediate risk of collapse nor any formal rehabilitation plan, urgent actions to support and protect the structure from the effects of further deterioration must be taken quickly, particularly with regard to the completion of its support base, which is badly deteriorated*".

The Turkish authorities are rightly focused on the earthquake's impact on survivors and the restoration of all functions of the city. In the long-term Antakya's recovery from the disaster depends on continuing to develop its assets including tourism, which implies paying attention to heritage assets such as the Iron Gate.

3.2. Brief history of the city

The ancient city of Antioch, once referred to as the "Queen of the East," was founded in 300 BC by Seleucus I Nicator, one of Alexander the Great's generals. Situated on the Orontes River, Antioch became the most significant and continuously inhabited major city in the eastern Mediterranean. From its humble beginnings as a Seleucid colony, it blossomed into one of the region's most prominent cultural and political centres. Seleucus actively encouraged Greeks to settle there, recognizing the city's exceptional geographical, military, and economic advantages. Its access to the Mediterranean through its port at Seleucia Pieria near the mouth of the Orontes River was a significant advantage. Antioch was involved in the spice trade and lay strategically close to both the Silk Road and the Royal Road.

Antioch served as the capital of the Seleucid Empire from 240 BC until 63 BC, when the Romans took control and designated it as their regional capital. Under Roman rule, Antioch continued to flourish, and so the city was developed with monumental palaces, public baths, circuses, theatres, aqueducts, and an extensive water distribution network. At its peak under Roman rule its population has been estimated at about 500 000. The city was often threatened by the Persians and city walls were built by Tiberius and more significantly in about 550 AD by the Emperor Justinian whose walls incorporated the Iron Gate.

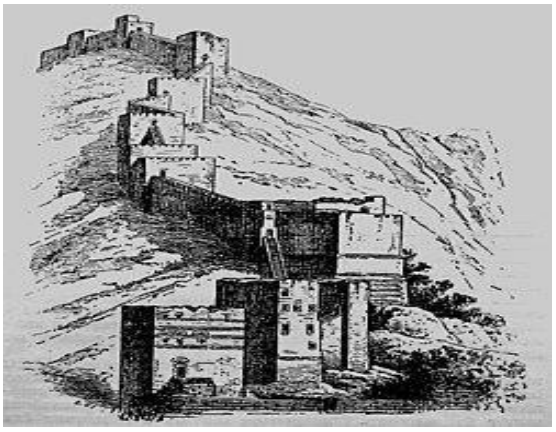
Antioch has become famous also for its association with early Christianity as St. Peter spent time there after he fled from Jerusalem. The first mention of "Christians" refers to those active in Antioch in those early years as they reputedly gathered together in caves near the site of the Iron Gate. St. Pierre's Cave Church commemorates these activities. It should be noted also that St. Paul, a key early Christian, is reputed to have lived for many years in Antioch after his conversion.

In 640 AD the city was captured by the Umayyads and stayed under Islamic influence until the Crusaders appeared in 1098 and remained until 1268 when Islamic control was reestablished. During the Crusades, Antioch became the capital of the Principality of

Antioch, one of the four Crusader states established in the Levant. Its port at Seleucia Pieria became silted up over the years and the city was largely destroyed by the Mamelukes in the 13th century. Later in the 16th Century it came under Ottoman rule but the city was a shadow of its former self due also to frequent earthquakes, and changes in the trade routes. More recently it formed part of Syria under the French mandate after 1918 and in 1939 reverted to Türkiye.

Modern Antakya is the capital city of Hatay Province with a population in 2022 of about 250 000. It still retains traces of its past rich history and cultural heritage.

3.3 The Iron Gate



The ramparts of Antioch climbing Mons Silpius during the Crusades and at right the Iron Gate at the end of XIX century (J. Carne, "Syria, The Holy Land, Asia Minor (1836–38)")

The associated city walls were also abandoned and fell into disrepair, much of the valued masonry blocks being removed over time, perhaps for reuse elsewhere

The Iron Gate formed part of the extensive city walls protecting Antioch built under the Emperor Justinian in the 6th Century. However, its origins are complicated, and this contributes to its unusual and heterogenous structure.

In about 300 AD the Parmenios gorge was crossed by a bridge to support an aqueduct as part of the fourth main water supply to the city from a source at Dunsunlu, 5 km south of the city, feeding to the historical city centre on Orontes Island.

By about 550 AD the Justinian walls were completed and the Iron Gate formed part of this with a main gateway. At the same time the lower section under the aqueduct level was reinforced to become a dam to help retain or delay flood flows which were becoming a problem for the city below. This dam section incorporated an outlet at the bottom level to allow the free flow of flood water and a small spillway at the level of the aqueduct. This structure was described in some detail by Procopius, an adviser to the Emperor Justinian, in his book entitled *"On Buildings"* describing major works undertaken by the emperor and he specifically noted the flood risks from torrents in this valley.

Later during the medieval period, the upper section of the ancient structure was partly destroyed, probably by a flood or an earthquake. The Iron Gate was then rebuilt in its current

form, using the remaining ancient structure and surviving building materials. This significant reconstruction included repairing a portion of the lower section, rebuilding the destroyed upper wall section and providing two new overflow spillway openings at the aqueduct level. In addition, three massive lateral piers were added to improve the structural stability. Decorated spolia from Islamic-period buildings (10th–12th centuries AD) have been found in these repairs which help to date them to after that period.

Following this reconstruction, the Iron Gate continued in service for many years but, with the decline of the city and the eventual closing of the aqueduct, the monument was eventually abandoned. Since then, it has suffered a continuous process of deterioration and neglect. The associated city walls were also abandoned and fell into disrepair, much of the valued masonry blocks being removed over time, perhaps for reuse elsewhere. The sequence of deterioration is not clear, but it is understood that by 1939 the only remaining part of the upper walls was immediately above the Iron Gate and included the city gate, and the adjacent city walls had virtually disappeared. The Iron Gate was thus and remains an isolated structure. Later in about 1980 the section comprising the city gate also collapsed leaving an even more isolated upper structure of about 30 m wide. The recent earthquake in 2023 may have resulted in further damage to the already fragile structure and this has still to be determined in detail.

As a result of the lack of attention to the structure by the Authorities over the years there is little detailed knowledge of its former or current condition and what information that does exist depends largely on studies done by independent academics.

The Iron Gate, despite its inherent technical and heritage importance, and its proximity to St. Pierre's Cave Church and the Charonion (a carved stone bust from the time of King Antiochus IV, 2nd century BC) has never been a significant tourist attraction probably due to the difficult access and inadequate knowledge and appreciation of its value.

4. Description

4.1 Overall historical description

The Iron Gate forms part of the ancient city walls of Antioch and is situated in a narrow gorge of the Parmenios River, an irregular torrential stream, which eventually discharges into the Orontes River. It ingeniously combines the functions of a roadway with an aqueduct bridge, a city wall and gate, and a flood protection dam.

The historical structure described by Procopius in the 5th Century was constructed mainly using *opus caementicium* (Roman concrete) with masonry additions. The lower dam wall comprising a 7.10 m thick closure wall situated just below the top level of the aqueduct / bridge and this earlier structure was incorporated into the new works. The maximum height of this dam section was about 18m. Above this, the city wall comprised a 3.0 m thick section with a height of a further 18 m. Both the lower dam section and the upper wall section are faced with small ashlars. So as to strengthen the Roman concrete infill, two horizontal layers of large ashlars are incorporated in the lower section, and several multi-layer brick courses are included throughout.

The innovative "arch" dam design using the form of the valley to buttress the structure greatly reduced the material use and the construction time and helped provide more reservoir

capacity when compared to traditional gravity dams. It was an exceptional structure for its innovative use of the narrow valley to strengthen the dam being one of the earliest examples of an arch dam. Engineers and architects in Justinian's time were renowned for their astute use of arches.

The gateway was a modest opening at the bridge / aqueduct level and was surprisingly unprotected as one of the five main gates in the defensive city walls. The roadway up the rugged valley seemed not to have been a major route or merited much attention.

The flood flows were passed from the reservoir through a bottom outlet and a rectangular spillway set at the level of the aqueduct. Smaller floods, those posing no threat downstream, were allowed to pass freely through the bottom outlet. For larger floods, the reservoir temporarily stored water and then discharged it by means of the bottom outlet and at higher flows over the spillways. This flood storage helped reduce and delay the peak discharges which all flowed without any human control.

4.2 Risks

Two main risks to the stability of a dam are those due to its geology and hydrology, and specifically here to earthquakes and floods. While an earthquake may not directly result in collapse it may weaken the structure which will later result in this occurring. Floods, especially if they overflowed the main dam structure excessively, may have a greater and more immediate impact.

The historical "Justinian" structure described above had inadequate capacity to pass large floods with only one high level spillway in addition to the bottom outlet. The "Medieval period" collapse of all the upper wall directly above the dam section was certainly due to a flood which rose above the aqueduct level and was not resisted by the upper wall section, which was not designed for this type of event. A wide gap in the wall of over 30 m resulted. When reconstruction took place two larger spillways were incorporated and the structure was reinforced by additional buttresses and the geometry was slightly amended to simplify the construction.

Further collapse of the structure occurred before the year 1800 for reasons unknown but was probably associated with the continued lack of maintenance by that time.

According to Dr Mathias Döring, the illicit removal of masonry may have contributed to the collapse of the city gate section after 1939. The limited presence on site of building material associated with the lost sections of the monument suggests that such practices may have continued over time. Adequate protection of the site against this type of risk would thus seem necessary.

Today, the Iron Gate also faces a severe threat from the hydraulic conditions in its bottom outlet. This is due to inadequate recent repairs and installations which intended to rectify the poor flow regime at this lower level. Consequently, the overall stability of the Iron Gate is now at risk. Further details are given in Section 5.1 & 5.2.

4.3 Existing state

Access to and on the site is very difficult and will present a major problem for any works, even quite simple ones and this would be especially difficult in poor weather. Two access routes are possible from the south and north of the valley and both are in poor condition. In time, both need to be restored to provide a circuit for visitors but initially probably the southern one would be preferable for construction access and further studies will be needed to confirm this.

A site visit was carried out by local and Europa Nostra/EIB-Inst. experts in February 2025 and they took note of the special site and its surrounds. It was noticed that a section of the upper wall had been damaged by the February 2023 earthquake and that the general state of the structure was very poor and in urgent need of attention.

The Iron Gate is an integral part of Antioch's city and is registered as a cultural asset located within an archaeological site. The monument was formally designated as a cultural property in 1993 and a protection zone was established around it. However, no preservation plans currently exist to prevent its further decay.

4.4 The proposed intervention

The general intervention programme aims to prevent further deterioration of the monument. It should be noted that this programme is intended to ensure the safety of the monument while safeguarding its heritage values, in accordance with international principles and standards for the conservation of cultural heritage. Therefore, any immediate or future action should be treated comprehensively, encompassing not only the physical fabric of the monument but also its spatial and historical relationships with its surroundings.

This would be done in several phases. Inevitably any works will be limited, at least in the medium term, as the Authorities of the City and others are very rightly concerned with the post-earthquake rebuilding programme of the City, its housing, its infrastructure and many other monuments, including the Hatay Archaeological Museum.

In the longer term, interventions beyond archaeological conservation may focus on landscape and environmental design strategies aimed at improving the site’s integration with the urban context, while respecting the monument’s archaeological character, authenticity, and integrity.

Noting the above caveat about priorities and available resources, it is proposed that the intervention (“rehabilitation” from now onwards) should comprise the following initial actions in preparation for the necessary work on site:

- A preliminary review of the current state of the structure to be undertaken on the site. This should provide information on its existing geometry and the condition of the various elements by visual means and appropriate tests.

- Based on these data, further technical studies should be done to assess the structural condition in terms of the stability overall and for individual sections of the works such as the bottom outlet and spillways.
- A comprehensive Feasibility Report to be prepared, perhaps in phases, to cover the repairs and restoring works proposed with justifications to ensure the long-term stability and sustainability of the Iron Gate and presented to give details of:
  1. the urgent works required to prevent any imminent danger of collapse.
  2. medium term works required to ensure longer term stability.
  3. longer term works to recreate its original form to the extent possible.

As a first step in this process, an archaeological and technical team, led by Prof. Dr. Hatice Pamir, has been appointed to carry out research on the site of the Iron Gate to assess its state and to identify measures to rehabilitate it and to ensure its viability in the long-term. The full details and extent of these proposed activities need to be studied but the work is part of a wider study on the Antioch hippodrome and its vicinity excavation. (see § 13 EIB Grant).

It appears that the team plans to start work on the Iron Gate during September/October 2025 so this should now be well underway. The main initial action is to prepare a photogrammetry documentation of the site and structure and convert this to a 3D scan. The preparation of technical documentation for the whole structure should follow but this phase is still unclear. The aim is to produce 1/50 scale plans, cross sections and elevations which will form the basis for archaeological, architectural and structural studies. From this the attention should move to preparing a diagnosis on the current state of the structure and propose interventions for the improvement of its stability presented in a Feasibility Report. It should also cover wider archaeological assessments, any environmental concerns as well as cost estimates and a proposed programme, suitably phased.

This Report will be assessed by a multidisciplinary team of the relevant Authorities and then decisions for financing and action can be taken.

The actions should include as priority the following proposals which might be provided in advance of the full Feasibility Report due to their urgency:

- Improvements to site access (to be carried out with sensitivity not only to cultural heritage, but also to the ecosystem).
- Addressing the problem of the bottom outlet.
- Stabilising the structure to prevent any immediate risk of collapse.

The later phases of rehabilitation and repairs and any new structural additions would follow depending on the conclusions and recommendations of the Feasibility Report.

5. Technical aspects

5.1. Structure

The remains of the Iron Gate appear very fragile, as it is now isolated without any lateral support, and it requires special care even for access, let alone to carry out the essential repairs. The structure's complex history, marked by various construction and repair phases of differing quality, only adds to this challenge. This construction history should be reviewed

and recorded during the research work to be undertaken by Dr Pamir, an archaeologist, with some technical support.

The entire structure above the aqueduct level may be at risk of collapsing due to ongoing erosion, natural events such as floods and earthquakes and perhaps manmade damage.

Initial limited repairs to the structure should focus on stabilizing key sections of the masonry skin and ensuring that the lower "dam" section is sound. The exact proposals will be defined following the detailed surveys and the appropriate stability studies.

It may be, in view of the urgency, that temporary repair work could be used comprising bulk timber and steel which would later be replaced by permanent new masonry. Transporting materials to the site will be a significant logistical hurdle, requiring an integrated design approach. Improvement to site access for personnel, equipment and building materials is therefore a first essential step before any meaningful activity.

The *opus caementicium*, the cementitious concrete infill between the masonry faced walls, is an important structural component for overall stability binding the blocks together. With age the properties of this "Roman cement" will deteriorate and it may now present a problem due to its unknown and probably varied properties. It will need detailed examination to determine its state and the cementitious quality it might still possess – the proportion of pozzolana and lime being a key parameter and its state of carbonation. This is a potential problem throughout but is a particular concern above the aqueduct level where it seems that the *opus caementicium* is directly exposed and lacks the protection of the masonry skin.

It might be possible to stabilize the *opus caementicium* in places through special injections (perhaps behind the masonry skin) but this would need special care and be risky. Alternatively temporary protective coverings in key places might be possible to reduce the short-term risk of erosion. The most prudent approach might be to pre-emptively dismantle any dangerous sections and provide temporary protection. This would be a short-term preventive measure, with the intention of rebuilding those sections later when feasible. If dangerous sections are not neutralised in this way it is likely that a more serious progressive collapse could result. These preliminary ideas may be revised when more information is obtained from the site investigations.

The other parts of the structure where further surveys are required are around the bottom outlet, the spillways and at the abutments of the dam section. If the dam is required to operate under flood conditions (which is very likely, see §5.2), these parts must be sound structurally and watertight and able to resist erosion from flood flows.

As an interesting aside, calculations show that the overall structure of the dam section by itself is not stable, with tension under its heel under full reservoir conditions. Thus, it depends for its overall stability on the constraint provided by the valley's form and so, even if it is not physically a full arch dam in form (this is not clear), it acts as one for its integrity. This means that the abutments must be sound.

5.2 The flood risk

The Parmenios river is sensitive to flood risk as was recognised when the Iron Gate was built in the 6th century to provide also a flood reduction dam to protect the city.

The situation has since changed somewhat as it appears that the dense urban parts of the city itself may not be so much at risk from a flood from the Parmenios river. However, while the Iron Gate's role as a flood reduction dam may have become less important with time, it still presents a risk as explained below. Much of this data is from Dr Mathias Döring's book "Antiochia - Wasser im Überfluss", see details in references.

The Parmenios valley is carved into the rugged mountainous terrain with an underlay of limestone rocks. The catchment area upstream of the Iron Gate is small at 9.4 km2. Most of the year there is minimal or no discernible flow, but torrential floods occur on a regular basis. No detailed rainfall or flow information is available for the Parmenios river and catchment. Annual rainfall for Hatay Province is 1150 mm (1940 - 2024) and is shown to be reducing in recent years. This general regional information does not provide much useful detailed data for the Iron Gate flows.

An estimate of the maximum precipitation gives a 24-hour rainfall of 432 mm and this would result in an estimated flood volume of 2.9 M m3, with a peak inflow into the reservoir upstream of the Iron Gate of 99 m3/sec. This estimated peak flow can be compared to those deduced by Dr Döring from a flood in 2003 which gave a peak inflow of 43 m3/sec. Unfortunately, no rainfall records of the 2003 flood event seem to be readily available. Dr Döring noted that a major flood occurred in 1938 which damaged the downstream area significantly, so it was likely that it was a greater flood than the 2003 event, but no further details seem to be available. Reportedly in 1967, a flood damaged several houses (about 30) and some 110 ha of agricultural land was submerged.

From this limited hydrological information, it is not possible to make any firm estimates of flood probabilities, but the recent 2003 flood could be treated as a lower limit for a 25-year event which would need to be catered for in the short term. Further refined estimates could be undertaken and may show a higher risk for the normal design life of the structure (say over a minimum 100 years' period).

The reservoir capacity is relatively small at 17 000 m3 at the sill level of the upper spillways. At peak inflow of 43 m3/sec (the 2003 flood) the reservoir would fill in under 10 minutes, so it would provide only limited useful storage to act as a buffer to even out flows, it being more of a "head pond" than a storage reservoir.

The hydraulic capacity of the Iron Gate to discharge the flood is complicated and has changed with time. The main outlet is an opening at the base of the dam structure. This had an estimated flow capacity at full reservoir level of 45 m3/sec, but the outlet has been modified (see later) and the current estimate is reduced to 19 m3/sec. The two higher spillways were added at an unknown date following the collapse of part of the upper wall and thus show the historical concern over the dam's ability to cope safely with the flash floods. These spillways are also uncontrolled openings and are estimated to have an indicative

discharge capacity together of about 11 m3/sec at high reservoir levels, but this flow clearly depends on the water level. At higher floods parts of the main structure or the exposed abutment may be overtopped.

The general conclusion is that the current capacity of the structure to discharge flood flows, with the maximum outflow estimated at some 30 m3/sec (19 + 11 m3/sec), is inadequate compared with the possible flood flows which could occur in the short term (i.e., 1 in 25 years flow of 43 m/s).

While the estimates presented above depend on various assumptions there is some firm evidence to underpin them. Dr Döring observed evidence of flows through the upper spillways as floating matter had lodged in the stonework, and this could be linked back to the major flood in 2003. From this the maximum reservoir level for that flood was established at 158.70 m above local datum and the various hydraulic flow calculations could then be made. Note that at 158.70 m datum the reservoir capacity was estimated at 27 600 m3.

The condition and state of the bottom outlet is particularly critical as it provides the main outlet for flood flows. The condition of the structure around the orifice has clearly deteriorated over the years. It has suffered high intermittent flow rates and is composed of a masonry arch, backed by *opus caementicum* (Roman concrete). The deterioration was noted by local engineers recently and so they decided to adapt the outlet to reduce the risks by trying both to reduce the sediment and rock flows (which could block the outlet) and to repair the masonry arch outlet. The resulting works have been unhelpful. They included constructing a retaining wall several meters upstream of the outlet with the intention to retain sediment, which it no doubt has done but with other negative effects. See sketches in Appendix 3/5.

The result of these actions has been to constrain and confuse the smooth flow conditions of the outlet and to significantly reduce its capacity from an estimated 45 m3/sec to 19 m3/sec. The finer sediment retained could have probably been safely passed through the outlet anyway and the more important larger blocks, if they were to be a problem, should have been retained much higher up in the stream and not close to the outlet. The new flow through the bottom outlet after these changes would be much more turbulent as the water must pass through two right angle turns just upstream of the outlet. This turbulent flow would have increased its erosive potential and the damage to the bottom outlet which is now very evident and serious.

These repairs were intended to rebuild the arch of the bottom outlet using reinforced concrete to protect the structure. Unfortunately, with the high flow velocities (estimated at 11 m/sec) and the increased turbulence, as explained above, the concrete layer has largely broken-down, leaving steel reinforcement bars which have trapped various floating matter and plastics to further reduce the efficiency of the outlet. It is unclear how well the added concrete was bonded into the existing dam structure as this is essential for long-term stability.

In summary, the stability of the structure is at serious risk from a major flood such as that of 2003, a quite probable event in the short term. The rainfall and hydrological data at the site are sparse, and further studies would be useful but the risk is clear, and action needs to be taken urgently. The dam structure could be seriously damaged by an erosion failure of the lower outlet or by overtopping and the impact of the resulting flood surge on the downstream area would be significant.

In general, the sediment retaining wall needs to be removed to improve the flow conditions upstream of the outlet and the outlet needs to be properly repaired so that the flow passes smoothly. Any concrete skin needs to be firmly connected into the existing dam structure. This work needs to be coordinated with other work on the structure as covered elsewhere. Ideally a rock trap may need to be installed further upstream of the dam to prevent potential blockage of the outlet.

The urgent priority is for a proper study to be undertaken by competent people to determine the existing state of the problem and to propose long term solutions.

5.3 Earthquake risk

Antakya and Hatay Province are situated in a zone of high tectonic activity. The East Anatolian fault runs in a north-east direction across the area, separating the Anatolian plate from the Arabian plate and both are in steady movement. The Dead Sea Transform fault extends southwards, eventually linking up to the Great Rift Valley fault system. Overall, this is one of the most active seismic areas of the world with numerous strong earthquakes occurring on a regular basis.

The latest earthquake to strike Hatay Province and a very wide area of south east Türkiye and Syria was on 6th February 2023. That day the first earthquake had an estimated magnitude (M_w) of 7.8, with an epicentre near Gaziantep, 200 km north-east of Antakya, at a depth of about 10 km. This was followed later the same day by another earthquake of M_w 7.7, with an epicentre some 100 km further north-east from the first event, at a depth of about 7 km. In the following three months some 30 000 aftershocks occurred, some of significant strength.

The previous earthquake of this magnitude in Türkiye was in 1939 near Erzincan, situated in eastern Türkiye and not directly on the same fault system. This latest one has only been exceeded historically by the North Anatolia earthquake in 1668, which illustrates and underlines the massive and exceptional nature of the two earthquakes in February 2023. Major earthquakes have been noted over the centuries, for example in years AD 37, 115, 365, 458, 526, 528, 713, 860, as well as many recent examples.

The damage sustained in 2023 in south east Türkiye was enormous with an estimated 14 M people directly affected (16% of the total population of Türkiye); with 53 00 deaths and 107 000 injuries this was the worst natural disaster in recent Turkish history. Antakya, despite being some distance from the epicentres, was one of the worst affected with an estimated 25 000 deaths and some 30 000 injuries. It is estimated in Antakya that 70% of homes and 6 400 major buildings were destroyed and many damaged. In comparison to this devastation, the Iron Gate seems to have suffered relatively lightly but no detailed review has been done to show the full extent of any damage, which may be hidden deep in the structure.

Earthquakes can have a devastating impact on dams and high wall structures such as the Iron Gate. It would seem from the geometry of the Parmenios valley that there is probably not a fault there but even so the closeness to major active fault systems as described above means that the structure is at high risk. It is likely that past earthquakes have caused collapses in the city walls or have weakened them so that erosion, floods or other forces have finally caused them to collapse.

Further studies into the recent damage sustained during the February 2023 earthquake event and its relevance for the future sustainability of the structure are recommended and should be included in the proposed studies.

6. Implementation

6.1 The Owner

The State owns the archaeological site on which the Iron Gate stands. The Ministry of Culture and Tourism (MCT) represents the State and works through the General Directorate of Cultural Heritage and Museums (GDCM) on practical matters. Any intervention concerning heritage monuments needs to be approved by the Monuments Council, a national institution.

6.2 The Nominator

The project was nominated to the "7 most endangered" programme in coordination with Prof. Dr. Hamza Yüksel Dinçer, former President of Europa Nostra Türkiye.

Follow-up work: managed by Yigit Ozar, current President of Europa Nostra Türkiye.

6.3 Other interested parties

- Provincial Directorate of Culture and Tourism in Hatay
- Regional Council Hatay Cultural Properties: The local authority responsible for all decisions regarding implementation, and the identification and registration procedures for cultural properties.
- Hatay Archaeology Museum Directorate: Responsible for conducting archaeological excavations and research and for inspecting archaeological sites and for such work on other movable cultural assets.
- Adana Directorate of Surveying and Monuments: Responsible for carrying out and commissioning all studies and project implementation services related to the maintenance, repair, construction, surveying, restitution, restoration, landscaping, preservation and evaluation works of immovable cultural assets within the GDCM's jurisdiction.

6.4 The Project Coordination and Management

At an early stage a specific person should be appointed with a support team to be responsible for managing the whole series of processes necessary for advancing the programme of preserving and rehabilitating the Iron Gate. It seems that this responsibility normally would devolve to the Hatay Directorate of Surveying and Monuments (on behalf of the Ministry of Culture and Tourism, the ultimate responsible authority). This is a key appointment and should be made as early as possible.

6.5 Design / consultants / experts

Some studies and repair works have been undertaken in the recent past (e.g. the bottom outlet repairs) but details are not available and should be sought to allow the most complete information to the benefit of the proposed rehabilitation. As noted elsewhere, Prof. Hatice Pamir will undertake a research project to update the knowledge on the condition of the Iron Gate and to propose further actions.

In view of the probable need to phase the works, as suggested elsewhere, it is likely that several consultants may be involved in the various future activities and phases. Those involved should have adequate experience and all their actions require close coordination with the competent Project Coordinator / Manager.

6.6 Contractors

In view of the nature of the works, competent contractors for the rehabilitation of the monument are essential and so suitable selection procedures to ensure this should be adopted. Depending on the scale and nature of the works it may be that firms from outside Türkiye become involved to supplement the local resources but, if so, this may increase the costs significantly. Proper procedures of selection are recommended.

6.7 Programme

Clearly phasing of the various activities and actions will be necessary to allow these to proceed in a logical and optimised manner. The phasing will clearly need to be refined when more information becomes available and will have to match the available finance. Progress depends on gaining approvals from the various entities responsible and this will need some encouragement and firm management.

An indicative target programme of the rehabilitation phases could be as follows:

1. Preliminary review. Start in October 2025. Say 2-3 months.
2. Further Technical studies. Start December 2025. Say 2-3 months.
3. Feasibility report finalised. Say mid 2026.
4. Appointment of Project Coordinator / Manager. By mid 2026.
5. Decisions on urgent actions. Mid 2026 or earlier.
6. Urgent actions on access, bottom outlet repairs, urgent stabilisation. Start end 2026 (or earlier). Duration between say 4 and 6 months.
7. Decisions on medium term rehabilitation actions and long-term strategies (integration with city etc.,) say by end 2026.
8. Selective actions on site to follow. From end 2026.

It must be noted that this programme shows short term (urgent) actions and only briefly refers to medium-term actions and long-term strategies, which must be properly programmed in due time.

7. Procurement

There is a need to have appropriate consultation/tendering for the selection of the various consultants and for the main contracts according to Turkish law, preferably aligned with EU requirements.

The contract strategy and the packaging of the lots will need to be adapted to the local conditions and needs, and this is a task which the Project Coordinator / Manager will need to address. Some form of prequalification may be desirable for the more specialised work.

8. Environment, sustainability, social

8.1 Environmental context

The Iron Gate is situated in rough mountainous terrain above the city. It is in a fairly remote and inaccessible area despite being close to the city. The greatest environmental impacts from nature have been due to earthquakes and floods combined with erosion (including land and rockslides), and this is a general issue for the wider region.

The Iron Gate and its associated walls are now in a poor condition, particularly the city walls, which have almost disappeared, and their direct impact on the local environment is now limited. The Iron Gate presents some risk from collapsing masonry and, in particular, to the possible damage resulting from a major flood, if no repairs and improvements are carried out, as explained elsewhere. The correct repair and reinforcement of the Iron Gate's dam component would provide an environmental benefit in terms of reducing the impact of major floods on the area downstream.

The works proposed for the rehabilitation would require the access road to be remade and this needs to be done appropriately to avoid excess damage to the environment. Later the same attention should be paid to any reconstruction works, particularly in terms of disposing of surplus material. Attention should be paid to ensuring safe access both to and on the site. In addition, some form of security to the site to avoid looting should be put in place. It is noted that quarries operate in the upper catchment area and that this could result in vibrations and increased erosion and pollution unless managed in a proper manner.

Efforts are being made after the 2023 earthquake to improve the integration of this area with the city and to improve the overall conservation efforts. This has been proposed by The Hatay Planning Centre in a Recovery Guide which would be beneficial and should be supported. It is entitled: "Action M-9-7: Development of a project that valorises the Antakya Walls together with the conservation plan, as a part of the archaeological heritage, presenting a complementary and unifying image within the relationship between the historic urban settlement area and natural areas".

8.2 Challenges to conservation efforts

St. Pierre's Cave Church, situated in proximity to the Iron Gate, was inscribed on the UNESCO World Heritage Tentative List in 2011; however, the designation process has remained stagnant since that date. It is pertinent to note that, as of 2019, a hotel development was completed directly above an adjacent archaeological excavation zone, which is currently under the management of the Necmi Asfuroğlu Archaeology Museum.

The Iron Gate's rehabilitation should ensure that all works comply with the latest environmental requirements and embrace the concept of sustainability. The project actions should, of course, adhere to all regulations and planning requirements related to heritage monuments including implementing best practices in recycling and waste disposal, following ISO 14001 procedures.
To respect its architectural heritage (a primary reason for its protection) the monument should be rehabilitated as appropriately as possible to retain the monument's distinctive, bold sculptural impact and its technical innovative character. If new structure were to be added, then this should be clearly shown separately from the original surviving works, as is usual good practice.

8.3 Social impact

The Iron Gate is remote from the city and so any direct social impacts will be rather limited. Its rehabilitation will provide employment during the study and design stages and during the construction works and this would give some benefit to the local economy.

As the last remaining of the city's five historical gates, it is an important landmark, although not widely known until recently. This value could make it a critical point of reference in the recovery process of the city, which suffered extensive damage from the recent earthquake. Promoting and rehabilitating the Iron Gate in the wider context of Antakya's restoration process could be an important step towards recovering the urban identity and thus, strengthened bonds of belonging and so contributing positively to social cohesion.

The wider benefit to the community of enhancing this exceptional heritage monument, especially if combined with other actions, would be reflected with time in enhanced tourism activity and would encourage a greater pride in the unique history of the city. In summary, social benefits would result in the longer term from preserving and enhancing the Iron Gate.

9. Use and tourism

Despite its renowned past, Antioch and its successor Antakya are not major tourist destinations compared to other sites in Türkiye. The recent earthquake and other challenges (e.g. the Syrian conflicts, Covid 19) have clearly not helped this situation.

To illustrate this, visitors in 2020 for some key sites in Antakya were as follows:

Hatay Archaeological Museum	240 000
St.Pierre’s Cave Church	195 000
Necmi Asfuroglu museum hotel	90 000
Hatay City Museum	32 000

Despite these low figures, tourism is a potential growth area for Antakya as it has exceptional heritage assets which may need to be better presented and organised.

The Iron Gate falls into this category being an unusual, probably unique, monument and site, and well worth promoting once the essential repairs have been completed.

Access to the site is challenging even when the pathways have been improved. The Iron Gate needs to be better promoted and information on its very unusual history should be made available through publications and brochures. In addition, a detailed model, perhaps physical or virtual, could be made and displayed in the Archaeological Museum or elsewhere. This model would explain the Iron Gate's history and be expanded to cover the city walls and Antioch's water supply system, both of which are exceptionally interesting. These are some ideas for consideration.

Adventurous walking tours have been organised in the past combining a visit to the Iron Gate with the nearby St. Pierre's Cave Church, a popular destination as can be seen from the data above, and other local historical locations. Other similar initiatives relating to nature and culture have been identified by a recent "Planning Dimensions Master Plan" undertaken by the Turkish Design Council which has included the Iron Gate in its considerations. The enhancement of the monumental heritage assets of ancient Antioch, including the Iron Gate, would underpin efforts to improve the attraction of specialist tourists to the region.

Overall, a wider study of the City's potential for tourism, both cultural and business, matched to the current and proposed assets and facilities would be of interest and help guide developments to enhance the tourism offer. In time special activities at the Iron Gate might be envisaged and, if so, appropriate arrangements need to be made.

10. Operation and maintenance

The operation of the site, the day-to-day management and looking after visitors, seems to be the responsibility of the Hatay Archaeological Museum but this needs to be confirmed as someone needs to be made responsible for this activity.

The main activity on the site will be visits by those interested to inspect and appreciate the remains. In time the site should be suitably enhanced with instructive signs to explain the Iron Gate and its surrounds. Later other activities may be added once the site has been adequately developed and these would need to be proper managed by the operating entity, perhaps with out-sourcing to private organisations.

A key issue will be to ensure that the access pathways and those on site are properly maintained so that visitors can always be safe. In addition, proper security on the site to protect the monument should be installed and adequately supervised and maintained.

Those responsible for these important tasks of operating / managing the site and its maintenance need to be designated by the appropriate time and an adequate budget provided for these on-going tasks.

11. Investment cost

The rehabilitation programme has not yet been defined in any detail so an estimate of investment costs at this stage would be premature. Once an outline of the needs has been determined following the initial studies, a cost estimate of the various phases can be made to fix ideas and thus allow appropriate funds to be obtained to advance the programme.

As a very unfounded “guesstimate”, the investment cost of the Urgent programme might cost say about € 1 m, followed by more substantial amounts depending on what would be proposed (say up to € 5 m should provide Basic Stabilization works). Thus, the amount needed to provide the essential repairs may be rather modest but more detailed estimates are required after further study to confirm this.

12. Economic review and financing possibilities

12.1 Economic aspects and justification for action

As with most heritage projects, the economic justification is not straightforward as many of the benefits are subjective. This is the case with the Iron Gate as the main quantifiable benefit is that due to tourism and this is rather weak, at least at present. A further benefit is provided by the flood protection which results from a reduction of the flood risk. The main justification for preserving this monument is however for its historical, cultural and technical interest which is significant but difficult to quantify.

As shown elsewhere (§ 9) the tourist interest in Antakya and its region is not high and has been negatively affected by recent troubles such as Covid 19, the recent conflict in Syria and most dramatically by the 2023 earthquake. Nevertheless, tourism interest in time should recover and efforts to enhance the tourism offer should form part of the recovery plans for the Hatay Province. The Iron Gate could contribute positively to this recovery in tourism if it were to be rehabilitated, made safe to visit and then properly promoted.

The Iron Gate is a most exceptional monument both as one of the last vestiges in Antioch of the former glory of the Byzantine period by being part of the city walls and the aqueduct system and for its technical interest. The construction of the walls and the aqueduct in such challenging terrain is a great feat of engineering. The history of the development of the Iron Gate from simple valley crossing through to its final multi-functional form with a city gate and flood prevention dam combined with the walls and aqueduct is probably unique. In addition, the form of the dam component directly supported by its abutments in the narrow valley in a partial arch form is revolutionary and a precursor of modern arch dams. It may be the oldest surviving such example, dating from the Justinian period (550 AD).

The Iron Gate, as conceived by Justinian’s engineers was to include flood protection to part of the city. Further improvements and repairs since then to extend and improve this protection have clearly shown that this has continued to be important and that this is likely to remain to be relevant.

A rigorous economic assessment of the flood prevention role would require a valid estimate of the likely extreme floods, a cost estimate of the works required and an estimate of the benefits in terms of value of damage prevented. None of these data are available at present and further work might be useful to refine such an assessment. Despite this, clearly the current situation with reduced flow capacity has significantly increased the risk of flood overflows which could result in damage or collapse of part of the structure with possible serious impacts downstream.

In conclusion, this is one of the last remaining parts of the city walls and is of considerable historical and technical interest. Action to stabilise the structure and improve the flood

protection function is essential to prevent the further deterioration and maybe destruction of this important monument. Undefined but interesting benefits could accrue from tourist visits and the flood prevention which would result from these appropriate improvements.

This is an important heritage monument, and some essential works are needed in the immediate future to prevent its demise.

12.2 Funding possibilities

Despite the Iron Gate being a monument of considerable interest, securing financing for its rehabilitation will not be easy due to the scarcity of funds for such investments in the country, and especially in the Hatay Province post-earthquake. Given the project's nature, grant financing is highly desirable, as the investment could not support a loan. Once the initial investment is made, the operational phase might be self-sustainable.

The European Union, through its various programmes, might be the most desirable source of grants. While the EU has shown some interest and support, it is fully committed following the earthquake to essential basic infrastructure and similar programmes for the next several years. Another potential source of support could be the USA's "Ambassadors Fund for Cultural Preservation", if this programme is still active. Local funding may also be scarce, but there might be possibilities for contributions from the Turkish Government and possibly the City of Antakya, to be set in the wider context of other funding needs for the 2023 earthquake reconstruction.

A thorough study into funding possibilities will be necessary once viable project and programme proposals have been defined, following the basic feasibility studies.

13. The EIB Grant

The EIB has agreed to provide a grant of €10 000 to each project selected for the "7 Most Endangered Programme" to act as a catalyst to advance the project or to carry out some essential priority investment.

The first and urgent step is to carry out a technical survey of the structure to assess its condition after years of neglect and to gauge the impact of the recent earthquake. This review would provide the basis for a programme of actions to safeguard and protect the historical structure and provide some guidance for its future development.

A preliminary "research study" has already been approved by the Authorities and is being undertaken by Prof. Pamir and her team as already described in § 4.4. The detailed output of this work is still unclear but scans of the outline of the structure and its surrounds should result and these would provide a useful base for further studies.

The main practical output sought would be a Feasibility Study covering the main themes cited above in § 4.4, perhaps issued in phases. Detailed Terms of Reference for the EIB Grant will need to be established following discussions notably with Europa Nostra Türkiye and others such as Dr Pamir.

Timing is important as normally the EIB Grant should be committed during the first half of 2026.

14. Conclusions and recommendations

The Iron Gate is an exceptional monument which reflects the long history of ancient Antioch. Its present state is very fragile and further deterioration due to natural forces of erosion, aided by earthquakes and floods will soon result in its effective destruction.

Action is required urgently to save the Iron Gate for posterity.

The context of the terrible 2023 earthquake must be kept in mind during discussions on any investments in the Iron Gate and the Turkish Authorities must set their priorities for action within this framework.

In order to advance the Iron Gate's rehabilitation in an effective manner the following main points should be considered (more details are given in the text of the Report):

- The actions need to be coordinated and managed between the numerous entities involved or interested and a Project Coordination / Management Team should be appointed at an early stage, with appropriate funds and support.
- The initial data collection and technical studies currently under way need to cover all relevant aspects necessary to understand the existing state and condition of the structure and how best it could be improved immediately, in the short and longer term. The EIB Grant may be useful to help these activities and is still to be agreed.
- Particular attention should be paid early on to the flood risk and to restoring sound flow conditions in the bottom outlet. Further hydrological and flood studies as well as hydraulic checks on flow capacities are recommended.
- Particular attention should be paid to the safe access to and on the site and in due time to the security of the physical assets.
- The studies need to conclude with a Feasibility Report and recommendations for action with an urgent phase, followed by longer term proposals. These should include cost estimates and an action programme so that decisions can be made by the Authorities and financiers in due time.
- Studies should be undertaken into the optimum development of the tourism sector in Antakya and to the integration of the city's heritage assets such as the Iron Gate, the walls, the aqueducts and others locally (St. Pierre's Cave Church) into the offer for interested tourists and to enhance local interest and local pride in the city.
- In due time when adequate work has been carried out for the site to welcome visitors safely, the responsibility for operating and maintaining the site should be appointed and adequate funding allocated. The past neglect should not be continued.

This is a worthwhile, necessary and long overdue rehabilitation of a much neglected and distinguished architectural heritage monument. Immediate action, at relatively modest cost, is required to prevent further damage in advance of a longer-term programme of rehabilitation.

Numerous actions are needed on many issues and the key to success is that all these are firmly coordinated and managed and an early decision on this is strongly recommended.

Appendix 1: Summary of Mission

Mission:

A visit to Antakya took place on 17 February 2025. It included a meeting at the Office of the Civil Society Development Centre (STGM) with the local Authorities and notably a visit to the Iron Gate site. St. Georges Church, Altinözü was also discussed. Those present included:

Local and Turkish experts:

Prof. Zeynep Ahunbay. Europa Nostra Türkiye Working Group.

Yigit Ozar. President Europa Nostra Türkiye

Hande Akarca. Europa Nostra Türkiye Working Group

Ali Çelikay (archaeologist), Director Hatay Archaeology Museum

Baran Bozyigit, civil engineer. Oxford University, Doruz Eylul University.

Burcin Altinsay. Europa Nostra Türkiye Working Group

Müge Yorganci Ozar. Europa Nostra Türkiye Working Group

Iskender Azaroglu. Europa Nostra Türkiye Working Group

Prof. Mustafa Hamdi Sayar. Euro Nostra

Prof. Hatice Pamir. Hatay Mustafa Kemal University

Abdullah Dinç. Hatay Provincial Director of Culture and Tourism.

Seyhan Tan. Hatay Metropolitan Municipality. Conservation & Control Bureau

Europa Nostra and EIB.Inst. experts:

Guy Clausse, Vice-President, Europa Nostra

Pedro Ponce de Leon, Consultant expert, Europa Nostra

David Castrillo, Consultant expert, EIB-Inst.

Dimitris Leventis, Architect, Europa Nostra

Mario Aymerich, Consultant, expert, EIB-Inst. (in meeting by ZOOM link)

Appendix 2: References

References

Documents consulted (internal)

ACTION FRAMEWORK for the rehabilitation of the Iron Gate

ANTIOCH IRON GATE (ANTAKYA DEMIR KAPI). 7 Most Endangered Sites in Europe program, 2023. Application form and answers to subsequent questionnaires.

IRON GATE SITE OBSERVATION REPORT. Europa Nostra Türkiye, 2024.

EARTH SCIENCE-BASED INTEGRATED DISASTER RISK ASSESSMENT FOR IRON GATE. Europa Nostra Türkiye, 2025.

Publications (external)

ANTIOCH ON THE ORONTES. History, Society, Ecology, and Visual Culture. Edited by Andrea U. De Giorgi. Florida State University, 2024

IRON GATE, Antioch on the Orontes. TITUS TÜNELI, Seleukia Pieria. Matthias Döring. Parmenios – Verlag Adenstedt 2026. In English

IRON GATE OF ANTIOCH. Gunnar Brands Professor of Classical and Oriental Archaeology. Martin Luther University Halle-Wittenberg, Germany. Newsletter, 2025.

NATURAL DISASTER RISK ANALYSIS AND MANAGEMENT FOR ANTAKYA, Istanbul University. Değerliyurt, M. (2013).

ANTIOCHIA – WASSER im ÜBERFLUSS Mathias Döring. Parmenios - Verlag Adenstedt. Note the plans and drawings from this in Appendix 3 of the report.

POWERFUL SPRINGS AND DANGEROUS TORRENTS ON UNSAFE GROUND. The hydraulic engineering buildings of Antioch and Seleucia Pieria. Mathias Döring

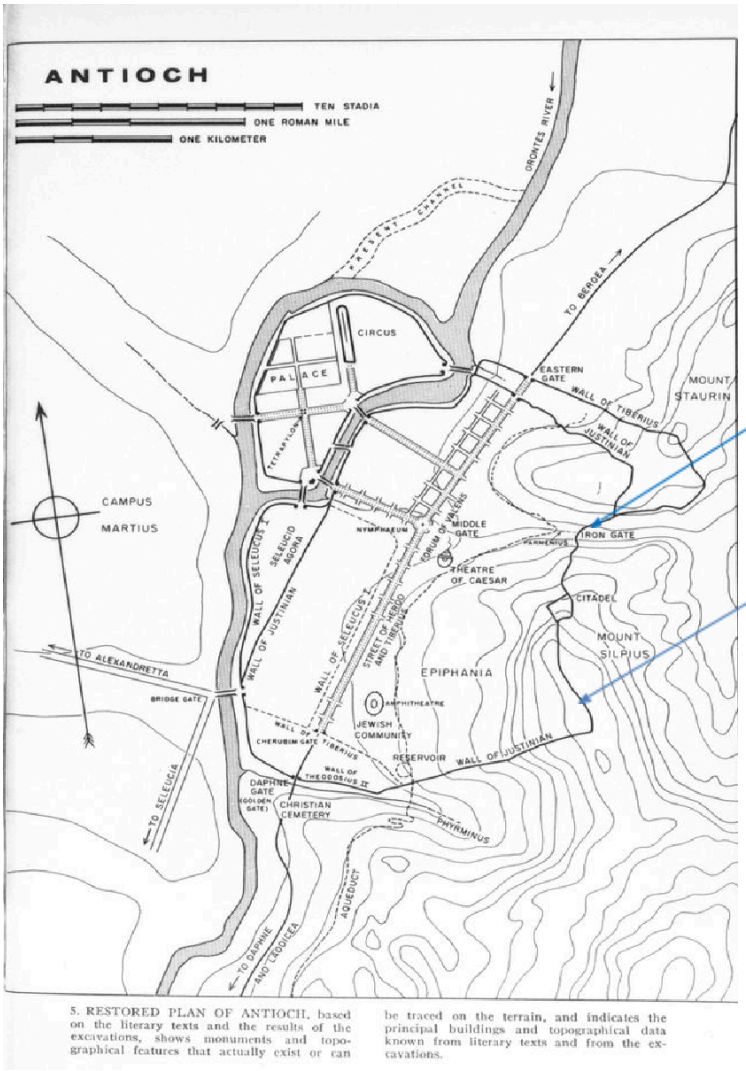
RECOVERY GUİDE (by Hatay Planning Center): For integration with the city and the wider development or for protection of the other historical city walls.

VARIATIONS OF TOTAL YEARLY PRECIPITATION IN EASTERN MEDITERRANEAN COASTS OF TÜRKIYE (1975–2006). Gönençgil, B., & İçel, G. (2010). Türk Coğrafya Dergisi, 55, 1–12.

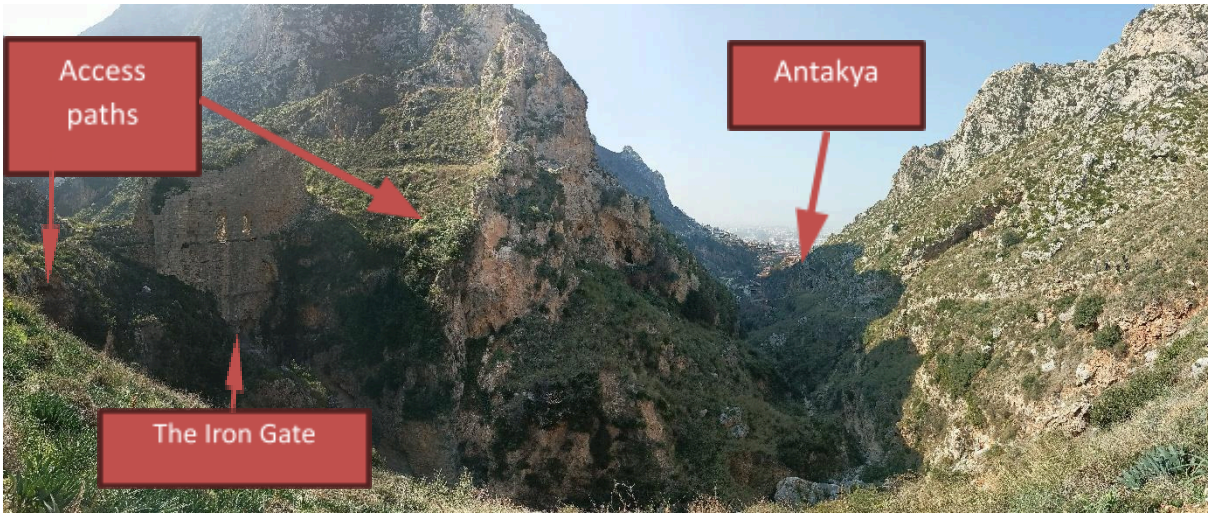
2023 Türkiye-Syria earthquakes. WIKIPEDIA

Appendix 3: Maps, photographs, drawings

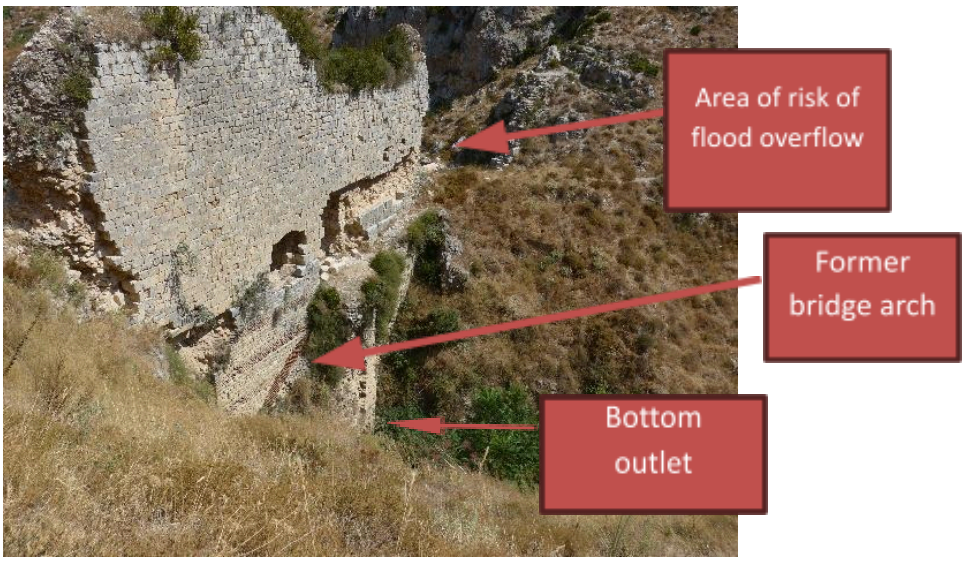
Maps, photographs and drawings



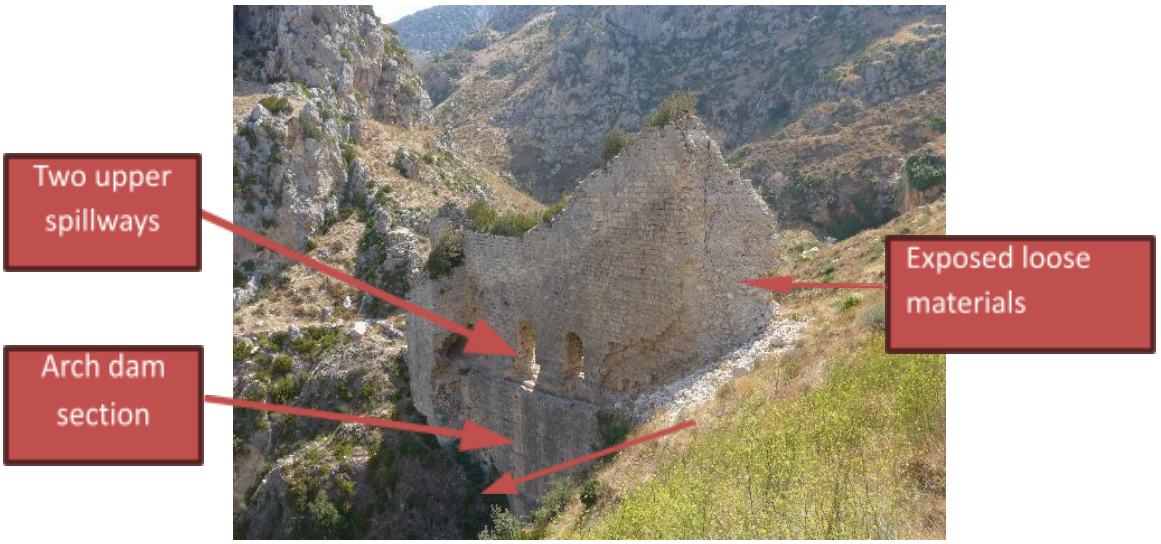
5. RESTORED PLAN OF ANTIOCH, based on the literary texts and the results of the excavations, shows monuments and topographical features that actually exist or can be traced on the terrain, and indicates the principal buildings and topographical data known from literary texts and from the excavations.



Panorama on the lower Parmenios valley



The Iron Gate from upstream 2024



The Iron Gate from downstream 2024 (earthquake-induced mass loose material and wall collapse)

Access path from South

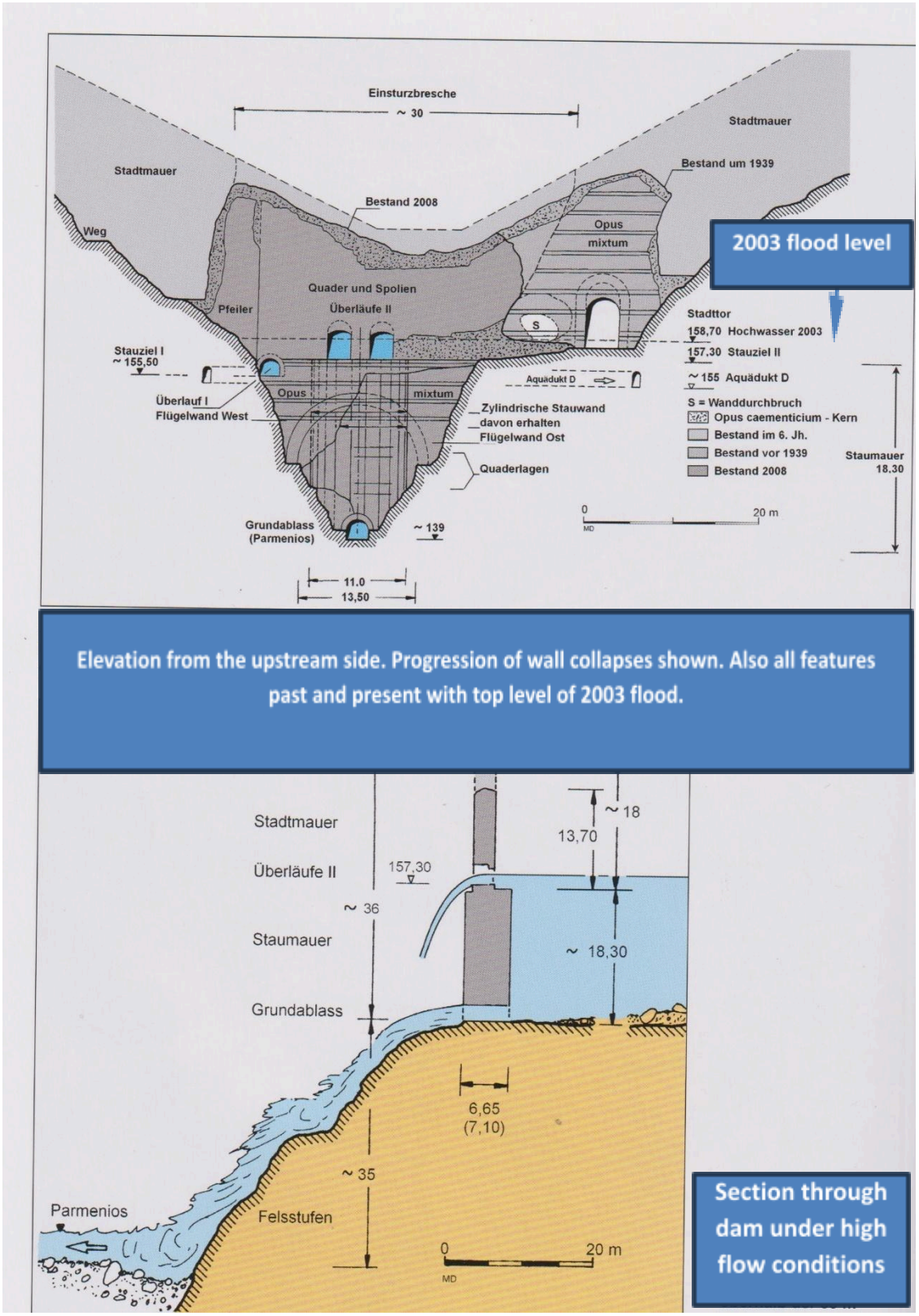
Structure at aqueduct level 2024

Side view on structure 2024

Appendix 3/4

<u>The Iron Gate. Elevation and cross section with flood flows</u>.

Reference: Mathias Döring „Antiochia – Wasser im Überfluss“



Appendix 3/5

<u>The Iron Gate. The Bottom Outlet</u> showing progression of damage.

Reference: Mathias Döring „Antiochia – Wasser im Überfluss“