SOCIETY FOR
THE PROTECTION
OF PRESPA

PRESPA'S
Green & Blue Lifelines

#03

The 5 Streams of Prespa

PRESPA'S
Green & Blue Lifelines

A few words about the project

The running waters of Prespa's streams have a huge ecological importance and are key spawning habitats for seven endemic fish species found in the lakes. In addition to their hydrological significance, riparian zones also provide habitats for many bird species, form crucial movement corridors for mammals and are vital elements of the landscape.

However, the streams, and the riparian forests that surround them, are threatened by unsustainable human practices and climate change. Unfortunately, streams are often seen merely as passive channels for water, and riparian habitats as just a line of trees rather than woodland, only good for grazing and logging. Meanwhile, existing management measures focus exclusively on coping with the alleged flood threat, without taking environmental and ecological parameters into account.

In the "**Prespa's Green & Blue Life Lines**" project, our goal has been to collect scientific data in order to create a comprehensive picture of the streams and riparian zones. We aim to make a meaningful contribution to their better management, incorporating their natural and cultural values and identifying their significant impact on the well-being of the local community, while actions to avert threats and rehabilitation measures are also an important part of our efforts.

A full hydrological year of fieldwork from 2022 to 2023 included monthly recording of physico-chemical characteristics such as pH, electrical conductivity, temperature and dissolved oxygen concentration. Water samples were analysed at the Hellenic Centre for Marine Research (HCMR) laboratory to determine nutrient concentrations of nitrogen and phosphorus in various forms, as well as water flow measurements. In addition, an HCMR specialist team also sampled benthic macroinvertebrates and diatoms on a seasonal basis.

The ecological status of the streams, based on biological and physico-chemical quality elements, was assessed according to national methodologies under the Water Framework Directive (2000/60/EC), or other internationally accepted scientific methods.

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THE 5 STREAMS OF PRESPA

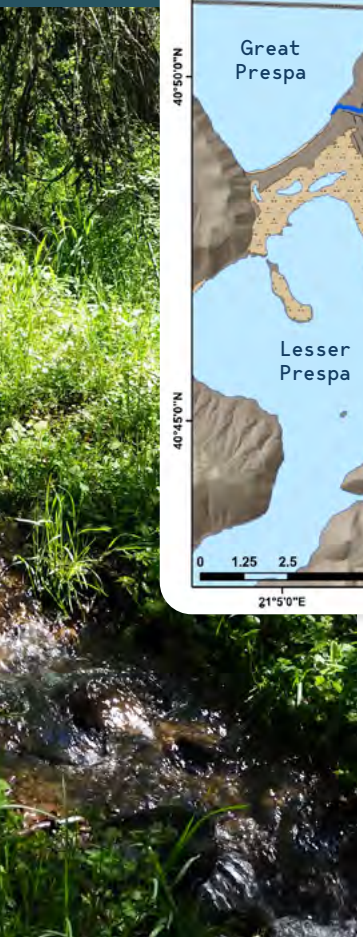
The Lesser Prespa streams

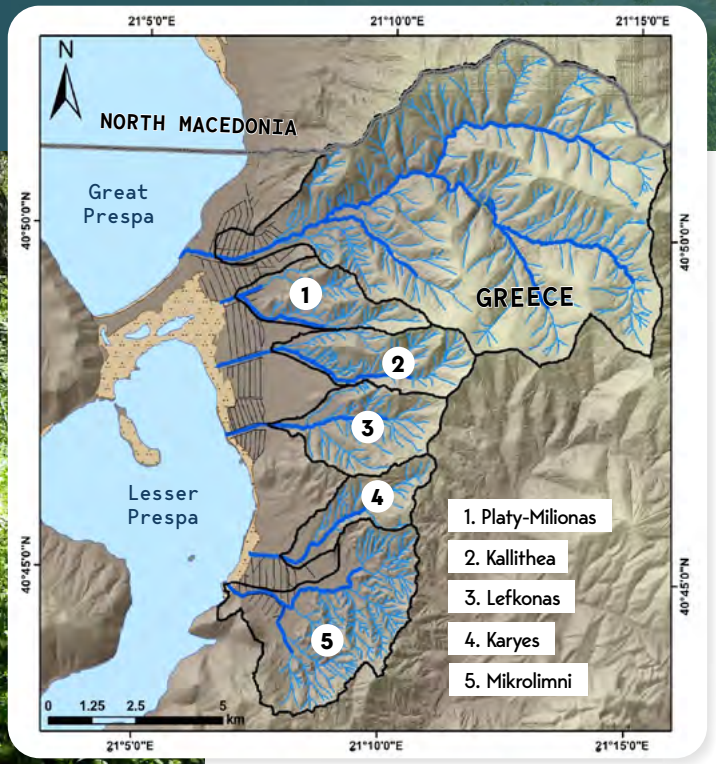
The pathways of water

Anyone familiar with Prespa would undoubtedly picture two lakes separated by a narrow strip of land. However, in the past they used to say that "...there was once just a single lake, but over time the waters of the Agios Germanos River slowly brought down mud, soil and gravel", thus making two lakes out of the one. Long ago, Lesser Prespa was probably just a shallow bay of the bigger lake. For long periods of time, it appears that water from the springs welling up below the nearby limestone mountains, along with water from the streams on the eastern igneous side of Prespa, collected in the low-lying land in between and created a body of water that seemed like a lake. The Mikrolimni villagers used to say, "Child, this lake wasn't always a lake, you know – in the old days, it used to be a river..." Legend had it that this river took its water from Mt Sfika and flowed north as far as Lake Ohrid.

The region's five known streams begin their life in the mountains on the eastern and southern sides of the Prespa National Park. The mountainous landscape of Prespa, with its varied topography and primarily siliceous rocks, has shaped the streams of Mikrolimni, Karyes, Lefkonas, Kallithea and Platy-Milionas, all of which discharge into Lesser Prespa Lake. In Prespa, it's a short step from the mountain peaks down to the lowlands, and this abrupt change in slope is what gives the waters of these streams their dynamism and speed.

These streams have been shaped by their own smaller drainage basins within the larger Prespa catchment, the largest being that of the Mikrolimni Stream at 15 km2, with the other stream sub-basins ranging from 5 to 8 km2 in size. All the streams flow westwards into Lesser Prespa and contribute significantly to the water balance of the lake.





After the Agios Germanos River, the second most mountainous sub-basin in Prespa is that of Kallithea Stream, with a maximum altitude of 2,113 m, just beneath the peak of Moutsara. Mikrolimni Stream has the lowest sub-basin, with a maximum altitude of 1,496 m.

In their mountainous sections, the sub-basins of the Kallithea and Lefkonas streams are characterised by steep slopes and rugged terrain, while those of the Platy-Milionas, Karyes and Mikrolimni streams have a comparatively gentler incline and a more even topography.

In the lowland parts of all the streams, as they approach Lesser Prespa Lake, the slope decreases sharply. As a result, the water that surges down from the mountains loses its speed in the lowlands and the streams increase in depth, thus reducing their energy, which protects the crossings and other works along their course and prevents erosion. Moreover, the water's greater depth and its flow pattern both improve its quality and oxygenation.

Although Prespa's landscape is generally considered mountainous, there are plenty of areas with gentle slopes that can be cultivated, especially in the lowlands. Where the five streams cross these flatter agricultural lands, their streambeds have been fully channelised in straight lines to the lake, while their deltas no longer exist, making space for agricultural fields to develop.

At the higher elevations in the drainage basins there is no forest vegetation, partly due to the altitude but also to the long-term impact of grazing. Below these heights, the streams are surrounded mainly by meadows and forests; lower still, they pass through croplands before reaching the lake. In the case of the Mikrolimni, Karyes and Lefkonas streams, their course through the mountains is largely forested, while meadows predominate in the case of the Kallithea Stream, and even more so around the Platy-Milionas Stream. On steep slopes, rainfall is slowed by vegetation, particularly by stands of trees or shrubs, retaining the water so that it penetrates the soil and recharges the underground aquifer.

So, in order to answer the question "Where do the streams of Prespa come from?", we would have to examine the landscape, geology, vegetation, history and climate of the region. Rocks that prevent water from seeping into the ground, the generally rainy character of Prespa, the snows and rugged relief of this mountainous region, as well as the impact of livestock farming, vegetation and forests in general, have all created these distinctive green and blue lifelines. The streams carry cool, richly oxygenated and life-giving water down from the mountains to the lake and the area's ecosystems. Interconnectedness permeates this landscape, and the water that flows between the forests, reedbeds, meadows, villages and lake carries along the medley of stories and natural materials that it gathers along its way.

The close relationship between the 5 streams and Lesser Prespa Lake

The five streams cross the mountains and lowlands of Prespa, passing through forests, meadows, pasture and farmland, as well as through or near villages. Consequently, their waters are affected by the area's human activities, as well as by the man-made infrastructure they encounter along the way.

Of all Prespa's streams, only the Mikrolimni Stream is considered to have a permanent flow, meaning that it consistently supplies water to Lesser Prespa Lake throughout the year. The lowest water supply is seen in the Platy-Milionas and Lefkonas streams, in some years, this may be as low as zero during the summer. The Platy-Milionas Stream shows the lowest annual average supply (0.014 m^3/s), while the Mikrolimni Stream has the highest (0.059 m^3/s). Although these numbers may seem small, they make a significant contribution to the total flow of surface waters into the lake.

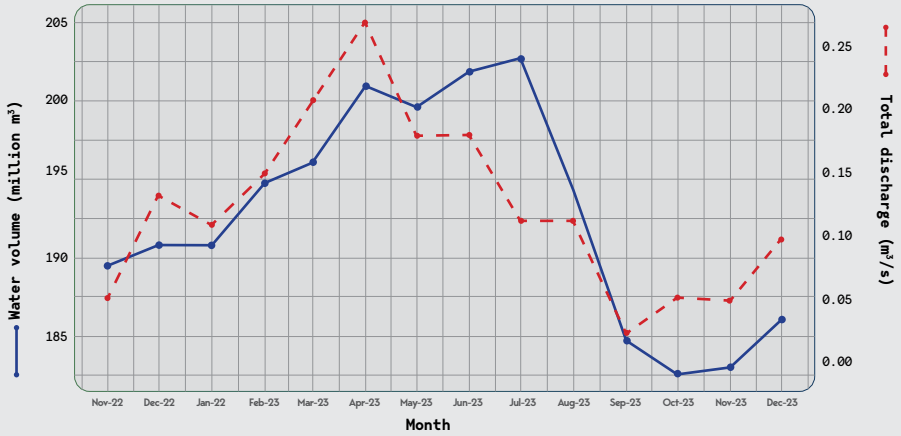
Stream	Minimum altitude of the drainage basin (m)	Maximum altitude of the drainage basin (m)	Average incline of the drainage basin (%)	Central stream bed length (km)	Average supply (m^3/s)
Platy-Milionas	867	1970	38,40	10,74	0,014
Kallithea	878	2109	47,34	8,27	0,04
Lefkonas	901	1835	41,38	6,12	0,019
Karyes	892	1675	37,33	6,44	-
Mikrolimni	863	1496	40,78	7,15	0,059

Combined, the streams supply the lake with approximately 4,000,000 m^3 of water per year, with the streams of Kallithea and Mikrolimni together supplying 80% of the surface water entering the lake. The largest inflow occurs in spring, when water from snowmelt reaches the lake and its shoreline ecosystems, increasing the water level. However, it should be noted that drought phenomena have intensified in the past three years and in 2022-2023, for example, the Karyes Stream dried up at times. The water that entered the lake in this period did so through the ground, due to a significant reduction in the level of the underground aquifer.

In previous years, when there was more precipitation, all five streams would have had a significant impact on the rise in the water level of the lake.

In order to assess the condition of the streams according to the Water Framework Directive 2000/60/EC, we need to examine their ecological state. The overall status of a surface water body, such as a stream, relies largely on biological and physico-chemical parameters.

Parameters such as pH, electrical conductivity, nutrient concentrations, dissolved oxygen and temperature determine the physico-chemical state of the waters and play a decisive role in the health of the streams, as well as the benefits they provide. Together, these parameters influence the plants and animals living in the streams, affect human activities and impact the water quality of the lake, due to the fact that they flow into Lesser Prespa.



Dissolved oxygen, one of the most important parameters for aquatic wildlife, is generally high in most streams, indicating good water quality. In terms of seasonality, the highest dissolved oxygen values are recorded in winter, while the lowest are seen in the summer. This is mainly because the streams have less water in summer and are renewed more slowly. Stream temperatures vary significantly throughout the year, from just above 0°C in the Platy-Milionas and Lefkonas streams, to almost 20°C in the Lefkonas Stream. Temperature is a very important parameter, because it affects the concentration of dissolved oxygen and thus the health of everything living in the water.

Electrical conductivity, which measures the salinity of water, seems to be low in general. High conductivity could indicate a high concentration of dissolved salts and contaminants. The widest range is seen in the Platy-Milionas Stream, in which the highest values marginally exceed the recommended ideal conductivity for drinking water (below 500 μS/cm).

The nutrient salts that end up in the streams, and ultimately in Lesser Prespa, are compounds of phosphorus (P) and nitrogen (N), and they have a significant impact on water quality. When their concentrations exceed the threshold levels, they cause eutrophication, a phenomenon that leads to the overgrowth of phytoplankton and other aquatic plants, reducing dissolved oxygen and disrupting normal ecological processes. Similarly, eutrophication can also facilitate the growth of toxic algae, which is particularly dangerous for the organisms in the lakes.

Greek marsh frog

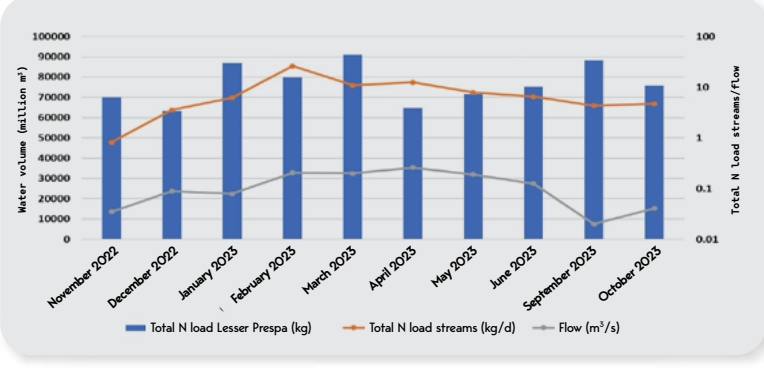
On the basis of their physico-chemical status, streams can be classified into five quality categories – High, Good, Moderate, Poor or Bad – depending on the concentration of nutrients and dissolved oxygen. Based on measurements taken by the Hellenic Centre for Marine Research, the overall physico-chemical quality of the Prespa streams ranges from High to Good.

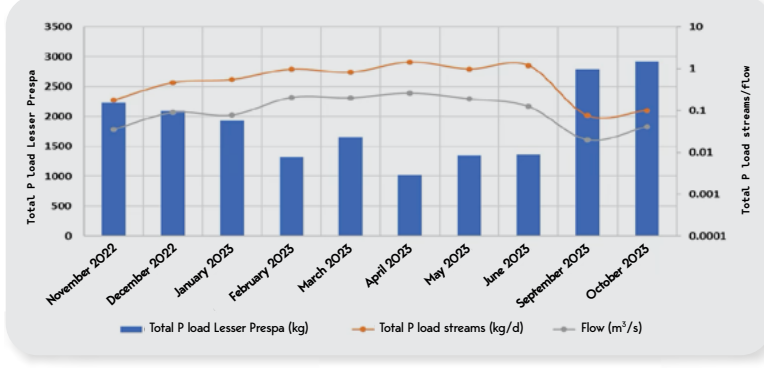
However, looking at the streams individually, only Kallithea Stream is characterised as High, due to its very low concentration of salts and high dissolved oxygen. In contrast, although the Platy-Milionas, Mikrolimni, Karyes and Lefkonas streams generally exhibit High or Good quality, they drop to Moderate quality during spring (May-June) and autumn (September-October). This is due to the high concentration of nitrogen compounds, which mainly come from the fertilisers used in neighbouring fields.

The Moderate quality of the Mikrolimni Stream, for example, is quite likely due to its direct connection with farmland drainage ditches. Additional pressure may also be put on the streams by nearby grazing livestock, which can adversely affect the water quality at a local level.

Comparatively speaking, the Platy-Milionas Stream seems to have the most negatively affected water quality, mainly due to an increased concentration of phosphates, nitrites and nitrates, as well as low dissolved oxygen values. During dry months, the physico-chemical quality of the water seems to deteriorate in general, due to the lower water flow during this period and the resulting increased concentration of contaminants in the water.

It is interesting to note that the concentrations of total nitrogen and phosphorus loads in Lesser Prespa Lake appear to lag slightly behind those of the streams. Thus, while the total nitrogen load in the streams is higher in December and February, this increase in the load occurs one month later in the lake, in January and March respectively. Correspondingly, while the concentration in the streams drops in April and May, this decrease takes place in the lake a little later. It is estimated that the annual amount of phosphates from the streams that ends up in the lake ranges between 178 kg and 218 kg.





Returning to the clear guidelines of Directive 2000/60/EC, the overall quality of surface waters must be assessed in comparison with natural ecosystems that remain unaffected by humans. Therefore, in addition to the physico-chemical parameters, it is important to have a clear picture of the organisms that live in water bodies, as they are sensitive indicators of possible alterations in the ecosystem. Accordingly, for the final assessment of the ecological status of the streams the physico-chemical parameters should be combined with these biological quality elements, following the rule that the most unfavourable parameter determines the final quality classification.

Examination of the micro-organisms found where the streams enter Lesser Prespa, indicate that these areas are more adversely affected in terms of quality, as they appear to be mainly pollution-resistant species. Point source pollution and seasonal pollution incidents, such as lime dumping, or diffuse source pollution, such as from fields and pastures, degrade the ecological status of the streams to Moderate. The only exception is the Kallithea stream, where the status appears to be Good.

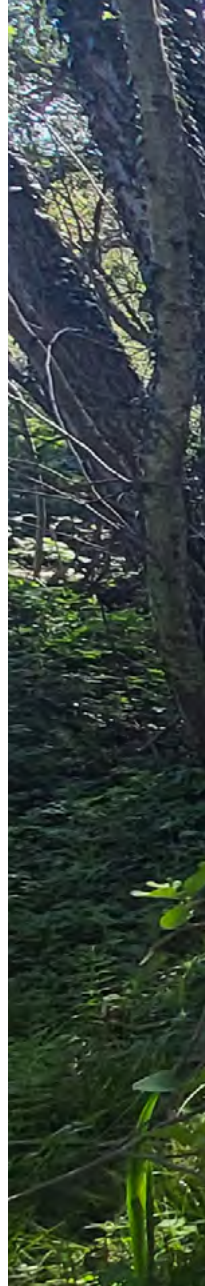
What the people of Prespa have to say about the streams

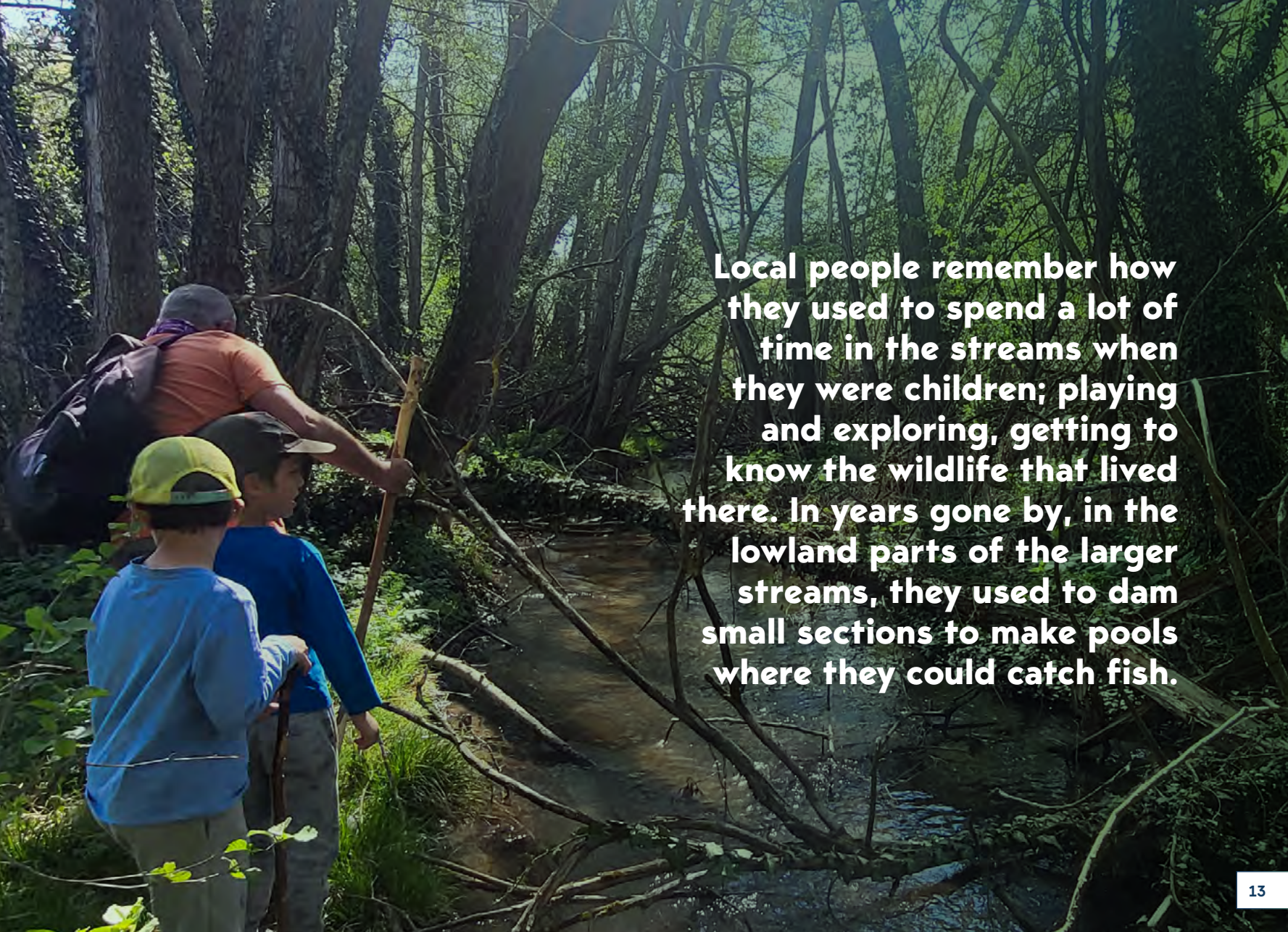
"In the past, people used to wash their clothes in the river; there were no washing machines, and even soap was very scarce. They would wash their clothes using ash... Instead of throwing away the ash from their stoves, they collected it; when they wanted to wash clothes, they used to put the ash in a tin can, add hot water and mix it. Once the ash settled at the bottom, they would take the clean water and pour it over the clothes to get the dirt and stains out; there wasn't any soap, so that's mainly what they used to use. That's why people built villages next to rivers and springs in the past. This is how people would wash their clothes back then...there wasn't anywhere else. They had this wooden thing they used to pound the clothes on, but for thicker, woollen clothes, they used to carry them to big flat stones and rub the dirt out by hand."

The importance of the five streams to local people is evident from their location and the village names. Almost half of the inhabitants surveyed say that they are in daily contact with the streams, either through their work in the fields, the view from their window or by simply taking a walk, while several use water from the streams for their backyard and kitchen gardens.

A typical example is the Kallithea Stream; until the mid-20th century, this stream supplied watermills, gardens, fields and meadows, almost as far down as the village of Platy and the lowlands. However, there hasn't been enough water in the stream for such uses for many years now.

Nowadays, everyone agrees that the streams are important, as they supply Lesser Prespa Lake and provide water to livestock and wildlife. Some also stress their significance for flood protection, as they drain off the water and prevent potential flooding. The negative impression created when the streams are full of litter or polluted was also noted, however. In addition, the people of Prespa are also worried about the effect of climate change on air temperatures, the streams and waters in general, since most of them believe that it will have an adverse impact, especially on bean farming.





Local people remember how they used to spend a lot of time in the streams when they were children; playing and exploring, getting to know the wildlife that lived there. In years gone by, in the lowland parts of the larger streams, they used to dam small sections to make pools where they could catch fish.

Pyrochroa serraticornis

Life in and out of the water

The vegetation that grows along the five streams is distinctively riverine and forms unique forests. These riparian forests grow in the streambeds and on their banks; they are dense in some places but sparse and fragmented in others, depending on the degree of human impact. Their roots hold the soil together, whilst also absorbing pollutants and enriching the water with oxygen.

Amongst the most special riparian forests are those with alder, or with willow and poplar, which respectively form the priority habitats 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) and 92A0 *Salix alba* and *Populus alba galleries*. The species diversity in these forests is significant, with typically water-loving species that differ from those found in other places. Alders, willows and poplars, and the unique forests they create, grow in or nearby water, or in waterlogged soils.

This characteristic makes them perfect for stabilising the stream banks, protecting neighbouring areas from flooding and purifying the water. Alders also improve soil quality by fixing atmospheric nitrogen, increasing its availability for other plants. Alder forests are found in very few places in the transboundary Prespa basin. On the Greek side, they are mainly found along the Mikrolimni Stream and up to its higher reaches, by the village of Karyes, in the Agios Germanos River and on the shore of Great Prespa Lake.

Pararge aegeria


Roots filter the stream water, while fish lay their eggs upon them

A healthy riparian forest ensures cooler temperatures in the summer, especially in the lowlands, and provides clean, oxygenated water that eventually enters the lakes. It serves as a refuge for numerous animals, and insects that are beneficial to crops, many of which are endangered. In addition, many lake fish, including Prespa bleak (Alburnus belvica), Prespa barbel (Barbus prespensis), Prespa nase (Chondrostoma prespense), Prespa roach (Rutilus prespensis) and Prespa chub (Squalius prespensis), lay their eggs on the tree roots in the streams.

Towards the stream mouths, where the terrain and water availability allow passage to Lesser Prespa Lake, the habitat type 6450 Greek hyper-Mediterranean humid grasslands can also be found. These meadows are mainly encountered at the mouth of the Lefkonas Stream, as well as around the villages of Karyes and Oxia. One such grassland is the meadow of narcissus near Oxia, which lies on gentle slopes and is positively influenced by systematic grazing with sheep and goats, as well as by changes in soil moisture. This particular meadow is found alongside a smaller branch of the Mikrolimni Stream.

Reedbeds can be seen where the streams meet Lesser Prespa, serving as a final water filter, as they retain nutrients and other pollutants.

The streams form lifelines that are threaded through the Prespa landscape and connect the lake with the mountains, as well as the wetlands with the woodland and meadow ecosystems. Thus, they form green and blue corridors for wildlife movement, ensuring safety, food and water, and used daily by small and large animals alike. The conservation of biodiversity and connectivity between habitats, which are often fragmented due to various factors, including human activities, depend upon these lifelines.

Birds

The Kallithea Stream is home to 21 of Prespa's breeding birds. Its dense vegetation, protective environment and cool microclimate provide the ideal conditions for starlings, nightingales and blackcaps to build their nests. In general, the streams host an abundance of small birds, such as the long-tailed tit, Eurasian blue tit and great tit, while Eurasian hoopoes and common blackbirds also nest here and there. Riparian forests usually contain softwood trees, which are often damaged or may come down during extreme weather conditions. These trees are a treasure trove for woodpeckers; Syrian woodpeckers, European green woodpeckers and lesser spotted woodpeckers all build their nests and forage there. Amongst the willows, the characteristic suspended nest of the Eurasian penduline tit or the startling yellow of the golden oriole can also be seen, as well as the flashing turquoise of the kingfisher on low branches above the water.

Eurasian hoopoe

Eurasian golden oriole

Fish

The streams are especially important for the fish of Lesser Prespa. The area's endemic fish are primarily species that are typical of rivers and not lakes. This means that most of them must seek running waters, such as streams and rivers, in order to spawn, although some can reproduce in still waters, provided they are well oxygenated. The streams of Lefkonas and Mikrolimni are of particular significance, as they are used for reproduction by at least five endemic fish species, with the Mikrolimni Stream mainly used by Prespa bleak, Prespa roach and Prespa nase. Correspondingly, mostly Prespa chub and Prespa Nase use the Lefkonas Stream, but in comparatively much smaller numbers. Although, when there is plenty of water in the stream, Prespa chub in particular enter in large numbers to spawn. The streams also provide food or shelter for non-native species, such as the stone moroko (Pseudorasbora parva), Western Greece goby (Economidichthys pygmaeus) and pumpkinseed (Lepomis gibbosus). As the fish approach the streams, they are squeezed together at the narrow entry point, making them relatively easy targets for predators. Consequently, fish-eating waterbirds tend to use the stream mouths to feed. This may be why so many fish cross into the streams at night, to avoid the birds lying in wait.

Prespa bleak

Mammals

Near the mouth of the Mikrolimni Stream, otters can often be seen hunting for fish and other prey. Some of the most common species to make an appearance are wild boar, foxes, roe deer and, more rarely, bears, jackals and wolves, while when it comes to smaller mammals, badgers, wildcat, martens and hares can also be seen. The presence of all these species in such relatively narrow linear ecosystems shows how vital the streams are to Prespa's biodiversity. Throughout all the riparian zones, the larger mammals have a preference for moving around at dusk and at night, so as to avoid encounters with people or stray dogs.

Squacco heron

The streams need our attention

It is already evident that Prespa is not unaffected by climate change. In a place so closely linked to water, the associated disruption in the water balance is most worrying of all. According to a study by the National Observatory of Athens, in the near future we can expect to see lower surface water flow, less snowfall and more dry years. Combined with high summer temperatures and drier soils, everything points to increased droughts and disruption of the seasons. The streams of Prespa are on the frontline of these changes, as their decreased flow will undoubtedly also affect the rate at which the water level of Lesser Prespa Lake will fall.

The main problems faced by the streams that discharge into the lake are:

→ **Negative effect of agrochemicals and nutrients:**

These enter streams from neighbouring fields and livestock facilities, as both point and diffuse pollution. This situation is exacerbated by lower water flow, which completely stalls in the shallow parts of the streams during the summer months, leading to increased water temperature, decreased dissolved oxygen and higher concentrations of nutrients, thus adversely affecting fish and aquatic wildlife as a whole.

→ **Built infrastructure:**

This is mainly found where the streams and the road network intersect. In some cases, it hinders the free movement of water or alters the morphology and functions of the streams. Works such as concreting the stream bed and enclosing the channel, for example in the Mikrolimni Stream, increase flow velocity and reduce the amount of water stored in the underground aquifer.

→ **Pollution and litter:**

Household waste frequently ends up on the stream banks and in the water, as well as agrochemical packaging, which breaks down into microplastics and spreads into crops, wildlife and water, ultimately returning to us with unknown consequences for our health.

→ **Overgrowth of reeds and other vegetation at stream mouths:**

As the lake waters recede, the thickening reedbed chokes up the streams as they reach Lesser Prespa, making it more difficult for fish to reach their spawning grounds upstream. Clearing these areas at the end of their spawning season is thus considered particularly important, while managing the reedbed with grazing livestock, or by cutting the vegetation, can prevent the spread of uncontrolled wildfires to nearby habitats, such as alder forests.

→ **Climate change:**

Less snow means less stored water in springs at the end of winter and a lower water flow in the streams, which may dry up completely in shallower stretches during the summer months. At the same time, higher water temperatures, lower dissolved oxygen and increased concentrations of nutrients, all negatively affect fish and other aquatic wildlife, as well as biodiversity in general.

4+1 ideas for the future of the streams

Mikrolimni Stream

→ **Monitor water quality and quantity:**
In order to have a complete picture of the water balance in the streams and Lesser Prespa Lake, data should be gathered regularly. Collecting water quality samples allows us to develop a long-term strategy and plan potential corrective measures.

→ **Ensure water quality:**
This requires the effective treatment of wastewater, particularly that which comes from livestock facilities and drainage ditches, before it ends up in the streams. It is important to avoid harmful agricultural practices, for rubbish to be collected in designated areas and to dispose of empty agricultural packaging in the appropriate bins.

→ **Manage water resources:**
Manage water consumption by modernising existing facilities, as well as activities that have high water consumption needs, mainly in tourism and agriculture. In all activities, we must keep in mind that water is scarce and requires careful management.

→ **Recreation, tourism, education:**
Prespa's streams hide many surprises and can be an excellent tool for teaching sustainability, ecology, economics and nature conservation. Their cool microclimate, the rich wildlife they host, the sounds of the birds and the water; these can all provide moments of relaxation to local people and visitors to Prespa. By following the streams from the mountains to the lake, we become part of the life that flows in their waters and creates this unique landscape.

Lefkonas Stream

→ **Restore natural flow and increase connectivity between the stream bed and the riparian zone:**

This is recommended particularly for the lower parts of the streams, where several interventions impede flow or cut off the streams from their riparian surroundings. Similarly, vegetation at stream mouths should be managed, in order to improve access to spawning grounds for fish, which in turn helps improve feeding grounds for waterbirds, such as herons and pygmy cormorants.

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