4.4.1. Lessons learnt during water quality monitoring pilot implementation

Work package 4. Transferring

Activity 4.4. EcoSUSTAIN Body of Knowledge

Project acronym:	EcoSUSTAIN
Project name:	Ecological sustainable Governance of Mediterranean protected Area via improved Scientific, Technical and Managerial Knowledge Base
Programme priority axis:	Priority Axis 3. Protecting and promoting Mediterranean natural and cultural resources
Programme specific objective:	3.2. To maintain biodiversity and natural ecosystems through strengthening the management and networking of protected areas

Document: Public/Confidential			
Responsible partner: **Involved partners: All**			
Version	**Status**	**Date**	**Author**
0.1	Report structure	July 2017	ALOT
0.2	Draft	November 2018	ALOT
0.3	Final Draft	December 2018	ALOT
0.4	Final report	December 2018	ALOT with revisions by all partners
Notes:			

Table of Contents

Executive Summary 4
1. Introduction 5
2. EcoSUSTAIN Pilots 5
3. Lessons learnt 7
3.1. Pilot 1 – Regional Park of Mincio: Ansa e Valli del Mincio 7
3.2. Pilot 2 – Global Nature Foundation: L'Albufera Natural Park 14
3.3. Pilot 3 – Public Institution "National park Krka: Krka National Park" 21
3.4. Pilot 4 - Public Company Una National Park Ltd: Una National Park 27
3.5. Pilot 5 – Democritus University of Thrace: Ecodevelopment Area of Karla-Mavrovouni-Kefalovriso-Velestino 33
4. Conclusions 39

List of figures

Figure 1: Location of EcoSUSTAIN STMS buoys installation in Mincio Park 9
Figure 2: Results of water monitoring in Rivalta (Mincio Park) for three different parameters 10
Figure 3: Temperature monitoring at three locations in Mincio Park 10
Figure 4: Location of EcoSUSTAIN STMS system in L'Albufera Park 15
Figure 5: Pilot results of water monitoring in L'Albufera: daily variation of Dissolved Oxygen 16
Figure 6: Pilot results of water monitoring in L'Albufera: Temperature trend across seasons 16
Figure 7: Pilot results of water monitoring in L'Albufera: Nitrates concentration vs Rainfall . 17
Figure 8: Pilot results of water monitoring in L'Albufera: Chl-a concentration vs Dissolved Oxygen 17
Figure 9: Location of EcoSUSTAIN STMS system in Krka NP 22
Figure 10: Pilot results of water monitoring in Krka NP: pH trend from May to December 2018 23
Figure 11: Pilot results of water monitoring in Krka NP: Chlorophyll trend from May to December 2018 23
Figure 12: Location of EcoSUSTAIN STMS buoy in Una Park 28
Figure 13: Pilot results of water monitoring in Una River – screenshot from EcoSUSTAIN web portal 29
Figure 14: Pilot results of water monitoring through LTMS in Lake Karla: NH_4 levels in October 2018 34
Figure 15: Pilot results of water monitoring through LTMS in Lake Karla: pH in March 2018 35
Figure 16: Pilot results of water monitoring through LTMS in Lake Karla: D.O. levels in July 2018 35

Executive Summary

This document describes the lessons learnt from EcoSUSTAIN pilots, from the preparation phase up to the installation, maintenance and operation of two different water quality monitoring systems, short- and long-term systems installed in five protected areas across five MED countries. These Lessons Learnt are part of the EcoSUSTAIN Body of knowledge, a set of four documents that contain the key results of the project, designed to capture the experiences gained during the pilots' implementation, as well as the problems encountered, results and the stakeholders' perception of the project.

EcoSUSTAIN pilots can be considered as a successful example of innovative water quality monitoring pilot testing, since all the Management Authorities of the protected area involved in the project and their key stakeholders are satisfied with the results. A key recommendation for similar projects or initiatives emerging from the pilots is to engage all relevant stakeholders since the early stages, including scientists and institutions whose area of interest is water quality monitoring. This is crucial in order to share useful knowledge and gain advice, but also for data comparison and integration and to create synergies in projects implementation, with the result to further strengthen relationships and potential for collaboration. Communication and involvement of the local communities living inside or around the protected areas are also crucial, in order to improve acceptability, ownership and cooperation. More specific and practical lessons learnt are also included for the two systems tested in this project.

1. Introduction

In order to develop deliverable 4.4.1 Lessons Learned, which is part of the EcoSUSTAIN Body of Knowledge, ALOT, as responsible partner, collected valuable elements on short and long term Water Quality Monitoring Pilot Implementation in 5 Protected Areas.

The aim of this document was to collect the lessons learnt that each partner can share on the pilot implementation, from the preparation phase up to the installation, maintenance and operation of the systems. The Lessons Learnt are part of the EcoSUSTAIN Body of knowledge, whose core object is the transferability within the project partners and to external actors. Lessons learnt were specifically intended to capture the experiences gained during the pilot implementation, as well as the problems encountered, results and the stakeholders' perception of the project.

2. EcoSUSTAIN Pilots

The Pilot Actions, even though implemented in regional and national parks have transnational characteristic and are guided by technical support from the EcoSUSTAIN partners RGO, DUTH and ARATOS. The main focus of all pilot actions was strengthening management of protected areas through 2 types of water quality monitoring solutions: (1) short-term monitoring solution (STMS) and (2) long-term monitoring solution (LTMS). Both of these solutions provide data on water quality to support decisions on protection and management.

The protected areas involved in the pilot activities are located in Spain, Italy, Croatia, Bosnia-Herzegovina and Greece, as per table here below, which also shows which subjects were responsible for the pilot implementation and the key information for each site.

Table 1. Natural areas and parks where EcoSUSTAIN pilots are implemented

Natural Area	Location	Area [km^2]	Official Management Authority	Project designation	EcoSUSTAIN partner implementing the pilot	Type of pilot
Albufera Natural Park	Valencia-Spain	211.2	Consellleria de Agricultura, Medio Ambiente, Cambio Climático y Desarrollo Rural	Natural Park, RAMSAR, IBA	**Foundation Global Nature (FGN)**	**STMS**
Ansa e Valli del Mincio	Rodigo (MN), Curtatone (MN), Porto Mantovano (MN) e Mantova	19.48	Parco Regionale del Mincio	Nature reserve, RAMSAR, Natura 2000, Regional Park	**Mincio Regional Park**	**STMS**
Krka National Park	Šibenik, Croatia	109	Public Institution	National Park	**Krka National Park**	**STMS**
Una National Park	Bihać, Bosna i	198	Public Company	NATIONAL PARK	**Una National**	**STMS**

	Hercegovina		Una National Park Ltd.		**Park**	
Ecodevelopment Area of Karla-Mavrovouni-Kefalovriso-Velestino	Greece, Magnisia, Volos	1218	Management Body of Ecodevelopment Area of Karla-Mavrovouni-Kefalovriso-Velestino	Ecodevelopment area	**Democritus University of Thrace (DUTH)**	**LTMS**

As shown in the table, four sites implemented the **short-term monitoring solution (STMS)**, providing continuous (24 hours a day, 7 days a week) real time data and early warning messages directly from a sensor-equipped buoy. STMS consisted of the installation of a buoy in the water of the protected areas to be monitored, equipped with a multiprobe base unit with battery powered sensors for relevant water quality parameters, battery powered, solar panels for charging the battery, data logger for all measurement values and GSM modem to send the measurement values to a server. Data are sent both to the client server and to the EcoSUSTAIN server. Thus, the Park Management Authorities receive data directly on their computers, displayed as tables and graphs, and in case measurements are outside of acceptable ranges set by the Management Authority, an alarm is sent to selected relevant users. Data are also published on the EcoSUSTAIN open online portal for each site, where authorized users can create periodic reports, which are also publically available on the portal.

The pilot testing of STMS involved a preparatory stage supported by RGO and DUTH, both technical partners. This phase consisted in:

1) The definition of the Status Quo of water monitoring and management in each pilot site and a Gap Analysis to identify potential for improvement guided by DUTH;
2) The definition of the best location for the buoy installation and the parameters to monitor in each site, and the development of technical specification for the buoy procurement, carried on by each partner responsible for the pilot implementation supported by the EcoSUSTAIN technical partners;
4) The development of the EcoSUSTAIN web platform and database by RGO.

All buoys were installed between April 2018 and August 2018, and are now fully operational.

The long-term monitoring solution (LTMS) is an integrated solution for satellite monitoring of environmental indicators via Earth Observation techniques and relevant satellite imagery processing/classification and elaboration of the meta-information, presented on a client graphical user interface (GUI). The preparation as well as the implementation of the pilot at the protected area of Karla-Mavrovouni-Kefalovriso was headed by ARATOS with support of Democritus University of Thrace (DUTH), both EcoSUSTAIN partners.

The pilot involved a first phase of technical and functional requirements definition, to detail the user's requirements, based on the needs of the Management Body of Karla-Mavrovouni-Kefalovriso, which was involved since the beginning of the project. Key elements defined in this phase were the desired environmental indicators to be monitored via LTMS, with support from DUTH.
The client application used consists of:

- A database hosting the LTMS data during the pilot operation;
- A GIS software, in-house prepared, using LTMS data and automatically developing several visual layers placed on a GIS map of the area of interest;
- A user-friendly GIS UI that displays to the user the final maps for each parameter monitored.

3. Lessons learnt

3.1. Pilot 1 – Regional Park of Mincio: Ansa e Valli del Mincio

The pilot site: needs and requirements

Regional Park of Mincio is a large protected area of 159 Km^2 designated to protect the Mincio river and its ecosystems along its way from the Garda Lake to the Po river. The Park includes within its borders 3 natural reserves and 4 Natura 2000 sites, with 229 species of avifauna and 60 species of plants and flower of conservation interest.
River Mincio changes its features along its way, gradually evolving from a relatively high flow stream river originated from the biggest alpine lake of Italy into a valley-lacustrine system, with reduced hydro dynamism and many hydro morphological alterations, forming three eutrophic urban lakes around the City of Mantova where the conditions are quite compromised. Main pressures within the river basin are the reception of urban wash-off, effluents and Waste Water Treatment Plants, in particular one big wastewater treatment plant in the upper part of the river, collecting all wastewaters from Lake Garda, which discharges high loads of nutrients into the river, especially during the touristic season. The excessive use of fertilizers and chemicals in agriculture also represents a problem for the river as well as the diversion of 75% of the river inflows for irrigation needs. Mincio's waters are used for water supply, watering, waste removal, fishing, mining and other activities, leaving only a minor percentage of the natural flow into the main river bed. Concerning hydro morphological alterations, canalization, artificial banks near the cities and substrate morphology alteration have caused a reduction in hydro dynamism. All these factors provide that, by the time the river reaches the City of Mantova, it is turned into a system with significantly low water flows, high concentration of nutrients, eutrophication and pollution; the Natural Reserve Valli del Mincio, located just upstream from Mantova, suffers from

eutrophication, rapid infilling and water scarcity. The combination of these three factors results in frequent algal blooms, elevated summer temperature of the shallow water column and anoxia. The three Lakes around the City of Mantova, created by dammed meanders, are also characterized by anoxia, which may strongly impact biological communities, from bacteria to fish, and substantially decrease the biodiversity of the area and its functioning. Furthermore, excess primary producers' growth (phytoplankton communities typical of eutrophic and hypertrophic systems with known toxic cyanobacteria presence) menace recreational activities (including large and small boat navigation, fishing and swimming) (chl-a up to 100 µg/l). Limited light penetration (about 1 m during summer), low flow, high seasonal temperature variation, relatively high DIN and SRP concentrations (20-350 µM and 0,14- 3,72 µM responsively) compose the image of the lakes. Furthermore, flow alterations due to draught incidents cause serious problems both to chemical water quality and biota.

The pilot: objectives, activities, results

The aim of monitoring pilot in Mincio Park is the assessment of pressures caused by human activities and morphological alterations along with preserving the ecosystems in the Natural Reserves and protected areas across the river. The monitoring findings could assist in the formation of an early warning system for certain management options, such as real-time flow regulation, which however is in charge to other authorities rather than the Regional Park. The aim is also to enhance and increase knowledge and data of the system, having continuous data series allowing to observe daily and seasonal variations of water parameters.

In April 2018 four buoys, equipped with sensors able to measure water parameters every 15 minutes, were installed in the following locations (Figure 1) across the River:

1) Rivalta sul Mincio (Rodigo – MN)
2) Superior Lake (Mantova)
3) Medium lake (Mantova)
4) Inferior lake (Mantova)

Figure 1: Location of EcoSUSTAIN STMS buoys installation in Mincio Park

The table below shows the parameters monitored by the buoy installed within EcoSUSTAIN pilot.

Table 1. Parameters monitored by STMS buoy installed in Mincio Park

	Parameter
1	Temperature
2	Dissolved Oxygen
3	pH
4	ORP (Redox potential)
5	Chlorophyll-a/ Bluegreen algae
6	Conductivity

The buoys send data to the Park's server and also to the EcoSUSTAIN server every half an hour. The user is able to visualize graphs for each location and each parameter, and also to compare on a single graph different parameters at each location (Figure 2), or the same parameter at different locations (Figure 3). Results are being used by the Park's Authority and also shared with other Stakeholders, like the University researching the area, as a way to monitor water state daily and seasonally.

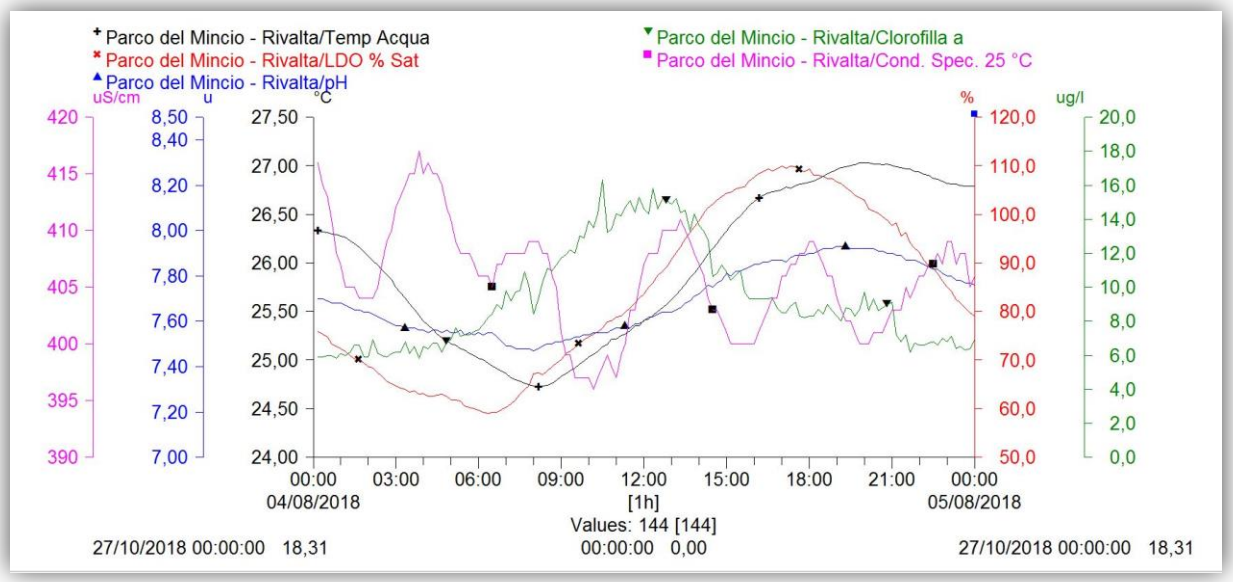


Figure 2: Results of water monitoring in Rivalta (Mincio Park) for three different parameters

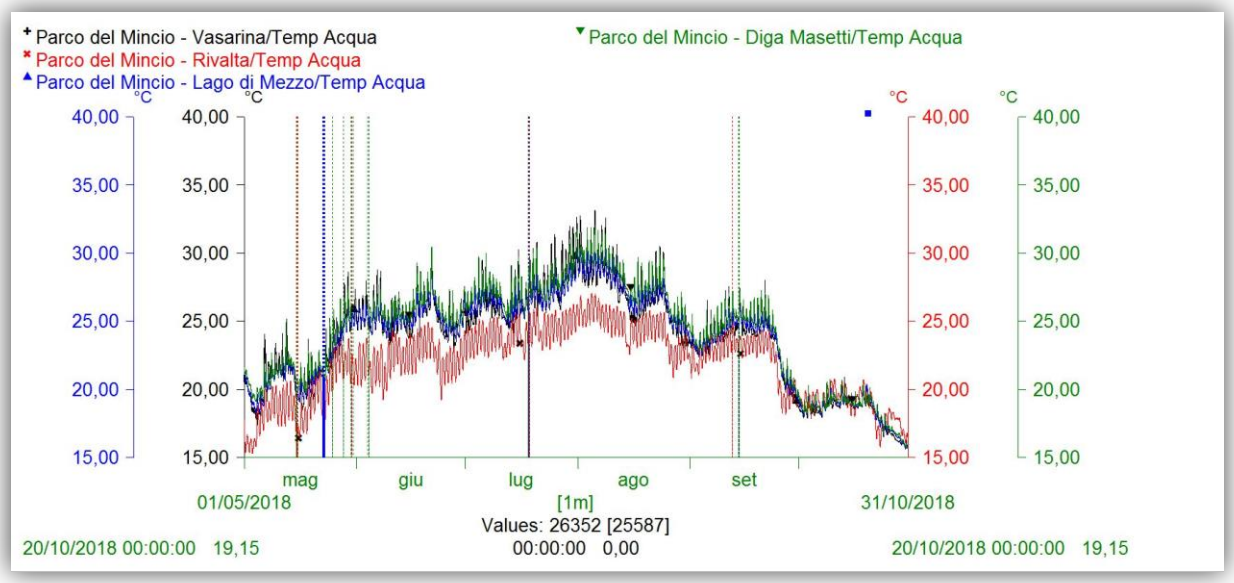


Figure 3: Temperature monitoring at three locations in Mincio Park

Lessons learnt from the pilot action

Overall the experience of Regional Park of Mincio through the pilot has been positive: no particular issues have been experienced and several benefits have been identified from the installed systems. In particular they found that the choice of including only few key parameters in the Technical specification of the systems was winning. The probes monitoring these parameters are robust and are working without problems and this choice has allowed to install more buoys in different locations along the river, building a more

complete picture of the lakes compared to monitoring in a single location. The selected positions of the buoy are a compromise between monitoring priorities and practical needs, like the ease of access for maintenance and limited exposure to damage and theft.

The procurement process required significant effort in terms of resources and time, in order to build-up a call for tender foreseeing a "full package": not only the supply and installation of the assets, but also maintenance, spare parts for the duration of the project and training for the Park's employees were included. The Park is pleased with the results of the tender, as the selected company is professional, capable and helpful. Technical support from the University of Parma, a scientific partner of Mincio Park, which regularly performs monitoring in the river for scientific purposes, proved to be very valuable.

Probes in wetland ecosystems require maintenance quite often, especially during the summer. The choice of simple and robust probes also allows the Park to perform it themselves every 6-8 weeks. The selected provider delivered a training course to the park's employees in addition to the manuals, thus park's employees learnt how to perform the maintenance activities themselves.

The involvement of some key stakeholders throughout the pilot implementation proved to be particularly important; in particular the collaboration with scientific research institutes, like the Faculty of Natural Sciences of University of Parma and CNR – IREA, allowed the validation of data through the other existing monitoring systems such as satellites; while data were shared and integrated with other existing databases from Regional and Interregional Authorities (Regional Environmental Protection Agency (Office of Mantova), Interregional Po river Agency).

The availability and publication of data from the buoys through the EcoSUSTAIN web platform also allowed improved communication and dissemination of knowledge about the Park to other Local public authorities and interested groups (included NGO) involved in the "Mincio river Contract", a partnership agreement signed by many stakeholders for the protection of the River, containing several goals. Continuous communication is carried on by the Park through the social networks and newspapers, in order to inform the public about project activities.

Key benefits from the pilot

Key benefits achieved in this pilot are summarised as:

1) Obtaining the first in-continuous system of water quality parameter monitoring, providing knowledge on when and how often the system achieve critical conditions (anoxia, etc.), also in periods when standard field measurements are not performed (for ex. during the night);

2) A first real time alert system, through which, if any parameter is out of range, an automatic alert is sent to the Park's relevant staff;

3) The availability of data on-line, through the web platform delivered by EcoSUSTAIN partners.

The installed systems are providing several benefits:

- Enhanced knowledge of the state of the water and therefore of the ecosystem, allowing the improvement in the management of the protected area;
- Availability of a real time alert system in case of emergencies;
- Data to build a rich database for scientific research (to share with the key stakeholders) and understanding of the behaviour of the ecosystem and its variations along the river and over time;
- Enhanced knowledge base for development of new projects related to water management;
- Enhancement of citizens' awareness on the state of waters, which is often better than what people generally expect, through the share of information online

Recommendations to other protected areas doing similar projects

The key recommendation emerging from this experience is the importance to strength the networks with other PAs and the key stakeholders, in the area and generally in MED area, in order to give greater importance to the data collected and possibly to create a common database useful for the best management of the protected areas under the different aspects each authority manages.

Surely, for Mincio Park, the involvement of the Faculty of Natural Sciences of the University of Parma and the Regional Environmental Protection Agency was fundamental. As these are the entities carrying out regular water monitoring of the Mincio River, one for scientific purposes, the other as the official authority for water monitoring, their technical and scientific support throughout the project proved to be particularly valuable.

Pilot area (Natural Park): NR/SAC/SCI "Mincio Valleys", Regional park of Mincio, Italy

Pilot location: 4 buoys installed at:

1) Rivalta sul Mincio (Rodigo – MN)
2) Superior Lake (Mantova)
3) Medium lake (Mantova)
4) Inferior lake (Mantova)

Partner responsible for the pilot implementation: Regional Park of Mincio

Monitoring System Installation date: April 2018

Key stakeholders involved in the pilot implementation

- *Faculty of Natural Sciences of University of Parma*
- *Regional Environmental Protection Agency (Office of Mantova)*
- *Interregional PO river Agency*
- *Local public authorities and interested groups (included NGO) involved by "Mincio river Contract"*

Key results:

- Obtain the first in-continuous system of principal water quality parameters' monitoring;
- Availability of data on-line.

Benefits:

- Improved knowledge of the state of the water and therefore of the ecosystem;
- Improved management of the protected area;
- Starting point for the creation of an alert system in case of criticalities in the ecosystem;
- Have a rich database for scientific research (to share with the key stakeholders);
- Understand the behaviour of the ecosystem and its variations along the river;
- Knowledge base for developing new projects related to water management;
- Enhanced citizens awareness of the state of the water, often better than what they expect.

3.2. Pilot 2 – Global Nature Foundation: L'Albufera Natural Park

The pilot site: needs and requirements

L'Albufera Park is the largest (211 km^2) among the 4 Parks participating in the EcoSUSTAIN short-term monitoring program, having the largest (23,2 km^2) shallow (1m) lake of the Spanish coast and one of the few in Europe. L'Albufera Lake is highly regulated, 70% of the lake inflows passes through a historic irrigation system for rice fields and the outflow is artificial by three canals with water barriers for steady water level maintenance. Key stressors for the lake are the agricultural activities, mainly rice fields and industries, both intensive around its shores. The lake is hypertrophic since the 70s, with the presence of potentially toxic cyanobacteria, which represent a potential risk for migratory birds. Despite this, L'Albufera is a wetland of high ecological and biodiversity value, included in the RAMSAR and Natura 2000 Networks. The key problems the Albufera Park faces can be summarized as follow:

- The reduction of freshwater from Júcar River due to the modernization of the irrigation system of the Júcar Royal Canal;
- Deficiency in sewage and wastewater systems;
- Water level in lagoon varies to cover rice farming necessities;
- Contaminants accumulated in the sediment.

To face these problems, the "Júcar Management Plan" was developed, with objective to reduce eutrophication within specific targets set by 2021 and 2027. Measures proposed to achieve these targets include:

- Increase of the volume of water;
- Sewage and waste water treatment;
- Reduction of nutrients in treated urban waste water;
- Reduction of intern supply;
- Treatment system based on artificial wetlands: TANCAT DE LA PIPA;
- Reuse of water;
- Better agriculture practices;
- Governance.

Connected to L'Albufera Lake, some constructed wetlands were built to clean the lake's water by means of green filters. As the output of one of this green filters, Tancat de la Pipa, one STMS was installed as part of the EcoSUSTAIN pilot programme. Despite the reduction in the external nutrient loading and the rice fields reclamation for constructed wetlands operation, the lake still faces issues linked to nutrient resuspension from sediments and metal pollution above World Health Organization WHO levels. According to Water Framework Directive WFD, its ecological quality can be classified even as "bad".

The pilot: objectives, activities, results

As the key issue of this ecosystem is eutrophication, the aim of monitoring through the EcoSUSTAIN pilot was to:

a) Study the effluent impact of Tancat de la Pipa constructed wetland on the Albufera Lake;

b) See how the water quality changes during the effluent discharge and how long this effect remains in the Lake.
The final scope is to pilot test the ability of this STMS to act as an early warning system for the physical-chemical status of the water (especially for discharges into the lake) and to see if this daily discharge from constructed wetlands is able to change the characteristics of the lake's water.

In May 2018 one buoy, equipped with sensors measuring water parameters every hour, was installed in a canal connected to L'Albufera Lake, just downstream from Tancat de la Pipa outflow.

Figure 4: Location of EcoSUSTAIN STMS system in L'Albufera Park

The table below shows the parameters monitored by the buoy installed within EcoSUSTAIN project.

Table 1. Parameters monitored by STMS buoy installed at L'Albufera

	Parameter
1	Temperature
2	pH
3	Conductivity
4	Dissolved Oxygen
5	Nitrate concentration
6	Turbidity
7	Chlorophyll a
8	Phycocyanin

The first results of STMS water monitoring show already interesting results and data, which have been analyzed already in terms of daily (Figure 5) and seasonal variations (Figure 6), also in comparison with meteorological data (Figure 7) or comparing multiple parameters (Figure 8).
An interesting application that is being tested, is the measurement of the difference in water quality, between the periods when clean water is discharged and when not from the Tancat into the lake.

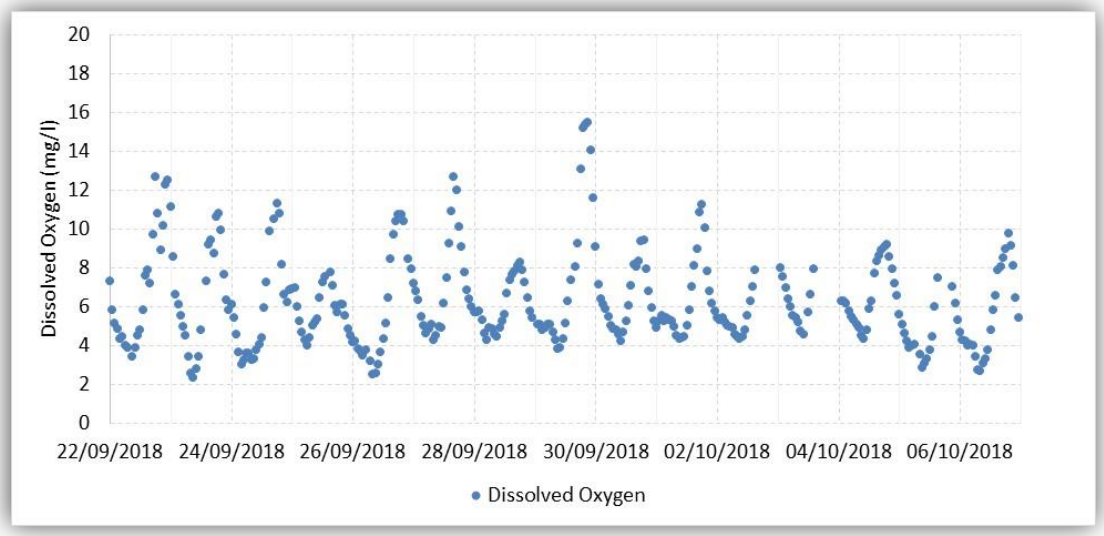


Figure 5: Pilot results of water monitoring in L'Albufera: daily variation of Dissolved Oxygen

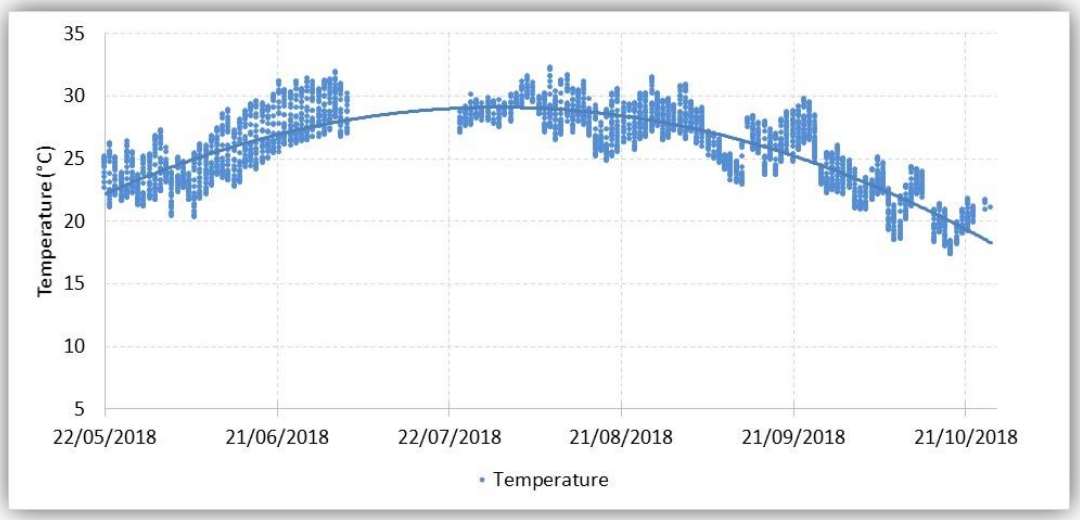


Figure 6: Pilot results of water monitoring in L'Albufera: Temperature trend across seasons

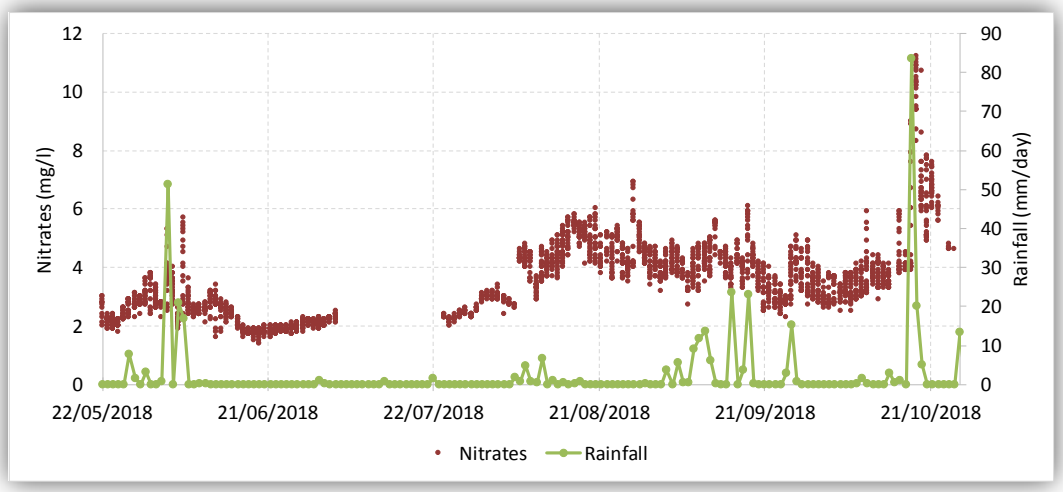


Figure 7: Pilot results of water monitoring in L'Albufera: Nitrates concentration vs Rainfall

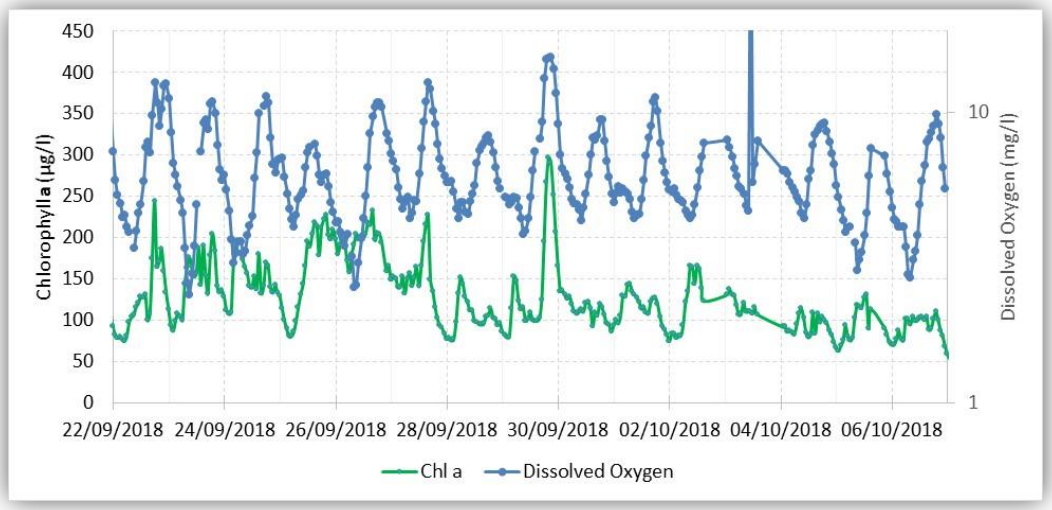


Figure 8: Pilot results of water monitoring in L'Albufera: Chl-a concentration vs Dissolved Oxygen

Lessons learnt from the pilot action

In this case, the partner who carried out the pilot is not the Park management authority, as in the other STMS pilot, but a private NGO, Fundación Global Nature; thus, collaboration with the Natural Park Authority since the preparation stage was crucial, in order to have them on board and gain permission to install the buoy in the Park. The Park Authority was however very positive about the project and the installation of a new measurement system in the lake. During the pilot implementation other organizations were involved:

- Júcar River Basin Authority, as the owner of Tancat de la Pipa;
- SEO-BirdLife and AE-Agró as two NGO's involved in the Tancat de la Pipa management;

- Institute of Water and Environmental Engineering (IIAMA) of the Technical University involved in the analysis of buoy data.

The involvement of these subjects was very positive: all of them participated in the EcoSUSTAIN Staff Exchange organized by FGN with ALOT's support in l'Albufera and have been kept informed of the project's developments throughout. The results from the buoy measurements are also very useful for them, in order to enhance their environmental awareness and education programs and, in the case of the University, to increase their knowledge of the system, gaining continuous series of water quality measurements of the lake for several parameters.
Overall, the experience for FGN was positive, no negative aspects were found along the process, from feasibility and technical specification up to installation. Support by partners was important to develop the technical specification. The buoy installed in l'Albufera is particularly suitable for eutrophic ecosystems, as the sensors are not in constant contact with water, avoiding fouling. Dialogue with scientific experts, other Interreg projects and also providers were useful in order to select the best option.
The installation phase had to take into account the selection of the location, which had to consider several factors: easy to arrive for maintenance operations, easy to see from the shore, but not too close to visitors for security reasons. Maintenance had also to be considered and included in the contract. In this case only one year is covered (work, not materials); even though the provider delivered training to the Staff for maintenance, FGN believe that it is better to leave this task to a specialized company.
Communication to the public is also important, in order to make them aware of the system and its benefits. In this case, communication was delivered through local guides and educational NGOs, website and social media and an article published on a scientific journal.

Key benefits from the pilot

The buoy is providing continuous series of data which confirms the eutrophication situation of the lake and the necessity of increasing the input of clean water from the Jucar River. This data is a useful tool to improve the Park's capacity to negotiate with stakeholders, in particular in requesting more water input. If this data allows to obtain higher inflow of clean water from de Júcar River, the need for maintenance of some infrastructures as canals, could be reduced, as clean water has less dissolved sediments.
Information and data can allow positive changes in the current Management Plans of the protected areas and improve relationship and communication with a wider range of stakeholders, such as conservationist associations that are very active in influencing public administrations towards protection policies.
Furthermore, the short-term monitoring system provides an amount of measurements that would be impossible to obtain with conventional monitoring systems. This new equipment

will deliver the biggest data series never achieved in the Albufera National Park (in one year more than 4,000 measurements of 6 different parameters). Thanks to this, researchers can study the changes in the water parameters in relation to atmospheric conditions or any other event that could happen in l'Albufera.
Finally, even if the benefits are great, having more than one buoy would provide more complete information about the several inflows to the lake.

Recommendations to other protected areas doing similar projects
Final key recommendations coming from this pilot are:

- To include maintenance of STMS into the provider's contract in the medium-long term;
- To consider the acquisition and installation of more than one buoy, at least two, for a comprehensive monitoring and data comparison;
- To compare results with traditional methodology to obtain a regulating coefficient of the two measurements;
- Possibly to involve the Natural Park Authority in this kind of project from the beginning, as a lot of information was needed and it was not always possible to obtain it.

Pilot area (Natural Park): L'Albufera Natural Park, Spain

Pilot location: Tancat de la Pipa (constructed wetland)
Partner responsible for the pilot implementation: Fundación Global Nature
Monitoring System Installation date: May 2018
End of pilot: April 2019

Key stakeholders involved in the pilot implementation

- Albufera Natural Park Authority, responsible to authorise the installation of the buoy;
- Júcar River Basin Authority, as the owner of Tancat de la Pipa;
- SEO-BirdLife and AE-Agró as two NGOs involved in the Tancat de la Pipa management;
- Institute of Water and Environmental Engineering (IIAMA) of the Technical University involved in the analysis of buoy data.

Key results and benefits

- First in-continuous series of several water quality parameters;
- Availability of a huge amount of data, impossible to obtain through field sampling, very useful for research;
- Improved knowledge of the state of the water and therefore of the ecosystem;
- Improved capacity to liaise with key stakeholders, in particular on the need for more water input;
- Better capacity to influence policies for the lake protection;

3.3. Pilot 3 – Public Institution "National park Krka: Krka National Park"

The pilot site: needs and requirements

Krka National Park covers 109 km^2 of territory around the River Krka, which flows for 72 km across the Dinarides karsts complex down to the Adriatic. Despite seasonal tributaries dry-out, high velocity water flow (>40 m^3/sec) can be recorded all year round. Main pressures identified are the urban areas wash-off, some minor morphological alterations and the untreated effluents of two large cities (185.000 inhabitants) that were diverted directly in the river until 2011. Metal traces have been found in relatively high concentrations in several areas, but with no pattern. Especially upstream, the Ecological Status is reported as good and these areas have provided EU with reference values for the Water Framework Directive.

Along the River there are several lakes formed by tufa barriers, with waterfalls that attract many tourists every year. These tufa formations have the ability to retain some pollution load enhancing the system's self-purification ability. One of these lakes is Visovac Lake, characterized by relatively high freshwater intake. Although located in sparsely populated and almost intact environment, upstream some significant anthropogenic sources of pressure can be found (towns of Drniš and Knin), making the lake a very sensitive ecosystem, exposed to increased eutrophication that can result in phenomena such as demersal hypoxia and anoxia. Nutrient salts and organic pollution recent measurements pose the matter of accumulation, potentially endangering biota and water quality.

Krka National Park was established about twenty years ago, thus can be considered as an experienced management authority, with its own management plan since 2006. All legal entities using water resources within the Park are bound to act in line with provisions of NP Spatial plan.

The pilot: objectives, activities, results

The aim of monitoring through the EcoSUSTAIN pilot in Visovac Lake was to assess and keep under control the intensity of eutrophication processes and generally achieve a better monitoring capacity according to the Water Framework Directive, also because part of the NP is characterized as Natura2000 site. Lake Visovac was chosen due to its natural reservoir of water that theoretically can be used also as a source of drinking water.

In May 2018 one buoy, equipped with sensors measuring water parameters every 15 minutes, was installed in Visovac Lake. The Park is now going to reduce the frequency of measures taken per hour (probably to 1/hour) to avoid unnecessary accumulation of data.

Figure 9: Location of EcoSUSTAIN STMS system in Krka NP

The table below shows the parameters monitored by the buoy installed within EcoSUSTAIN project.

Table 1. Parameters monitored by STMS buoy installed in Krka NP

	Parameter
1	Temperature
2	pH
3	Dissolved Oxygen
4	Conductivity (CDOM/fDOM)
5	Chlorofill-a
6	Turbidity
7	Bluegreen algae

Data gained so far are all within the limits given by the National laws and have been shared with key stakeholders for data sharing and knowledge exchange, such as the University of Zagreb, which performs research in the Park, and Croatian Water, which regularly monitor the river, to compare data from the buoy with their field sampling. Data have also been used to integrate knowledge from existing research projects on Diatoms, phytoplankton and tufa communities.

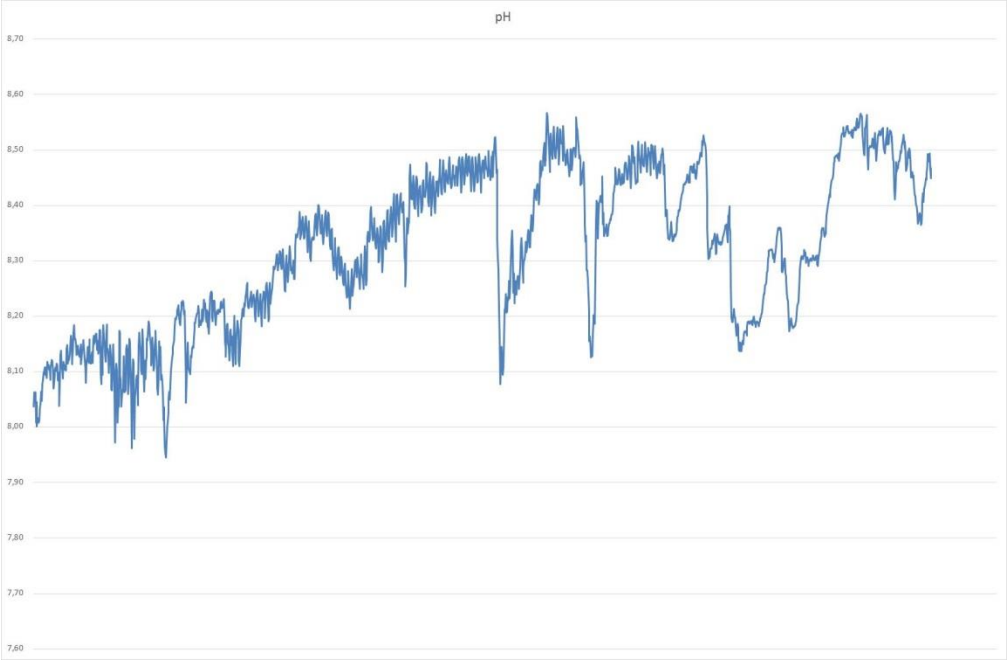


Figure 10: Pilot results of water monitoring in Krka NP: pH trend from May to December 2018

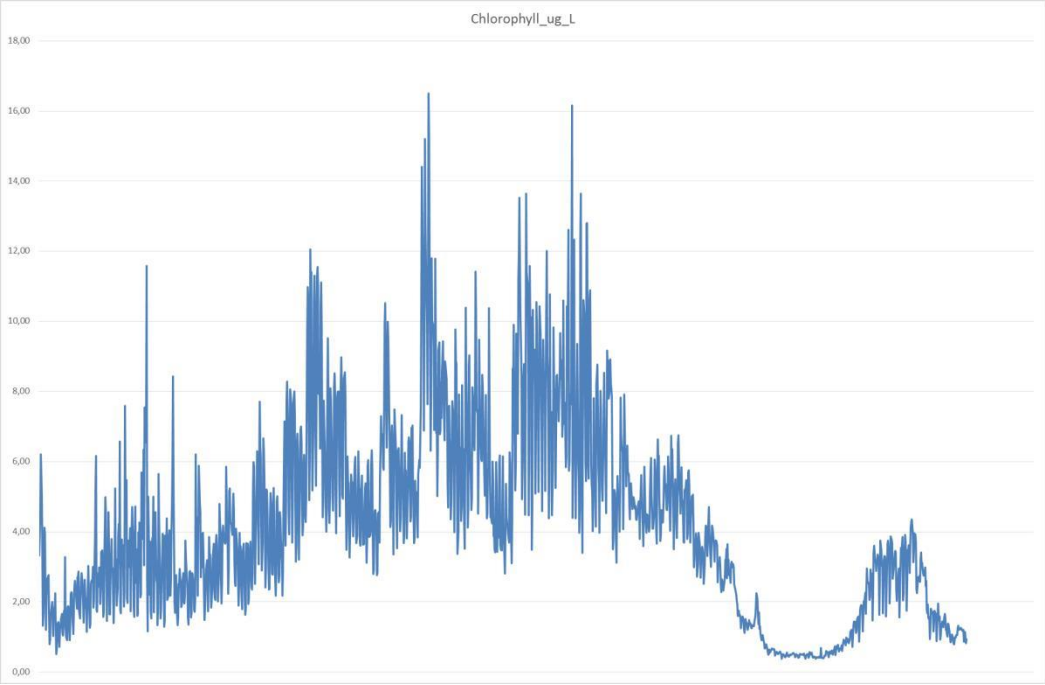


Figure 11: Pilot results of water monitoring in Krka NP: Chlorophyll trend from May to December 2018

Lessons learnt from the pilot action

Krka National Park is overall satisfied with the pilot implementation. There were no specific obstacles encountered during the pilot, from preparation through implementation and monitoring. The procurement process went smoothly, even if it would have been better if started earlier, due to the long procedures. However, the preparatory phase, including the selection of the site to install the buoy, the parameters to be monitored and the technical specification of the whole system required some time and was crucial for the procurement process to be successful.

The installation process was effective, the buoy is anchored on Lake Visovac, not far from the shore. The supplier provided all necessary support, manual and training courses for employees of the NP Krka involved in the project and in monitoring. Stakeholders were adequately informed about the project activities and results expected and the EcoSUSTAIN web portal has been a very useful tool for the Park to increase communication to the public.

Data are shared with the relevant stakeholders (Croatian waters, Faculty of Science of the University of Zagreb, Public Health Institute of the Šibenik-Knin County) to enable them to compare data with the results of regular water sampling.

Key benefits from the pilot

The results of the water monitoring through the buoy are now an integral part of the water monitoring system in Krka National Park, which is a fundamental aspect of the NP's management and the Park's management plan. The pilot provided great benefits to the park. Similarly to other parks involved in the project, this is the first time that a continuous series of data is available, 24 hours/day, every day, throughout the seasons. These series are very useful, not only to the Park, which for the first time owns the water quality monitoring data, but also to other stakeholders that performs research or data sampling in the area. Comparing data and achieving a more comprehensive dataset of water quality is of great value. Increased knowledge of water parameters allows the Park to assess changes due to pollution or other phenomena, to react quickly to any potential pollution event thanks to a simple real time alert system, to develop better projects in the future and also to enhance the Park's management practices and planning. Creation of waterfalls and travertine barriers, as a natural and most attractive phenomenon of National Park Krka, depends on water quality. The National Park waters, as well as in similar protected areas of the region, are very sensitive to any form of pollution and the conservation of travertine barriers is one of the key issues, also due to their purification ability. This is the reason why water monitoring system should always be further improved.

Furthermore, enhanced cooperation with Universities and relevant water bodies is now possible thanks to this data, as before monitoring was performed only by Universities for research purposes and the Water Authority for the analysis required by law. The buoy is also very well seen by the local community, and sharing data through the online portal enhance

the Park's ability to increase awareness, knowledge and engagement of the local communities and visitors.

Recommendations to other protected areas doing similar projects

Projects like EcoSUSTAIN, with the goal of enhanced monitoring of water quality, are important for all stakeholders in karst areas, and particularly for subjects with an interest in water quality control in protected areas.

Key recommendation from this pilot is to involve all stakeholders since the early stages of similar projects or initiatives, including scientists and institutions, whose area of interest is water quality monitoring, especially in protected areas. Communication and involvement in the same projects of the local communities living in or around the park is also crucial, in order to improve acceptability and cooperation.

Pilot area (Natural Park): Krka National park, Croatia

Pilot location: Lake Visovac, Krka National park
Partner responsible for the pilot implementation: Krka National park
Monitoring System Installation date: May 2018
End of pilot: April 2019

Key stakeholders involved in the pilot implementation

- Department of Water Protection, travertine barriers and biodiversity NP "Krka";
- Ministry of Environmental Protection and Energy;
- The City of Skradin - a local community along the lakeshore;
- Department of Public Health of Šibenik-Knin County;
- Croatian Waters, a legal entity for water management;
- Faculty of Science of the University of Zagreb.

Key results and benefits

- First in-continuous series of several water quality parameters;
- Real time data detection and alert system, allowing quick intervention;
- Improved monitoring capacity, tracking changes of main ecological factors;
- Data obtained will enhance the management of the lake system, the Park's planning activities and the development of new water related projects;
- Enhanced shared knowledge across stakeholders;
- Enhanced cooperation with key stakeholders (universities, other authorities);
- Increased communication capacity and acceptance by the local community.

3.4. Pilot 4 - Public Company Una National Park Ltd: Una National Park

The pilot site: needs and requirements

Una National Park is a proportion of a basin which hosts the Una river along with its two main tributaries Unac and Sana. Similarly to Krka NP, it hosts tufa formations. The area within the NP is sparsely inhabited (<70/km^2 across 8 municipalities) and agriculture is of small scale, mostly for domestic use. The main pressures identified are the touristic growth, which shows a clear seasonal pattern, and also traces of agrochemicals and the residues from the cities, along with the scattered dumps of waste disposals and unsanitary municipality waste for the basin system, but still with no effect on the water quality, highlighting the self-purification ability of the river system. Overall, the water quality is very good, with no visible effects of pollution or morphological alteration across the Park. This also thanks to the tufa formations, forming a sequence of small falls, turns, springs, gauges and sinks which allow aeriation to the water preserving its low temperature and dissolved oxygen. Waters are characterised by neutral to alkaline pH with relatively high Calcium concentration (65-78 mg/l). Metal traces are reported to be found with Manganese being the most disturbing.

Una National park was recently designated as a protected area (2008) and the management authority, despite its short operation time (7 years) has performed important steps towards biodiversity protection, eco-friendly infrastructure use and touristic attraction. The area has an uneven and gradual longitudinal profile with very steep slopes (45% of terrain has 10-30 incline and more). It is of first priority to preserve the tufa formation phenomenon.

As a young National Park, Public Company Una National Park Ltd does not have professional and technical capacity to monitor the water quality in this area and for this reason, before EcoSUSTAIN, they only used services and data from other agencies and external associates. Automatic hydrological stations measure water level and flow rates, which are publicly available on the agency website and updated every hour. When it comes to monitoring the physical and chemical properties of water, they are occasionally done by the USSC Public Health Institute and sporadically by the National Park management.

The pilot: objectives, activities, results

The aim of EcoSUSTAIN pilot in Una River was to improve water monitoring in order to preserve the river biodiversity and fish-life, water quality for aquaculture production, ensure safe conditions for touristic activities and water sports and improve the ability to assess the impact on the river of potential human activities.

For these reasons, in August 2018 one buoy, equipped with sensors measuring water parameters every hour, was installed in Ćelije, a more lentic part of Una River, downstream of three settlements and some agricultural fields. These settlements are sparsely populated,

but with unknown sewage treatment processes. As for agriculture, there are mostly small fields for domestic use.

Figure 12: Location of EcoSUSTAIN STMS buoy in Una Park

The table below shows the parameters monitored by the buoy installed within EcoSUSTAIN project.

Table 1. Parameters monitored by STMS buoy installed in Una River

	Parameter
1	pH
2	Nitrogen
3	Temperature
4	Conductivity
5	Dissolved Oxygen
6	CDOM-fDOM
7	Chlorophyll-a

The first results were under analysis by UNA NP and shared with several stakeholders interested in the data as well. Data and graphs are sent directly both to UNA NP and to the EcoSUSTAIN server. Figure 13 shows a screenshot of the EcoSUSTAIN online platform where periodic reports for each location can be generated. The figure shows how data are visible to UNA NP; the system displays not only the series of data for all parameters in a given period selected by the user, but also the minimum, maximum and mean values for each of the parameters, allowing a quick overview of data over a selected period.

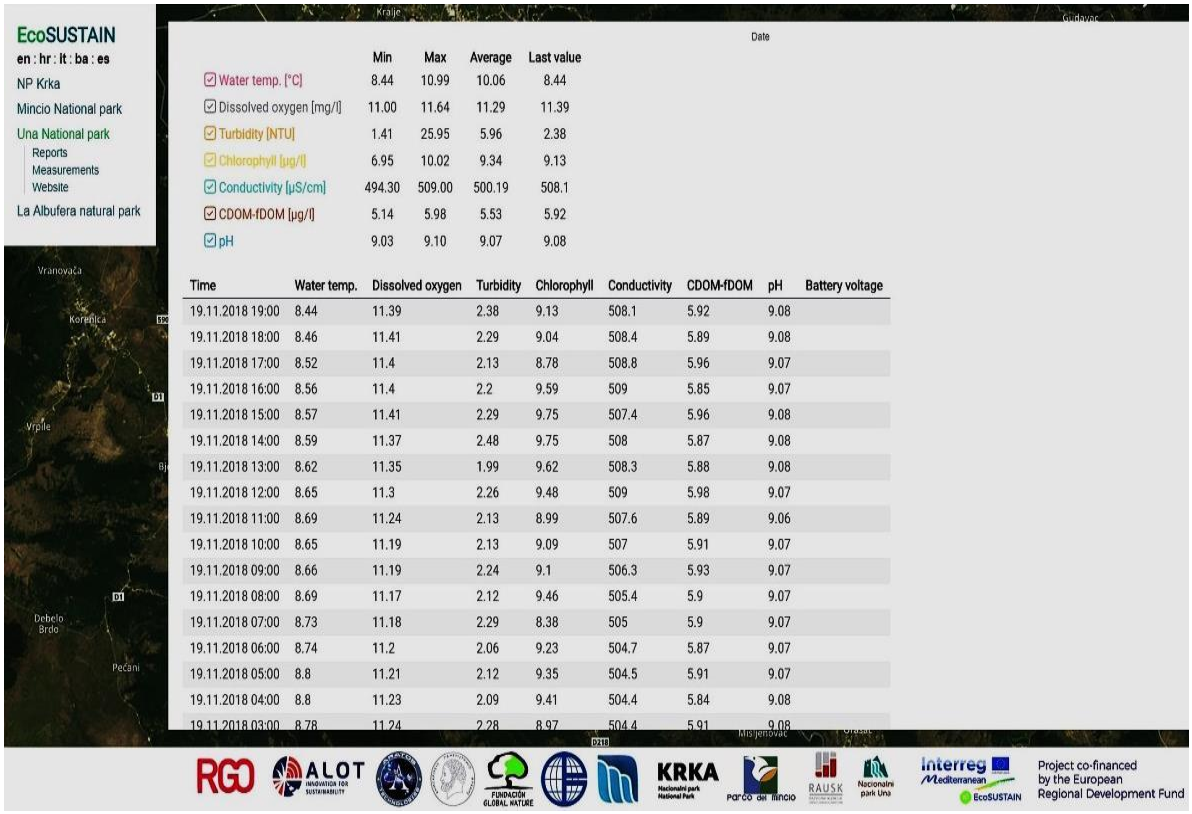


Figure 13: Pilot results of water monitoring in Una River – screenshot from EcoSUSTAIN web portal

Lessons learnt from the pilot action

Overall the pilot implementation process went smoothly and is considered as a success by NP Una. The development of a sound technical specification for the monitoring hardware was very important, thanks to EcoSUSTAIN partners support, and the system installed is working with no need for frequent maintenance or calibration of the sensors, thanks also to the transparency and good quality of the waters. Some problems were encountered during the public procurement process, especially due to delays of suppliers in responding and providing all necessary information.

The installation process was successful; the first winter season (2018/19) with the first floods, will provide more data about how well the buoy is anchored and how the equipment behaves in high water level conditions.

The selection of the location considered both monitoring priorities, but also practical considerations, such as:
- Upstream of the buoy there are 3 inhabited villages that stretch along or not far from the river Una, which are known to pollute one part of the river, while downstream there are waterfalls and most valuable natural phenomenon-travertine barriers;
- Considering that the buoys must be anchored to heavy concrete blocks, the location must have sufficiently deep waters for the block and not too strong streams (reducing risk for the buoy to be disanchored); it is also desirable to install the buoy in a location which is accessible to an adequate vehicle to transport the concrete block and lower it down into the water.
- The accessibility to the site is very important also for security reasons, in order to give the Park's employees, the possibility to observe and control the equipment when needed and for maintenance purposes.
The selected provider delivered all the necessary support, a manual and training courses for employees of Una NP who are involved in the project and work with the installed buoy.

Key benefits from the pilot
Key benefits from the pilot are summarised by Una NP as:
- First in-continuous series of several water quality parameters compared to few measurements per year before the pilot;
- Real time data detection and alert system, allowing quick intervention;
- Enhanced shared knowledge: data are very useful not only for NP Una, but also for several stakeholders: the Ministry of environment and tourism of the Federation of Bosnia and Herzegovina, Public health agency of Una Sana canton, the Faculty of Science of the University of Sarajevo and the Faculty of Biotechnical Sciences of the University of Bihac.
- Enhanced relationships with key stakeholders, as the sharing of data allowed also to enhance collaboration with these stakeholders.
- Improved Management planning and project development: data will be useful also to develop the new Management plan for Una NP and new projects related to water management and wastewater treatment through constructed wetlands.
- Useful tool to monitor the impact of development activities, such as the influence of agriculture and urbanization on water quality in the future.
- Improved communication and acceptance by the local community, which had a very good perception of the project, thanks also to the EcoSUSTAIN platform allowing to publish data from the buoy.

Recommendations to other protected areas doing similar projects

Projects related to water monitoring systems such as EcoSUSTAIN are important for many PAs in the UNA region (Dinaric Arc region) particularly for those managing aquatic systems in protected areas. Therefore, the sharing and transfer of knowledge and experience about water management of the EcoSUSTAIN project is very important for UNA NP, who will continue to share it in the future.

Water quality is a crucial factor for UNA NP, both as it affects fish health and performance in aquaculture production systems, and as it influences all other species and habitats across the river, which constitutes a very sensitive aquatic ecosystem, characterized also by travertine formations.

The key recommendation coming from UNA pilot is the importance of communication and engagement of key stakeholders, including the communities, in all projects related to water monitoring and protection:

"Participation by all stakeholders, including workers from PAs and the community is very important. This approach will involve new institutional arrangements, but this must at the same time be associated with transparency and accountability for all decisions. It is also important to ensure that representatives provide feedback to the constituencies they represent. Aquatic ecosystem management seeks to combine interests, priorities and disciplines as a multi-stakeholder planning and management process for natural resources within the catchment ecosystem, centered on water" (UNA NP Staff).

Pilot area (Natural Park): Una National park, Bosnia

Pilot location: Ćelije, Una River, UNA National park
Partner responsible for the pilot implementation: Una National park
Monitoring System Installation date: August 2018
End of pilot: April 2019

Key stakeholders involved in the pilot implementation

- Ministry of environment and tourism of the Federation of Bosnia and Herzegovina
- Ministry of Agriculture, Water Management and Forestry of the Federation of Bosnia and Herzegovina
- Sava River Basin Agency
- Public health agency of Una Sana canton
- City of Bihać
- Institute for agriculture of Una Sana canton
- Faculty of Science of the University of Sarajevo
- Faculty of Biotechnical Sciences of the University of Bihac

Key results and benefits

- First in-continuous series of several water quality parameters;
- Real time data detection and alert system, allowing quick intervention;
- Enhanced shared knowledge: data are very useful for several stakeholders (Ministry of environment and tourism, Public health agency, Universities);
- Enhanced relationships with key stakeholders;
- Improving Management planning and project development;
- Useful tool to monitor the impact of development activities, such as the influence of agriculture and urbanization on water quality;
- Improved communication and acceptance by the local community.

3.5. Pilot 5 – Democritus University of Thrace: Ecodevelopment Area of Karla-Mavrovouni-Kefalovriso-Velestino

The pilot site: needs and requirements

Ecodevelopment Area of Karla – Mavrovouni – Kefalovriso Velestino, is located in Eastern Thessaly region of Central Greece. It extends over an area of 1217 km^2 and includes eight Natura 2000 sites, including five Special Protected Areas (SPAs) and three Special Areas of Conservation (SACs), besides six Wildlife Shelters.

Within its territory the artificial Lake Karla is located (38 km2), used as a reservoir supplying with water the surrounding farms.

The Management Body of Ecodevelopment Area of Ka.Ma.Ke.Ve. is in charge for the protection, preservation and management of nature and landscape, as natural heritage and valuable national natural resource in parts of the region Karla Mavrovouni Kefalovriso Velestino. With their environmental monitoring programme they perform:

- Monitoring of fauna important species (Directives 92/43/EEC and 2009/147/EC);
- Monitoring of natural habitats and flora (Directive 92/43/EEC);
- Monitoring of water (Water Framework Directive 2000/60/EC).

Key issues of Lake Karla can be identified as:

- High water level fluctuation, with level often below the lowest ecological level set in order to support the functions of the wetland;
- Higher values of total Nitrogen, nitrate and BOD_5 concentration, especially in the North-East of the lake, mainly from the significant number of cattle, sheep and goat farms in the surroundings area, discharging organic load into the lake by runoff;
- Algal blooms frequently observed throughout the dry period;
- Fish and bird death incidents observed during the past warm seasons.

The pilot: objectives, activities, results

Lake Karla was chosen for the LTMS pilot because it is a heavily modified water body under the protection of Natura 2000 Network and it hosts important species of fish fauna and avifauna. Monitoring through LTMS should also help to understand if its water resources are adequate to be used for irrigation. The data is very important for the Management Body of Karla-Mavrovouni-Kefalovriso Velestino-Delta Pinios because Lake Karla is a newly born lake and is under a restoration stage. It is also affected by punctual and diffused pollution.

The pilot monitoring through LTMS started in October 2018, when the software was successfully installed by ARATOS at Karla Management Offices. The LTMS client application acquires updated information of satellite data and images and data are hosted in ARATOS database. ARATOS held a training session for Karla Management Body staff in order to effectively use the software, which is however very user friendly.

The table below shows the parameters monitored by the LTMS installed through EcoSUSTAIN. The satellite passes over Lake Karla two times per month, so this is maximum frequency of measures. The average frequency so far is less than 2 samples per month.

Table 1. Parameters monitored by LTMS in Karla

	Parameter
1	Chlorophyll-a (mg/cm^3)
2	NO_3 (mg/lt)
3	NH_4 (mg/lt)
4	Phosphorus (mg/lt)
5	pH
6	Dissolved Oxygen (mg/l)

Data gained through the LTMS application provides Lake Karla Management Body with one geo-referenced image per parameter per sample each time. The first results are presented in the pictures below.

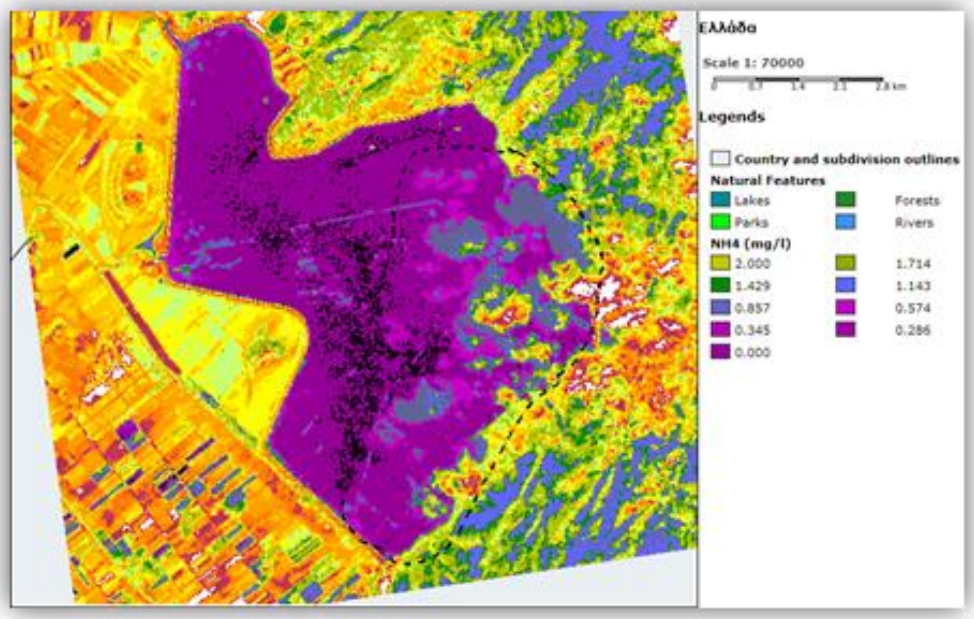


Figure 14: Pilot results of water monitoring through LTMS in Lake Karla: NH_4 levels in October 2018

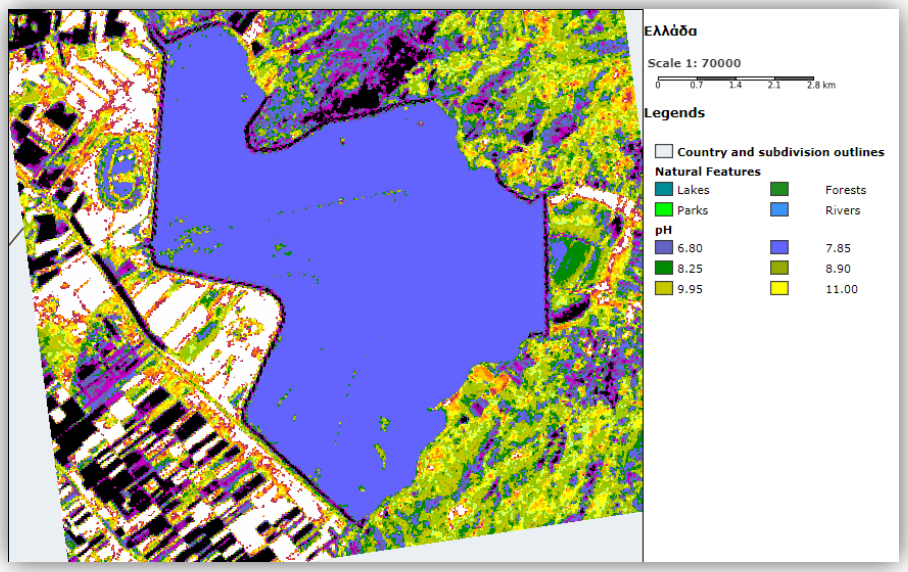


Figure 15: Pilot results of water monitoring through LTMS in Lake Karla: pH in March 2018

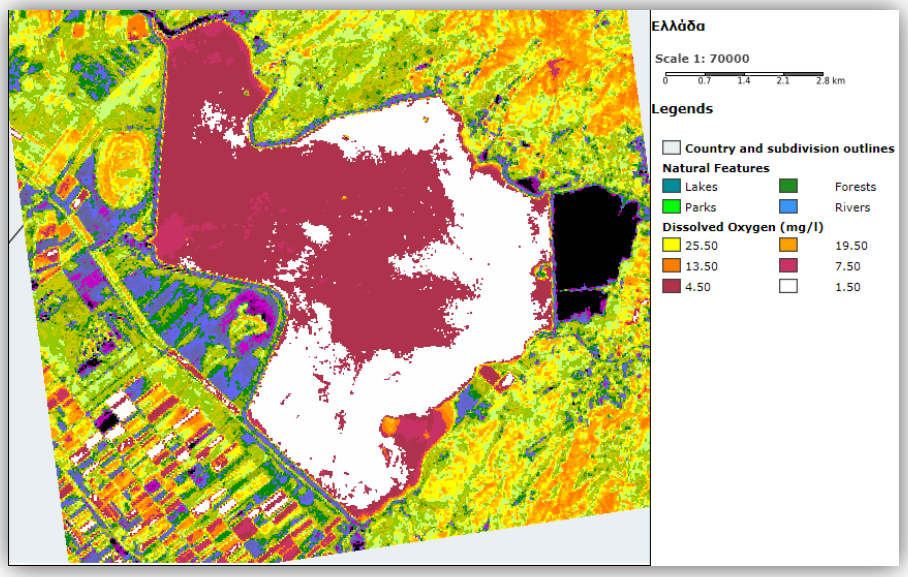


Figure 16: Pilot results of water monitoring through LTMS in Lake Karla: D.O. levels in July 2018

Lessons learnt from the pilot action

The application of satellite LTMS in Lake Karla is at the early stage. Due to the frequency of measurement and output from the software, the system is able to assist and support the Management Body's existing monitoring routine and to follow the progress of the River Basin Management Plans. The first results of the water monitoring are an integral part of the water monitoring system, which is an integral part of the Parks' management.

A large number of stakeholders is excited for the new monitoring solution, its potential and also the visualization of monitoring results through simple maps. It is considered a good tool for communicating with the public.
The installation of the software was easy and successful, it could be done remotely if necessary. No maintenance is needed, as the user simply gets a software to install and there is no need for increased capacity building besides basic GIS knowledge for using the software, thanks to a user-friendly interface.
As it is possible to capture seasonal or annual trends, the satellite produced results can be useful for preparation of new projects and implementation of measures related to water management. Data will be shared with all relevant stakeholders and scientists in the network, to enable them to compare data with the results of regular water sampling.
As a downside, meteorological (cloudy) conditions obviously affects the clarity of the pictures.
Integration of data is also very important: Lake Karla is on a state monitoring routine according to the Water Framework Directive, the staff frequently collects samples and measures nutrients and other abiotic parameters. Also, the Democritus University of Thrace (DUTH) took samples simultaneously with the LTMS measures in order to calibrate the satellite system; calibration should be taken into consideration. In the next months there should be the opportunity to build a database of data, integrating field sampling results and LTMS results.

Key benefits from the pilot

The key identified benefits from LTMS pilot in Lake Karla can be summarized as:

- It provides a quick visualization of the status of the entire lake on selected parameters;
- This method can detect possible “sensitive areas” and areas where the lake’s inflows are subject to punctual and diffused sources of pollution. It can also support the understanding of the efficiency of buffer zones and constructed wetlands (green filters). This can allow to intensify field sampling & monitoring strictly in the more degraded sites and control the quality of inflows for quality improvement and water security measures, as well as pinpointing the vulnerable areas and design site specific measures & demand for investment;
- It can provide a depiction of annual trend for water quality related parameters;
- The data will be useful for preparation of new projects and implementation of measures related to water management.
- It can assist the evaluation of hydrological modification designed in favor of the waterbody.
- It can possibly assist in cost and time reduction for samplings.

- Visualization of monitoring results and the nature of the outcome (picture) is an effective tool to communicate with the public.
- The capitalization of LTMS will (hopefully) lead to the optimization of water resources management practices, consequently improving Biodiversity conservation and protection, ecosystem services enhancement, with potential benefits in sectors such as fisheries, agriculture, tourism and education.

Recommendations to other protected areas doing similar projects

Key suggestions coming from this pilot implementation are:

- Carefully select the parameters to be monitored, based on needs and requirements of the Park, but also on feasibility with the system provider;
- Verify at an early stage with the provider the frequency of measures and of data detection;
- Test the precision of measurements under different weather conditions;
- This monitoring provides useful long-term trends of the system, thus it should be run for at least a couple of years;
- Involve all relevant stakeholders in the pilot monitoring, including scientists and research institutions, whose area of interest is water quality monitoring, as they can provide useful advice and support as well as data for the system calibration, comparison and integration.

Pilot area (Natural Park): Ecodevelopment Area of Karla-Mavrovouni-Kefalovriso-Velestino

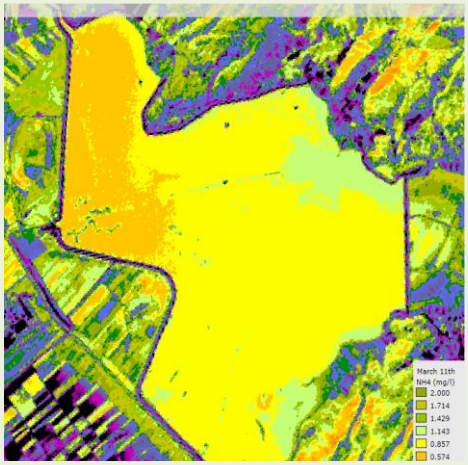
Pilot location: Lake Karla
Partner responsible for the pilot implementation: Democritus University of Thrace (DUTH)
Monitoring System Installation date: October 2018
End of pilot: April 2019

Key stakeholders involved in the pilot implementation

- Water Administration of Thessaly, Decentralized Administration of Thessaly - Central Greece
- Department of Environment and Hydro-Economy of Magnesia, Administration of Environment and Regional Planning, Administration of Thessaly Region
- Administration of Technical Works, Administration of Thessaly Region
- Ministry of Environment and Energy
- Municipal Water and Sewerage Company of Larissa
- Geotechnical Chamber of Central Greece
- Technical Chamber of Magnesia
- Municipalities of Agia, Rigas Fereos, Kileler
- Institute of Soil Mapping and Classification, National Agricultural Research Foundation
- Local Authority of Land Reclamation of Lake Karla
- Local Authority of Land Reclamation Pinios River
- National Centre of Biotopes
- University of Volos, Department of Civil Engineering and Department of Civil Engineering
- Management Body of Ecodevelopment Area of Karla-Mavrovouni-Kefalovriso-Velestino

Key results and benefits

- It provides a quick visualization of the status of the entire lake on selected parameters;
- It can detect possible “sensitive areas” and areas where the lake’s inflows are subject to point and diffuse sources of pollution;
- It can provide a depiction of annual trend for water quality related parameters;
- It can assist the evaluation of hydrological modification designed in favour of the waterbody;
- It can possibly assist in cost and time reduction for samplings;
- Visualisation of monitoring results and the nature of the outcome (picture) is an effective tool to communicate with the public.



4. Conclusions

In conclusion, the pilot implementation of the EcoSUSTAIN project in five protected areas can be considered successful, since all Parks are satisfied with the results and also the stakeholders involved in water management across these regions.

Key recommendation and lesson learnt emerging from the pilots is to involve all relevant stakeholders since the early stages of similar projects or initiatives, including scientists and institutions whose area of interest is water quality monitoring, especially in protected areas. They can provide useful knowledge and advice, but also data comparison and integration, as well as synergies in projects implementation, further strengthening relationship and potential for collaboration.

Communication and involvement of the local communities living in or around the park is also crucial, in order to improve acceptability, awareness of good water quality importance and cooperation. The key lessons learnt are here summarized for the two systems tested in this project.

Lessons learnt from STMS pilots

Overall the experience of four protected areas involved in STMS was very positive: no particular issue has been experienced and significant benefits have been identified from the installed systems. The key recommendations and lessons learnt can be summarised as:

- When considering STMS installation, the acquisition and installation of more than one buoy, at least two, should be considered; this allows to compare results and have a wider picture of how the ecosystem acts;
- Water parameters selection should be based on monitoring needs, but also on other considerations (costs of the probes, duration and robustness, maintenance requirements, etc.). The choice of including only few key parameters for which sensors are robust and not too expensive may be a good choice, also leaving budget for more than one buoy. The water condition affects maintenance and duration of the probes and this fact must be considered;
- The location for installing the buoys should be carefully evaluated, considering not only the best location for monitoring purposes, but also installation, operational, security and maintenance factors. Considering that the buoys must be anchored to heavy concrete blocks, the location must have sufficiently deep waters for the block and not too strong streams, it should be also accessible by vehicles needed to perform installation, maintenance and security checks;
- Preparation of technical specification and procurement should be supported by technical experts, such as Universities or other technical partners with experience in water monitoring that can advise on the best solutions. It is also important to request

a “full package”: not only the supply and installation, but maintenance, spare parts for the duration of the project and training for the Park’s employees;

- Engagement of key stakeholders of the area is crucial, in order to create synergies, ownership, compare data and possibly create a common database useful for the best management of the protected areas under the different aspects each authority manages. In particular, if the solution is not implemented directly by the park authority, its engagement in the whole process should be ensured. Key stakeholders to engage are considered the Universities and research community and other Authorities responsible or interested in water monitoring and quality or in the Park’s activities. However, the data obtained from STMS can be interesting for a variety of stakeholders, such as environmental NGOs, associations, educational institutes in order to enhance their environmental awareness and education programs;
- Finally, communication to the public and the local communities is fundamental, in order to make them aware of the system and its benefits. In this case, besides communication through local guides and educational NGOs, website and social media, the EcoSUSTAIN web portal provides a very useful tool to increase communication and visibility of the Parks, displaying directly the monitoring data from the STMS online. In relation to this, which data and how to display them should be carefully evaluated by Parks, to ensure effective and useful communication.

Lessons learnt from the LTMS pilot

The application of satellite LTMS in Lake Karla allows to support the monitoring routine of the Park and provides useful information on the long-term behaviour of the lake, useful for the progress of the River Basin Management Plans. Key suggestions coming from this pilot implementation are:

- Carefully select the parameters to be monitored, based on needs and requirements of the Park but also on feasibility with the system provider;
- Verify at an early stage with the provider the frequency of measures and of data detection;
- Check the robustness of the empirical algorithms that will be used to simulate Nutrients and other parameters not deriving directly by the spectral analysis;
- Test the precision of measurements under different weather conditions;
- This monitoring provides useful long-term trends of the system, thus it should be run for at least a couple of years;
- Involve all relevant stakeholders in the pilot monitoring, including scientists and research institutions, whose area of interest is water quality monitoring, as can provide useful advice and support as well as data for the system calibration, comparison and integration.

- End of document -