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Limnological characteristics and trophic state of a newly created site: the Pareja Limno-reservoir

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1. INTRODUCTION

The creation of dams in the riverine zone of large reservoirs is an innovative action whose primary goal is to generate water bodies that ensure a stable level of water there, so called "limno-reservoirs".

Limno-reservoirs represent environmental initiatives with corrective and/or compensatory effects, mitigating the impacts of large reservoirs. Pareja Limno-reservoir is one of the first initiatives of this type.

We are investigating the hydrology, limnology, microbiology, siltation risk and other aspects of this site, as acquiring knowledge may be helpful for further limno-reservoirs constructions (Molina-Navarro *et al.*, 2011).

Figure 1: Pareja Limno-reservoir view.

The primary goal of this study is to describe the limnological characteristics of the Pareja Limno- reservoir, which was built in 2006 in a sidearm of the Entrepeñas Reservoir (fig. 1). Special interest is placed in the study of the trophic state, as on of the European Framework Directive objectives is to achieve a "good ecological status" in every aquatic ecosystem by 2015 (OJEU num. 327, 2000).

2. STUDY SITE

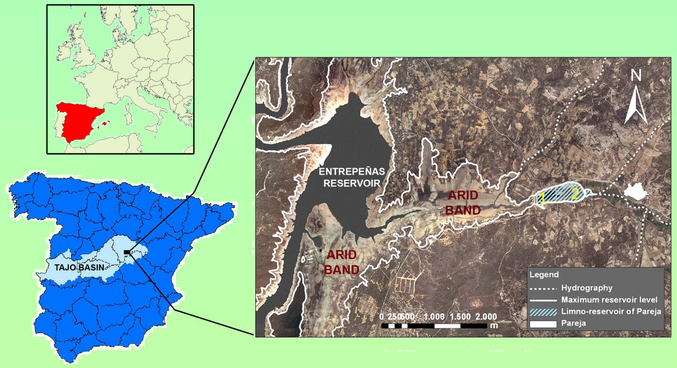

Figure 2: The location of the Pareja Limno-reservoir and the comparison of the volume of water stored in Entrepeñas Reservoir in 2006 with its maximum capacity.

The Pareja Limno-reservoir is adjacent to the village of the same name, southern Guadalajara Province (central Spain, upper Tagus River Basin), and in the Entrepeñas Reservoir potential inundation area (fig. 2).

Pareja Limno-reservoir facts:

- Capacity: 0.94 Hm^3
- Inundation: 26 ha
- Maximum depth: 9.0 m
- Main tributary: Ompólveda River
- Basin area: 87.8 km^2 basin.

Pareja wastewater is released downstream the reservoir, favoring, *a priori*, the good quality of the water discharged by the river.

3. METHODOLOGY

Twelve sample collections (fig. 3) were made seasonally (spring 2008 - winter 2011). Two sampling points were selected: one located next to the dam and another in the inflow section ("1" and "2" in fig. 2). Field work has included:

- Surface samples for N compounds, TP, CHL*a*, major ions and phytoplankton.
- Zooplankton collection.
- Depth profiles of temperature, pH, O_2 and conductivity (1 m increments, nearly monthly during the 2009-2010 hydrological year).
- Secchi disk depth

Figure 3: Sample collection

4. RESULTS AND DISCUSSION

4.1. Limnological characteristics

Temperature profiles obtained (fig. 4a) showed a warm monomictic stratification pattern. The distribution of dissolved oxygen generally followed the temperature pattern. However, low concentrations were found in late winter and early spring in the bottom, probably due to a silt-laden inflow after high precipitation.

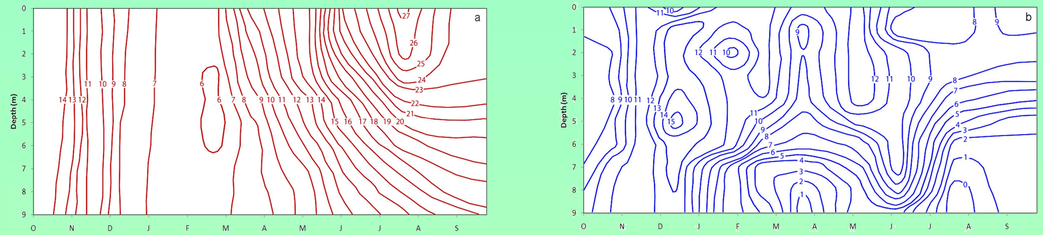

Figure 4: Depth-time distribution of temperature (°C) (a) and dissolved oxygen (mg/l) (b) in de dam zone during 2009/2010.

The water was slightly alkaline and sulphated-calcic, showing high conductivity values (mainly due to the SO_4^{2-}).

Table 1: Average seasonal values for the main limnological parameters.

	Dam Zone				Inflow Zone			
	Spring	*Summer*	*Autumn*	*Winter*	*Spring*	*Summer*	*Autumn*	*Winter*
Conductivity (µS/cm)	1183	1317	1405	1096	1181	1320	1408	1024
$N\text{-}NO_3^-$	<0.31	<0.23	<0.23	1.220	<0.31	<0.23	<0.23	<0.64
$N\text{-}NO_2^-$	<0.015	<0.015	<0.015	<0.024	<0.017	<0.018	<0.016	<0.015
$N\text{-}NH_4^+$	0.070	0.072	0.111	0.027	0.065	0.079	0.113	0.290
TP (mg/l)	<0.015	<0.015	<0.010	<0.017	<0.013	<0.023	<0.013	<0.052
Secchi depth (m)	2.57	1.23	1.87	1.66	1.38	0.71	1.03	1.03
CHL*a* (µg l^{-1})	1.30	1.93	2.28	1.16	1.20	3.52	2.38	1.73
Phytop. biom. (mg/l)	0.24	0.79	0.63	0.16	0.38	0.81	0.53	0.12

The results obtained (table 1) were similar in the two sampling points:

- The highest nutrient concentrations were found during the winter, when the Ompólveda River has highest flow.
- The maximum CHL *a* and phytoplankton biomass values were found during the summer (thermal stability and enhanced light climate) and the autumn (beginning of mixing and re-suspension of nutrients and sunken algae).

4.2. Trophic state

Table 2: Trophic state assessment through different indicators.

INDICATOR	TROPHIC STATE	CRITERIA
CHL a	**Oligotrophic / Oligo-mesotrophic**	OECD (1982) / TSI (Carlson, 1977)
Nitrogen compounds	**Oligo-mesotrophic**	Camargo & Alonso (2006)
TP	**Oligo-mesotrophic**	OECD, TSI
Phytoplankton biomass	**Oligo-mesotrophic**	Willén (2000)
Zooplankton species	**Oligo-mesotrophic**	Caramujo & Boavida (2000)
Secchi disk depth	**Eutrophic / Meso-eutrophic***	OECD / TSI

* Secchi disk depth might be expected to produce erroneous values in lakes and reservoirs receiving high amounts of non-algal particulate matter (Carlson, 1977)

5. CONCLUSIONS

- Pareja Limno-reservoir follows a warm monomictic stratification pattern. Water was slightly alkaline with high conductivity. Highest nutrient concentrations were found in the winter, whereas CHL *a* and phytoplankton showed highest concentrations during summer and autumn.
- Results obtained suggest that the Pareja Limno-reservoir is oligo-mesotrophic. It may fulfill the WFD requirements, but further monitoring is needed.

6. ACKNOWLEDGEMENTS

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