LANDSCAPE RUNOFF, PRECIPITATION VARIATION AND RESERVOIR LIMNOLOGY

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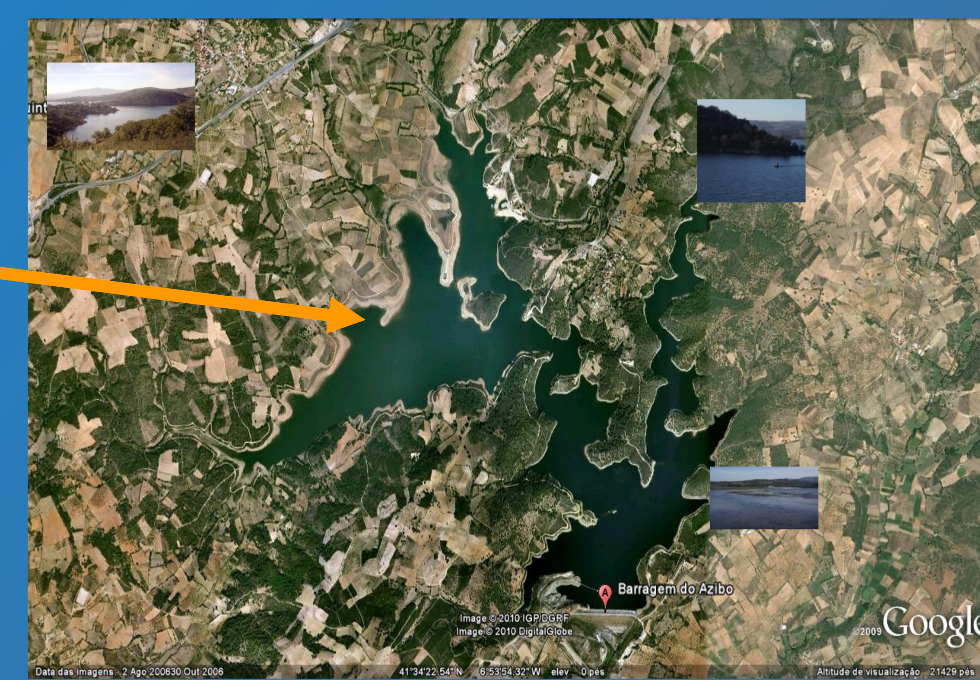
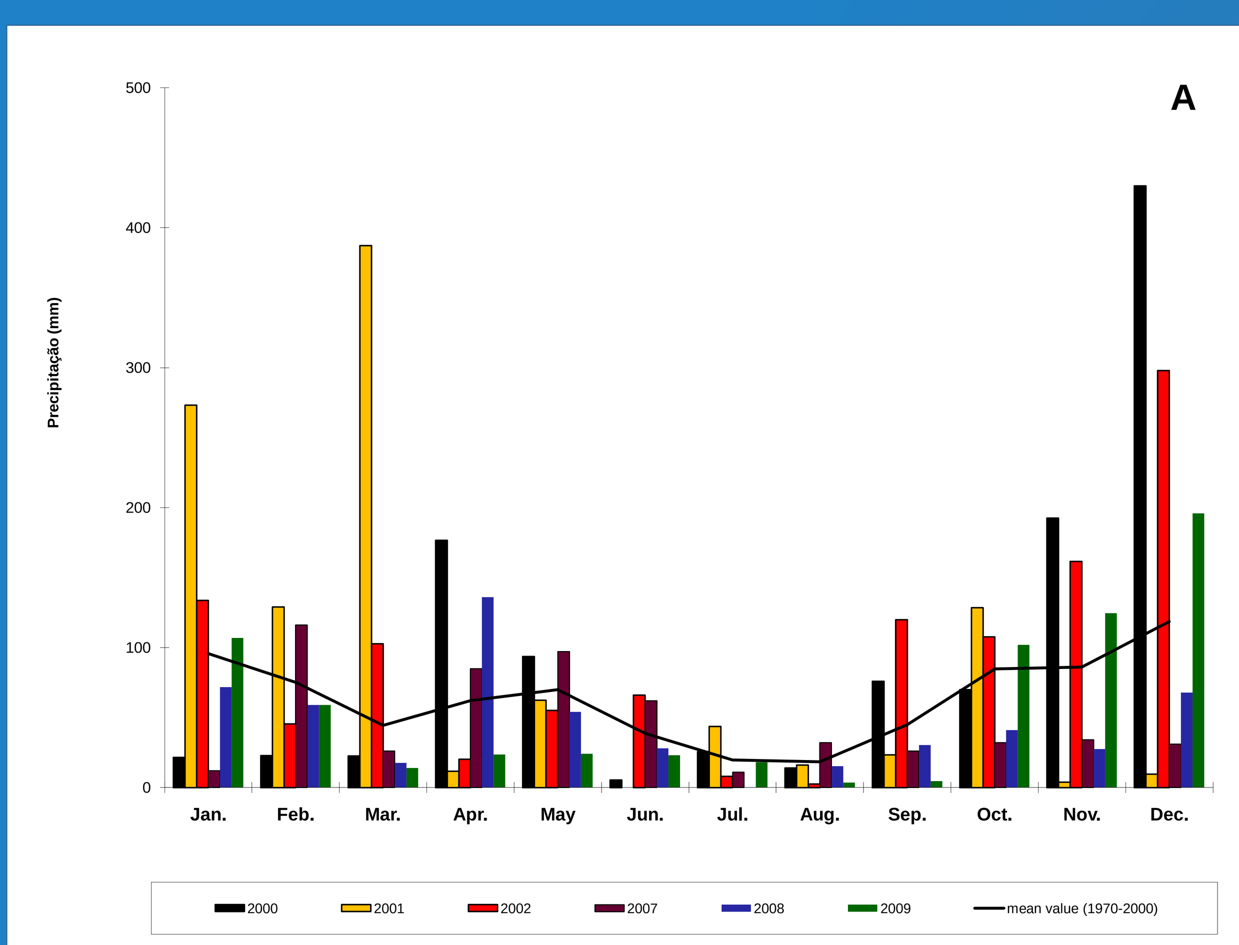
Introduction

Landscape runoff potential impact on reservoir limnology was indirectly evaluated by assessing the effect of precipitation variation on several water quality parameters, on *Anabaena* (Cyanophyta) and crustacean zooplankton abundances. The obtained results showed that total phosphorus increased with strong precipitation events whereas water transparency presented an opposite trend. Wet periods followed by long dry periods favored *Anabaena* dominance, which induced an accentuated decreasing on all crustacean zooplankton species abundance. Therefore, in a climate changing scenario these data are crucial to monitor and predict the effect of landscape changes on aquatic ecosystem integrity and ultimately in water quality.



Azibo

- **Altitude (m): 500**
- **Geology: Schistic bedrock**
- **Mean annual precipitation (mm): >800-1000**
- **Mean annual air temperature (ºC):<12.5-14.0**
- **Watershed area (km^2): 89**
- **Area (ha): 410**
- **Total Capacity (10^{3}m^3): 54470**
- **Max. Depth (m): 30**
- **Mean Depth (m): 13.2**
- **Residence time (years): 2.22**
- **Water level variation (m): 1.5-2**
- **Year of filling: 1982**
- **Main uses: Recreation, urban water supply and irrigation**



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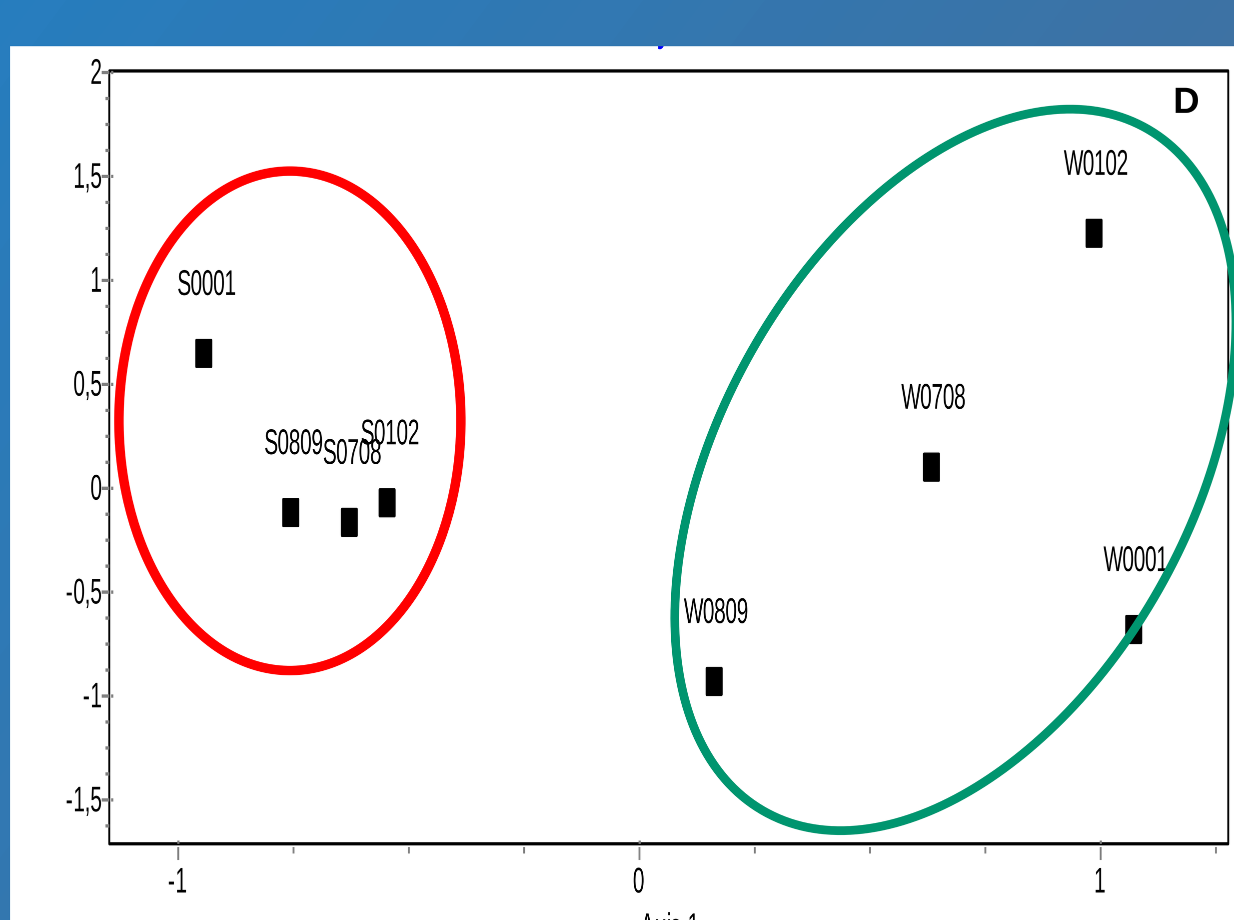
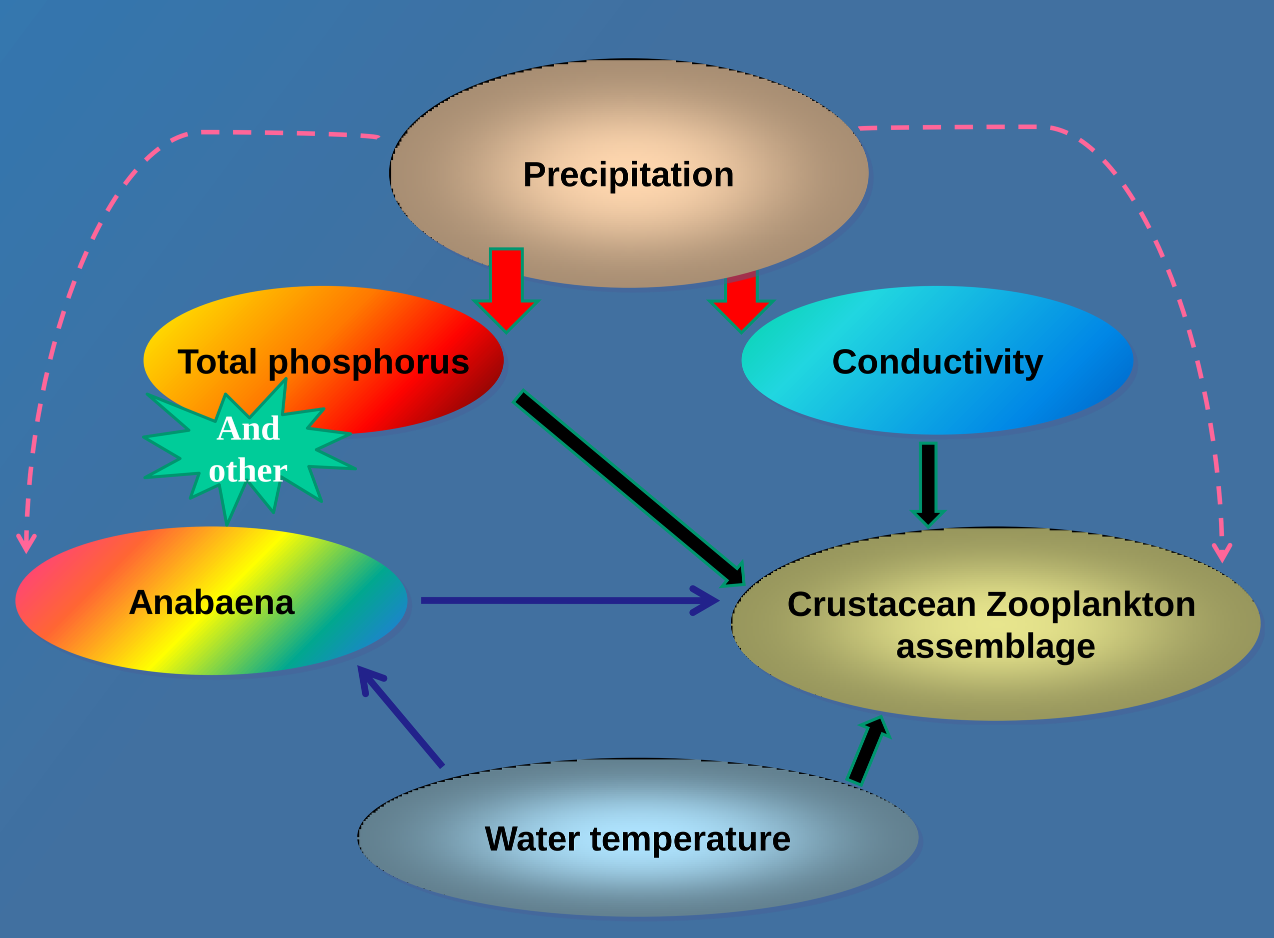
Variables	2000/2001		2001/2002		2007/2008		2008/2009	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Total precipitation (mm)	1482	156.9	423.5	217.7	245.5	263.9	315.9	97.7
TP (µg/l)	66.96 (21.70)	64.30(18.15)	60.29(9.85)	61.45(7.15)	47.53(10.06)	31.56(7.16)	46.67(18.62)	31.67(24.01)
Water temperature (ºC)	10.68 (2.66)	20.33(3.19)	10.09 (3.77)	18.87(4.72)	10.54(3.27)	18.38(3.55)	10.58(3.65)	20.00(4.04)
Conductivity (µS cm^{-1})	54.67(10.67)	58.92(6.65)	48.42(4.92)	64.33(9.17)	91.60 (2.78)	90.35(3.19)	89.92(4.56)	98.78(1.16)
DO (mg/l)	9.06 (1.39)	9.70(1.42)	8.71(0.46)	8.48(0.76)	8.58(1.16)	8.58(1.29)	9.67(0.67)	9.44(1.07)
pH	6.6-7.0	7.0-8.4	6.9-8.3	7.5-7.9	6.0-6.4	6.3-7.2	6.0-6.8	6.5-8.2
Water transparency (m)	2.83(1.51)	4.33(0.44)	3.00(0.71)	4.21(1.74)	4.30(0.67)	5.75(0.42)	5.42(1.07)	6.42(1.5)
Chl a (µg/l)	2.05(0.95)	1.16(0.77)	3.31 (1.68)	1.10(0.48)	2.54(1.46)	1.58(1.33)	1.31(3.45)	2.67(1.50)
Anabaena (ind l^{-1}x 10^3)	0.23(0.26)	14.97(33.76)	90.07(97.91)	0.29(0.43)	0.0	0.0	0.0	4.78(7.84)

C

Species (ind m^{3}x 10^3)	2000/2001		2001/2002		2007/2008		2008/2009	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Cladocera								
Daphnia longispina/pulex	0.90 (0.98)	1.89(3.72)	0.30(0.19)	0.54(0.69)	0.62(0.71)	2.16(2.07)	3.41(2.51)	1.30(1.69)
Ceriodaphnia pulchella	2.98 (5.79)	3.19(3.70)	0.14 (0.24)	3.93(4.33)	1.19(1.35)	3.52(6.47)	2.32(4.30)	3.60(7.87)
Diaphanosoma. brachyurum	0.0	0.31(0.54)	0.0	0.71(1.13)	0.21(0.31)	1.24(2.11)	0.40(0.83)	1.21(1.16)
Bosmina longirostris	0.07 (0.09)	0.22(0.18)	0.06(0.02)	0.17(0.16)	0.06(0.08)	0.06(0.05)	0.07(0.04)	0.19(0.32)
Copepoda								
Acanthocyclops robustus	0.04(0.04)	0.21(0.16)	0.10 (0.12)	0.09(0.66)	0.11(0.06)	0.07(0.04)	0.05(0.07)	0.13(0.14)
Copidodiaptomus numidicus	2.65(2.20)	3.47(2.84)	0.86(0.86)	5.67(0.92)	3.07(2.02)	4.39(1.36)	3.66(3.20)	4.52(1.50)
Nauplii	0.22(0.28)	1.97(1.53)	0.88(0.67)	2.56(1.50)	1.65(1.63)	1.63(0.82)	2.18(2.34)	3.18(3.37)

A- Precipitation for the studied hydrological years in Bragança city (Instituto de Meteorologia, 2009)
B- Total precipitation, mean and standard deviation (in brackets) of environmental variables including Anabaena.
C- Mean densities and standard deviation (in brackets) of the crustacean zooplankton species
D- N-MDS analysis for crustacean zooplankton data (W: winter; S: summer)





Final Remarks

✓. **Significant inter-annual differences were found for TP (χ= 10.01; p= 0.001), for conductivity (χ= 34.71; p= 0.000), for water transparency (χ= 19.74; p= 0.000) and for *Anabaena* densities (χ= 13.97; p= 0.003). The maxima of TP and the minima of water transparency was recorded in the winter 2000/2001.**

✓**The low value of water transparency observed in winter 2001/2002 was a consequence of the increasing of *Anabaena* abundances. The lowest densities for all crustacean zooplankton species was coincident with this period and with winter 2001/2002 .**

✓**The observed variations in TP, water transparency and in *Anabaena* and crustacean zooplankton abundances were related to changes in rainfall/ landscape runoff intensity. Similar results were obtained by authors studying reservoirs located in other regions influenced by Mediterranean climate (e.g. Armengol *et al.* 1999; Soria *et al.* 2000).**

✓**The lowest mean values of TP and the highest values of water transparency noticed in the reservoir during the years with low precipitation reinforce the above evidence.**

✓**The nutrient increasing scenario created during the wet period (Winter 2000/01) followed by the environmental conditions (e.g. absence of water turbulence, larger water residence time and higher irradiance) created by the subsequent dry periods (summer 2001 and winter 2001/2002), had lead to *Anabaena* dominance over the other groups of phytoplankton assemblage. As this alga is not edible by the most of the species of crustacean zooplankton their densities decreased accentually.**

✓**Changes in limnological parameters are related to variations in precipitation intensity, which ultimately influence landscape runoff. Therefore, long term data series on reservoir abiotic and biotic components will allow to understand how changes in surrounding landscape will influence reservoir ecological processes and consequently water quality.**

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