

Importance of the karstic geosystem in protecting the relict Dades trout *Salmo multipunctatus* (Teleostei: Salmonidae) against climate change impacts in the M'Goun geopark, High Atlas range, Morocco

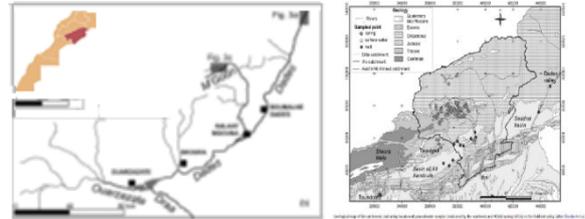
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Oral presentation

Among the characteristics of the karst areas of the High Atlas range is their impermeable Triassic basalt underlying substantial subsurface reservoirs with high potential discharge rates (1). The network of karstic groundwater aquifers is extensive, probably with hierarchical flow paths. Most (70%) of the surface water is directly lost to groundwater. Infrequent, high rainfall or snowmelt intensities cause a particularly high flood risk to these karst areas. In addition, agriculture and land use changes have degraded the karst areas due

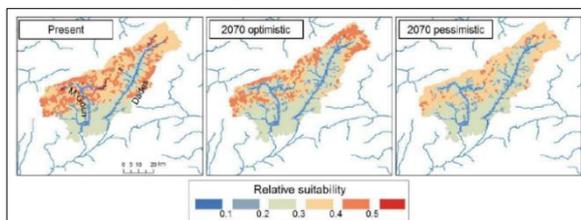
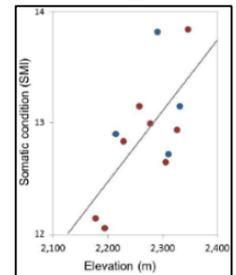
Figure 1. Geographic location and geology of the study area



Water temperature (°C)	9.1	HCO ₃ ⁻ (mg/l)	115.9
pH	8.18	Cl ⁻ (mg/l)	5.3
Conductivity (µS/cm)	306	NO ₃ ⁻ (mg/l)	4.1
Ca ²⁺ (mg/l)	39.6	SO ₄ ²⁻ (mg/l)	54.8
Mg ²⁺ (mg/l)	14.3	SI aragonite	0.1
Na ⁺ (mg/l)	3.6	SI calcite	0.2
K ⁺ (mg/l)	0.8	SI dolomite	0.1
SiO ₂ (mg/l)	1.7	SI gypsum	-2.0
Sr (mg/l)	0.2	SI quartz	-0.3

SI = Saturation Index.

to permanent overgrazing and the excessively increasing use of firewood (1). Large-scale afforestation has occurred in the oro-mediterranean zone, between 2600 and 3400m, which coincides with the most important zone for karstic groundwater occurrence. The combination of high amounts of groundwater flow and rapid surface flow due to sparse vegetation has increased the problems of flood flow (1). The Dades trout *Salmo multipunctatus* is a relict salmonid species from the Draa basin, on the southern slopes of the High Atlas Mountains, Morocco. Apart from its genetic and morphological singularity (2), only few data are available about this species (3,4). Only two isolated populations exist (in the Dades and M'Goun catchments, occupying an extremely small range, <22km of stream reaches in a narrow altitudinal range (c. 2150-2375 m). m). The Somatic condition increased with altitude. Climatically suitable areas will be confined to mountain summits without permanent water bodies by 2080. A constant low water temperature (9°C) of well-oxygenated cold-water spring fed steam, ensure suitable spawning sites and spring and summer refugia. The low concentration of nitrates (4 ppm at Aflafal karst spring(1)) indicates low agro-pastoral activities in these areas.



Estimated present and forecast future habitat suitability for the Dades trout across sub-catchment units in the Dades and M'Goun basins. Future suitability is forecast under two contrasting (optimistic and pessimistic) climate scenarios. Suitability is shown only for sub-catchments with minimum elevation >1,500 m (3)

The Dades trout is a Critically Endangered species that requires active management for its persistence.

We propose actions for the long-term conservation of the species, including catchment-scale erosion control, riverbed restoration, and local-scale measures to mitigate global warming effects and afforestation on both karstic system and trout survival.

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