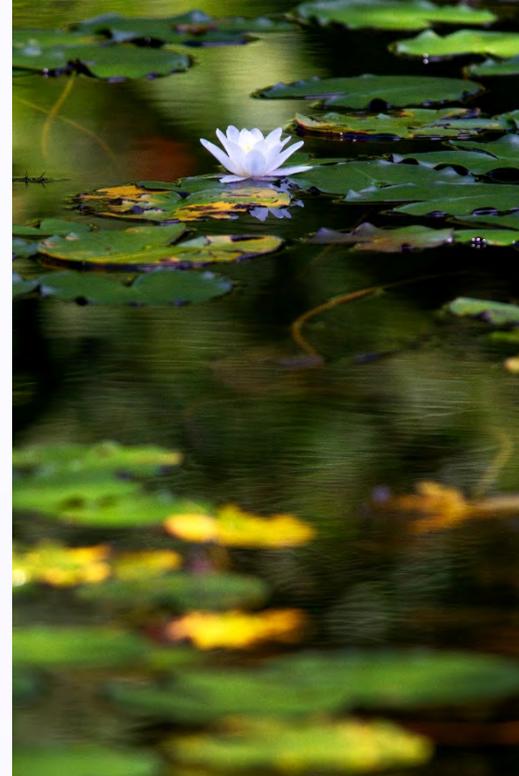




Università  
Ca' Foscari  
Venezia



# (Re)Connecting MUSEUM to WATER

*Heritage, research, outdoor education  
and SDGs for integrated museums*

**Oswaldo Negra**  
PhD Animal Behaviour,  
Science Communicator,  
MUSE Science Museum, Trento (Italy)  
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17/12/2021

# 1. Water in the surroundings



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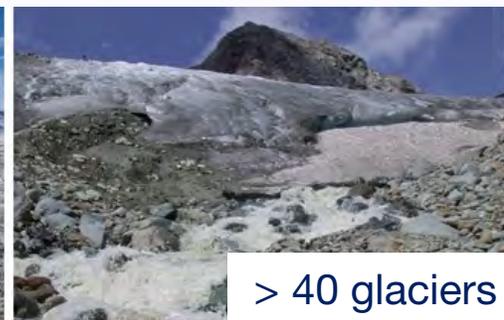


# A highly mountain region

## Trentino

(Autonome Province of Trento):

Area: 6 207,12 km<sup>2</sup>  
 Population: 544 585 inhabitants  
 Pop. Density: 88 inhab./km<sup>2</sup>  
 (Italy: 206 inhab./km<sup>2</sup>)  
 Municipalities: 166 «Comuni»



> 40 glaciers



The Dolomites UNESCO World Heritage

Trentino encompasses an extraordinary variety of (aquatic) environments, landforms and climatic conditions.

80% of land surface > 600 m asl



2,000 km of running waters, streams and rivers

300 lakes



River Adige

Lake Garda

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# An intensively cultivated valley bottom

Trento: 115.000 inhabitants, capital city of the Autonomous Province of Trento, lies in a wide glacial valley just south of the Dolomite Mountains, where the Fersina and Avisio rivers join the Adige River (the second longest in Italy). The broadly curving course of the Adige River was straightened around 1850.



Trento and the river Adige

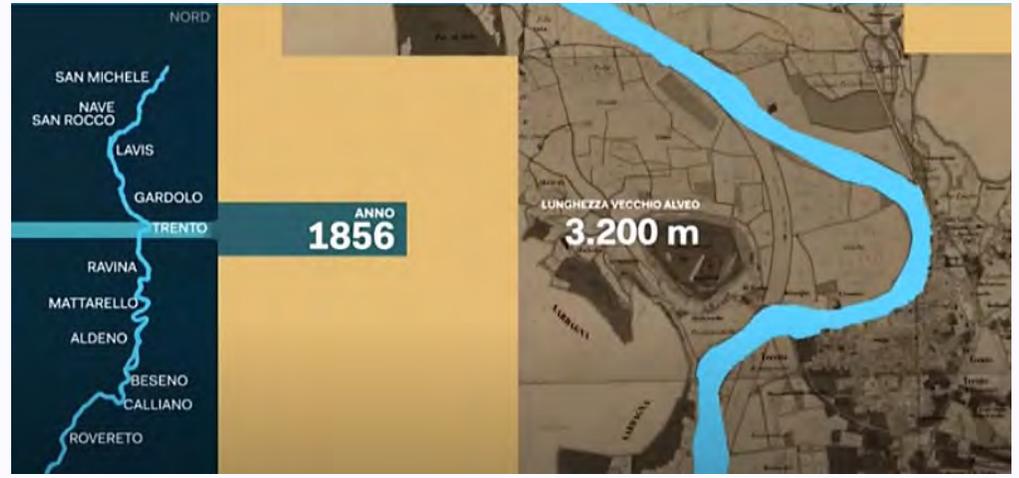


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# A small town that has excluded the river from its centre



Tridentina, exactus Germaniae super. ad Rhenum fluvium. Vide Trigoria. Tridentina Dicitio, sive Tridentinus Episcopatus, das Bisthumb von Trient proprio Episcopo, 18. mil. Germ. 2b Ocipontis in Meid, 6. a Bglano,



Verona, on the other hand...

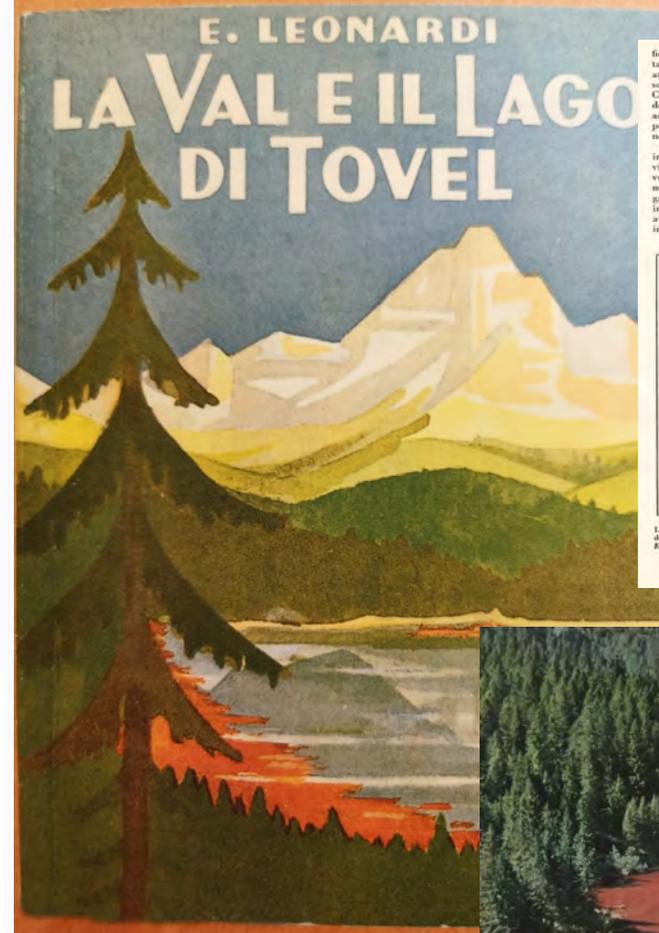


# Water in the mind: the “old museum” researches



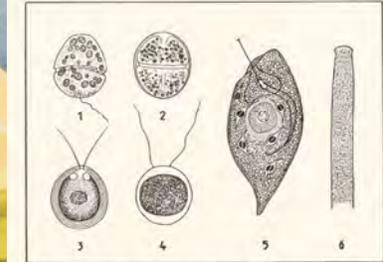
 museo tridentino di scienze naturali

Born as a local museum collecting and monitoring “natural objects” in the surrounding territory, the (former) MTSN has a long tradition of field researches in hydrobiology and limnology.

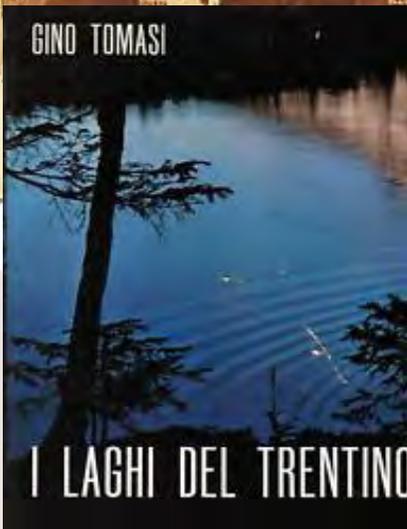


ficco; *Oscillatoria rubescens*; tale microflora filamentosa si riproduce con tale intensità (anche alcune migliaia di filamenti per cc) da formare anche in laghi di grande estensione masse compatte galleggianti o semi-sommerse; tale fenomeno si è verificato anche nei due laghi trentini di Caldonazzo e di Levico ed è noto alle genti rivierasche come la «spurga del lago». In qualche lago svizzero (lago Murten) l'arrossamento delle acque è stato così intenso che fu chiamato «Burgunderblut»; la fantasia popolare in tal caso si è richiamata alle sanguinose scendite dei Burgundi nei pressi del lago Murten.

In questi ultimi decenni abbiamo assistito a invasioni di questa alga in acque nelle quali non era stata segnalata, come ad es. nel Retone (in vicinanza di Lacerina) presso nel grande lago di Zurgio, dove ha provocato pesanti diminuzioni di zooplancton e quindi di pescosità. Il fenomeno è stato segnalato alcuni anni or sono anche per le acque di Castelgandolfo presso Roma, che hanno subito un arrossamento parziale ma intenso. È probabile che la colorazione rossastra mazzonata da Pinnis ed avvenuta durante l'anno 2001 a. C. nel lago di Bobenna sia anch'essa da imputarsi a questa stessa microflora.



Le principali microflora che producono arrossamenti: fig. 1-2 *Glenodinium oregonense* del lago di Tovel, fig. 3-4 *Glenodinium striolatum* e *G.* *complanatum* delle seccie alpine, fig. 5 *Euglena heterotetras* dalle acque rosse alpine e fig. 6 *Oscillatoria rubescens* (tutte le figure sono state ingrandite di circa 1000 volte).



VITTORIO MARCHESONI

LA VAL DI TOVEL  
E IL  
“LAGO ROSSO,”

LA VAL DI TOVEL E IL “LAGO ROSSO,”  
(Estratto da «Natura Alpina» 1959 N. 2)

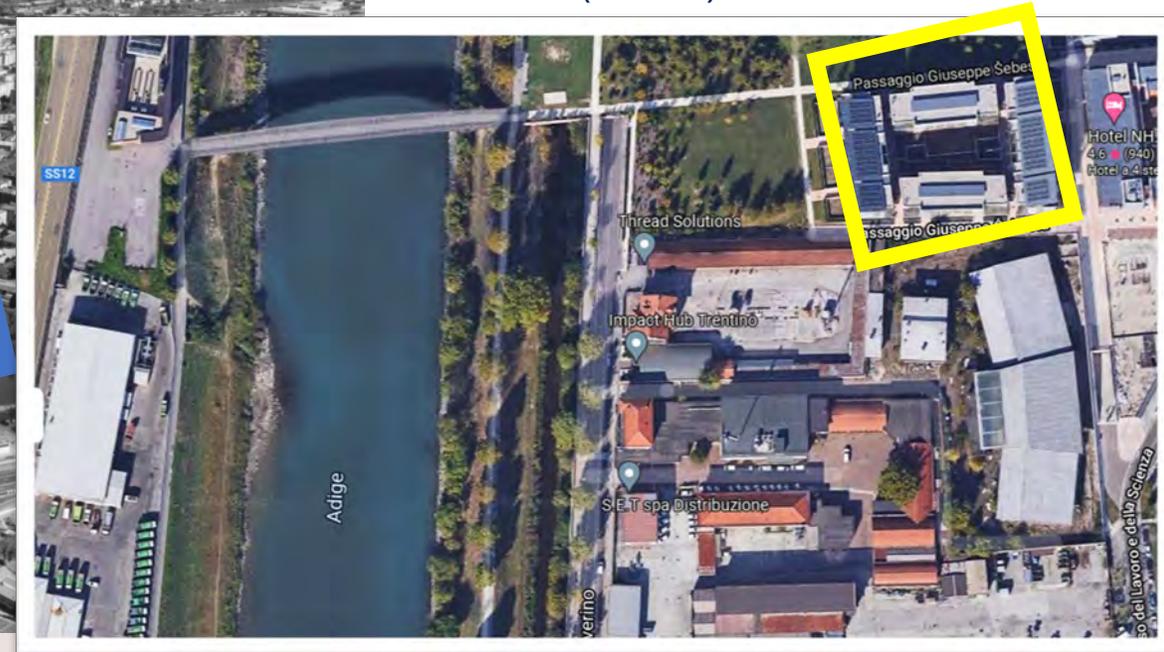
MUSEO DI SCIENZE NATURALI  
Via Somme, 9  
TRENTO

# A museum that moves toward the river...



In 1992 Michelin tires factory, the largest industrial compound of the region, moved the production away.

In the same place, in 2006 the local government financed the development of a new quarter for the city, including a new scientific museum... to respond to the number of visitors attracted by the new museology of our “traditional museum” (MTSN).



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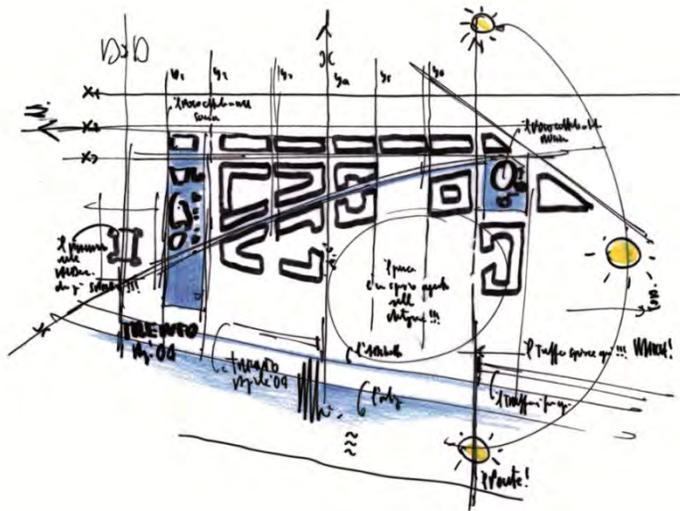
A narrow stream/channel flows between the new museum and the river Adige, the Adigetto, a small water body with heavy organic pollution but still a bit of riverine vegetation... a potential source of aquatic colonizers.



The 27<sup>th</sup> of July 2013  
24 Hours of Opening Ceremony  
(30,000 participants)



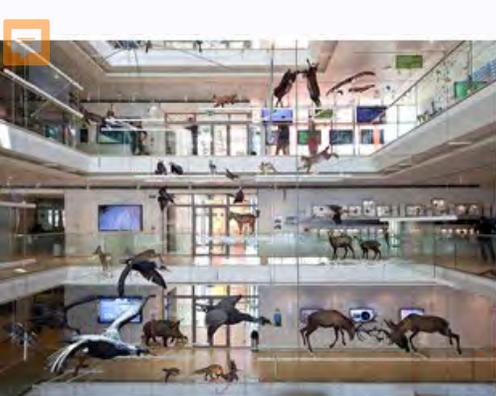
**MUSE - Science Museum of Trento:**  
a creation of the famous architect  
Renzo Piano... .. and of a team  
of almost 40 people (scientists and  
curators, project managers, educators,  
designers, architect & interior designers...



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# MUSE in a nutshell... floating on water!



## The “promise” of MUSE – Science Museum of Trento

A journey into the fabulous space of MUSE to appreciate the **uniqueness of the Alpine nature** and to imagine **smart solutions for our common sustainable future.**

### Numbers:

12,600 m<sup>2</sup> of space; 500,000 visitors/year; 200,000 students/year; 50ML €/year the positive impact on city economy; 240 FTE employees.



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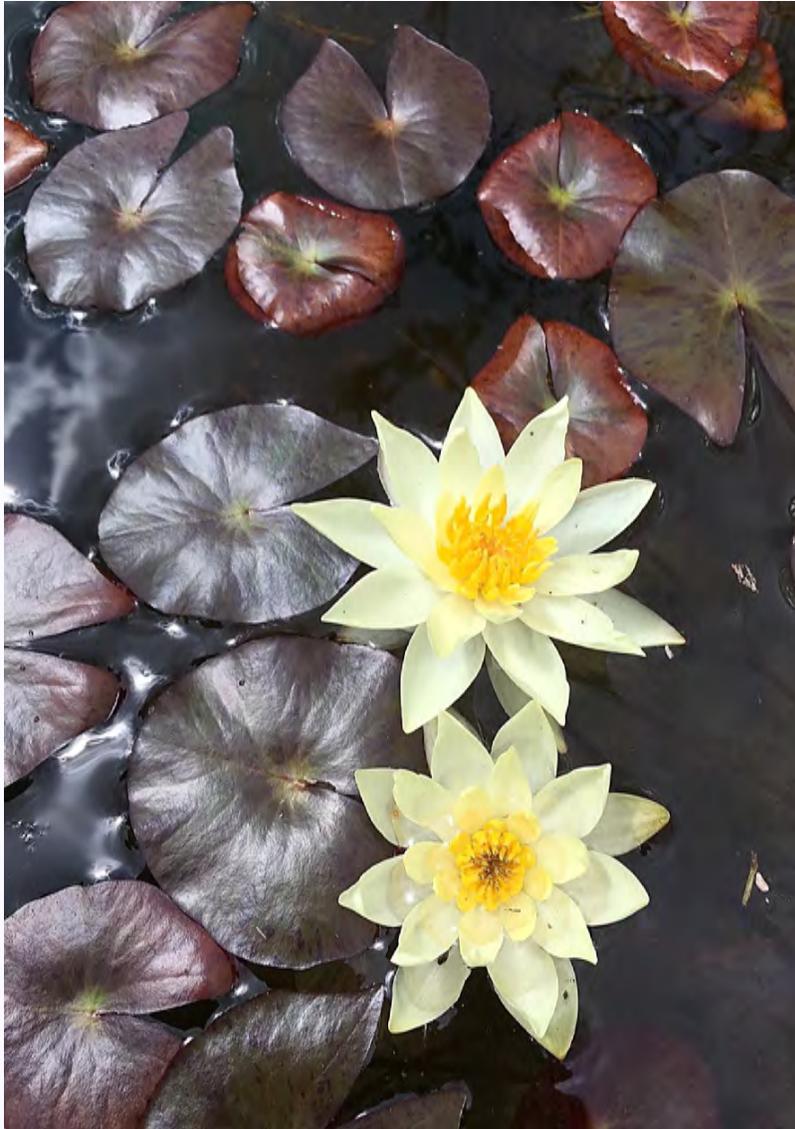
## Water to reflect, and more...

The whole building is surrounded by water in shallow squared pools.

In the basic aim of the architects, the role of this “caged” water is merely aesthetic, to allow the intriguing reflection of a transparent, light structure, apparently without weight (“gravity zero”), but...



## 2. Water inside the museum



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# Water and the SDGs: the mid-term communication strategy of MUSE



The **SDGs** are the new «comprehensive mission» of MUSE

The **key message** concerning the «**necessary reconnection**» between (aquatic) environments and humankind are the following:

- **Reconnection** of (aquatic) environments and humankind **is necessary for current society**, so it is a *must* in the science communication actions of MUSE.
- **Science-museums** (like MUSE) **provide data and knowledge dissemination to citizens, education and decision makers.**

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*How does this mission be carried out (hopefully at best) by MUSE?*

Let's start with an «aquatic» journey  
from the top to the bottom of the museum...



**4° floor of MUSE** - Science communication actions, data and knowledge dissemination to citizens, education and decision makers on: **climate changes and glaciers.**

## **(Frozen) Water as a sensitive and threatened environment**



A small-scale replica of a glacier tongue, variously exposed to sunlight, exemplifies the melting of glaciers and makes it clear how much the phenomenon is influenced by the outside temperature.

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**13** CLIMATE  
ACTION

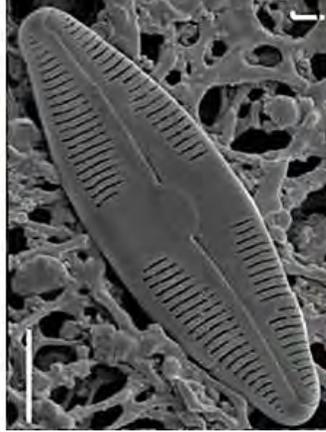


# (Frozen) Water as memory of the past and home to unexpected biodiversity

Thematic and interactive exhibits point out the role of the frozen water of glaciers (and Antarctica) as natural archive and “chemical memory” of past climates.

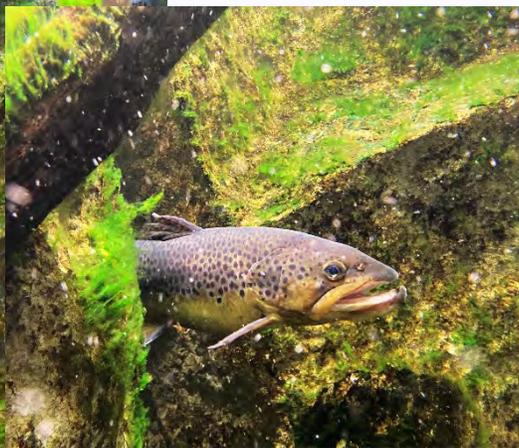
Enlarged models of tiny invertebrates inhabiting the ice surfaces “unveil” the presence of animal biodiversity in an environment that is commonly perceived as unsuitable for life.





**3° floor of MUSE - Science communication actions, data and knowledge dissemination to citizens, education and decision makers on: high- & low-altitude water environments, springs, streams, rivers and lakes.**

## Water as a “fluid environment” changing with the altitude and the seasons



On Alps, like on other mountain systems, there are many different but connected environments along a virtual line of descent from peak to valley bottom.

The “altitudinal stratification” affect ecosystems on land as well in lotic and lentic waters.

Land and water conditions change throughout the year.



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BEY  
MUS

6 CLEAN WATER AND SANITATION



14 LIFE BELOW WATER



g the Natural  
Heritage

# (Virtual water where “true” water is too heavy)



To suggest continuity in the aquatic environments from the heights down to the lowland plains, computer graphics were used to represent the flowing water of Alpine streams and then rivers in places where structural constraints in the building did not allow the installation of real aquariums.

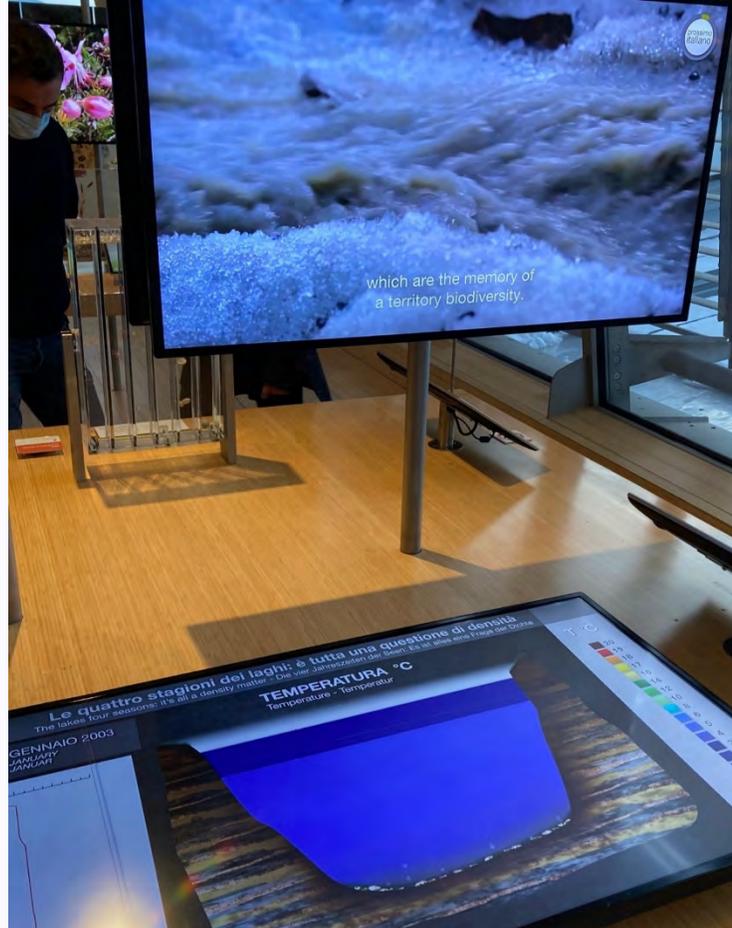
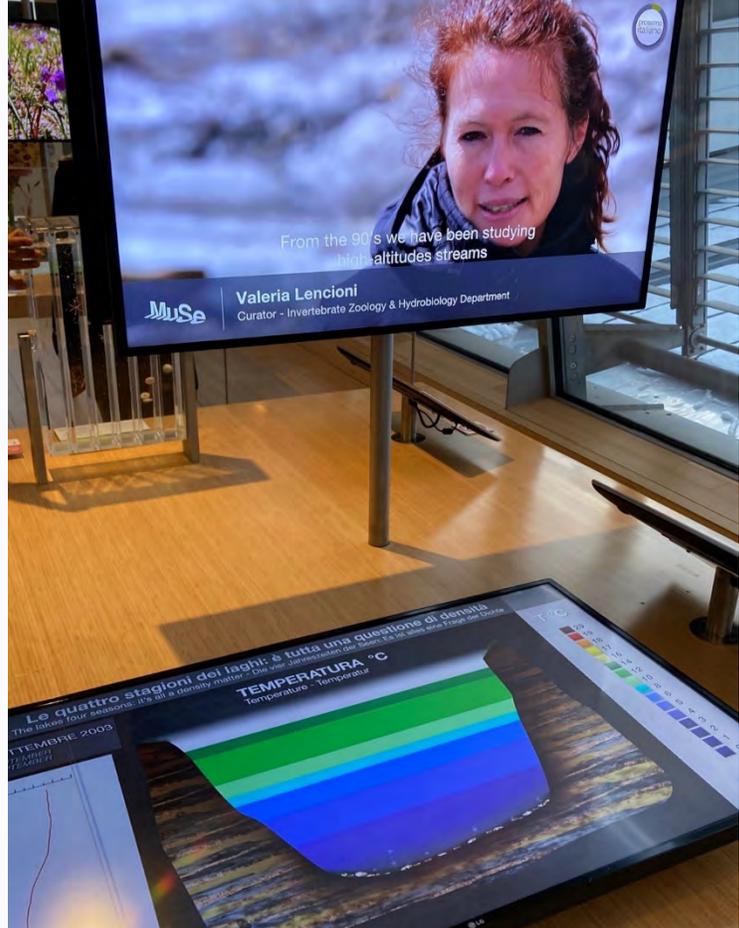


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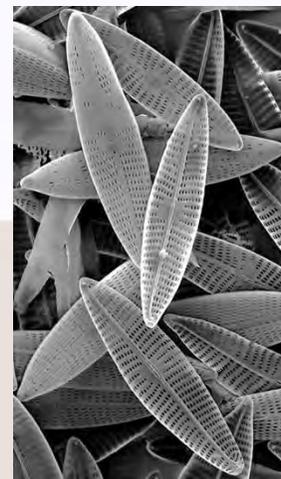
# BEYOND MUSEUMS

Tools for Promoting the Natural and Cultural Water Heritage

Thematic and interactive exhibits point out the changes that occur in aquatic environments as the seasons change.



Enlarged pictures of diatoms and other freshwater algae “unveil” the microscopic presence of phytoplankton and its pivotal ecological role inside the alpine spring biotas.



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**2° floor of MUSE - Science communication actions, data and knowledge dissemination to citizens, education and decision makers on: geological and geomorphological role of water, protection of the territory.**



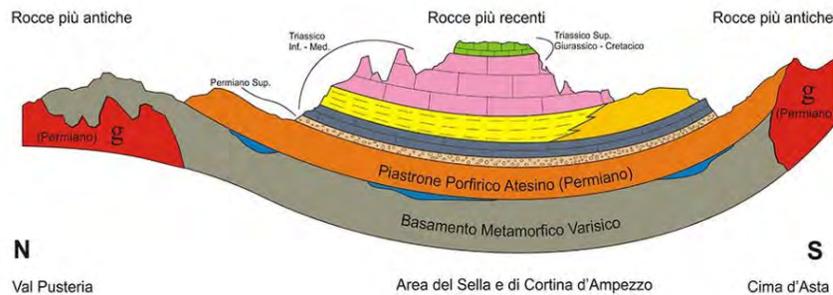
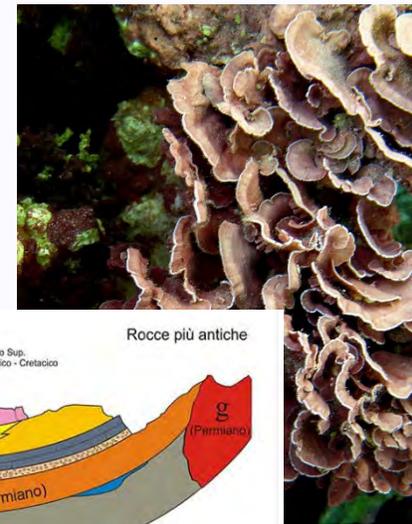
## Water in the territory, today and in the past

Interactive exhibits and computer simulations make it easier to understand that water could also act as an a hydro-geological risk factor causing (as surface water, in liquid or solid form, or as groundwater) many kinds of instability (floods, landslides and avalanches).



Diagrams and explanatory schemes underline that the hydro-geological risk is strongly influenced by human action: population density, urbanization, abandonment of mountain land, unauthorized building, deforestation, environmentally unfriendly agriculture could easily aggravate instability.



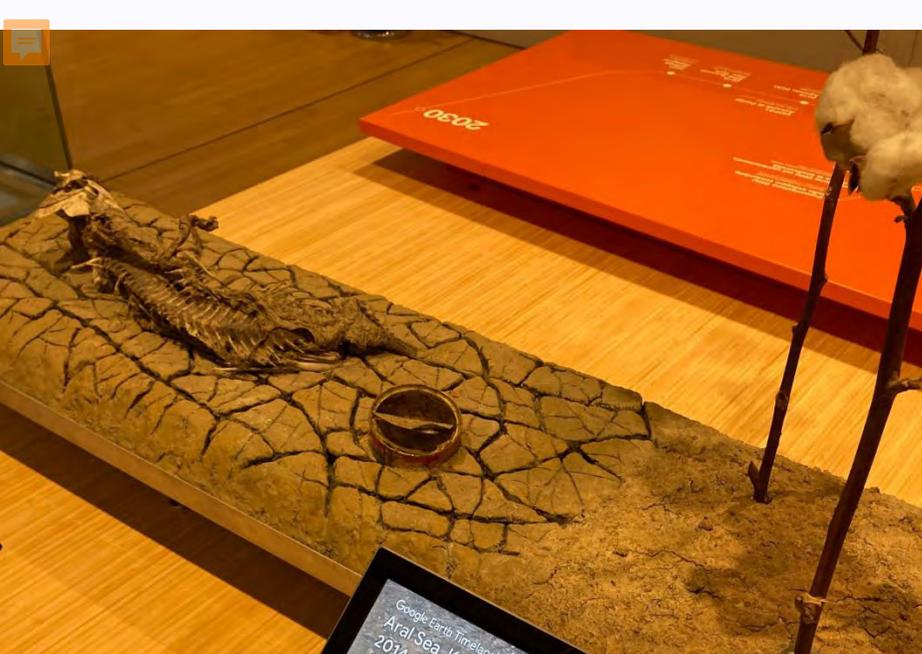


# Water in the Deep Time

A tropical marine aquarium evokes the coral reefs and highlights the role of saltwater aquatic environments (barrier reefs, atolls, lagoons and deep sea) in the lithogenesis of several rock types widely represented in the mountain massifs of the Alpine chain.

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**1° floor of MUSE** - Science communication actions, data and knowledge dissemination to citizens, education and decision makers on: **sustainability, conservation of the aquatic biodiversity, aquatic resources, water supply, water use, water pollution** (in partnership with private companies).

## Water in the Antropocene

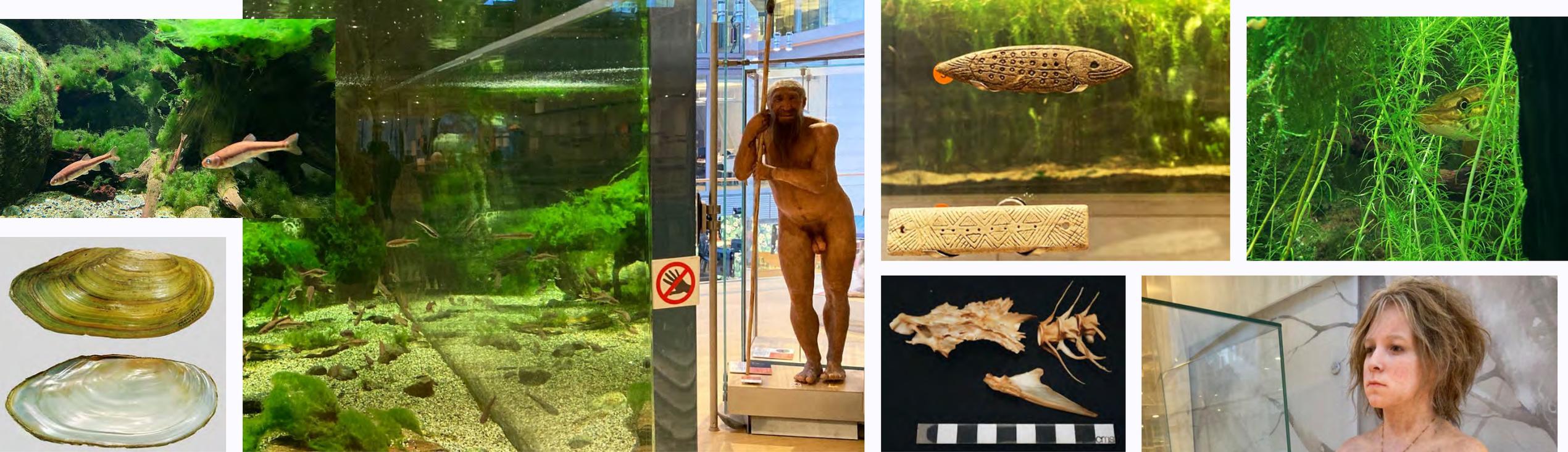
Natural objects and human artefacts, infographics and interactive exhibits, old documentary clips and “impossible interviews” explore the complex and contradictory world of our recent interactions with the planet, the use of its resources, the survival of other living beings and the future of life on Earth (and in the water...)



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## Water and humankind, the ancient connection

Local archeological finds, multimedia presentations, uniquely lifelike replicas of prehistoric humans belonging to hunters-gatherers or early Neolithic agriculturalists in the Alps and two freshwater aquaria representing Alpine archeological sites facing waterbodies remind of the strong dependence of the ancient humankind from water supply and from the water as source of different kind of biological resources (fish, mussels, plants).

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**Ground floor of MUSE.** Science communication actions on water: landscape, recovery of traditional water cultures and... something engaging for schools!



Landscape, historical use and transformation of Adige river, legends and myths.

Natural, historical and anthropogenic aspects of Adige river... and rafting!

Water-tasting of the various Trentino streams and comparison with bottled water.

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MUSE



MUSE



# Water (in tanks) from the top to the basement



+3



+2



+1



-1



## Numbers:

10 aquaria, from 2.1 to 4.5 m<sup>3</sup>;  
>300 individuals belonging to  
>50 different species

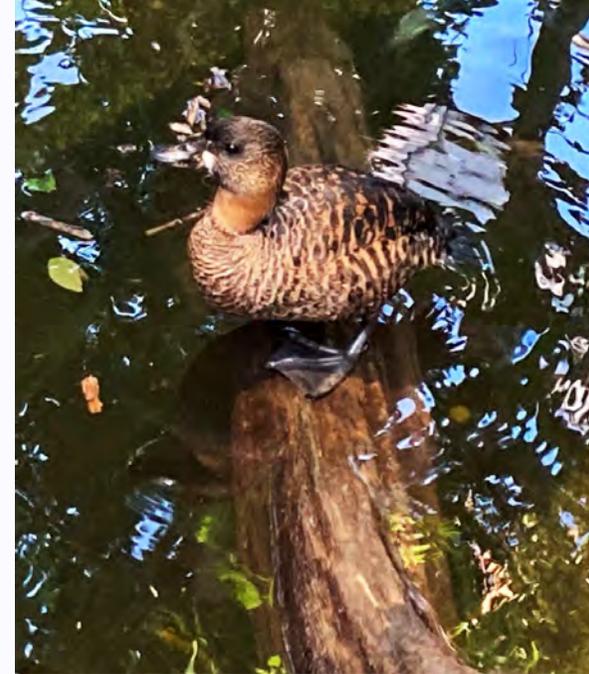
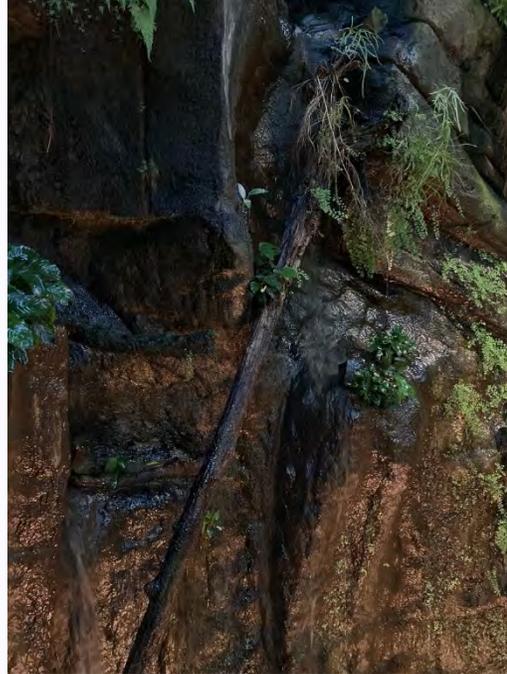
«A world of fishes» activity



*Esox cisalpinus*, an Italian endemism



*Pseudotropheus saulosi*, an endemic species of Lake Malawi



## Water in the greenhouse (and in the Tropics)

Taking inspiration from a mountainous region of Tanzania covered by rain- and misty-forest and rich in water (the Udzungwas) where the museum has been conducting research and conservation projects for two decades, the MUSE greenhouse give an impressive first glimpse of the astonishing terrestrial and aquatic biodiversity in the (African) intertropical regions.

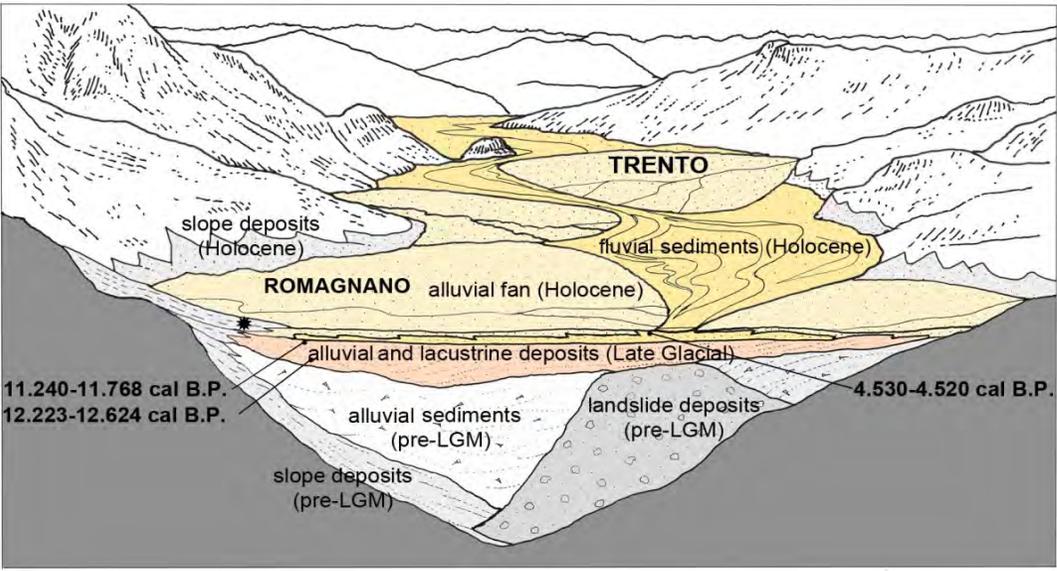
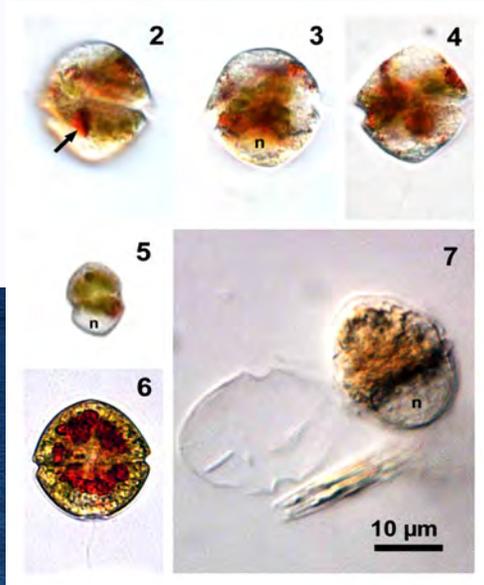


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### 3. Water outside the museum



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# A network of water (museums)



Interpretation



Summer schools for University students

Museo delle Palafitte in Ledro

Lake Tovel Limnological Station

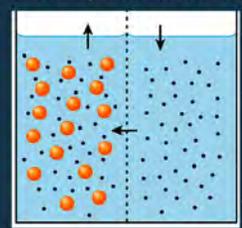
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# Water as opportunity for *Citizen Science* and for training to research



## Osmosi, un fenomeno a 1 direzione



Con la parola "osmosi" si indica la diffusione del solvente attraverso una membrana semi-permeabile dal compartimento a concentrazione minore di soluto verso il compartimento a concentrazione maggiore di soluto, quindi secondo il gradiente di concentrazione.



L'osmosi è un processo fisico spontaneo, vale a dire senza apporto esterno di energia, che tende a diluire la soluzione più concentrata, e a ridurre la differenza di concentrazione.

Si tratta di un fenomeno importante in biologia, dove interviene in alcuni processi di trasporto passivo attraverso le membrane biologiche.

Progetto Terra, acqua, luce e movimento  
Workshop - Trento, 17 novembre 2011

 museo delle scienze  
la rete dei musei della scienza in Trentino - ITALIA

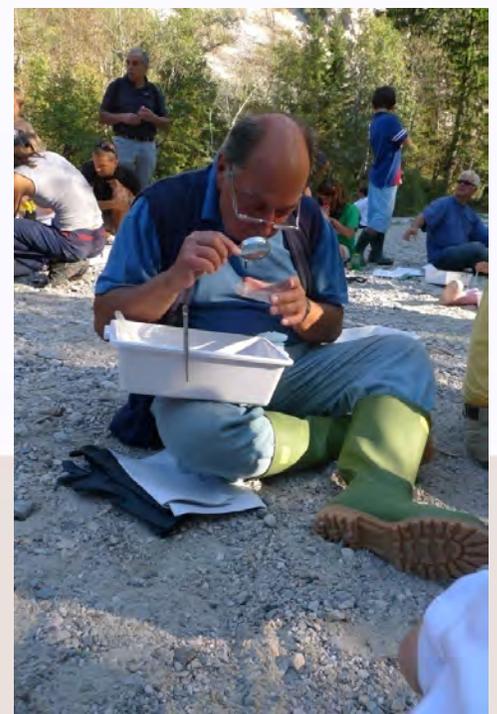
 FONDAZIONE BRUNO KESSLER

 UNIVERSITÀ DEGLI STUDI DI TRENTO

Museo delle Scienze - Trento



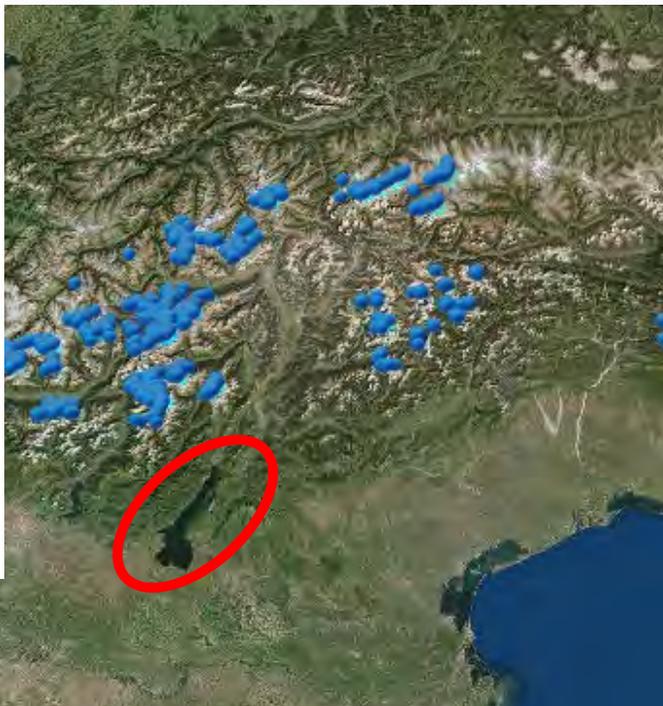
Natura, acqua e vita.  
Lungo il Torrente Centa alla scoperta dell'oro blu



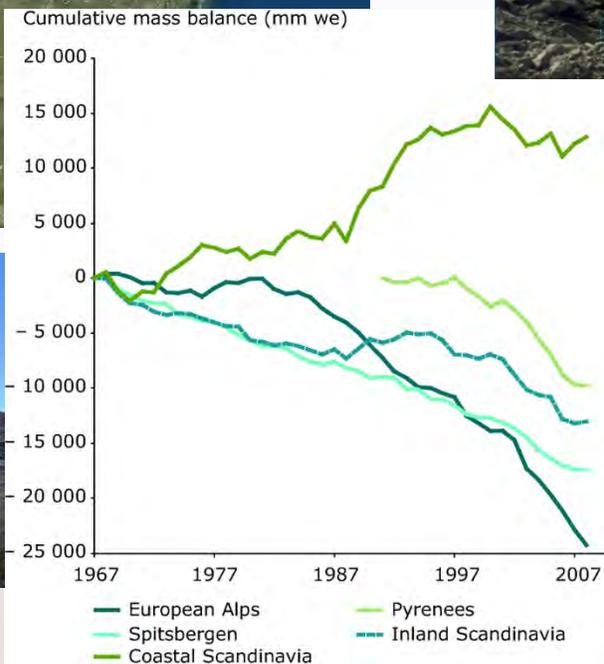
...oting the natural  
Water Heritage

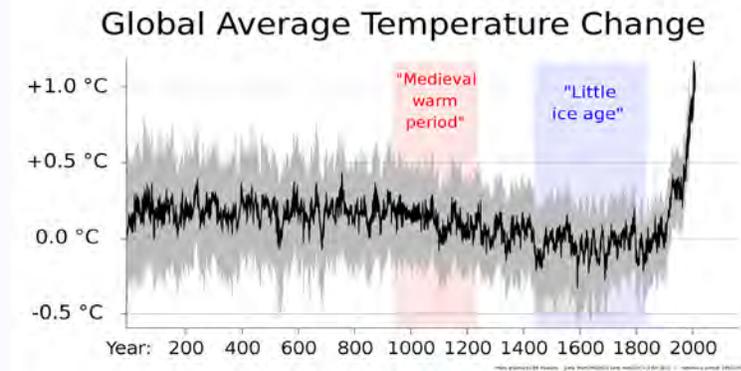
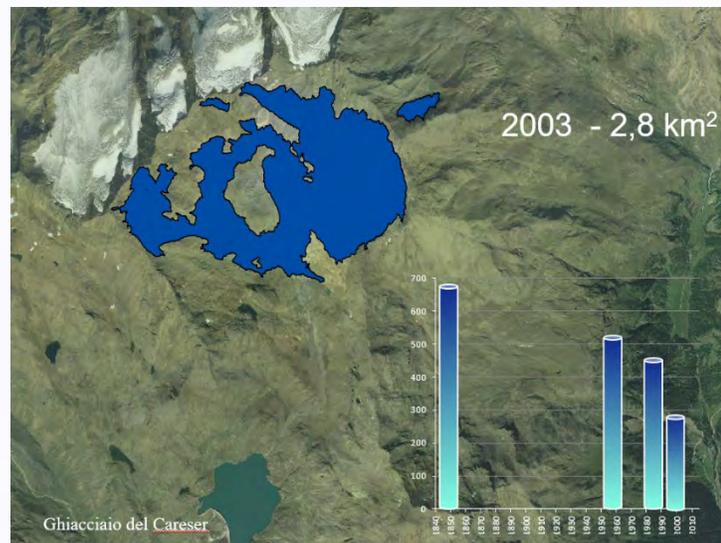
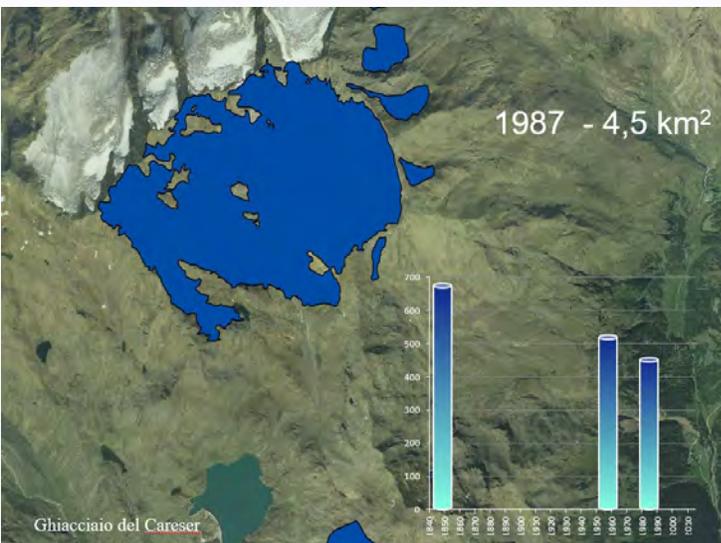
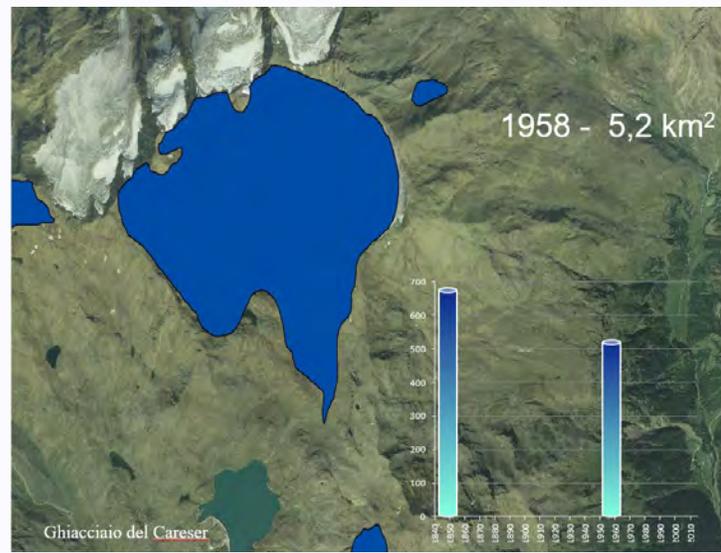
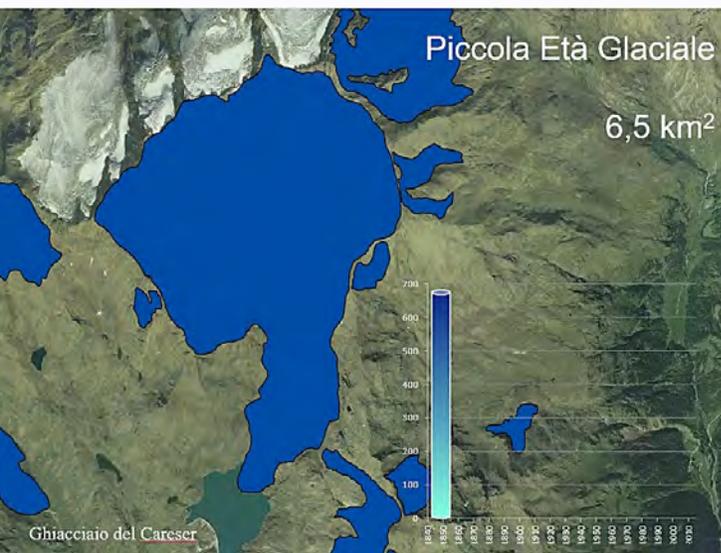
# L'agonia dei ghiacciai trentini, l'esperto: "Tra vent'anni in Trentino saranno quasi estinti"

*I ghiacciai presenti sul nostro territorio sono poco più di 130. Negli ultimi anni al di sopra dei 2500 metri abbiamo assistito ad un aumento della temperatura di circa 2 gradi. Casarotto: "Occorre annullare gli effetti dei gas serra se vogliamo mitigare questa drammatica situazione"*

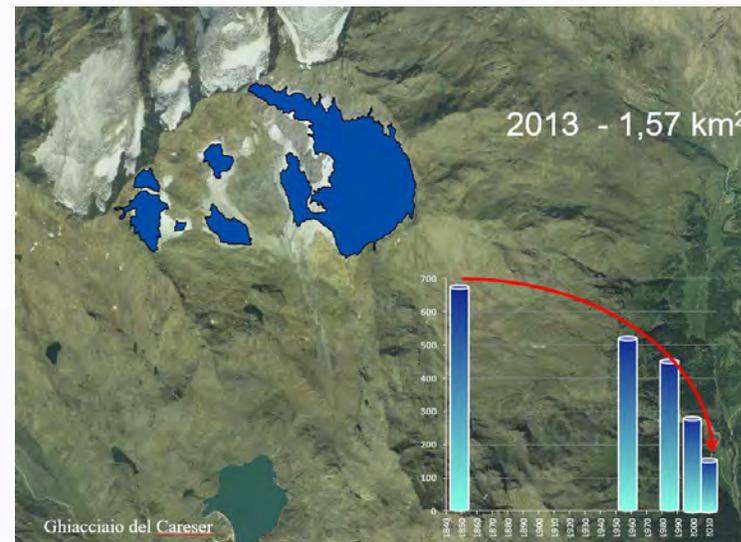


# Monitoring the glaciers retreat





## Monitoring the climate changes from the Little Ice Age (LIA)

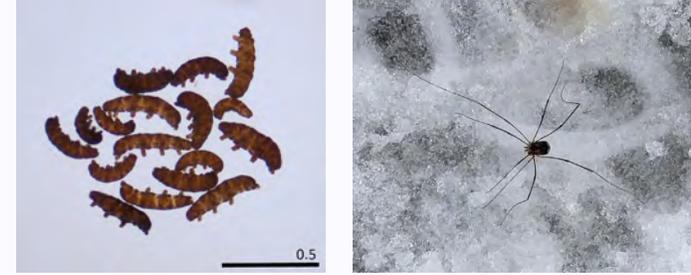
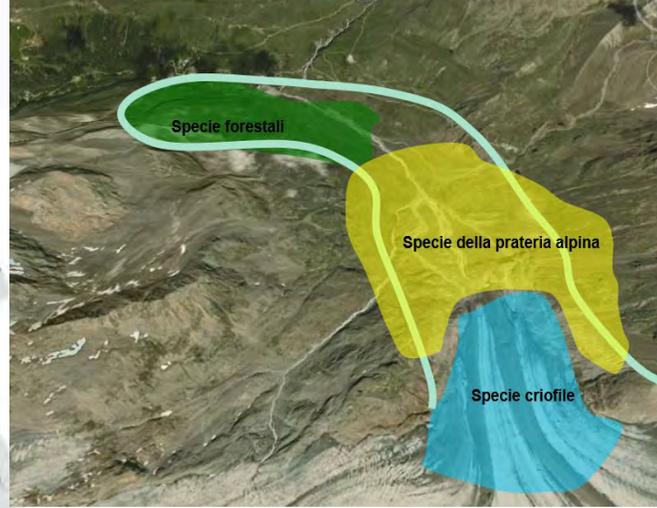
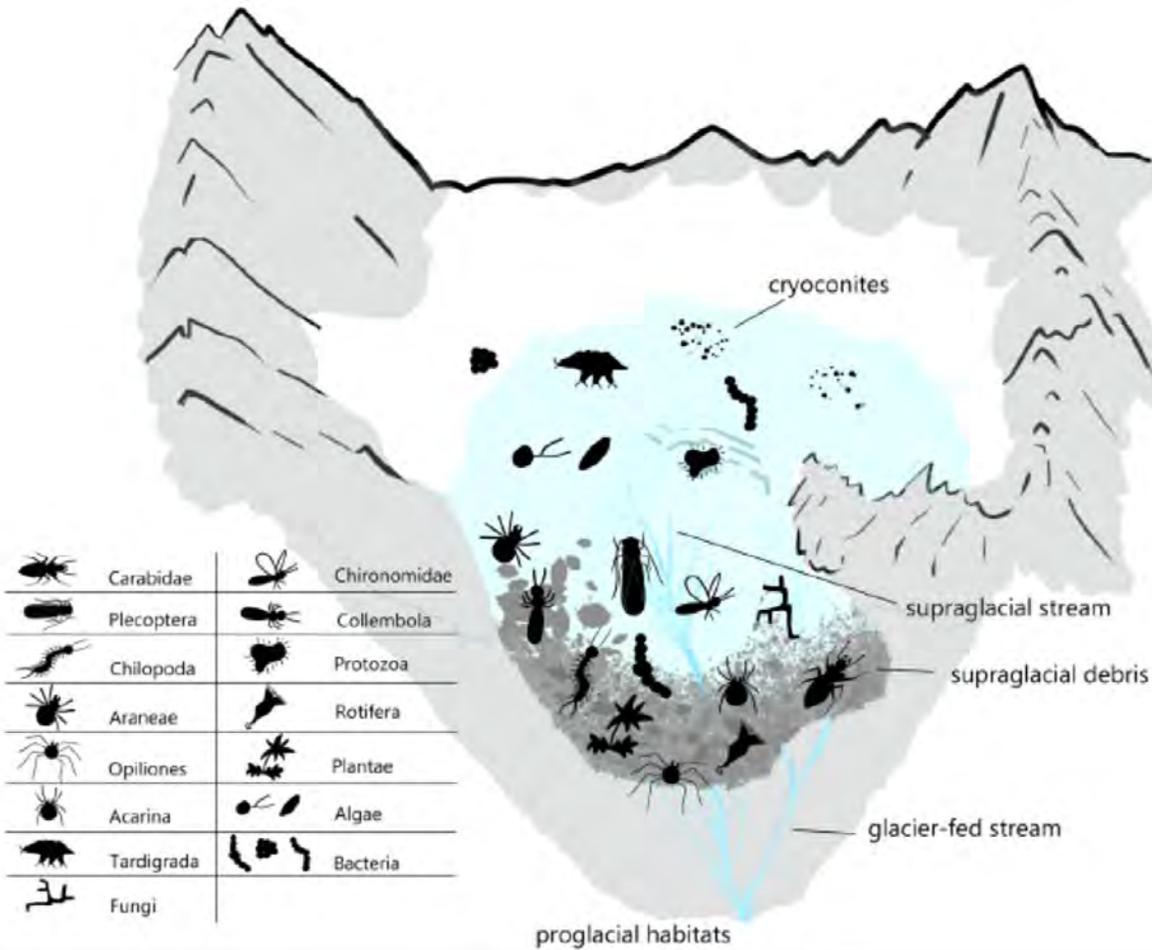


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# Life on frozen water



Estimated biodiversity >100 species per glacier (the composition of species varies from glacier to glacier).

frontiers  
in Ecology and Evolution

ORIGINAL RESEARCH  
published: 29 January 2021  
doi: 10.3389/fevo.2020.616562

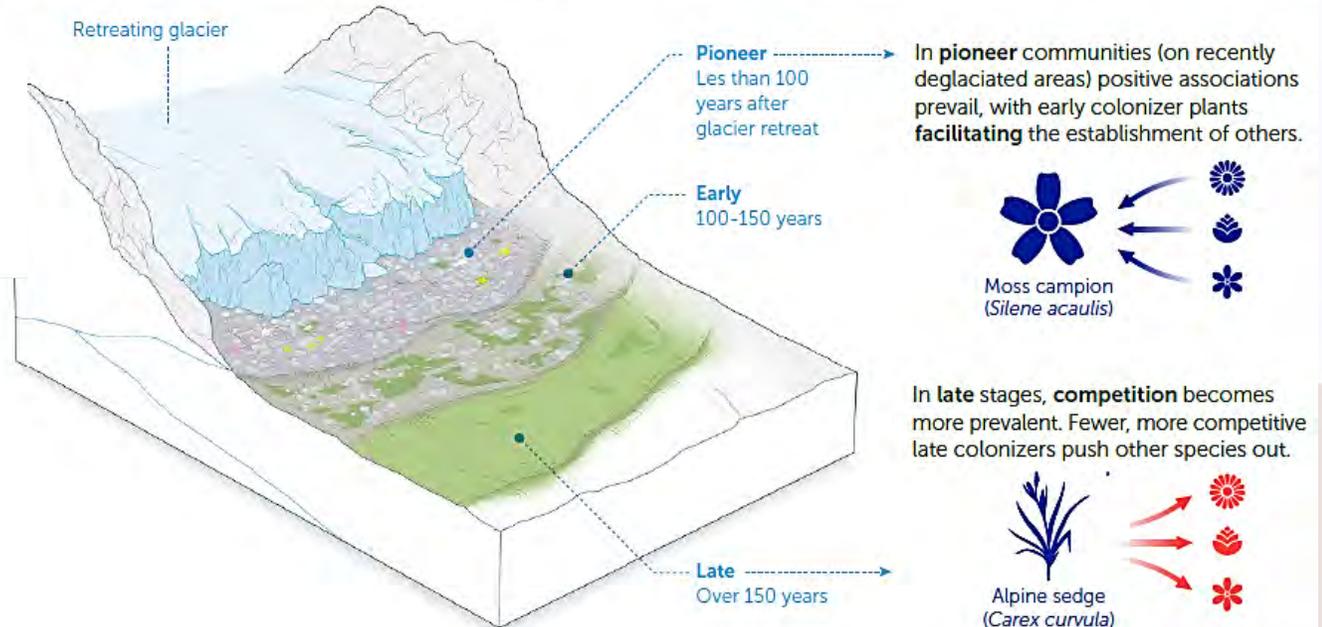
## The Consequences of Glacier Retreat Are Uneven Between Plant Species

Gianalberto Losapio<sup>1\*</sup>, Bruno E. L. Cerabolini<sup>2</sup>, Chiara Maffioletti<sup>3</sup>, Duccio Tampucci<sup>2</sup>, Mauro Gobbi<sup>4</sup> and Marco Caccianiga<sup>3</sup>

<sup>1</sup> Department of Biology, Stanford University, Stanford, CA, United States, <sup>2</sup> Department of Biotechnologies and Life Sciences, University of Insubria, Varese, Italy, <sup>3</sup> Department of Biosciences, University of Milan, Milan, Italy, <sup>4</sup> MUSE – Museum of Science, Trento, Italy

### evolving ecosystems

When glaciers retreat, newly exposed terrain is colonized by plant species. As the effects of global warming shift the dynamic of plant communities, different stages can be seen:



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# Estimating the “biodiversity balance”

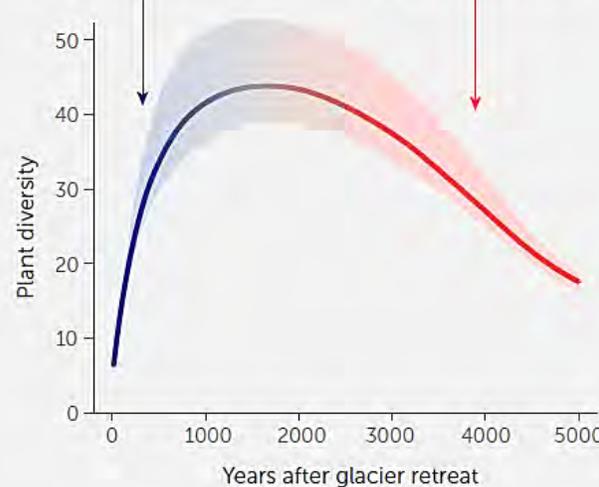


Debris-covered glaciers (particularly widespread in the great mountain ranges of Asia) are also spreading in the Alps as a result of the deglaciation processes underway due to climate change and the parallel increase in slope instability and physical degradation of the embedded rocks.

## Less diversity, perhaps extinction

Plant diversity initially increases with glacier retreat ...

... but ultimately decreases after glacier extinction.



Glacier retreat affects **51%** of local species:

**WINNERS** →

**29%** will flourish



Example: Alpine sedge (*Carex curvula*)

**LOSERS** →

**22%**

may face local extinction after glaciers vane.



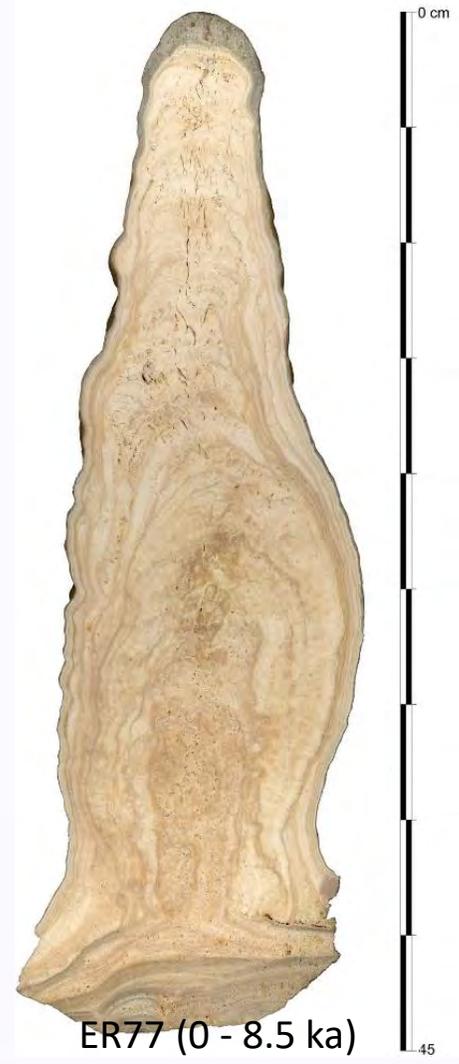
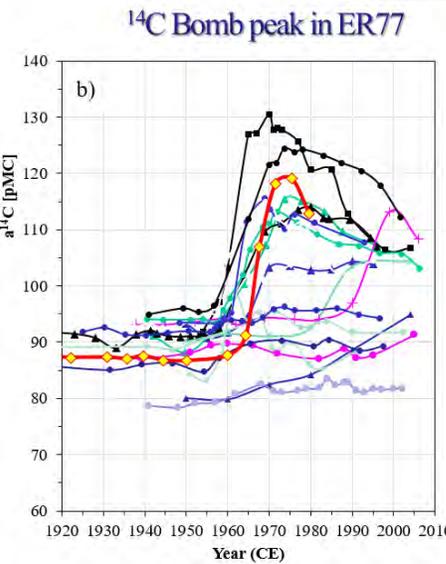
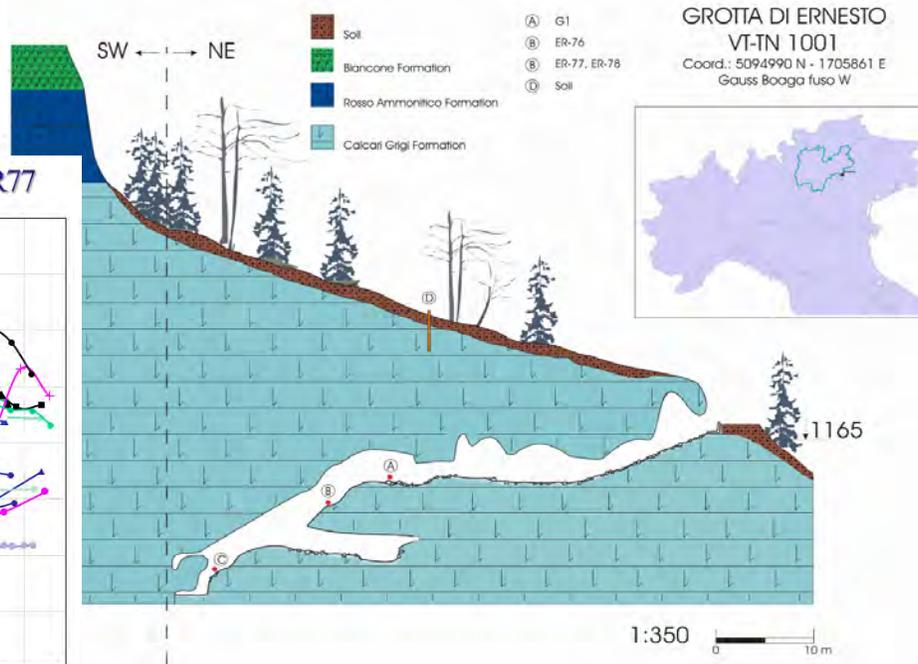
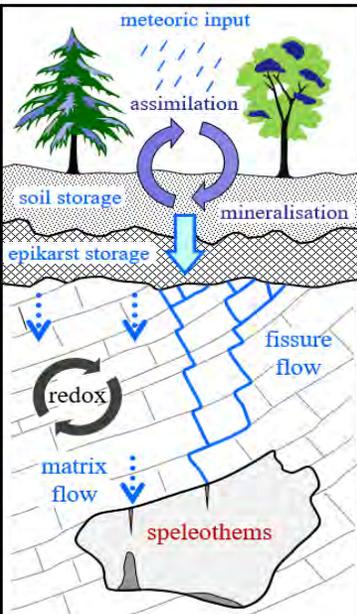
Example: Glacier buttercup (*Ranunculus glacialis*)

Other species are indifferent.

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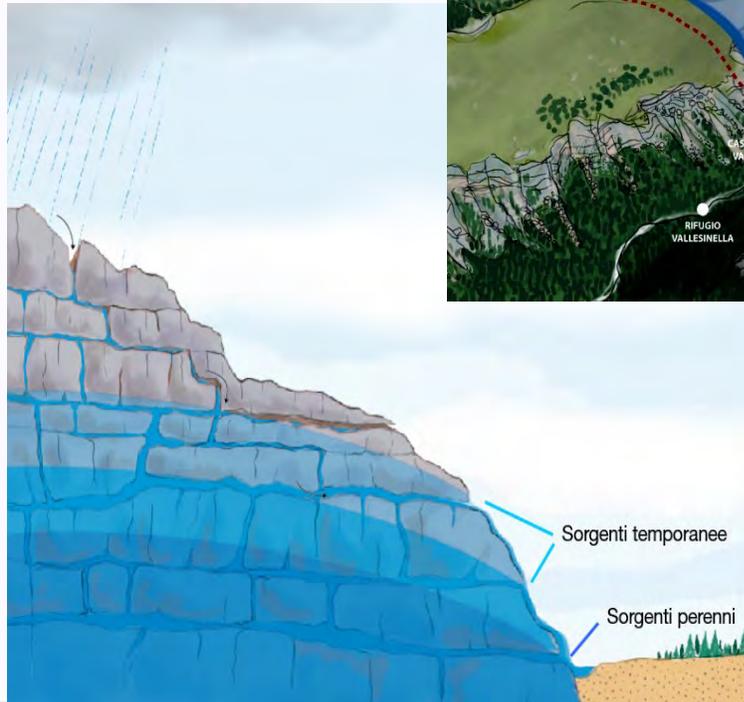
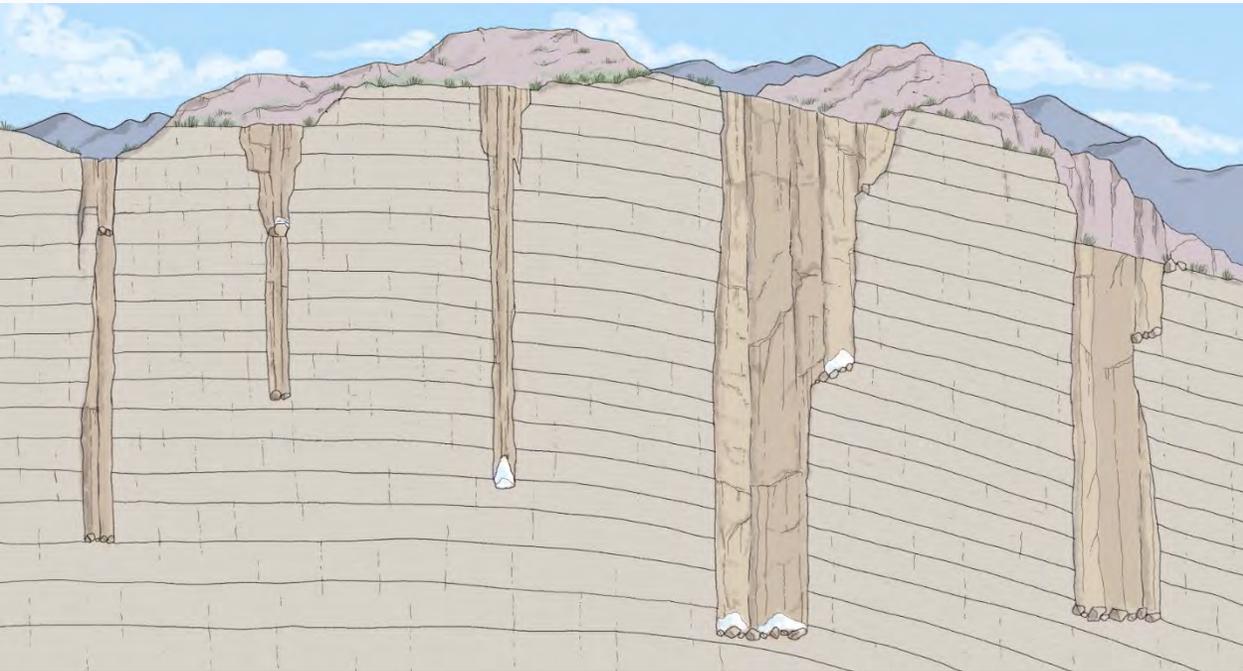
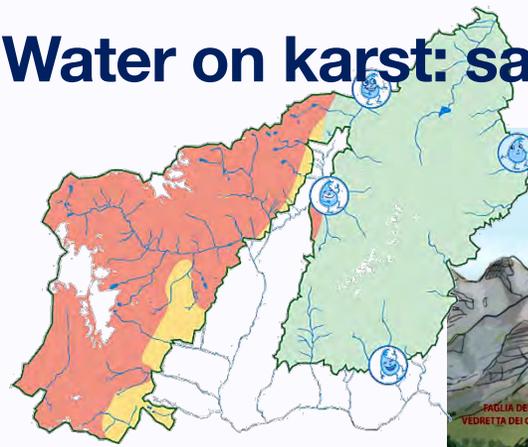


# Searching for climate changes in cave water

Mean Holocene growth rates around 50 micron/year. Acceleration in the last 200 years to >150 micron/year  
Slow growing about 5mm for the Anthropocene



# Water on karst: sampling the spring biotas

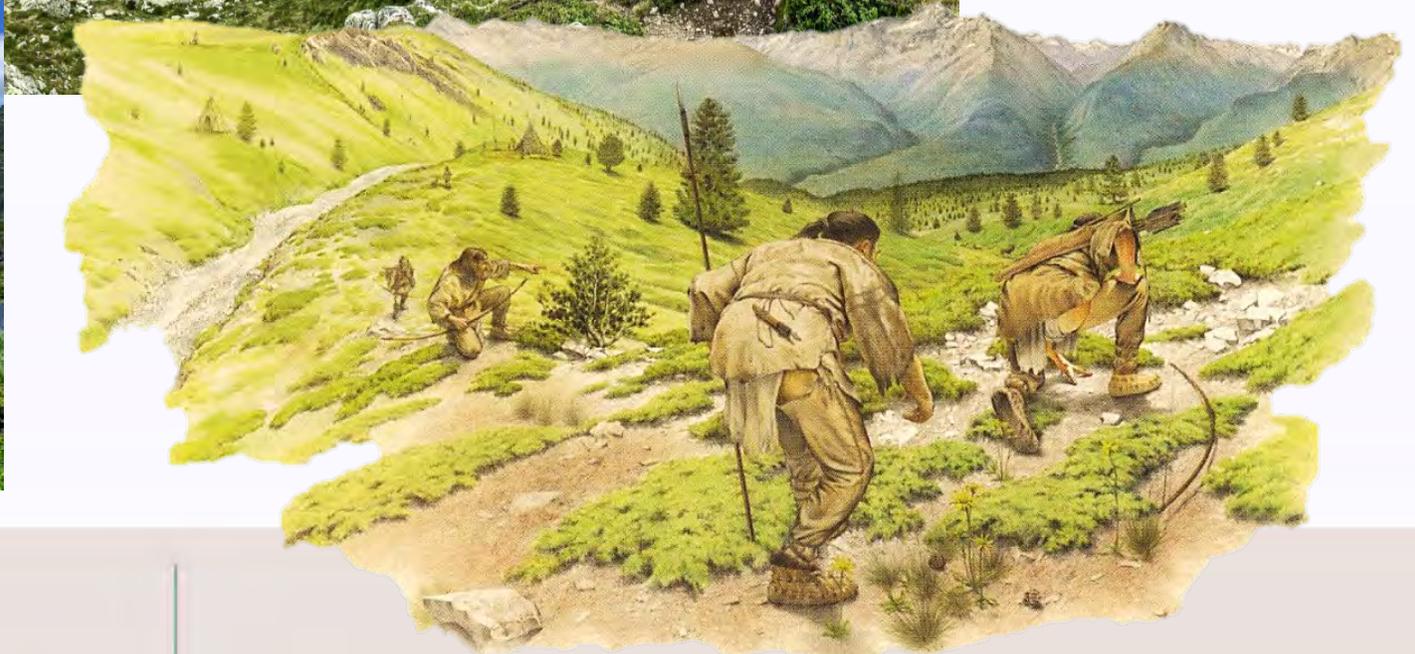


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# Investigating the ancestors' water



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# Monitoring Vertebrate populations in wetlands

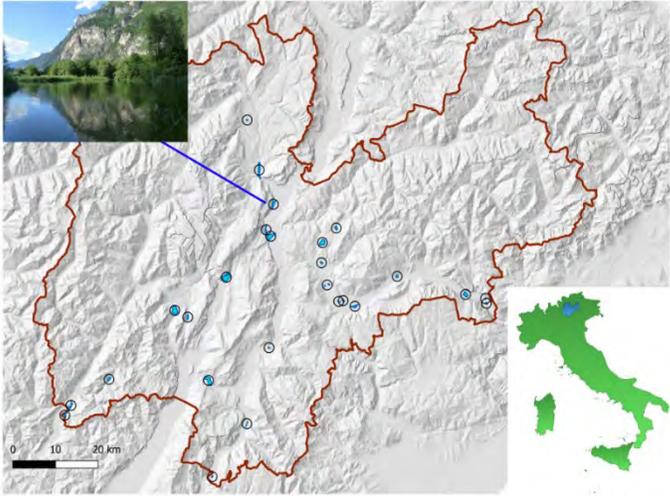


Fig. 1. Distribution of wetland PAs in the Trento province (in light blue with dark blue line, encircled black); the lower right inset shows the location of Trento province in Italy. The example wetland in the upper left corner is "La Rupe". (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)



The effectiveness of a network of small protected wetlands in preserving birds has been tested by investigating changes in species occurrence and relating them to their ecology.

Generalist species increased their occurrence rates, whereas species with stricter requirements, generally underwent contraction, suggesting that the conservation of isolated wetlands is not enough to preserve the more specialized species.

La rilevazione in 26 aree protette

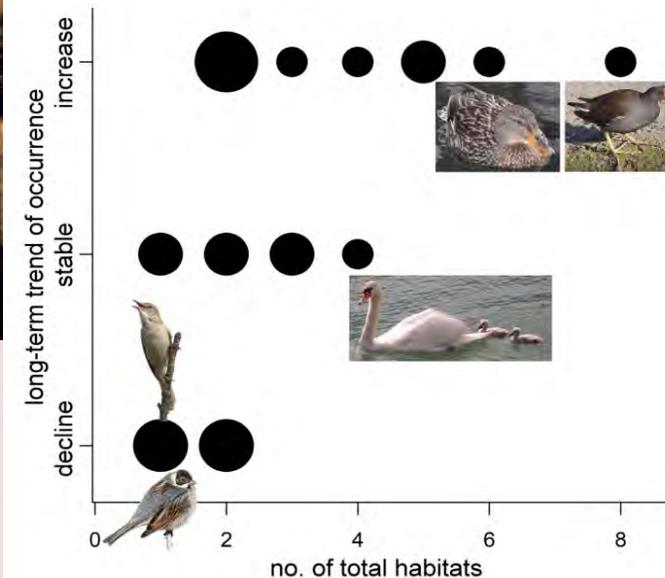
Le zone umide, scrigni di biodiversità

In trent'anni il 43% delle specie ornitologiche censite è aumentato

Lo studio del MUSE, pubblicato sulla rivista internazionale Biological Conservation, racconta 30 anni di tutela e studio delle aree umide in Trentino. Il 43% delle specie di avifauna censite in 26 differenti biotopi è andato incontro ad espansione; in calo il cannaieccione e il migliarino di palude.



Fig. 2. Graphical representation of the relationship between the number of habitats used by a species and its long-term trend of occurrence within the study network of protected wetlands. Dot size is proportional to the number of species. Example species (from bottom to top, and from left to right) are reed bunting *Emberiza schoeniclus*, mute swan *Cygnus olor*, mallard *Anas platyrhynchos* and moorhen *Gallinula chloropus*.



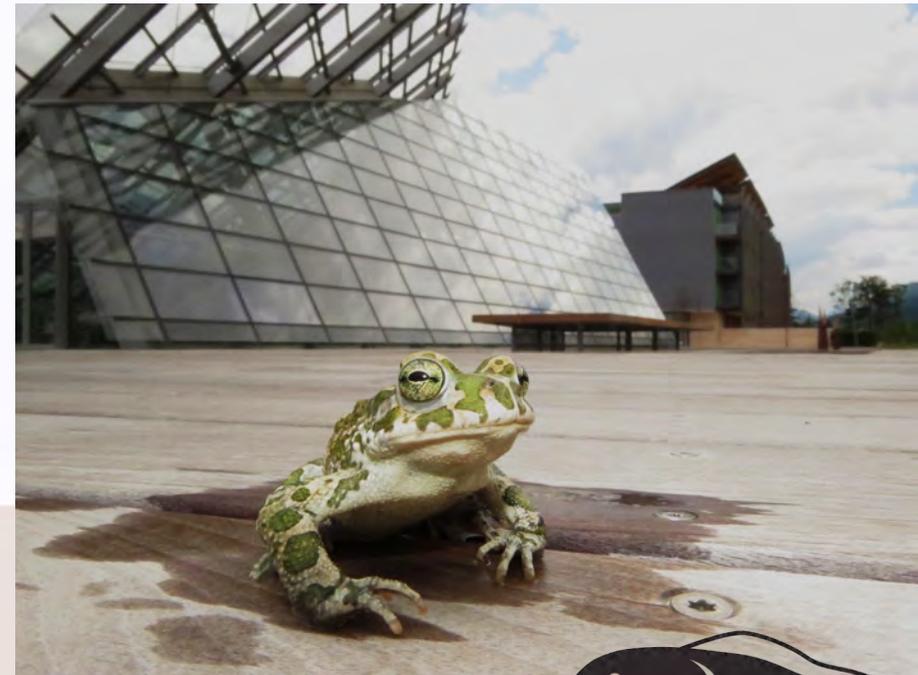
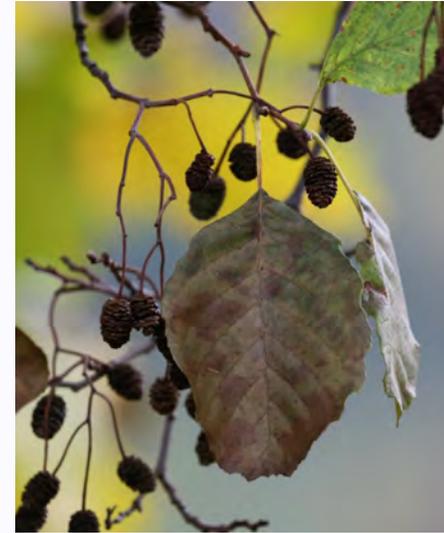
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## 4. Water around the museum



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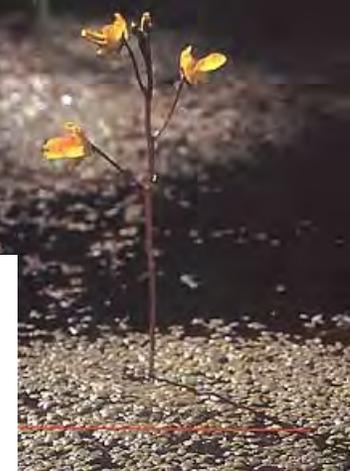
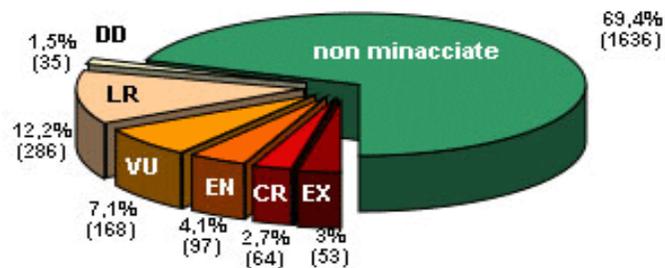
# Water, from mirroring to reflection



**Waterplants** in Trentino:  
 ~ 120 species (hygrophytes + hydrophytes)  
 ~ 1/3 facing different levels  
 of threat (from VU to EX)



**Specie a rischio in Trentino**  
 suddivise per categoria di rischio locale



Waterplants nursery in Mattarello (TN)



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# Working with water



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*Thanks for the attention*



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