Understanding the climate pressure on aquatic ecosystems

Gianni Tartari, CNR-Istituto di Ricerca Sulle Acque

With the collaboration of:

Elisa Carraro, Sudeep Thakuri, Diego Copetti, Gaetano Viviano, Franco Salerno

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Rationale

The scientific approach to climate change is changing.

From the discovery of the phenomena related to climate pressure now we are looking in more detail the mechanisms by which changes take place and the processes they contribute to determine.

To understanding the mechanisms, however, often is required the separation of the contributions by individual pressures (climate, human activity, natural factors etc.).

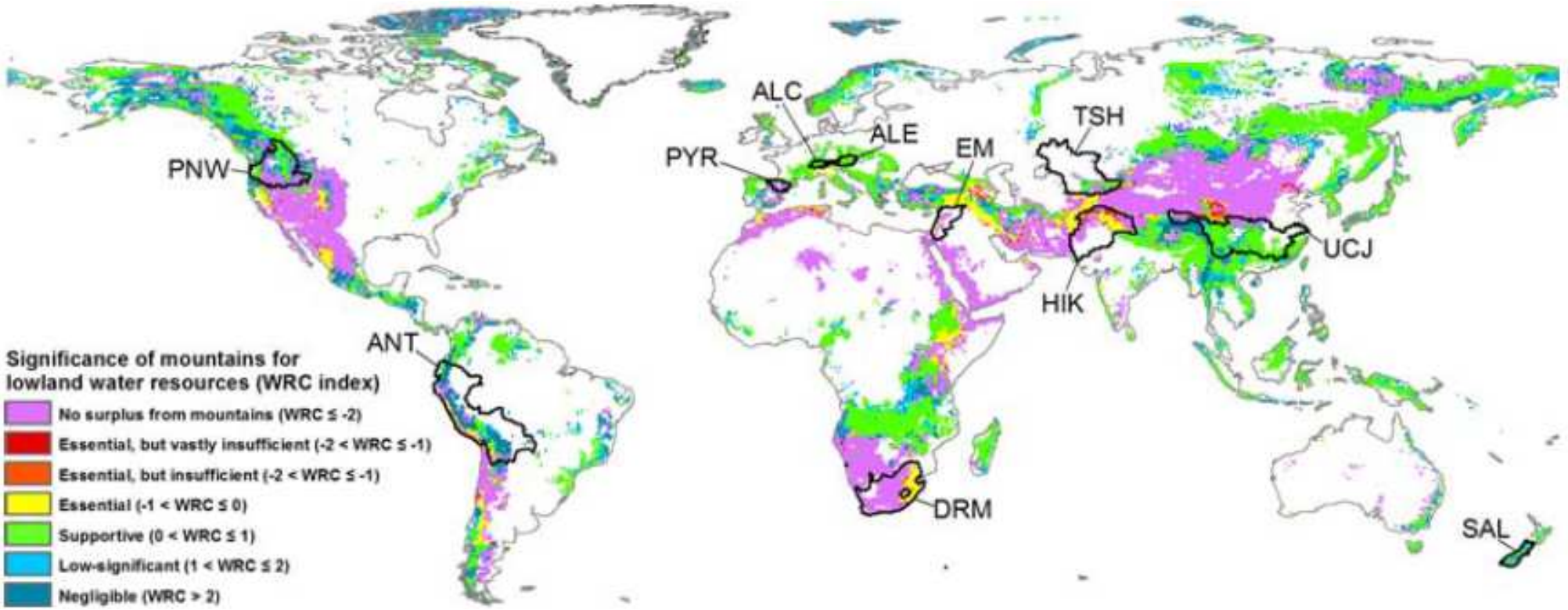
Generally, the separation of individual mechanisms of action on ecosystems is carried out by deterministic models more and more sophisticated.

The calibration and validation of models requires a large amount of reliable data. These conditions are not so readily available, expecially in extreme situations, such as high altitudes.

In this presentation, I will illustrate with some examples of the research effort that IRSA is doing to contribute to the scientific development of these themes.

Significance of mountain regions for lowland water resources

(Viviroli et al., 2011)

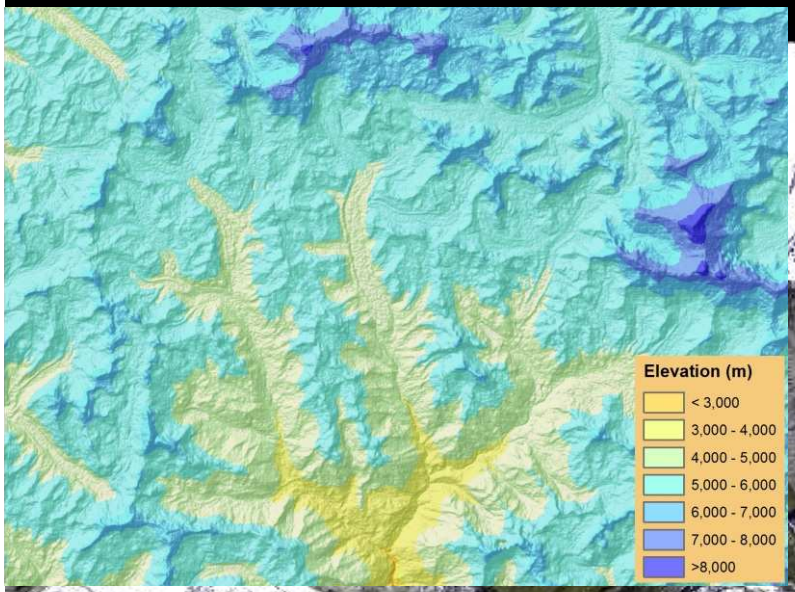


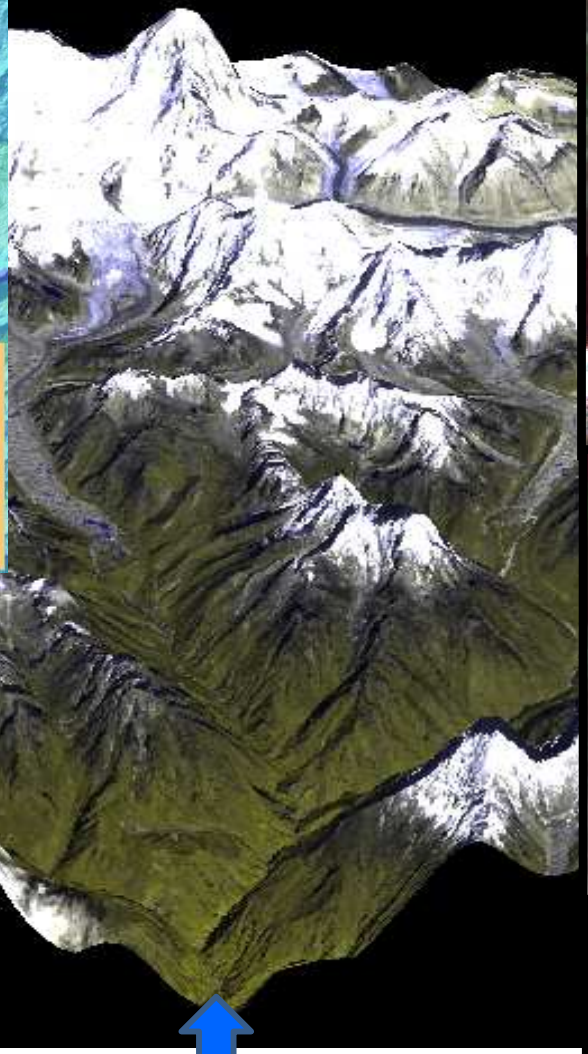
Some research questions on water budget in mountain regions

1) How does the climate variables (temperature and precipitation) behave at local scale?
2) What are the status, trend and morphometric behavior of glacier at small scale?
3) Which climate variable play vital role in glacier and lake variation and the severity of impact on them?
4) How the changes in glacier melt run off influences the river discharge and water availability?

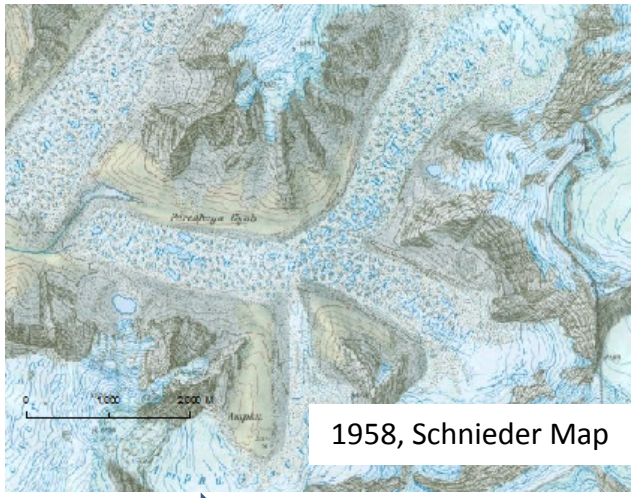
Sagarmatha National Park Mount Everest region in Nepal Himalaya

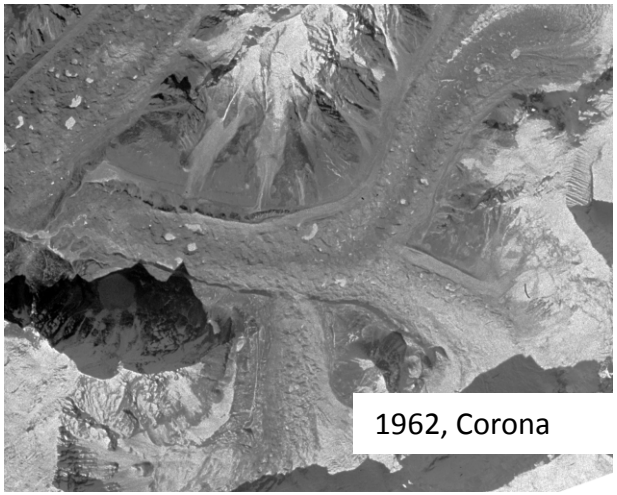
ALOS- AVNIR-2, Acquisition 24Oct 2008; Cloud cover: 0-2%

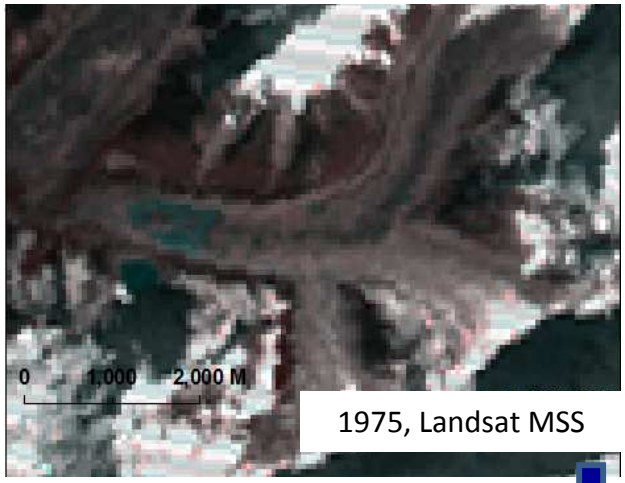




Spatio-temporal analysis of glaciers

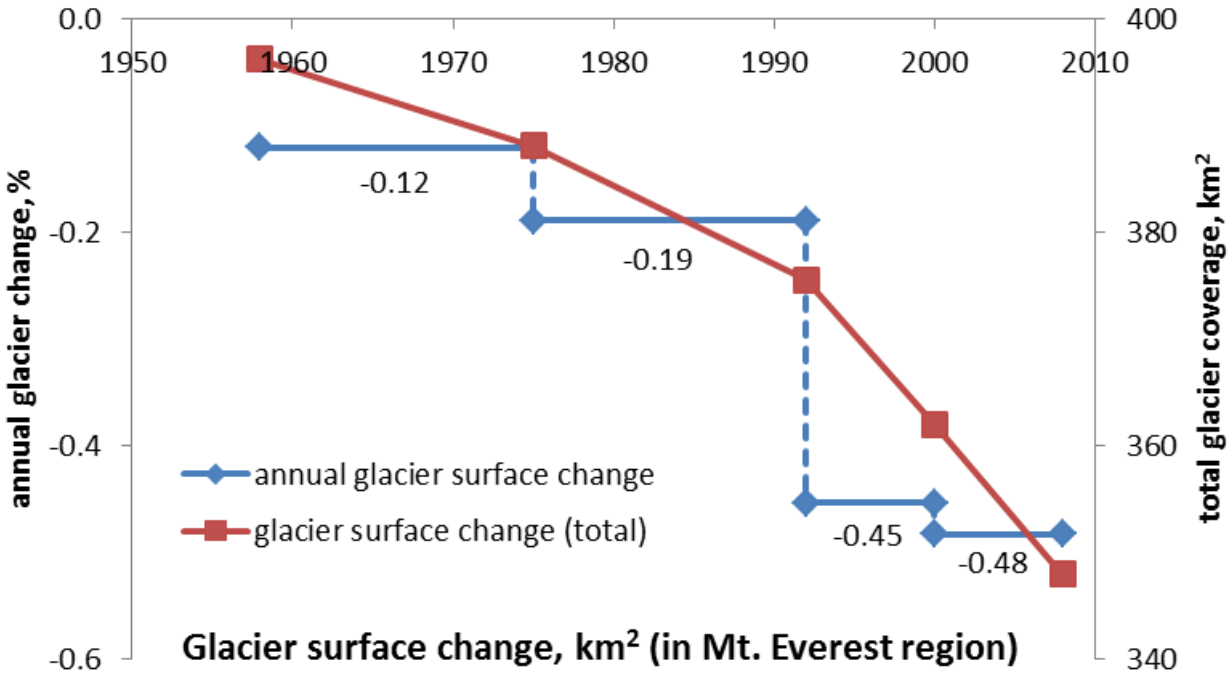






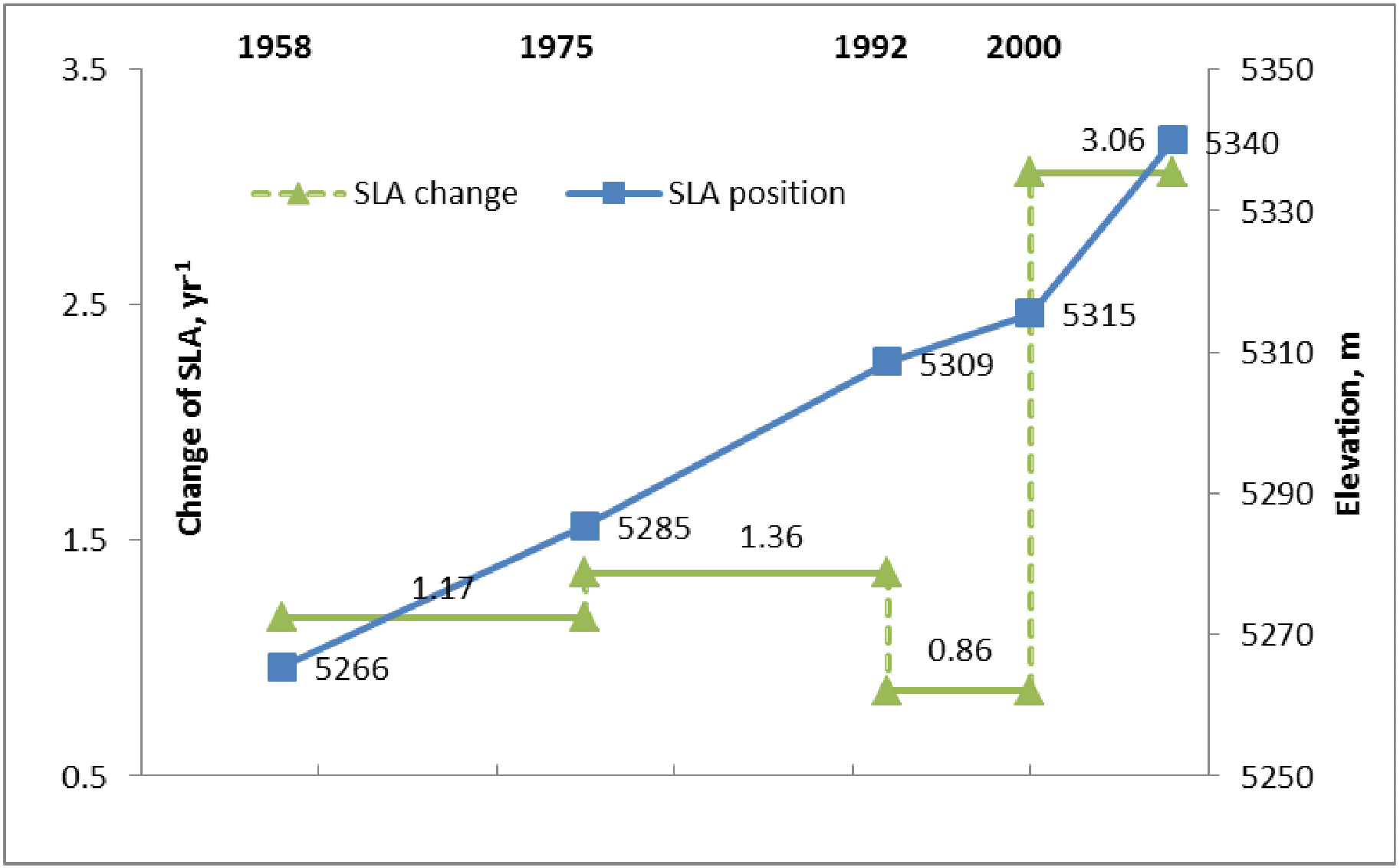
Evaluation of Imja lakes (pro-glacial) and terminus changes (1958-2008)

Glacier surface variation

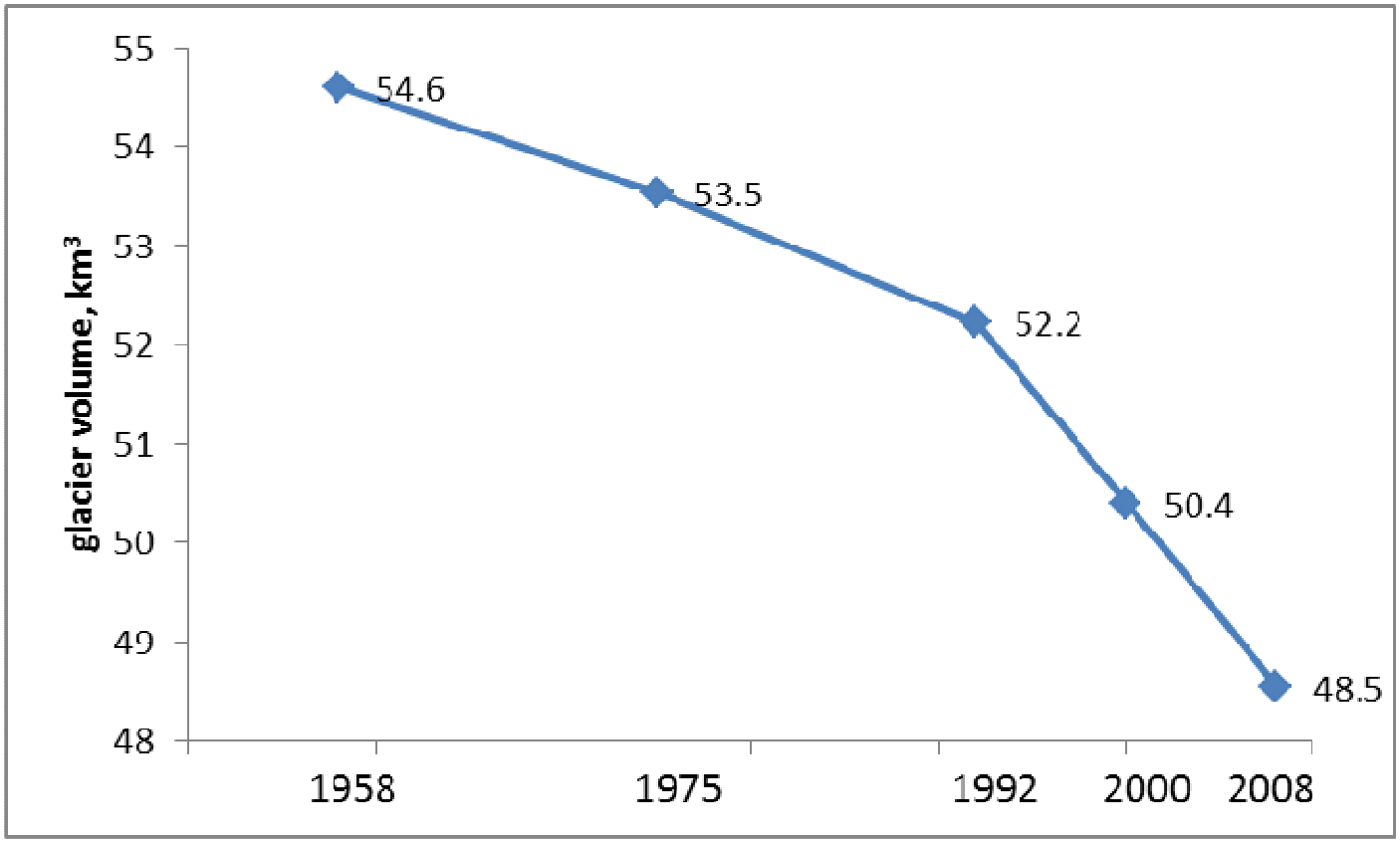


year	glacier area, km²	
1958	**396.2**	
1975	388.0	
1992	375.5	
2000	362.0	
2008	**347.9**	
Total glacier % change		**12.2**
period	change	change yr^{-1}
1958-75	-2.1%	**-0.12**
1975-92	-3.2%	-0.19
1992-00	-3.4%	-0.43
2000-08	-3.6%	**-0.48**

Variation of Snow Line Altitude (SLA)

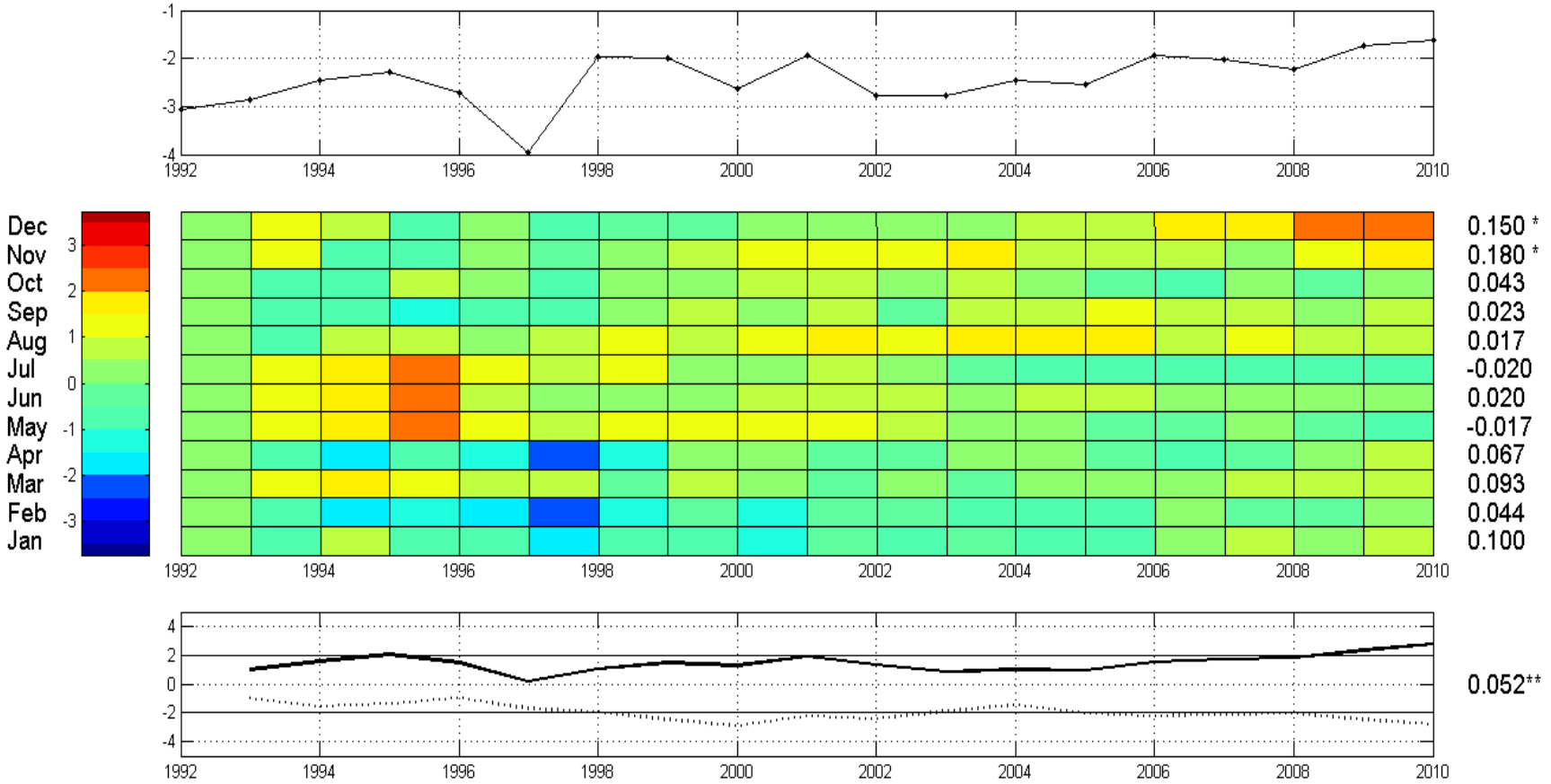


Estimated glacier volume changes



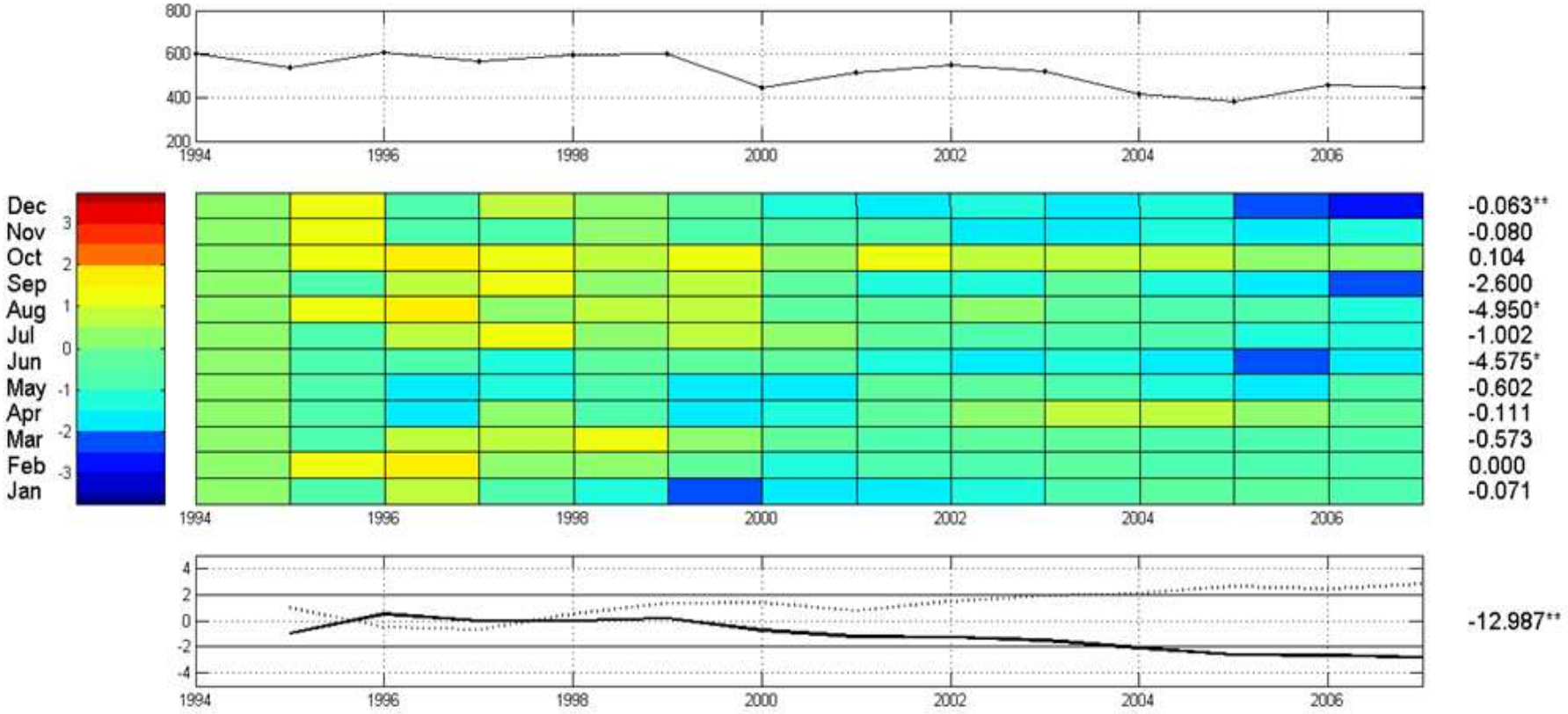
- 54.6 to 48.5 km^3 in 1958-08 period
- loss of 11.1% loss

Temperature (AWS 1992-2010)



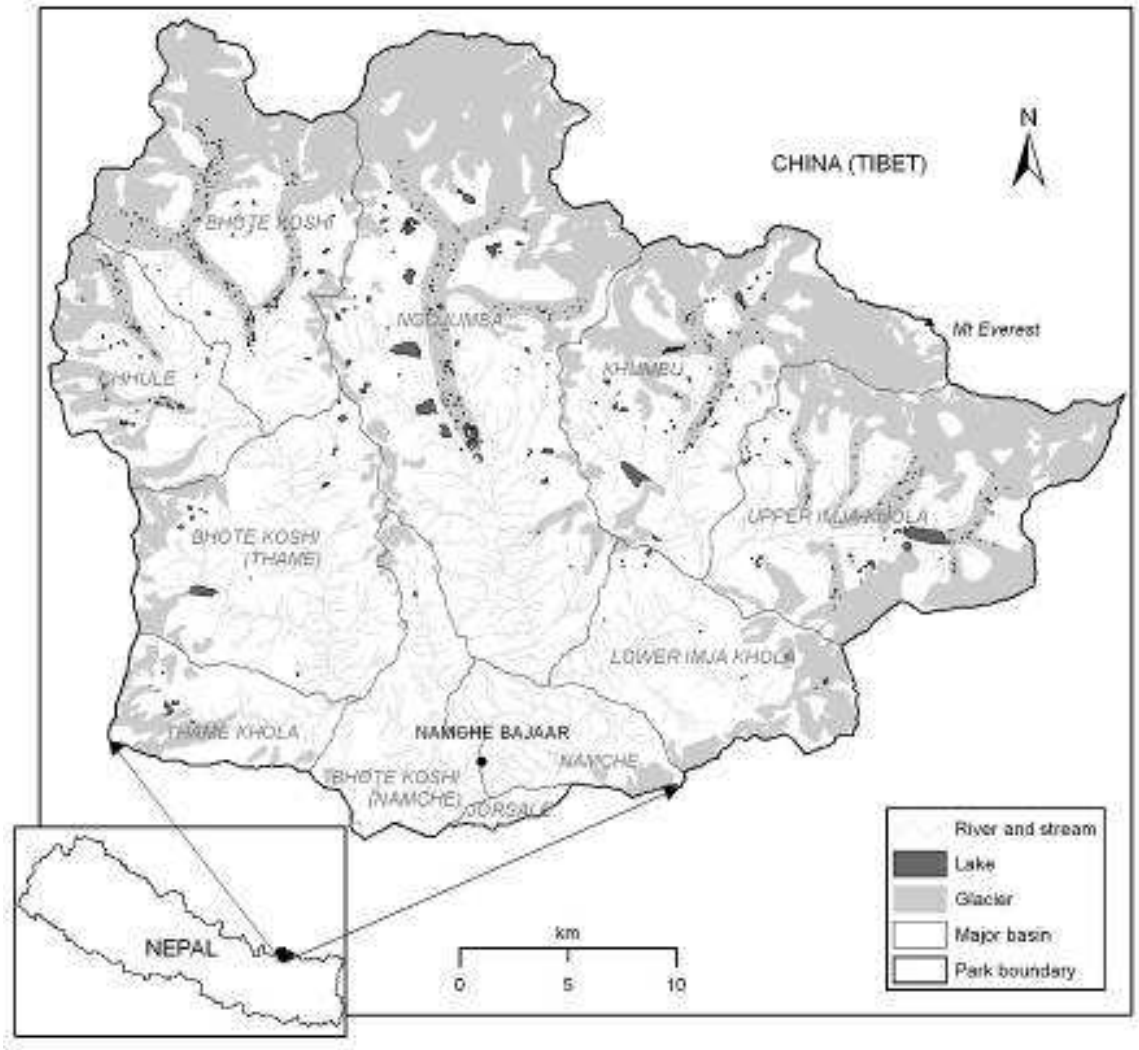
- Increasing trend of temperature
- Winter temperature - Nov. and Dec- significative increasing

Precipitation (AWS 1994-2007))



- Decreasing trend of precipitation
- Significance for Dec., Jun., Aug. months (monsoon season

Glacial lakes in Sagarmatha National Park



	Number of lakes (N)	Surface (km^2)
Proglacial	17	1.8
Supraglacial	437	1.4
Glacial	170	4.3
All lakes in SNP	**624**	**7.4**

Proglacial: moraine dammed

Supraglacial: lakes on the glaciers

Glacial: lakes not connected with the glaciers

Area: ~ 1250 km^2

1 lake per 2 km^2 (1.4 x 1.4 km)

J. Limnol., 67(2): 139-154, 2008

Journal of Limnology

Lake surface area variations in the North-Eastern sector of Sagarmatha National Park (Nepal) at the end of the 20th Century by comparison of historical maps

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[2)]Earth Sciences Department "Ardito Desio", University of Milan, Italy
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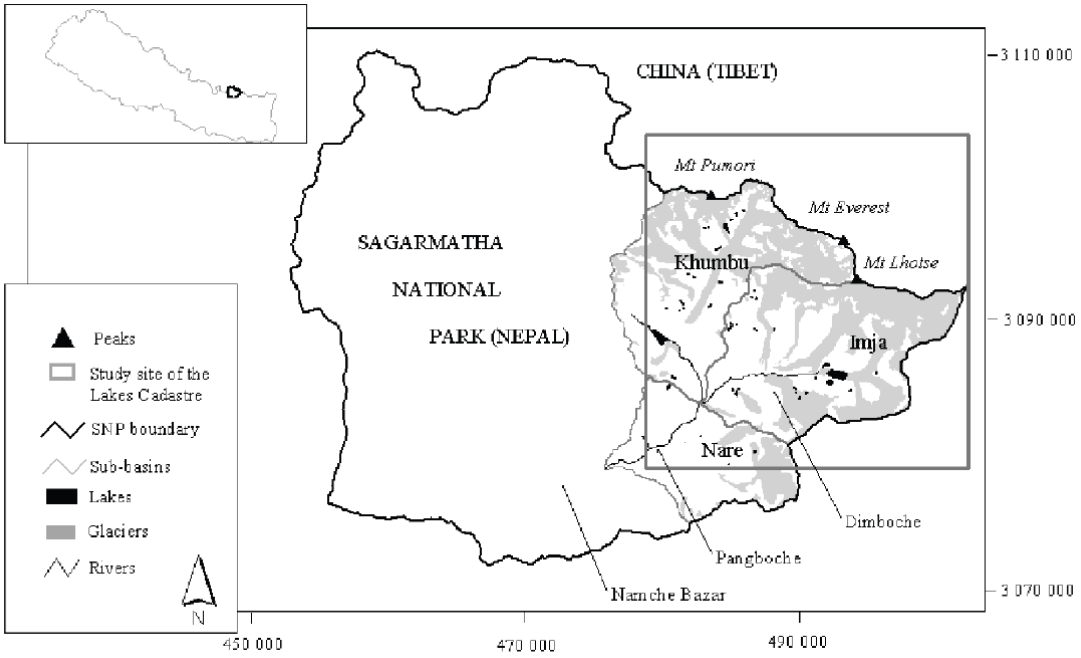
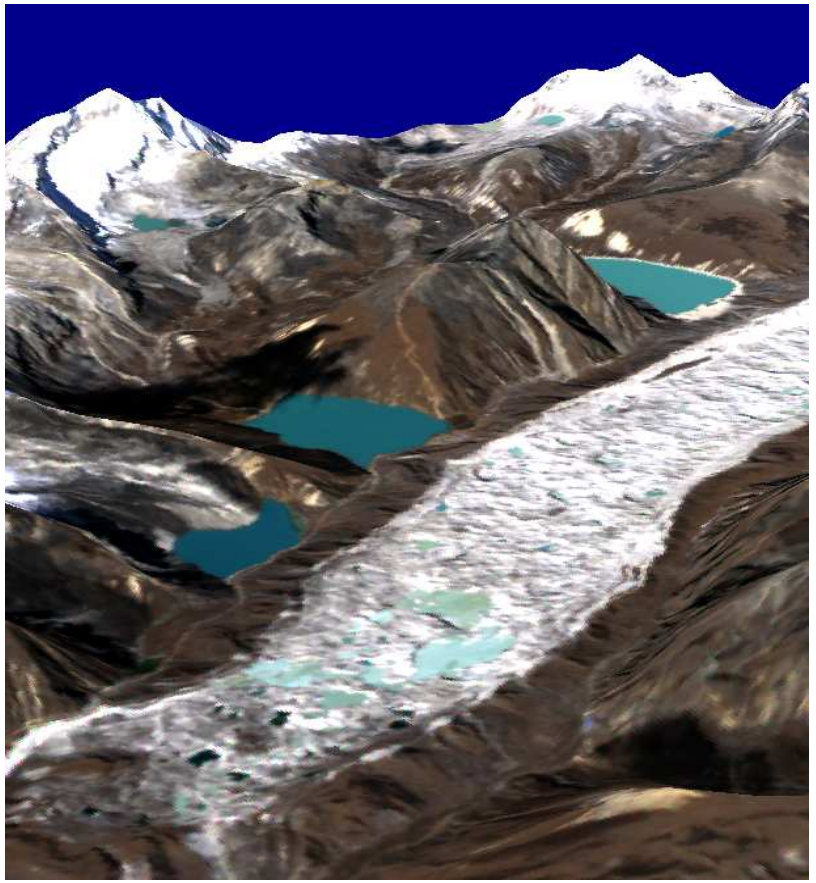


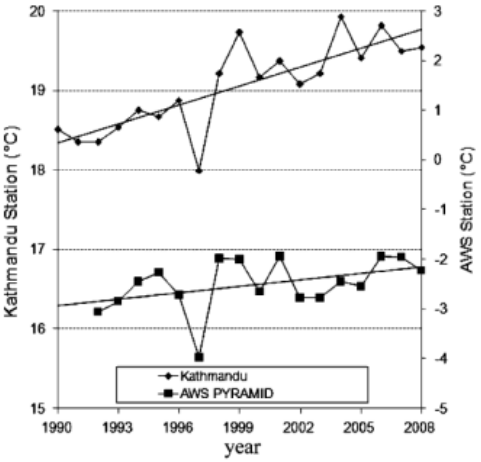


The analysis of the changes occurring between the 1980s and the 1990s in the surface areas and distribution of lakes in the north-east sector of SNP reveals that lake areas substantially increased, **by 15.4%**

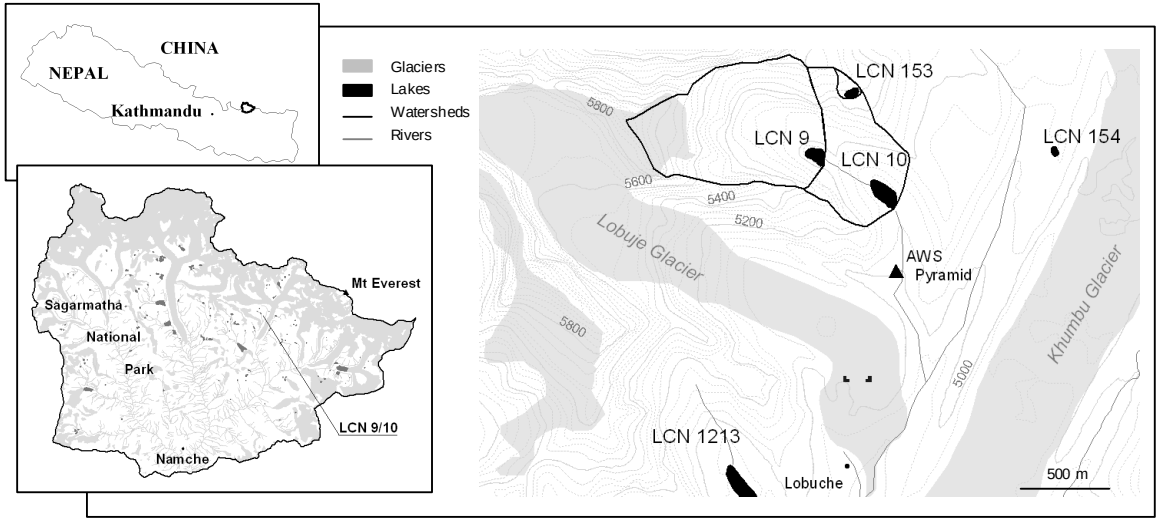
Hydrobiologia (2010) 648:189–205

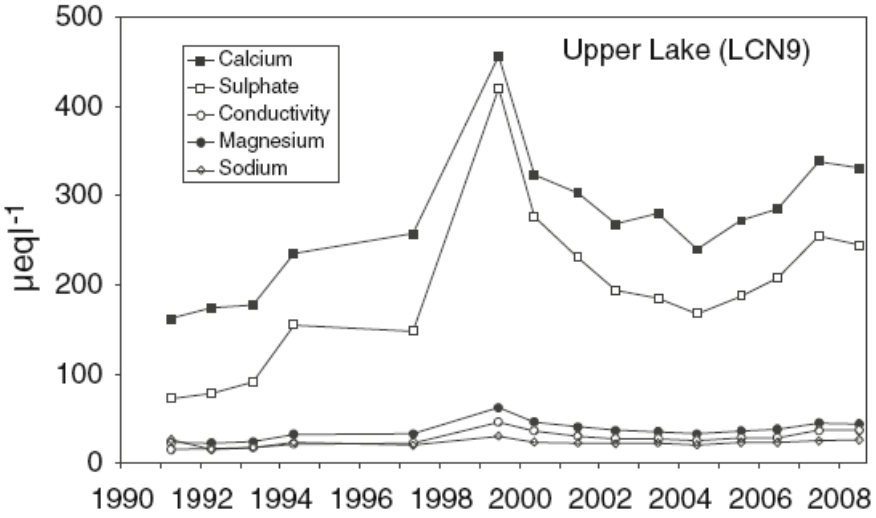
Chemical and biological response of two small lakes in the Khumbu Valley, Himalayas (Nepal) to short-term variability and climatic change as detected by long-term monitoring and paleolimnological methods

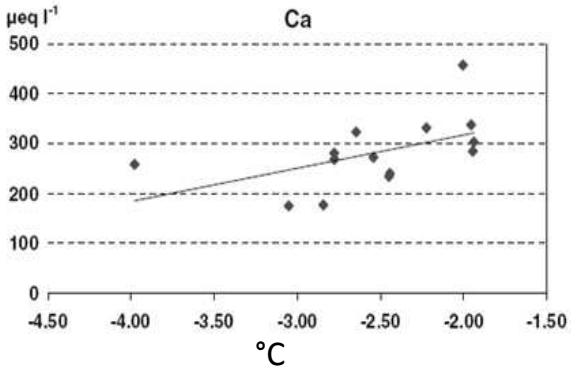
Andrea Lami · Aldo Marchetto · Simona Musazzi · Franco Salerno · Gianni Tartari · Piero Guilizzoni · Michela Rogora · Gabriele A. Tartari

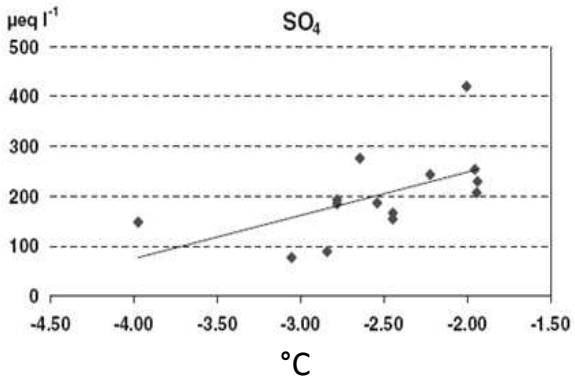


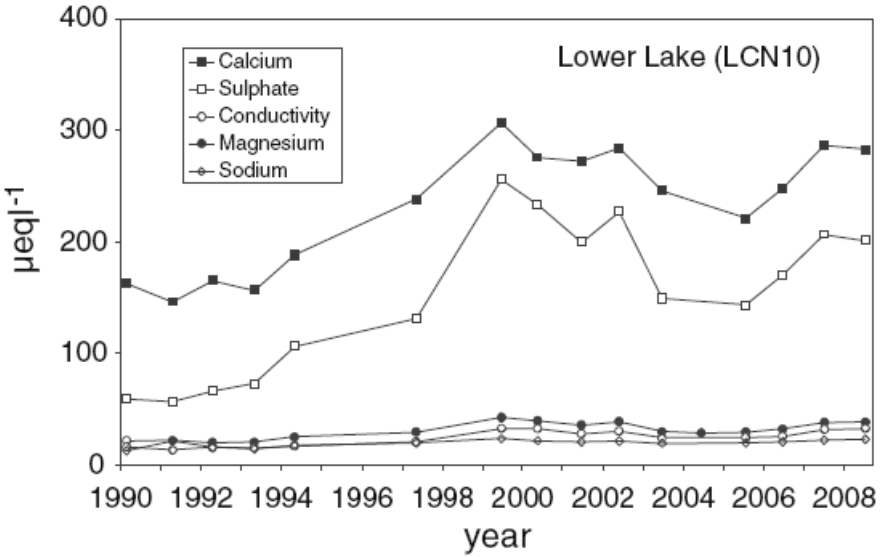
LCN 9



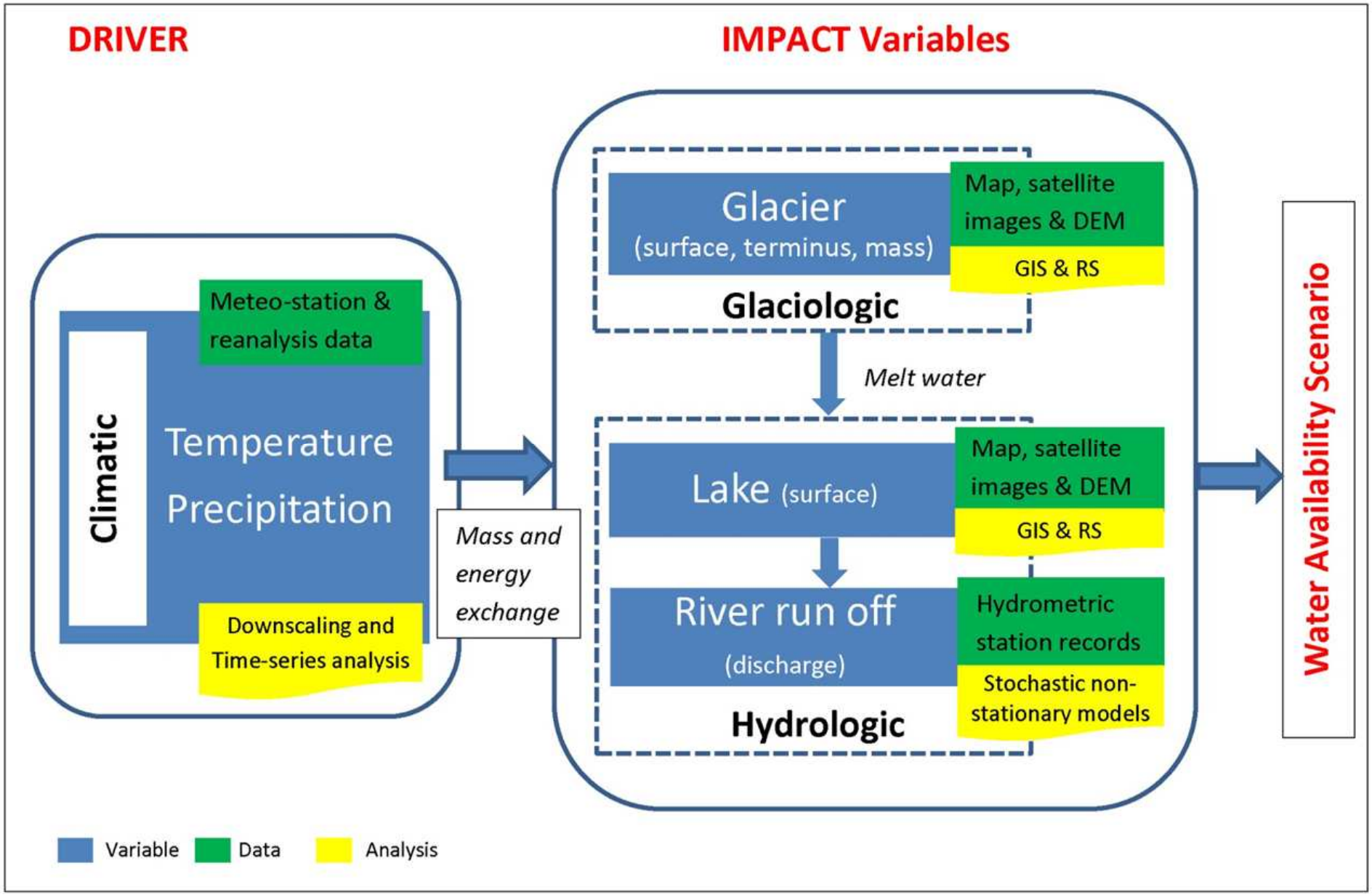




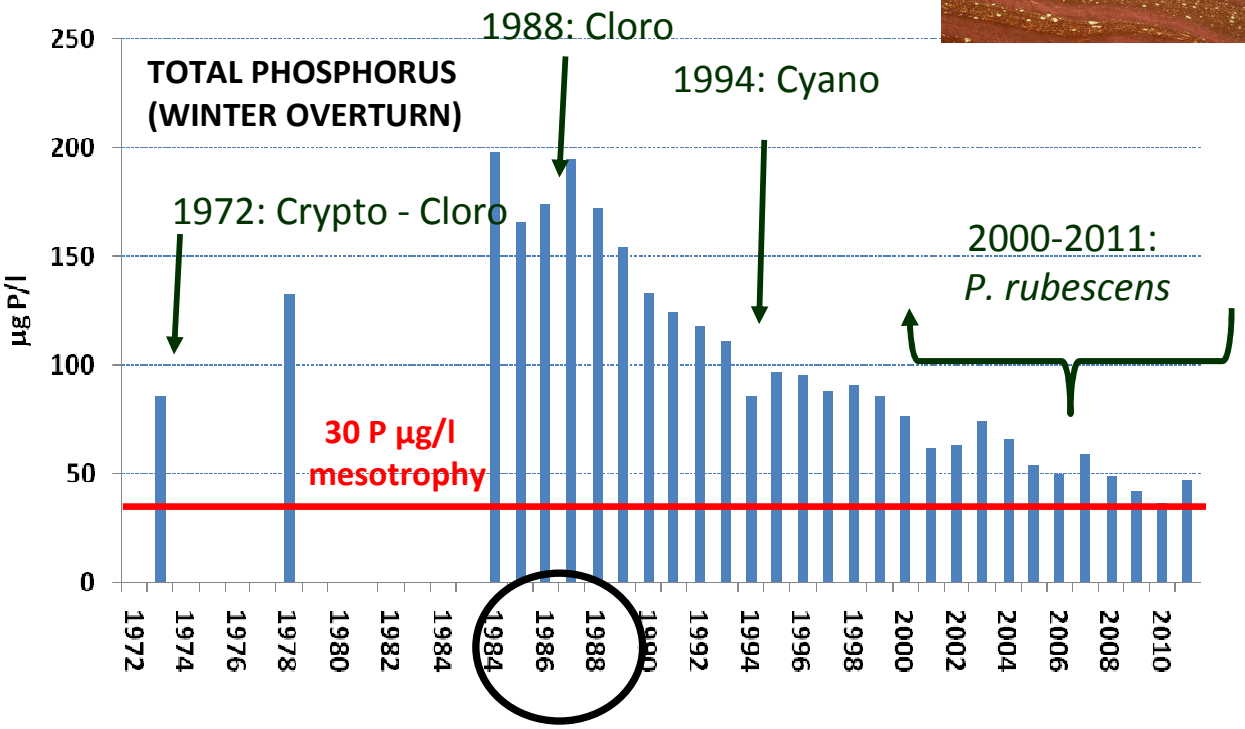




Coupling climate with glacier and periglacial environment to understand the climatic impact on hydrologic process and future water availability scenario



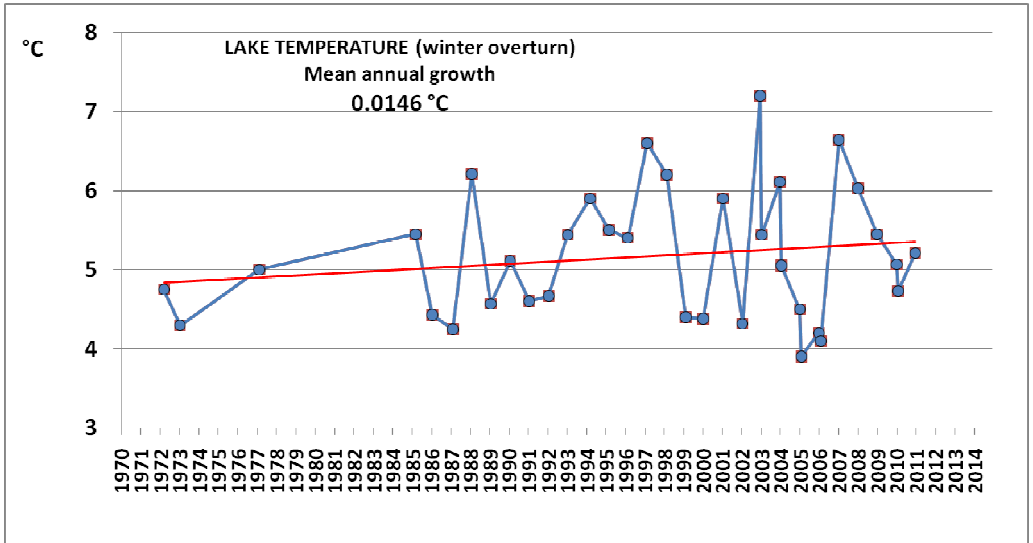
The case of Lake Pusiano

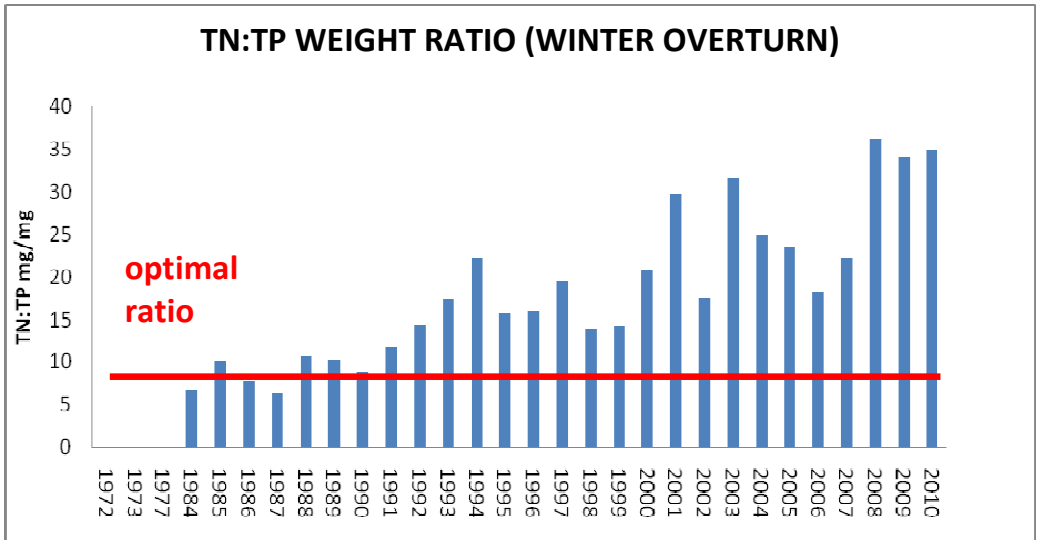


Surface: lake 4.9 km^2 ; watershed 95 km^2
Volume: 69.106 m^3
Mean Depht :13,5 m
Max Depht : 25 m
Residence time: 0.8 yr

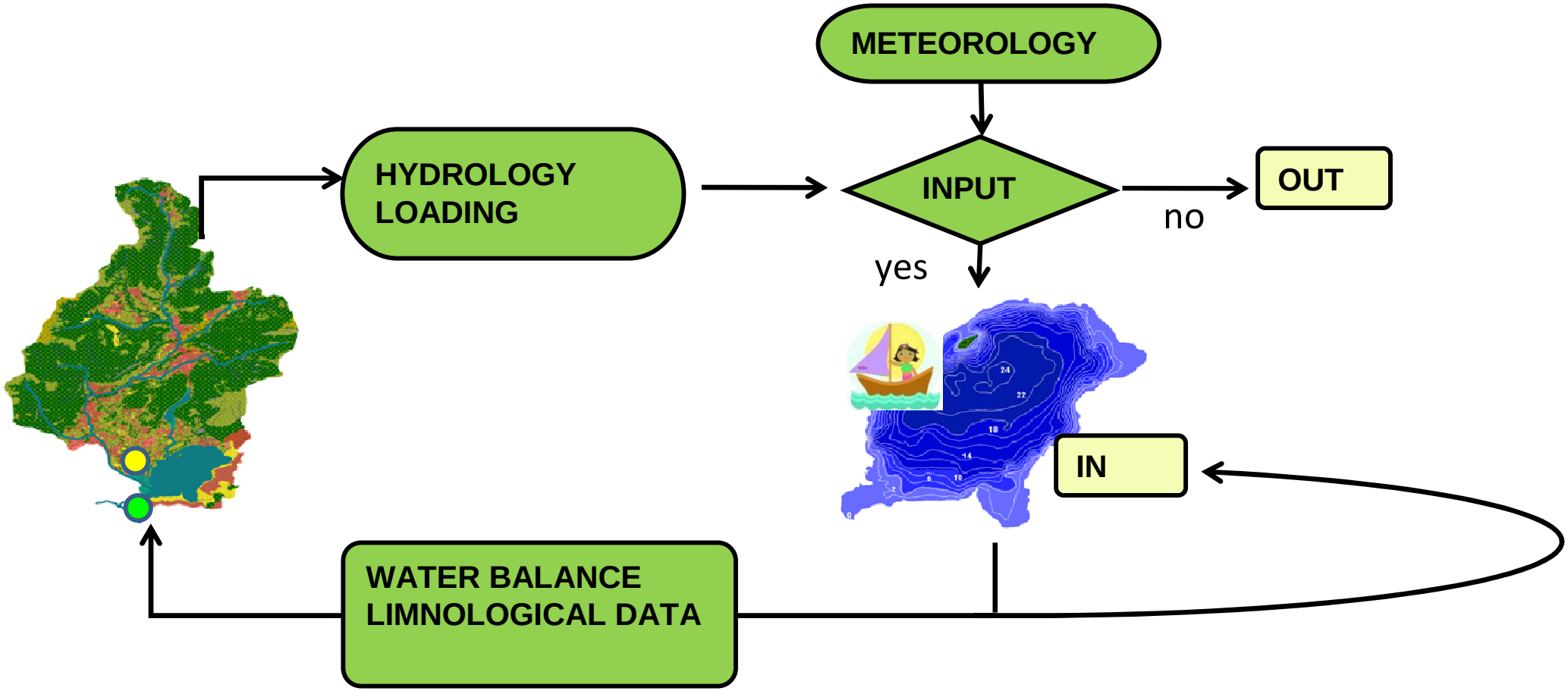
(Ambrosetti and Barbanti 1999; Livingstone 2003; EEA 2008)

Sewage plant and drainage system

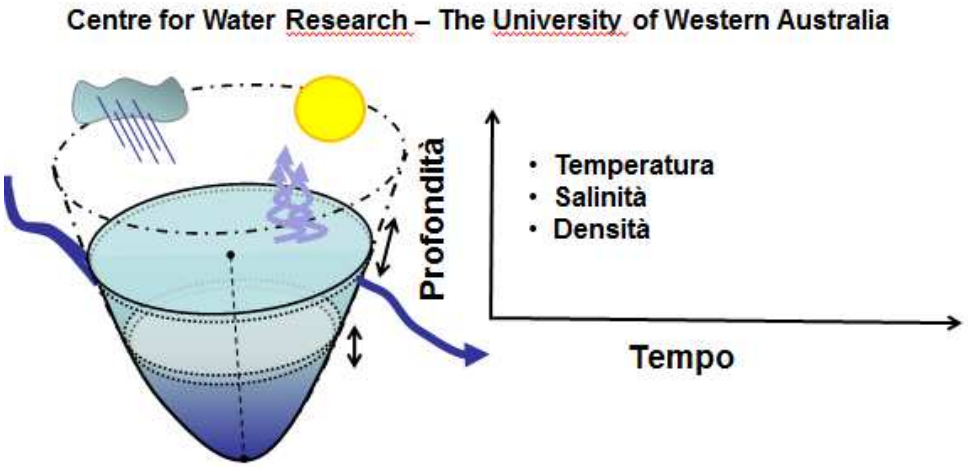


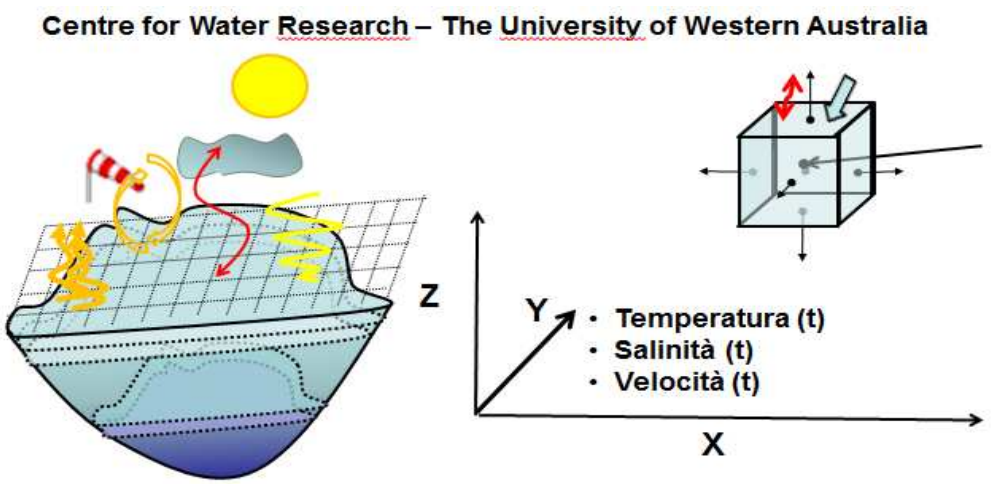


Lake/catchment integration plan



Hydrodynamic lake simulation





DYRESM (DYnamic REServoir Simulation Model)

- Low spatial resolution (1D)
- Long term capability

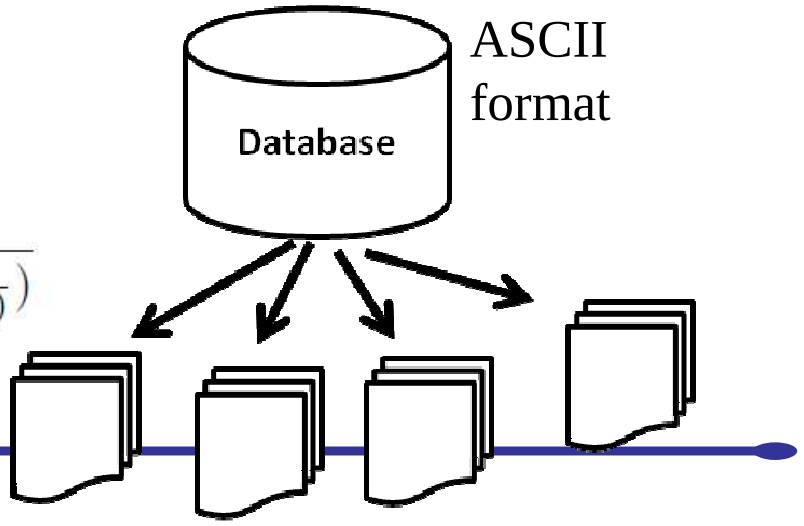
ELCOM (Estuary, Lake and Coastal Ocean Model)

- High spatial resolution (3D)
- Short term and high frequency

Multi-layer structure (Lagrangian).
Definition of the height and thickness of a layer.

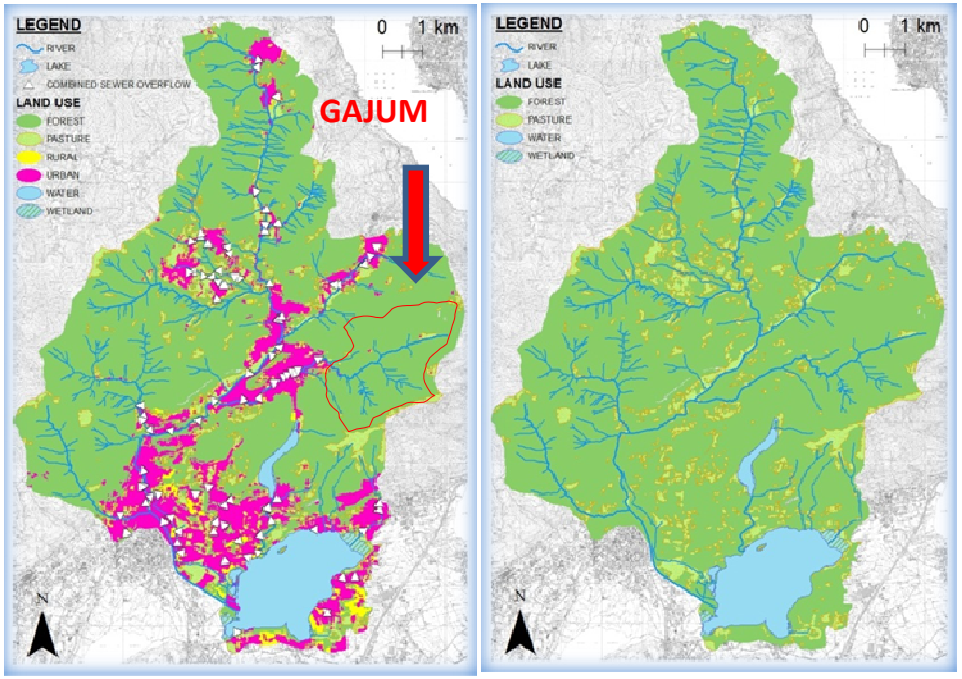
Equation of state (UNESCO 1981) for density in each layer

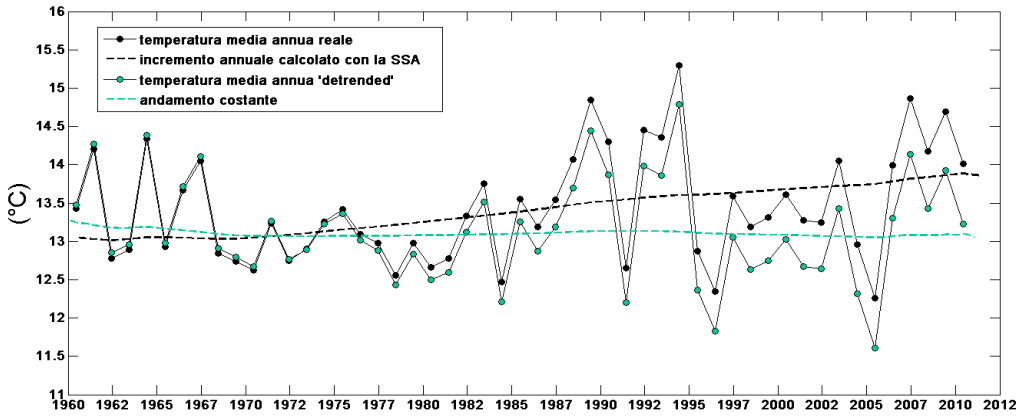
$$\rho(T,S,P) = \frac{\rho(T,S,0)}{(1 - \frac{P}{K(T,S,P)})}$$

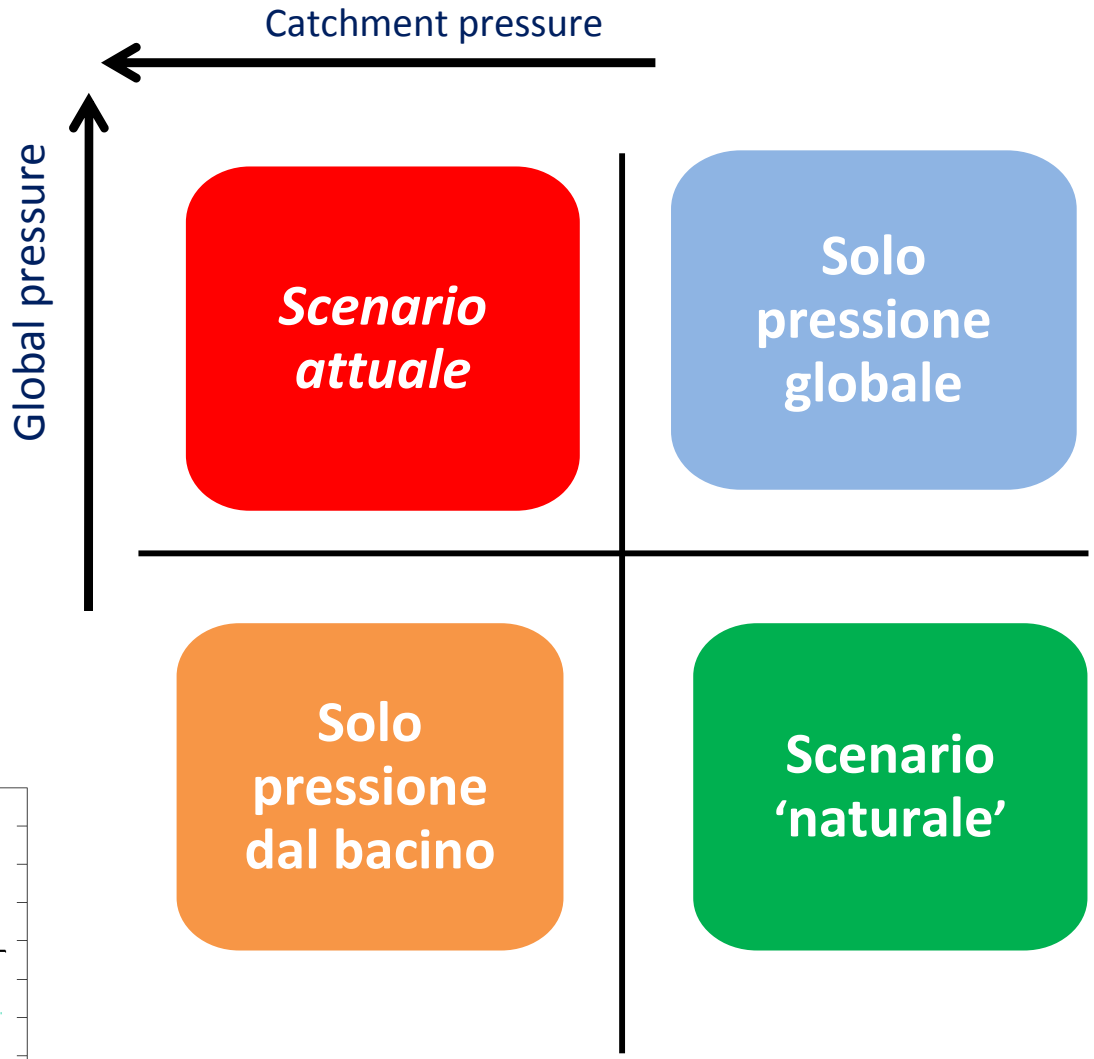


IRSA CNR

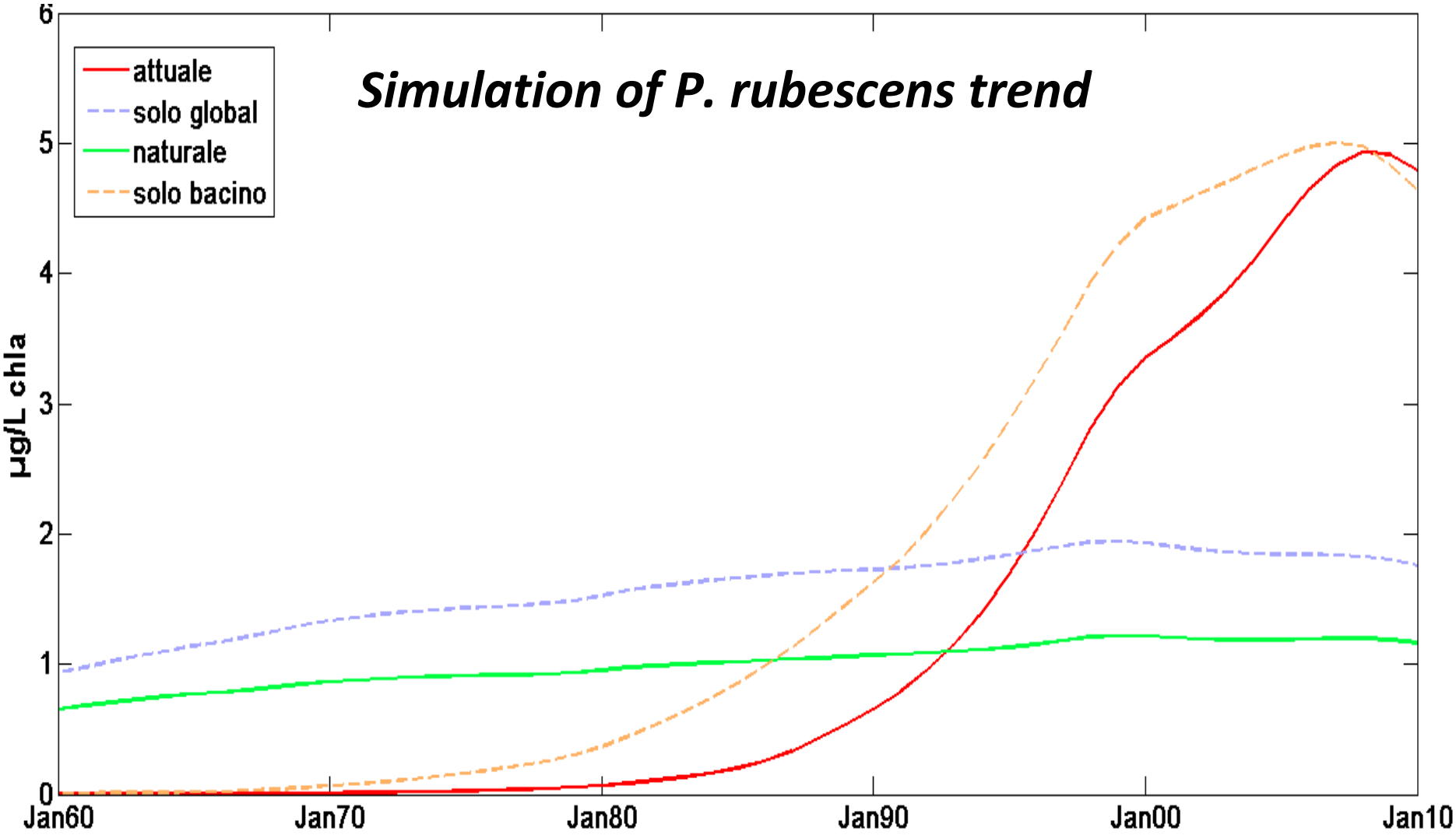
Differentiation of local human and global impacts (1960-2010)







Results modeling



Carraro et al. accepted by Ecological Modeling Special Issue (Jorgensen Ed.): *"Models of the ecological hierarchy from molecules to the ecosphere"*

Politecnico di Milano, 20 Ottobre 2012

Un sentito grazie per il gentile invito

a festeggiare il decennale di attività, durante il quale MNW ha percorso una lunga strada, per l'azione determinata e intelligente di tutti voi appassionati di meteorologia e climatologia. ***Una passione che vi invidio.***

Gianni Tartari