

# Regional Adaptation Strategy: the case of Lombardy Region

**Antonio Ballarin-Denti**

*Dept. of Mathematics and Physics, Catholic University, Brescia  
Lombardy Foundation for the Environment*

Water and risk management facing climate change: towards the local adaptation  
Brescia, 10 October 2013



# Outline

## I. TOWARDS A REGIONAL ADAPTATION STRATEGY IN LOMBARDY

- **State of the art**
- **First steps of the regional strategy**

## II. IMPACTS OF CLIMATE CHANGE IN WATER RESOURCES

- **Climatic stressors**
- **Main impacts**

## III. MAIN CHALLENGES AND RECOMENSATIONS FOR ADAPTATION

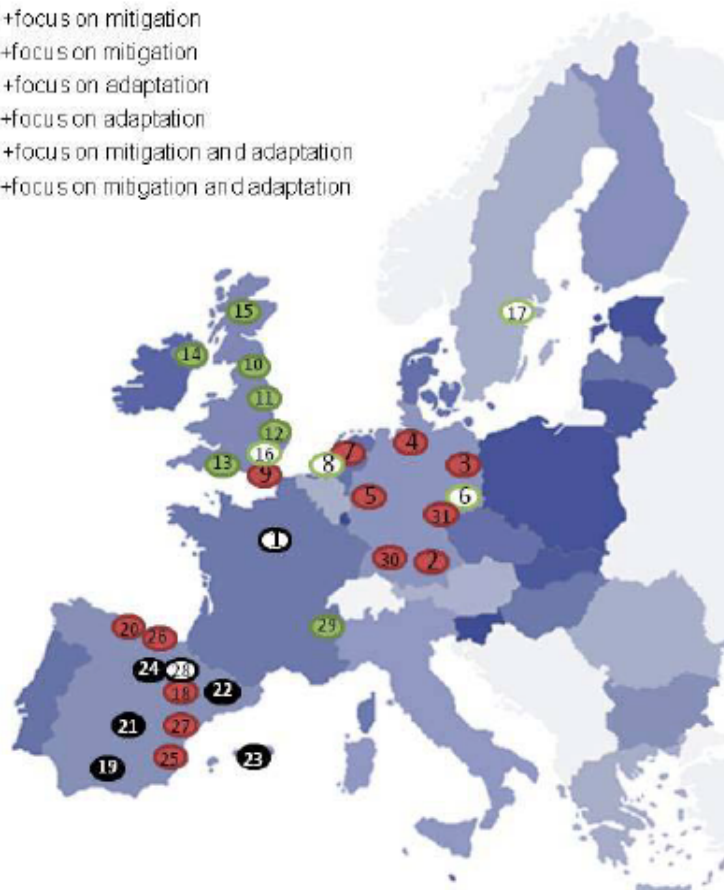
- **Methodology**
- **Recommendations**

# EU - policy context

- **GREEN PAPER** “*Adapting to climate change in Europe - options for EU action*” (2007)
- **WHITE PAPER** “*Adapting to climate change: Towards an European framework for action*” (2009)
  - ✓ Every effort must be made to adopt national or regional adaptation strategies at the member states
  - ✓ Adaptation strategies in Europe must be implemented in two faces:
    - FI** ( 2009 -2012): preparing the ground
    - FII** ( from 2012): adoption of the National Adaptation Strategies
- **EU ADAPTATION STRATEGY** “*An EU Strategy on adaptation to climate change*” (April 2013)
  - ✓ Encourage all Member States to adopt comprehensive adaptation strategies
  - ✓ Provide funding to support capacity building on adaptation ( LIFE, cohesion fund)
  - ✓ Bridge the knowledge gap
  - ✓ Further develop Climate-ADAPT platform for adaptation information
  - ✓ Mainstreaming adaptation into EU policies

# Regional adaptation strategies in EU

- with SAS + focus on mitigation
- with LAS + focus on mitigation
- with SAS + focus on adaptation
- with LAS + focus on adaptation
- with SAS + focus on mitigation and adaptation
- with LAS + focus on mitigation and adaptation



- 1... Paris
- 2... Bavaria
- 3... Brandenburg
- 4... Hamburg
- 5... North-Rhine Westfalia
- 6... Dresden
- 7... Utrecht
- 8... Rotterdam
- 9... South East England
- 10... North East England
- 11... Yorkshire and Humber
- 12... East England
- 13... South West England
- 14... Northern Ireland
- 15... Scotland
- 16... London
- 17... Stockholm
- 18... Aragon
- 19... Andalusia
- 20... Cantabria
- 21... Castilla la Mancha
- 22... Catalonia
- 23... Islas Baleares
- 24... La Rioja
- 25... Murcia
- 26... Pais Vasco
- 27... Valencia
- 28... Zaragoza
- 29... Rhone Alps
- 30... Baden Württemberg
- 31... Saxony

SAS - Sub-national governments with varying levels of autonomy adaptation strategies

LAS - Large cities or urban agglomerations adaptation strategies

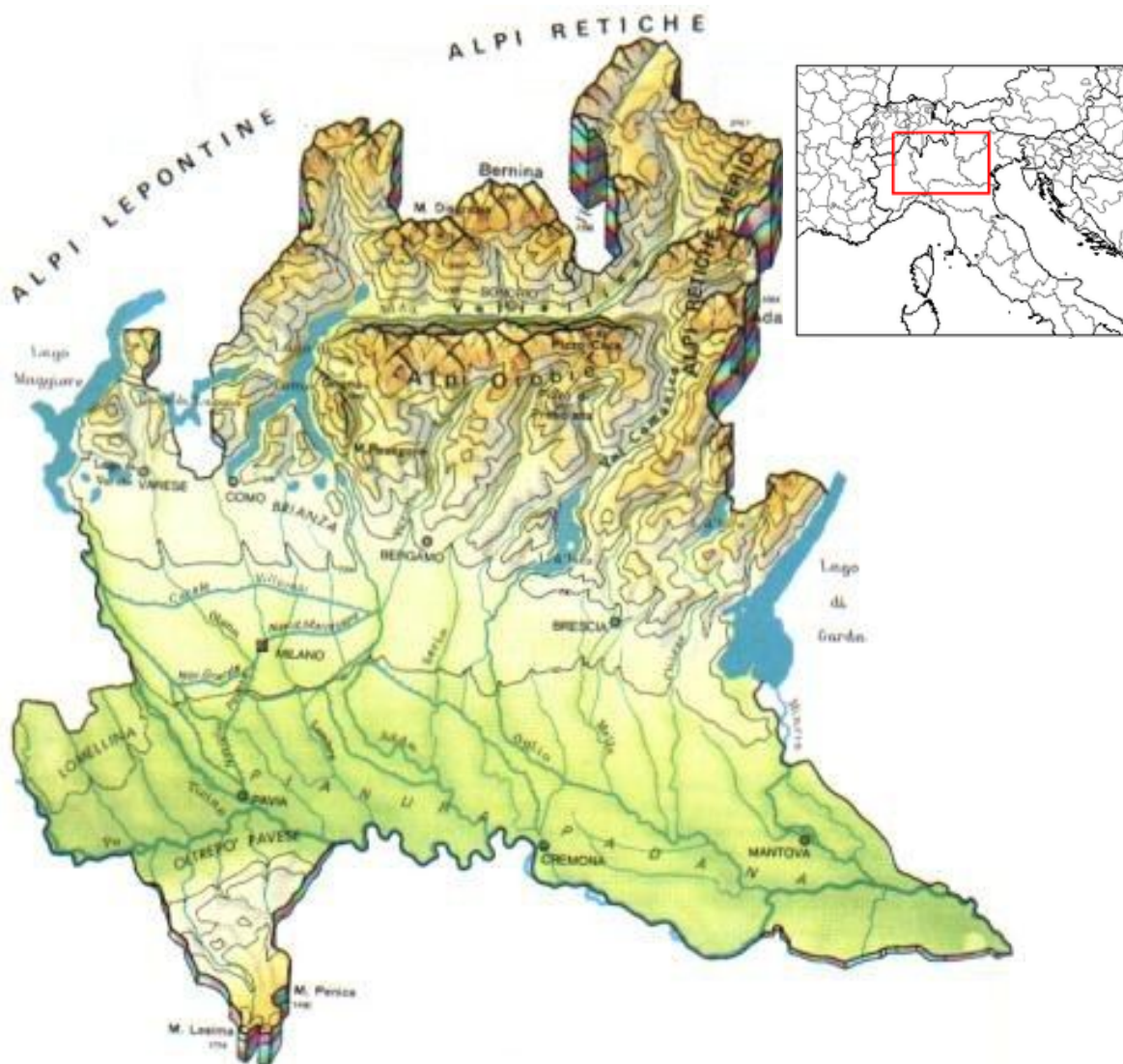
Climate change strategies assessed (showing both municipalities and sub-national government strategies) .Source: Ribeiro et al, 2009

**White paper : “Due to the regional variability and severity of climate impact most adaptation measures will be taken at regional or local level”**

**Article 4 of the UNFCCC: “every effort must be made to adopt national or regional adaptation strategies”**

**EU adaptation strategy: “In view of the specific and wide ranging nature of climate change impacts... adaptation measures need to be taken at all levels, from local to regional and national level”**

# The Lombardy region: characteristics



- ✓ high population density (9 909 348 inhabs 413 inhab/km<sup>2</sup>)
- ✓ highly industrialized
- ✓ high degree of soil sealing
- ✓ large-scale agricultural production
- ✓ high geographical heterogeneity (large Alpine region)
- ✓ high climatic variability

# State of the art

## Guidelines for the elaboration of a Regional CC Adaptation Strategy (RAS) in Lombardy Region, 2012



### Linee Guida per un Piano di Adattamento ai Cambiamenti Climatici (PACC) della Lombardia

Antonio Ballarin Dentì<sup>1,2</sup>, Giulio A. De Leo<sup>1,3</sup>, Mita Lapi<sup>1</sup>,  
Juan Terrades Mas<sup>1</sup>, Marisa Rossetto<sup>2</sup>, Rebeca Palencia Rocamora<sup>1</sup>

<sup>1</sup> Fondazione Lombardia per l'Ambiente, <sup>2</sup> Università Cattolica, <sup>3</sup> Stanford University, <sup>4</sup> Politecnico di Milano

#### Executive summary

#### SIGNIFICATO E NECESSITÀ DI UNA STRATEGIA DI ADATTAMENTO

Il presente studio ha l'obiettivo di fornire un quadro generale di indirizzo per la valutazione della vulnerabilità regionale agli impatti dei cambiamenti climatici, presentando altresì una metodologia con la quale analizzare diverse strategie e misure settoriali di adattamento nel territorio regionale lombardo, costituendo così la premessa per un percorso finalizzato alla successiva redazione di un organico PACC per la Lombardia

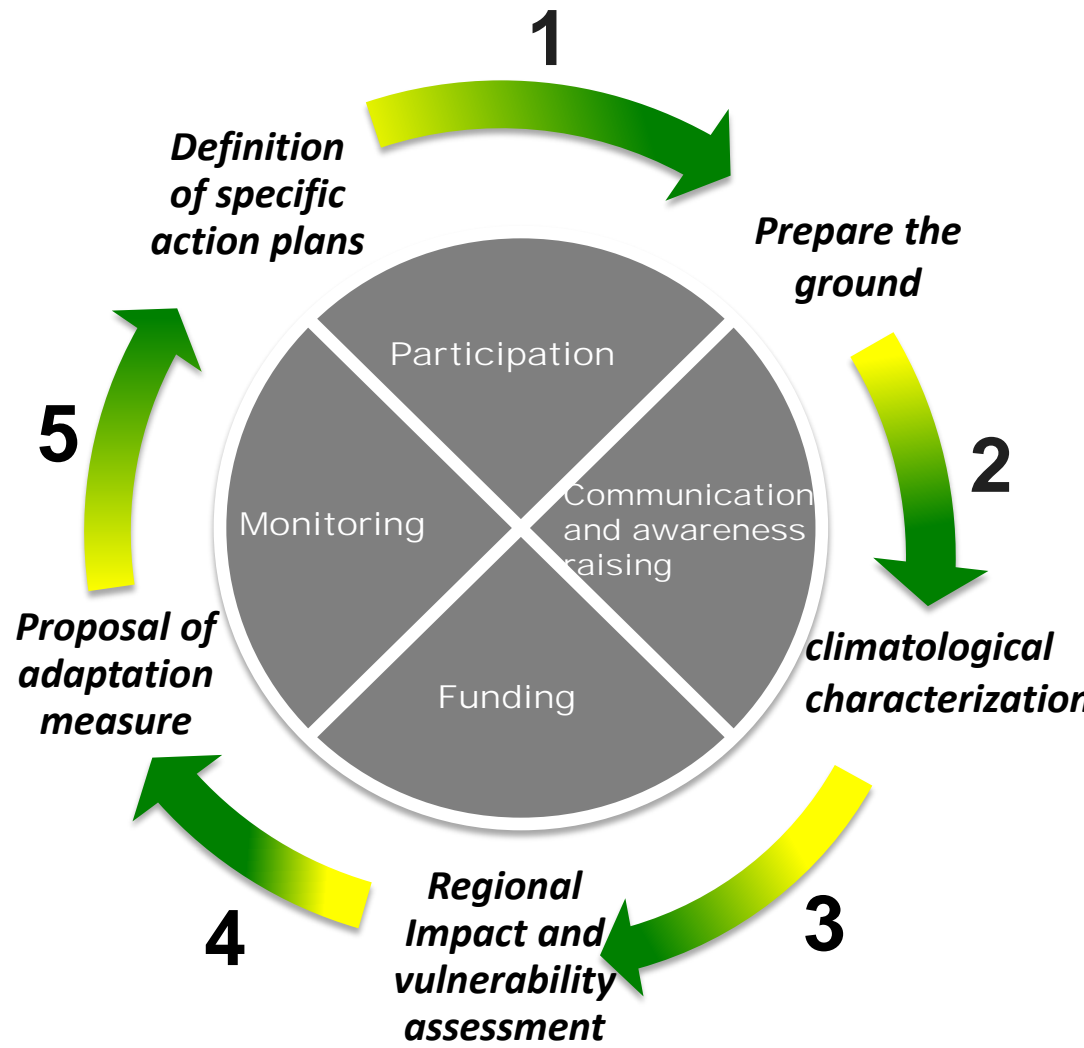
La lotta ai mutamenti del clima impone due tipi di risposta. La prima consiste nell'adozione di misure volte a ridurre le emissioni di gas serra, i cosiddetti interventi di **mitigazione**. La seconda consiste nell'intervenire per ridurre la vulnerabilità dei sistemi naturali e socio-economici, e aumentare la loro resilienza di fronte agli inevitabili impatti di un clima cambiante, cioè, interventi di **adattamento**. Rispetto alla prima tipologia di lotta, sono state intraprese molte iniziative in materia di controllo delle emissioni di inquinanti atmosferici e gas serra soprattutto nei paesi industrializzati.

Tuttavia, l'obiettivo della Convenzione Quadro delle Nazioni sui Cambiamenti Climatici (UNFCCC) e dei successivi trattati di stabilizzare le concentrazioni atmosferiche di gas a effetto serra è ancora ben lontano dall'essere raggiunto. Inoltre, anche se a livello planetario si riuscisse a ridurre anche sensibilmente le emissioni di gas serra, gli impatti del cambiamento climatico resterebbero elevati per almeno alcuni decenni a causa dell'inerzia del sistema climatico (IPCC, 2007). Di conseguenza vi è un urgente bisogno di valutare la vulnerabilità dei sistemi socio-economici e naturali alle conseguenze prevedibili del mutamento del clima, e avviare conseguenti strategie di adattamento.

La Lombardia, a causa della sua singolare posizione geografica e delle sue caratteristiche orografiche, territoriali e socio-economiche, presenta un'elevata vulnerabilità agli impatti del cambiamento climatico. È opportuno inoltre considerare che, mentre le azioni di mitigazione richiedono una risposta comune e coordinata a livello internazionale, le iniziative di adattamento ai cambiamenti climatici devono invece essere definite e messe in atto a livello nazionale e soprattutto regionale come è indicato anche dall'Unione Europea (White Paper for Adaptation to Climate Change, 2009).

[http://www.reti.regione.lombardia.it/cs/Satellite?c=Redazionale\\_P&childpagename=DG\\_Reti%2FDetail&cid=1213581345956&pagenam=DG\\_RS\\_SWrapper](http://www.reti.regione.lombardia.it/cs/Satellite?c=Redazionale_P&childpagename=DG_Reti%2FDetail&cid=1213581345956&pagenam=DG_RS_SWrapper)

Source : FLA, 2012



# Lombardy RAS: main elements expected

- **Evaluation** (and quantification) estimate of the **present and future CC impacts** at regional level for each sector;
- Evaluation of **sectoral vulnerabilities** to present and future climate;
- Possible estimation of **socio-economic costs of sectoral impacts**;
- Evaluation of **already implemented measures** in the **current sectoral policies**, concerning **adaptation co-objectives**;
- Evaluation of **adaptive capacity of each sector**;
- Proposal and possible estimate of **future adaptation measures per sector** and **cross-sectoral issues**, providing methodological support for **mainstreaming** the proposed measures into current sectoral policies, and **monitoring systems**;
- Implication of **decision-makers** and other **stakeholders** in the process throughout **participatory tools**;
- **Public information** and **dissemination** through workshops and online tools, as well as **networking**.

# RAS: Sectors and working program

## Main sectors

1. **Water resources: hydrological cycle, water quality, energy supply, drinking water and irrigation;**
2. **Structure and soil quality: stability of slopes, land degradation and desertification;**
3. **Built environment, transport and mobility;**
4. **Air quality and human health;**
5. **Ecosystems, forests, biodiversity and protected areas;**
6. **Agriculture.**
7. **Tourism.**

## Working program

### **Phase 0.**

*collection of basic documentation and organization of the RAS*

### **Phase I.**

*Construction of the climatic bases of the RAS*

### **Phase III.**

*Sectoral impact and vulnerability assessment*

### **Phase IV.**

*Definition of the lines of action for the adaptation process*

### **Phase V.**

*Definition of the specific actions and measures for adaptation*



# Outline

## I. TOWARDS A REGIONAL ADAPTATION STRATEGY IN LOMBARDY

- **State of the art**
- **First steps of the regional strategy**

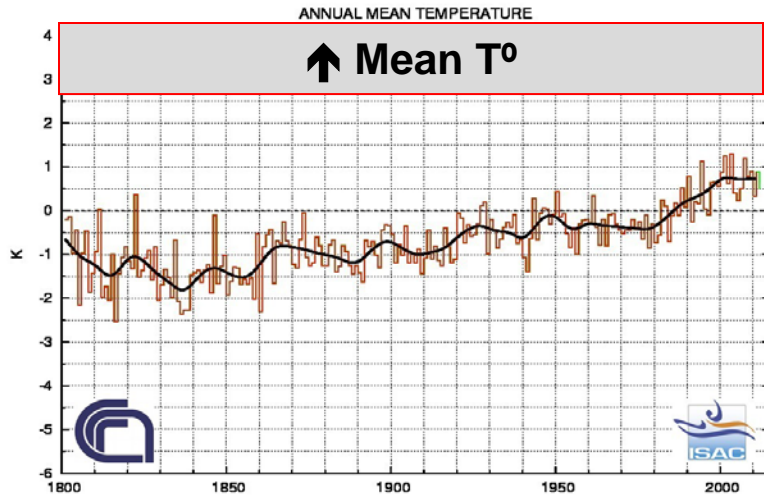
## II. IMPACTS OF CLIMATE CHANGE IN WATER RESOURCES

- **Climatic stressors**
- **Main impacts**

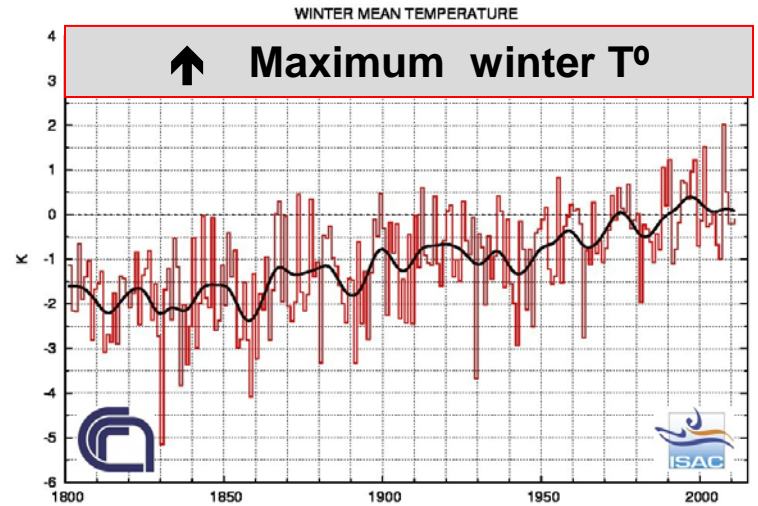
## III. MAIN CHALLENGES AND RECOMENSATIONS FOR ADAPTATION

- **Methodology**
- **Recommendations**

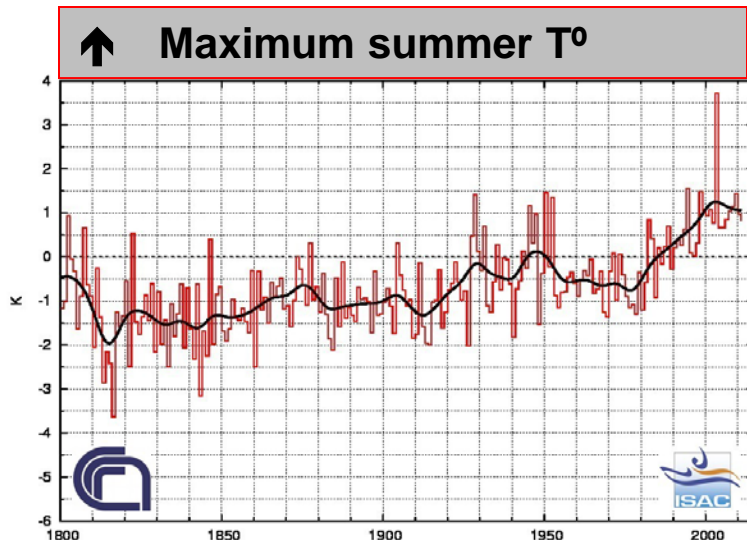
# Climatic stressors: temperatures



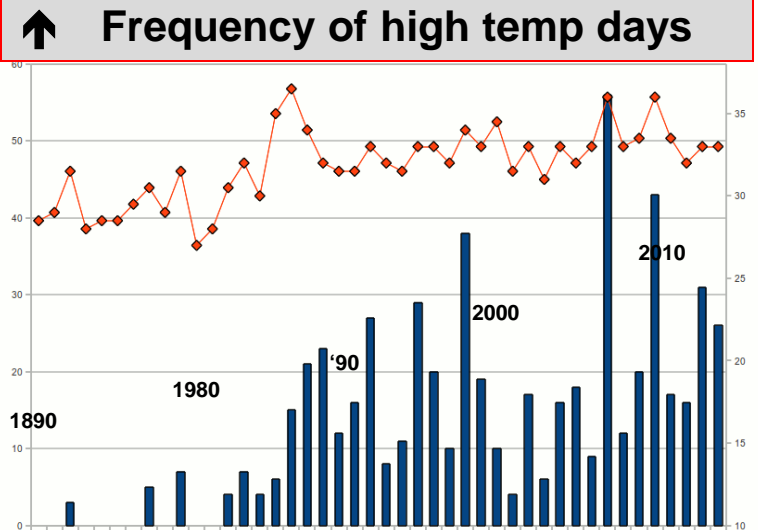
Trend of average temperature anomalies in the North of Italy compared with the period 1961-1990. Data source: ISAAC 2012



Andamento delle anomalie delle temperature massime invernali per il Nord d'Italia, rispetto al periodo 1961-1990. Fonte: ISAAC 2012



Trend of anomalies of maximum summer temperatures in the North of Italy compared with the period 1961-1990. Source: ISAAC 2012

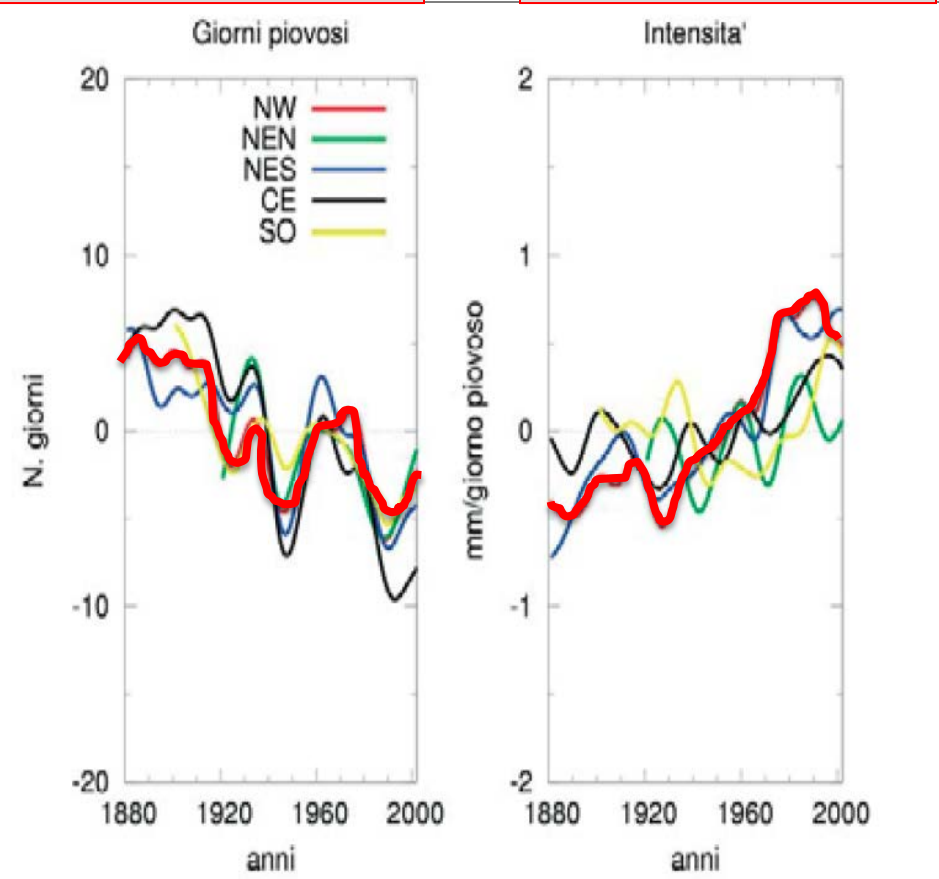


Number of days per year that exceeded 30 degrees in temperature (blue bars) and the maximum temperature reached for Varese. Data source: Geophysical Centre Prealpino - Weather Statistics

# Climatic stressors: precipitations

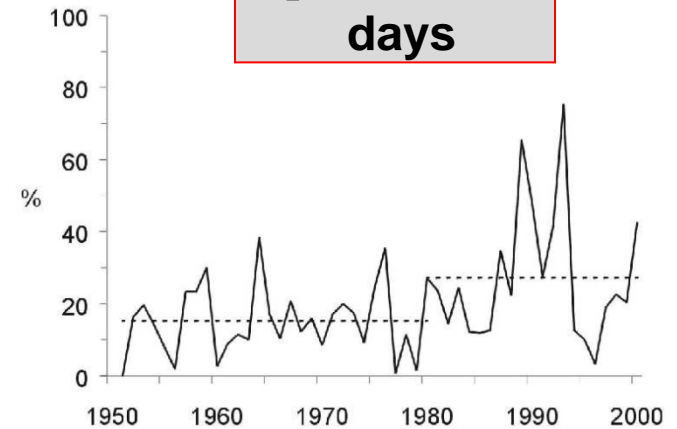
↓ N° number of rainy days

↑ Rainfall intensity

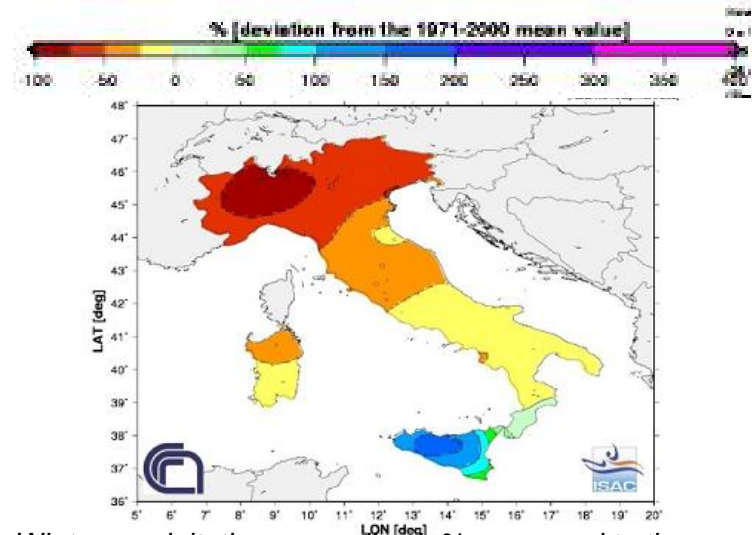


Trend of the number of rainy days and rainfall intensity in different Italian regions, during the period 1880-2006.

↑ Drought days



evolution of winter drought days in northern Italy.  
Source : Brunetti et al. 2002



Winter precipitation anomalies in% compared to the average of the period 1971-2000. Source: ISAC CNR, 2012.

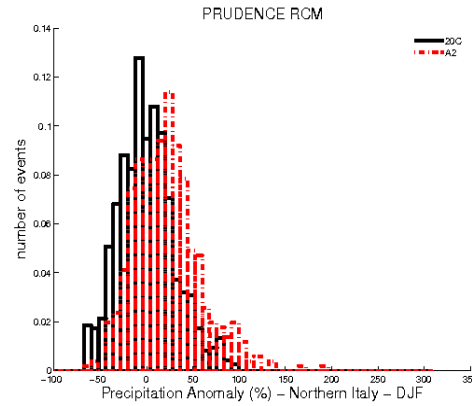
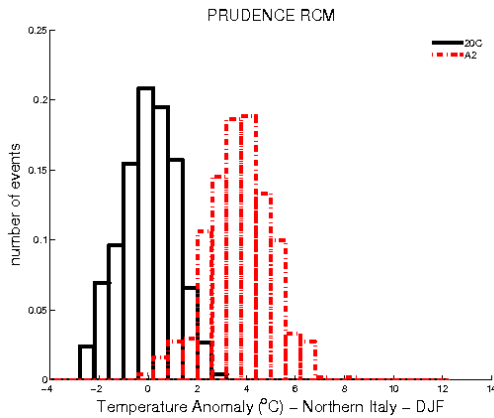
# Climatic projections: increase climate variability

## Distribution of seasonal temperatures

## Distribution of seasonal rainfall

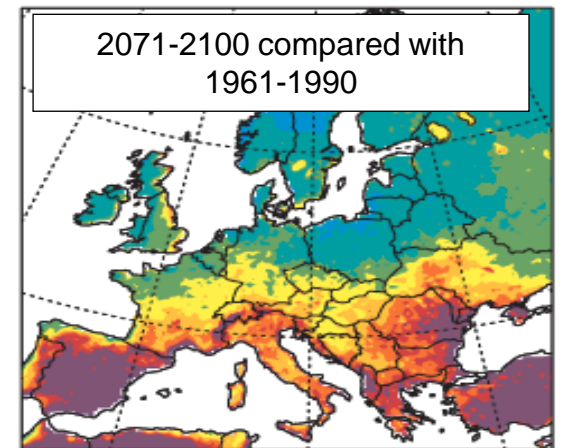
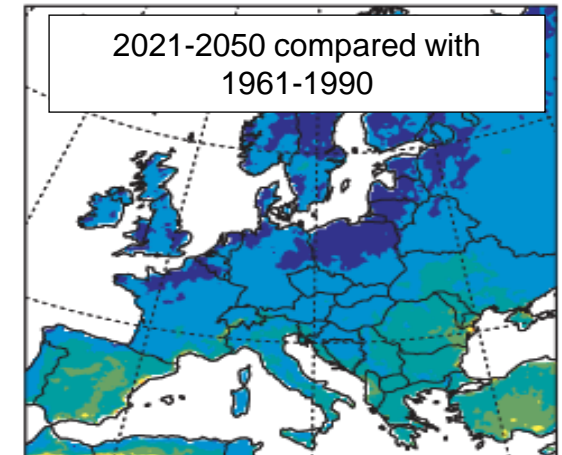
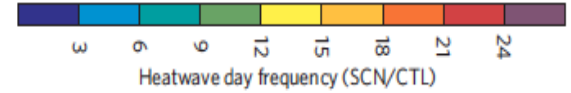
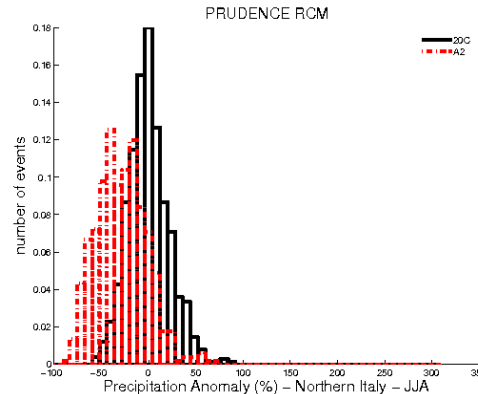
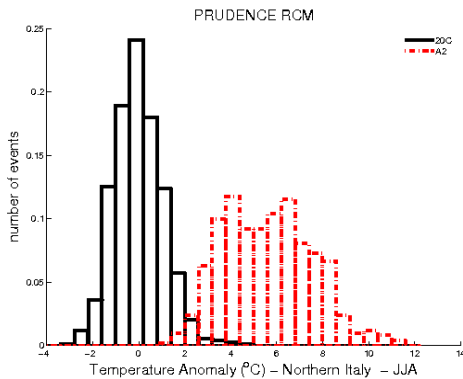
## Frequency of heatwaves

Winter

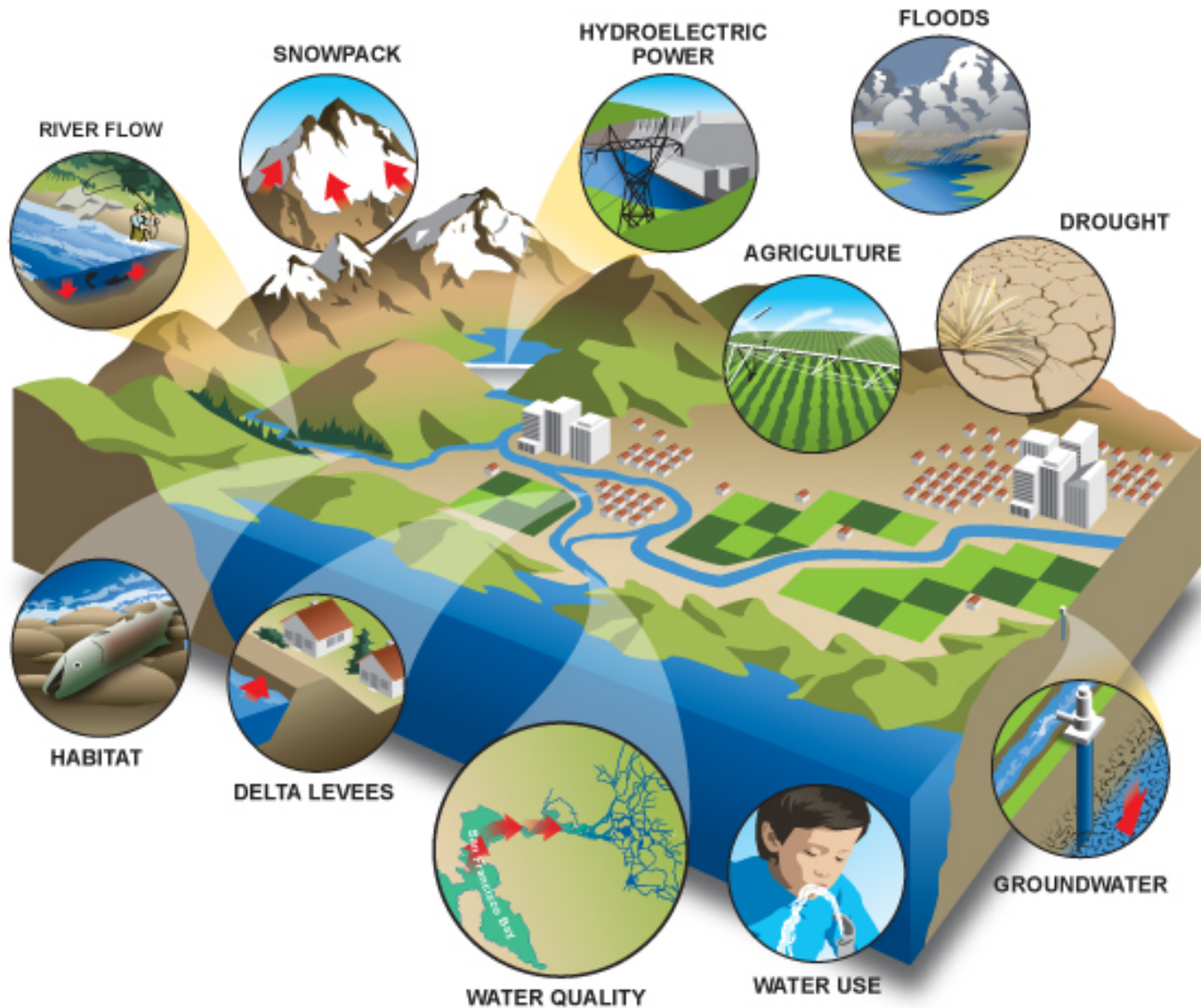


Red Histograms = projected values for 2070-2100  
Black Histograms = average values 1961-1990

Summer



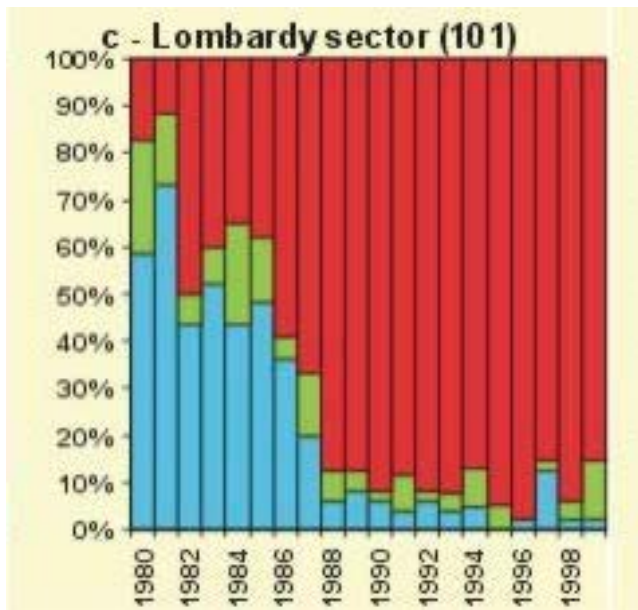
# Main impacts



# Main impacts

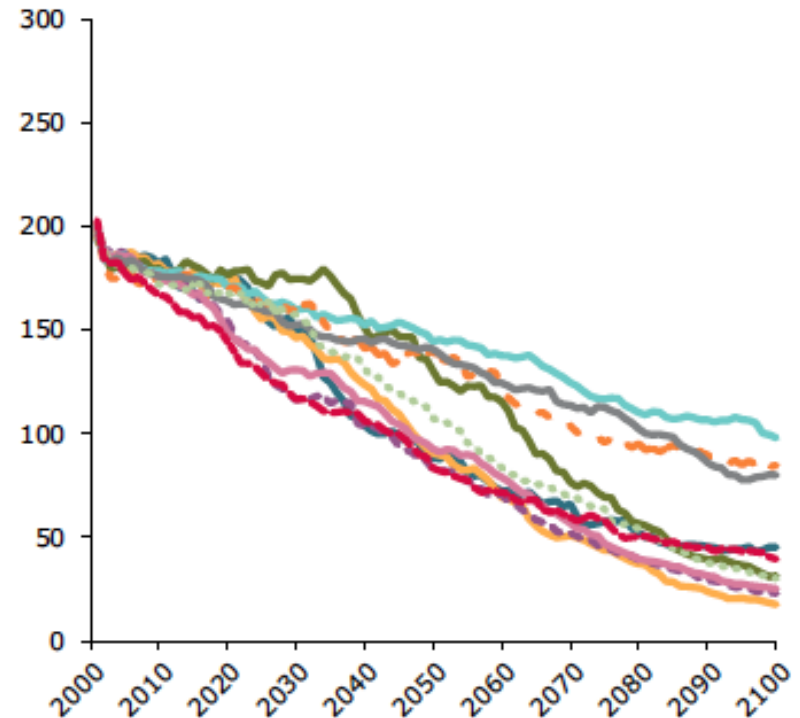
## ★ Glacier retreat

### Glaciers retreat in the Lombardy Alps



Percentage of advancing glaciers (blue), stationary (green) and retreating (red) in the Alps in 1980-1999, Source: Comitato Glaciologico Italiano, 2006)

Projected changes in the volume of mountain glaciers and ice cap of European Alps (in km<sup>3</sup>, for 10 different models)

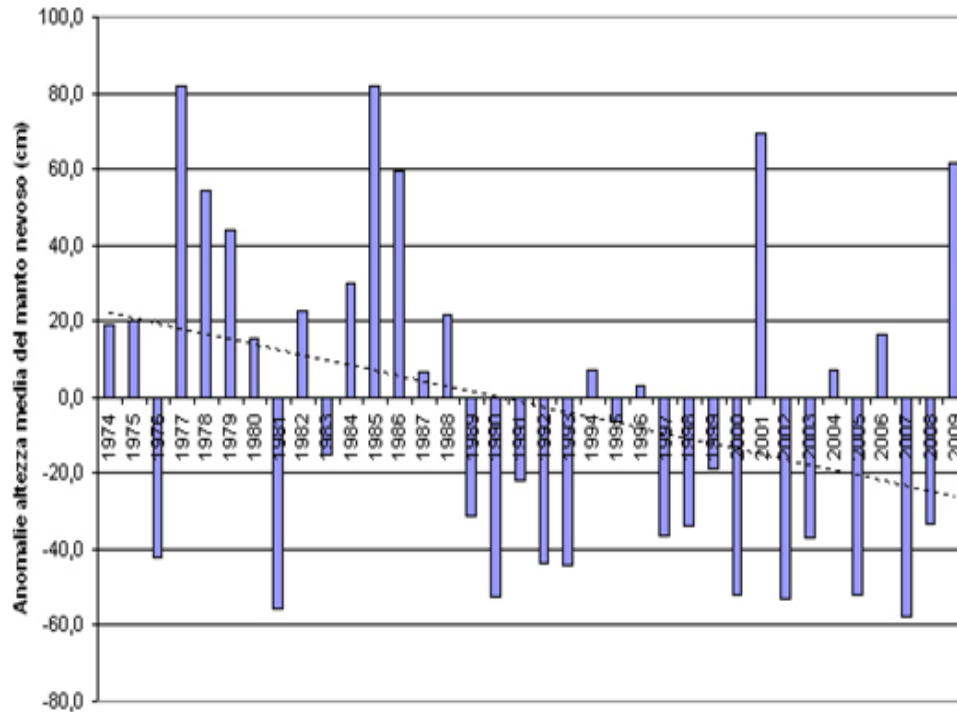


Source: Impacts of Europe's changing climate. Indicator-based assessment, 2012

# Main impacts

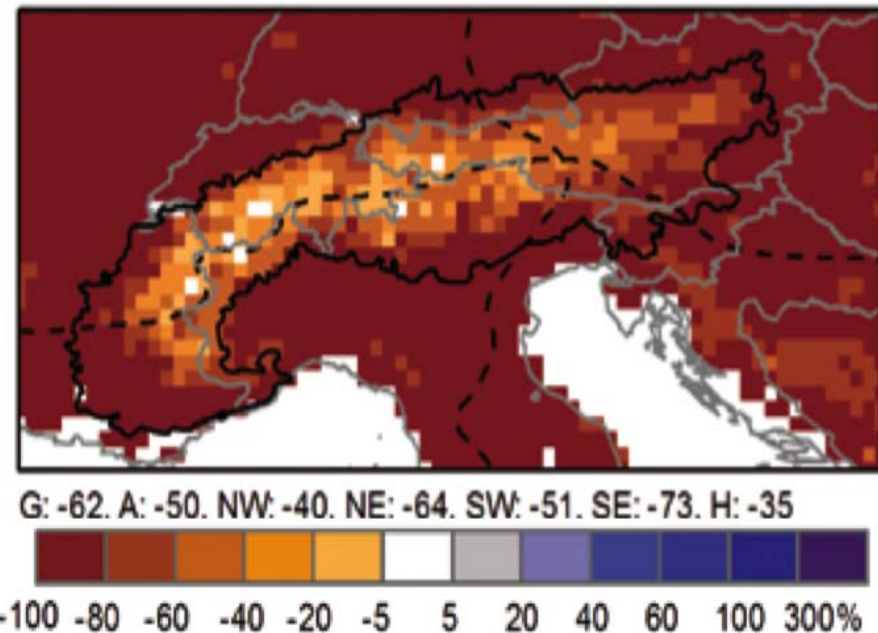
## ★ Snowpack loss

Snowpack anomalies in Lombardy (in cm) between 1974-2009



Source: ARPA Lombardia

Prediction of the relative difference (in%) on days with snow cover for 2070-2100, respect to between 1961-1990 (SRES A1)

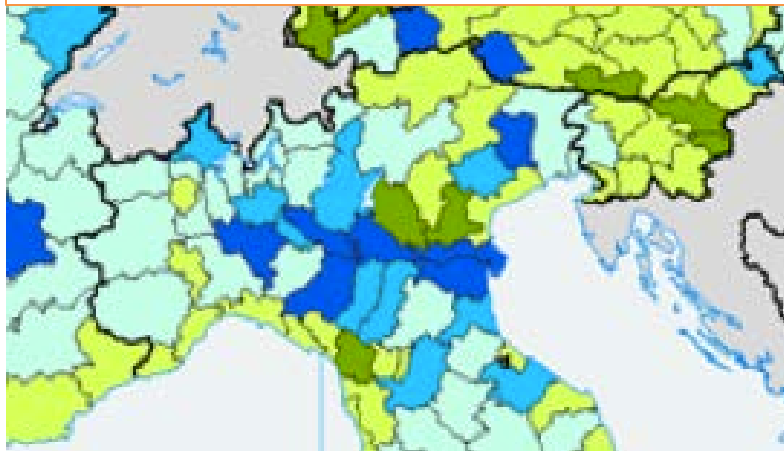


Source: Lautenschlager, 2008

# Main impacts

## ★ Changes in seasonal runoff and increase in hydro-geological hazards

Change in regional population affected by river floods (% of total population, change between 2001-2100, A2 scenario)

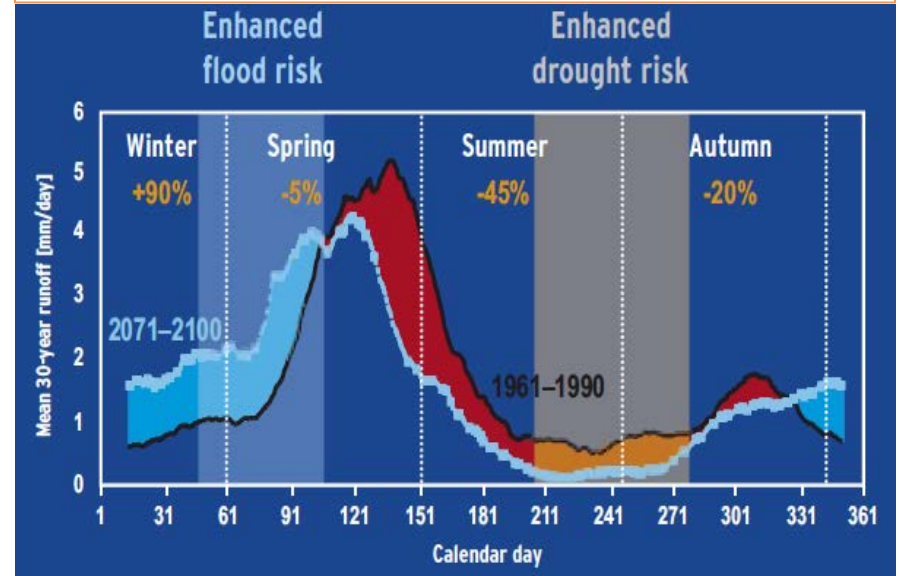


Change of population affected by river floods

Change expressed in % of total population



Projected changes in runoff for the period 2071-2100 in the central Alps, compared with the period 1961-1990



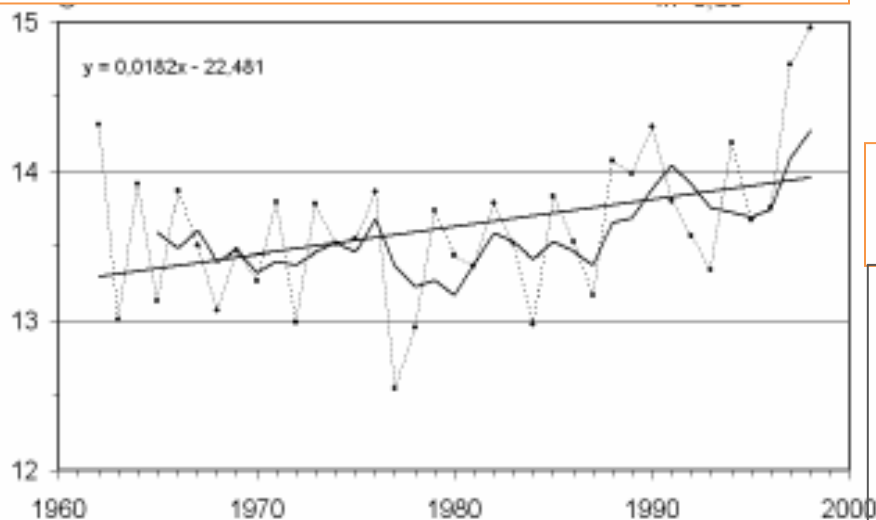
Source: Beniston. 2006



# Main impacts

## ★ Increase of water temperature and decrease of water quality

Evolution of mean water temperature (°C) of Lago Maggiore lake measured at 0.5 m deep (1960-2000)



Source: Ambrosetti et al. 2006

Algal bloom episodes in the main subalpine lakes over 1975-2005

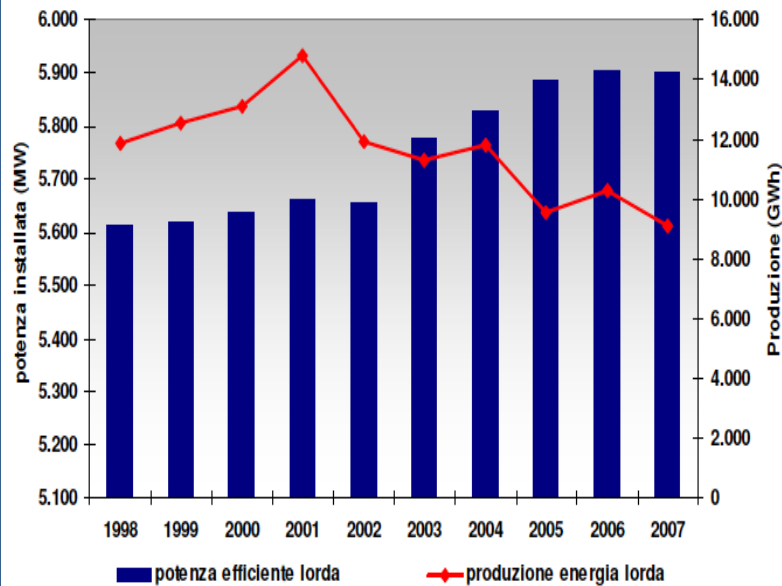
	<i>Anabaena lemmermannii</i>	<i>Planktothrix rubescens/ag.</i>	<i>Microcystis aeruginosa/flos-aquae</i>
Garda	1990		(1990-1992)
Iseo	1997	1998	<b>2006</b>
Como	<b>2006</b>		anni '80-2000-2003
Lugano		(1980-85)	<b>(2006)</b>
Maggiore	<b>2005</b>		

Periods in brackets represents isolated phenomena during such period (from SALMASO, 2005). In bold data illustrate new bloom events detected after 2004. Source: Mosello et al. 2010

# Main impacts

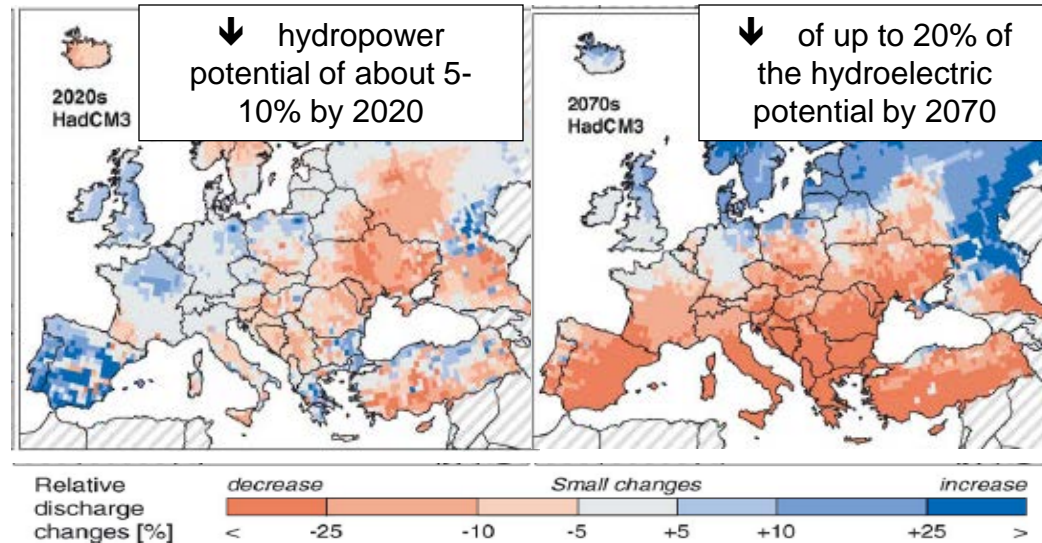
## ★ Reduction of water storage capacity

Overall reduction of about - 30% of hydropower production since 1998 ( respect an increase of + 10% in power capacity)



Source: Piano d'Azione per l'Energia, aggiornamento 2008.TERNA, 2008

Projected decrease in hydropower production capacity

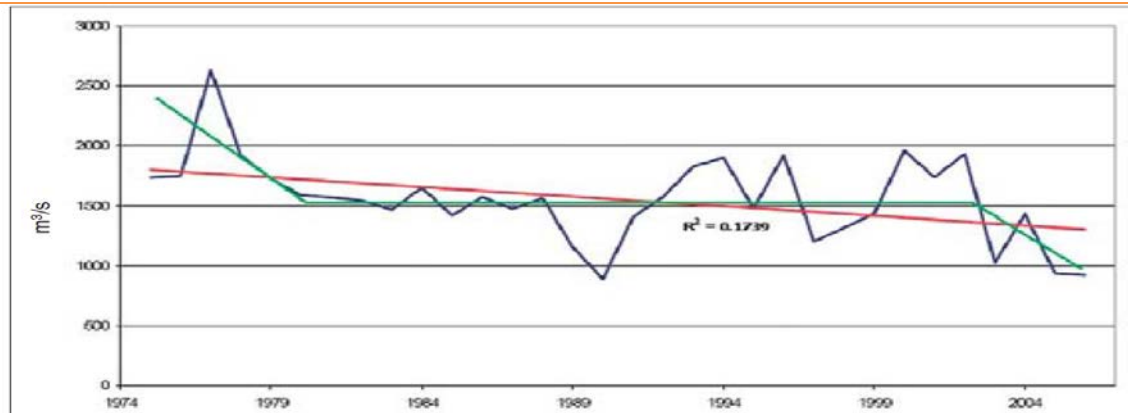


Relative changes in the annual runoff of the main European rivers by 2020 and 2070 compared to the 1961-1990 runoff average value: climate model HadCM3. Source: Lehner et al., 2005.

# Main impacts

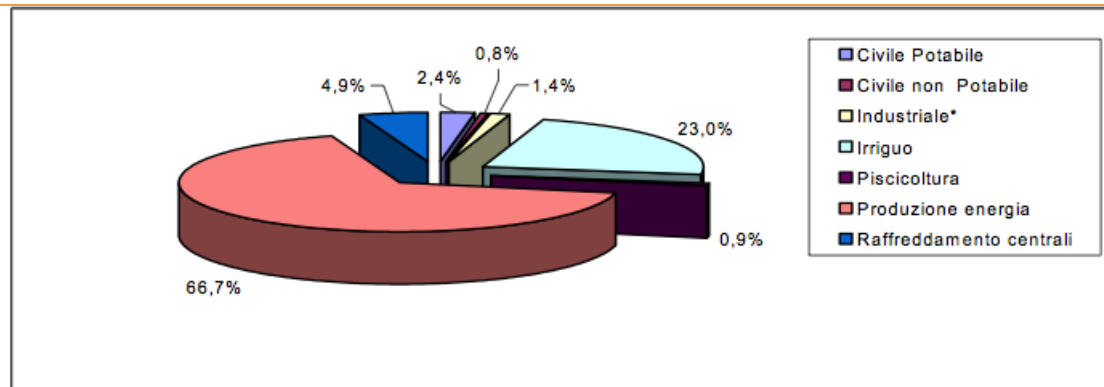
## ★ Imbalance between supply and demand of water resources

### Trend of the average annual flow of the Po River at Pontelagoscuro



Source:  
ARPA Emilia  
Romagna, 20  
07

### Water concessions in % per sector in Lombardy



- 1° Hydropower
- 2° Irrigation
- 3° Cooling TPP
- 4° Drinking water

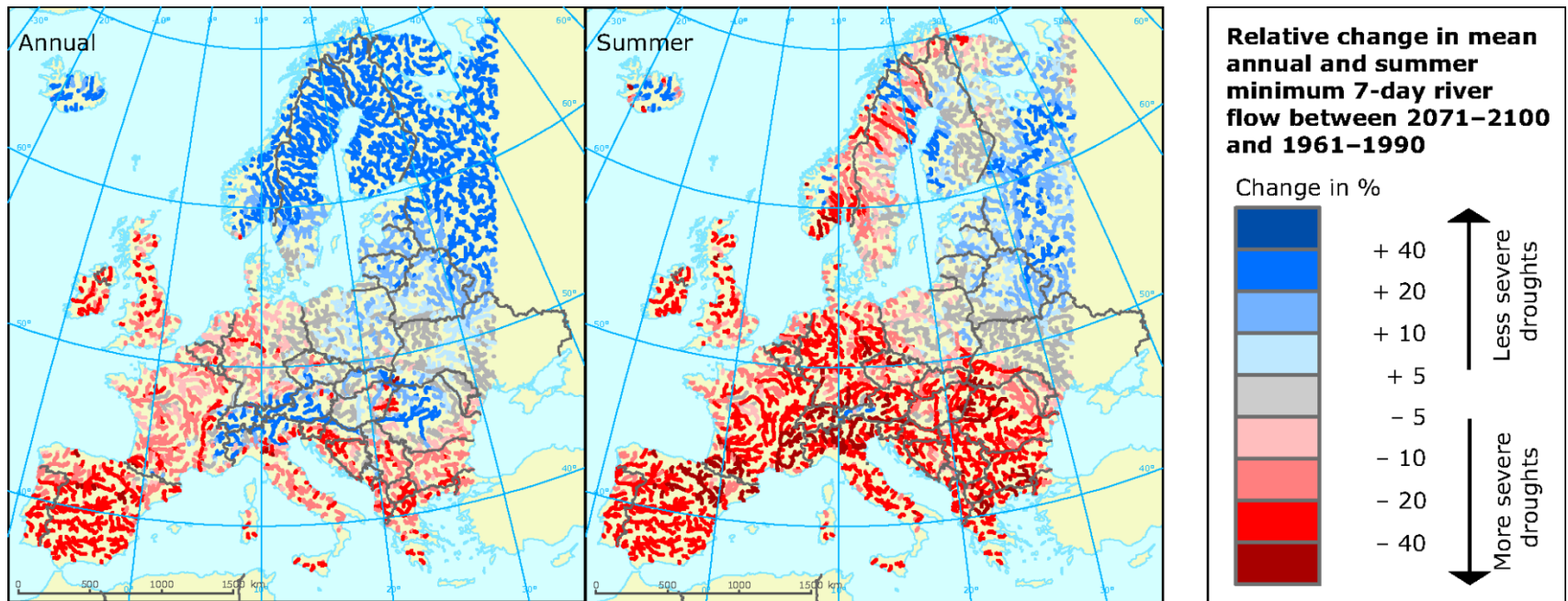
Source: PITUA 2006,  
Programma di Tutela e  
Uso delle Aque in  
Lombardia

\*Industriale al netto del raffreddamento termoelettrico

# Main impacts

## ★ Reduction of (summer) river flow and ecosystem risk (minimum instream flow endangered)

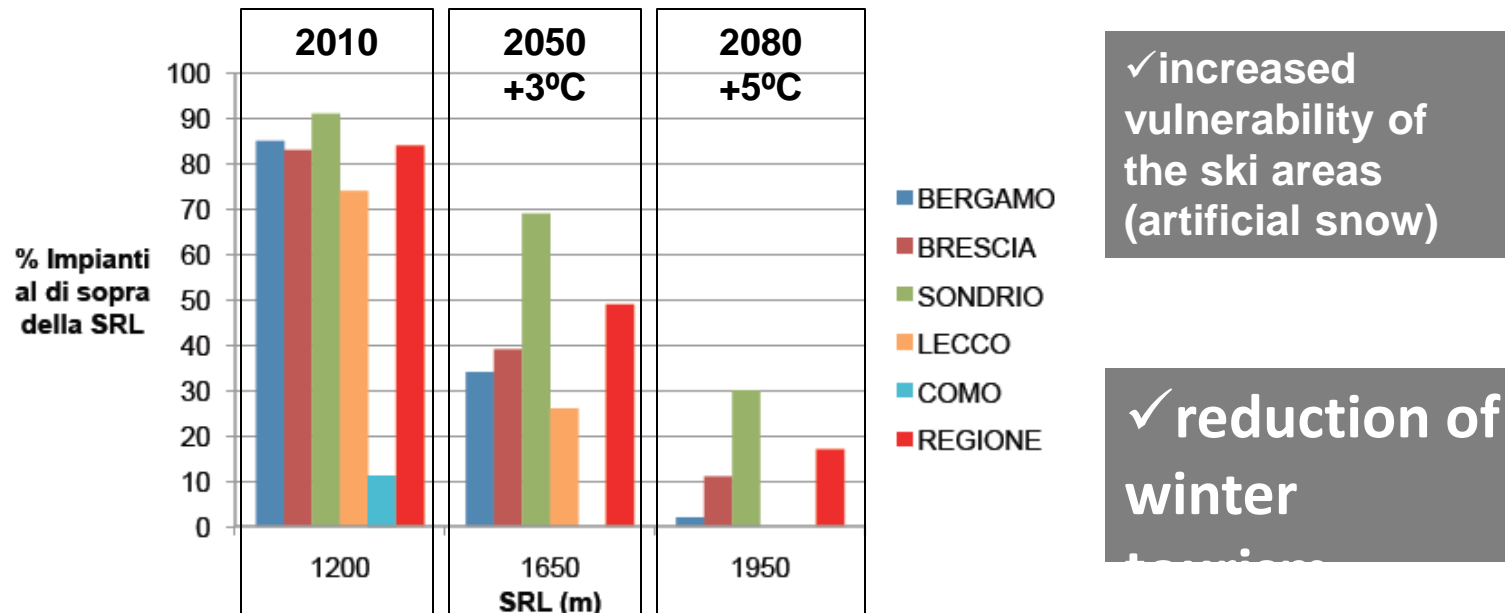
Projected change in mean annual and summer minimum 7-day river flow between 2071-2100 and the reference period 1961-1990



# Main impacts: tourism

## 4. TOURISM

### 1 ✓ Snowline rise



Projections of % of snow lifts above the Snow Reliability Line in Lombardy using scenario A2. Source: own elaboration from data of Kyoto Lombardy Project, FLA 2008.

✓ Increase of glacial hazards in mountain zones

✓ Water quality decrease for bathing

# Outline

## I. TOWARDS A REGIONAL ADAPTATION STRATEGY IN LOMBARDY

- **State of the art**
- **First steps of the regional strategy**

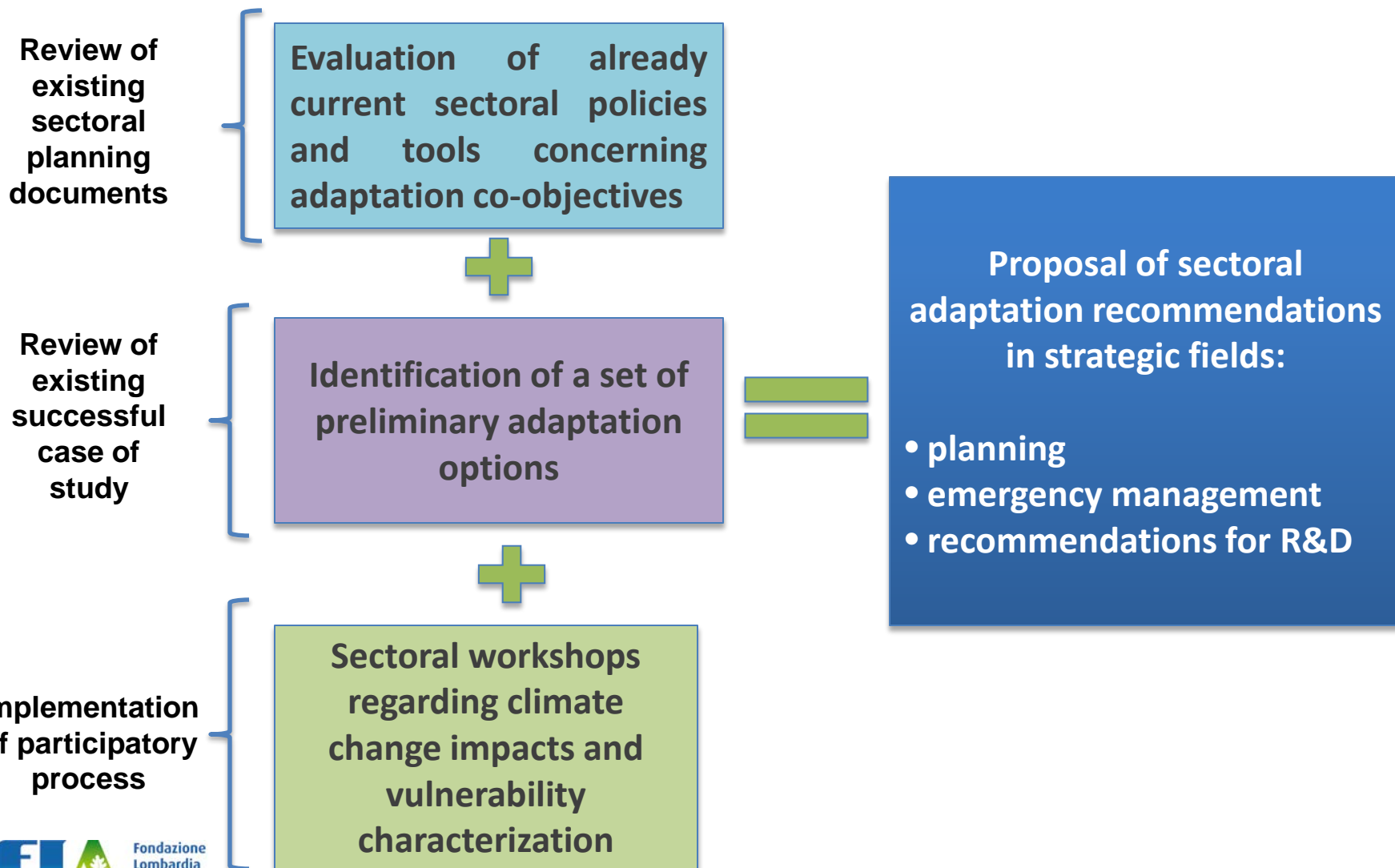
## II. IMPACTS OF CLIMATE CHANGE IN WATER RESOURCES

- **Climatic stressors**
- **Main impacts**

## III. STRATEGIC RECOMMENDATIONS FOR ADAPTATION

- **Methodology**
- **Recommendations**

# Proposal of strategic adaptation directions: Methodology



# Planning

- ❑ Improve the computerized mapping database of the minor hydrographic networks.
- ❑ Check the legal framework of water management at regional level (distribution rules and procedures of water storage, revision of legal provisions on low water, discharges, lake regulation).
- ❑ Regionalization and networking of the supply of drinking water and treatment of wastewater.
- ❑ Set up a high altitude snowpack monitoring network system.
- ❑ Ensure progressive legal compliance with the minimum river flow and water quality standards in accordance with the Water Framework Directive and ensure the safety of large-scale dams.
- ❑ Optimize current water reservoirs as well as agricultural and farming systems and techniques.
- ❑ Reinforce current monitoring systems for water resources and consumption (water level forecasts for the Po river, trans-regional info).
- ❑ Ensure the required space for revitalization, flood control and a healthier ecology for watercourses so that they can fulfill their natural functions.



# Emergency management

- ▣ **Identification of emergency measures to reduce and restrict consumption in case of severe drought;**
- ▣ **Integration of management protocols to reduce untreated water spills in current emergency plans and crisis;**
- ▣ **Optimize transport capacities during low water periods by implementing specific measures along waterways.**

# Recommendations for R & D

- ❑ **Build up a Regional water demand model starting by an accurate census of water users and their consumption (improve the current regional cadastre of water users);**
- ❑ **Improve regional modeling of climate and water regime developing different scenarios (short, medium and long term), with a high level of downscaling;**
- ❑ **Intensify research regarding new technologies and hydraulic systems to save water, improve water treatment systems and water recycling;**
- ❑ **Building a model application from a detailed survey of water users and their consumption;**
- ❑ **Create incentives/funding mechanisms for watershed management (at interregional and transnational level);**
- ❑ **Refine water balances at watershed level.**

*Thank you for your attention*

