PROJECT RICLIC – WARM

Regional Impact of CLImatic Change in Lombardy WAter Resources: Modelling and applications.

EGU General Assembly - WIEN, APRIL 20, 2007

REGIONAL IMPACT OF METEOROLOGICAL EXTREME EVENTS: CLIMATIC CAUSES AND SOCIO-ECONOMIC EFFECTS

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FINAL GOALS

DEVELOP A SCIENTIFIC METHODOLOGY TO ASSESS CLIMATIC IMPACTS ON WATER RESOURCES AND PROVIDE A SUPPORT TO DECISION-MAKING PROCESSES ON WATER MANAGEMENT

RICLIC-WARM

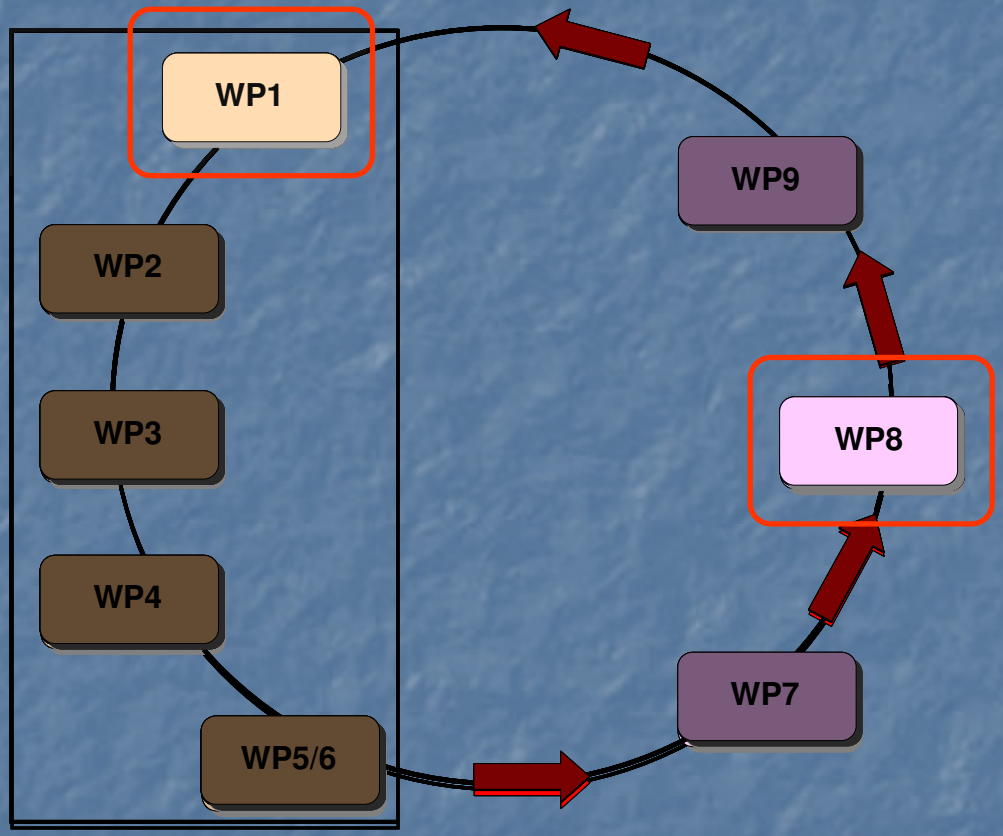
SCIENTIFIC RESEARCH UNITS

- University of Milano-Bicocca (UNIMIB)
- University of Milano (UNIMI)
- University of Pavia (UNIPV)

REGIONAL PUBLIC AUTHORITY

- Regione Lombardia
- ARPA Lombardia (Regional environmental protection agency)

PROJECT FRAME



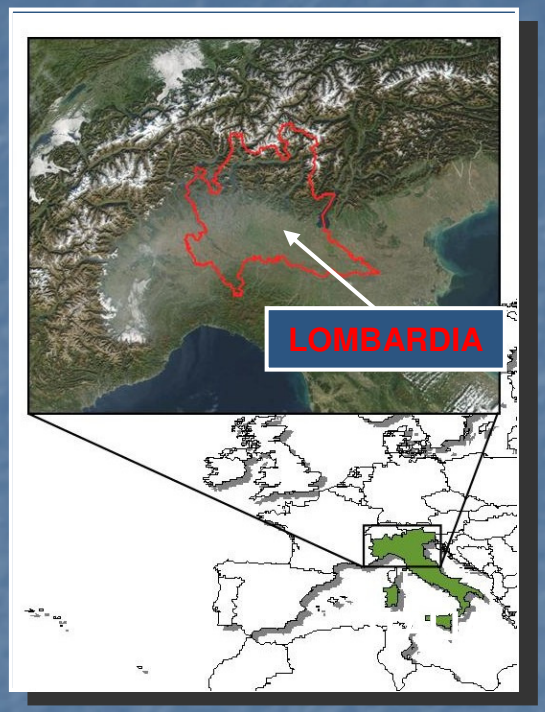
WP1
CLIMATIC DATASET MANAGEMENT

Prof. Valter Maggi
DISAT
University of Milano - Bicocca

WP8
DAMAGES AND RISK EVALUATION

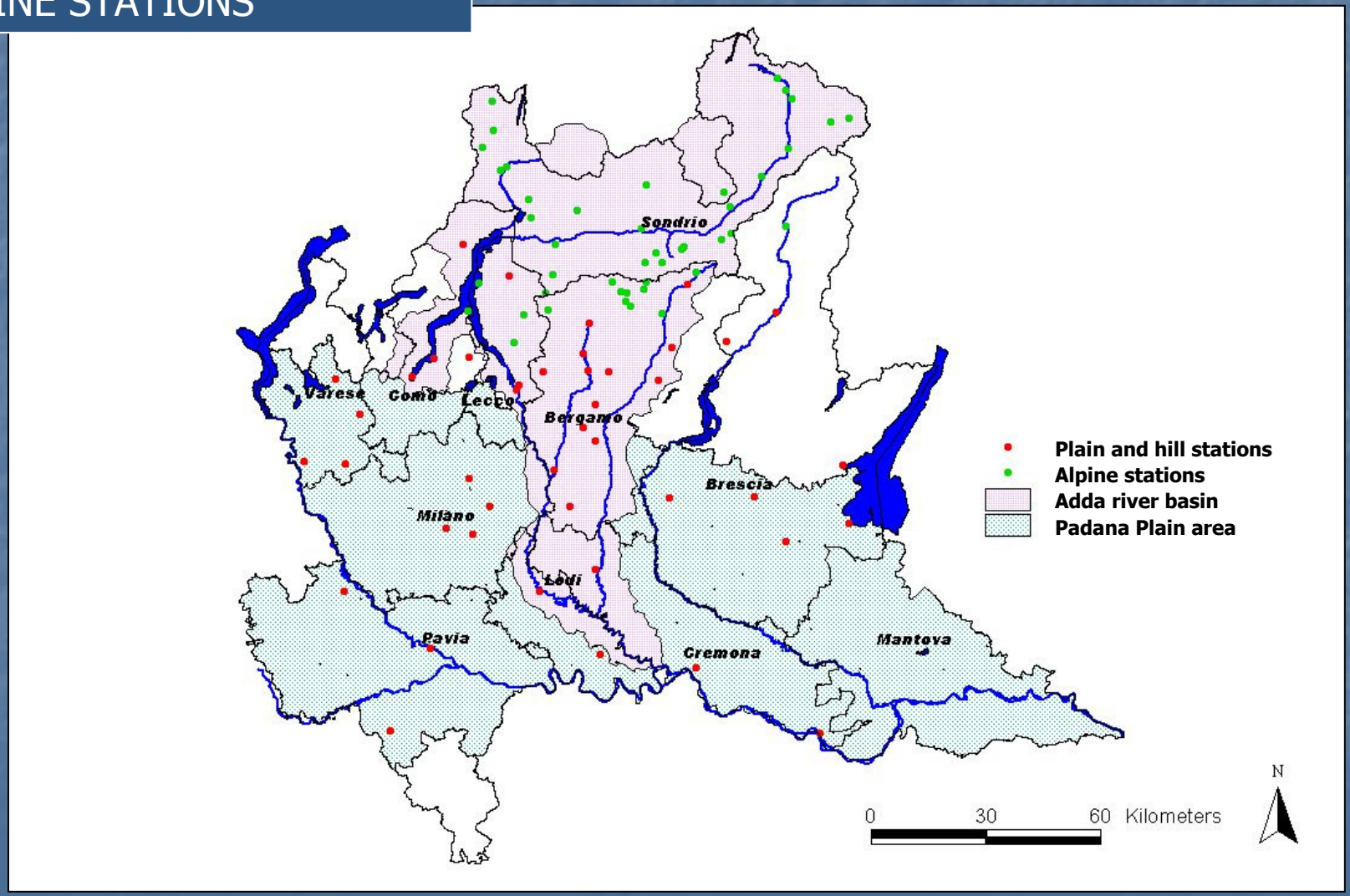
Prof. Paolo Giacomelli
DEPAAA - University of Milano

STUDY AREA

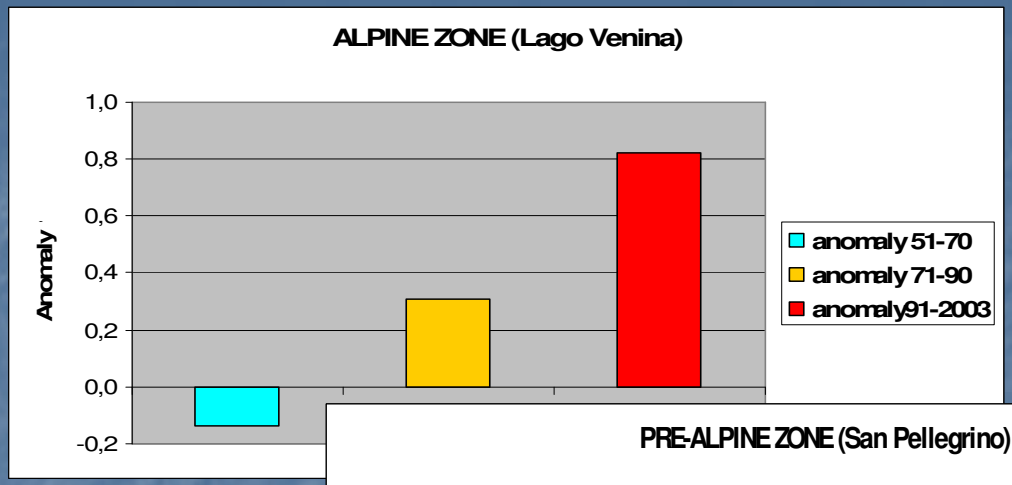


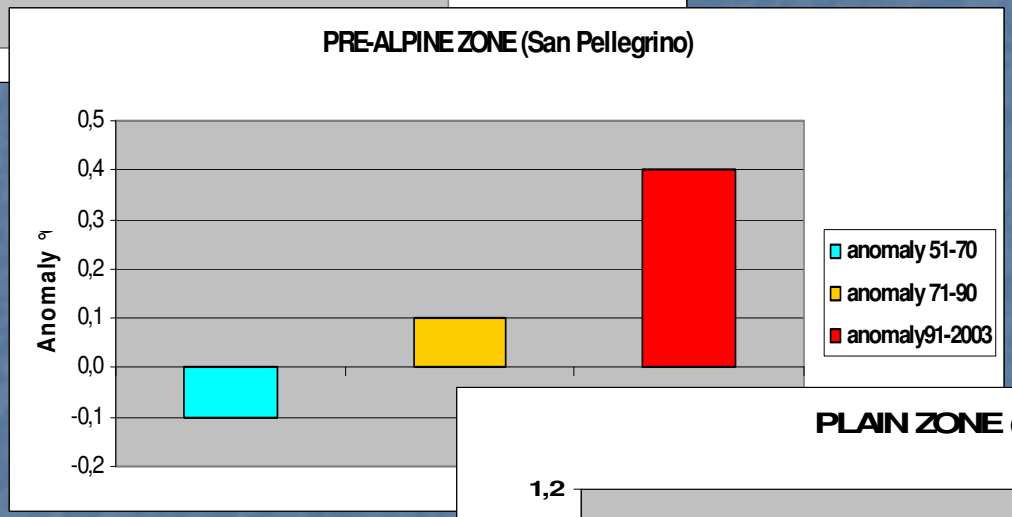
METEO-CLIMATIC STATIONS

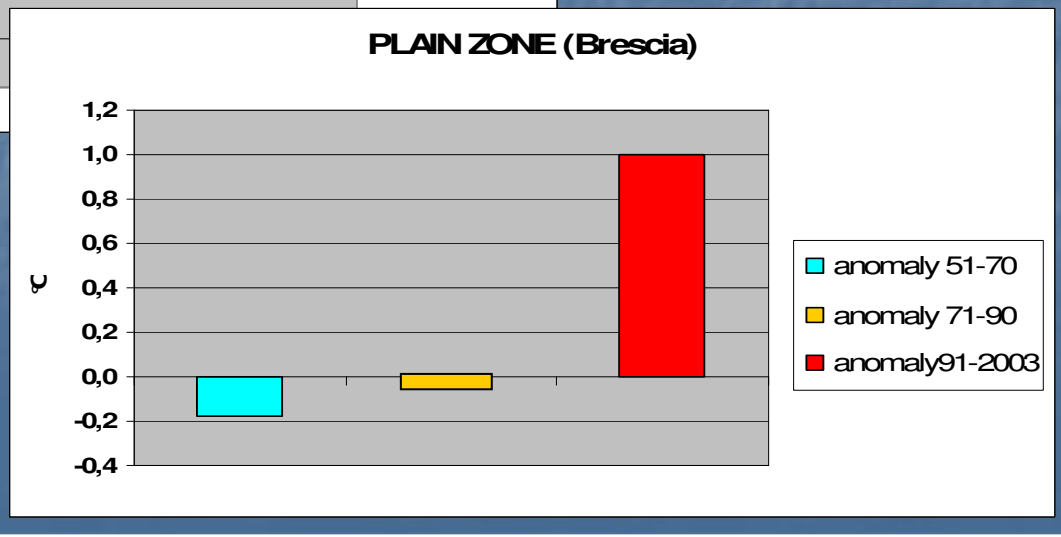
44 PLAIN AND HILL STATIONS
44 ALPINE STATIONS



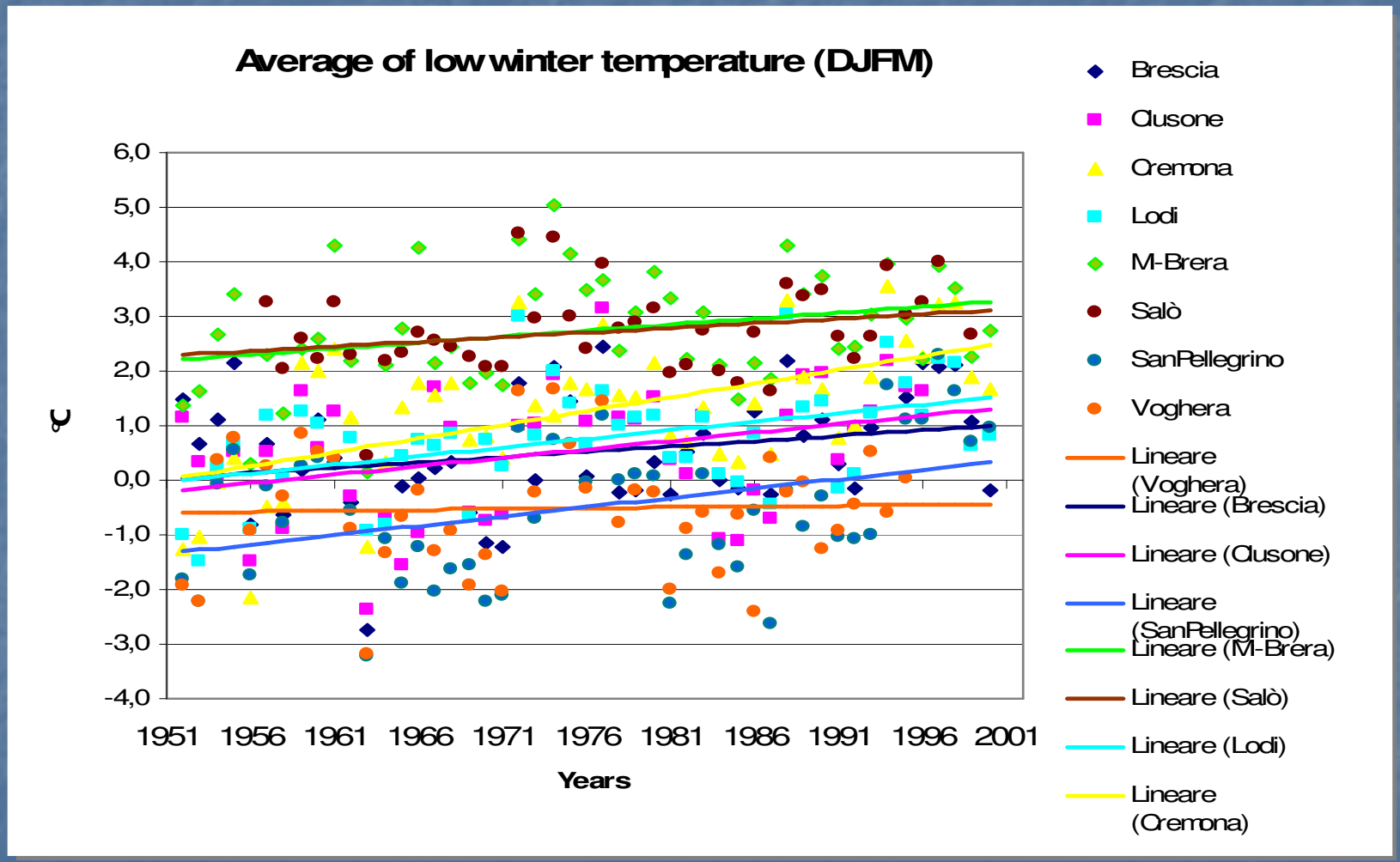
YEARLY MEAN TEMPERATURES ANOMALIES





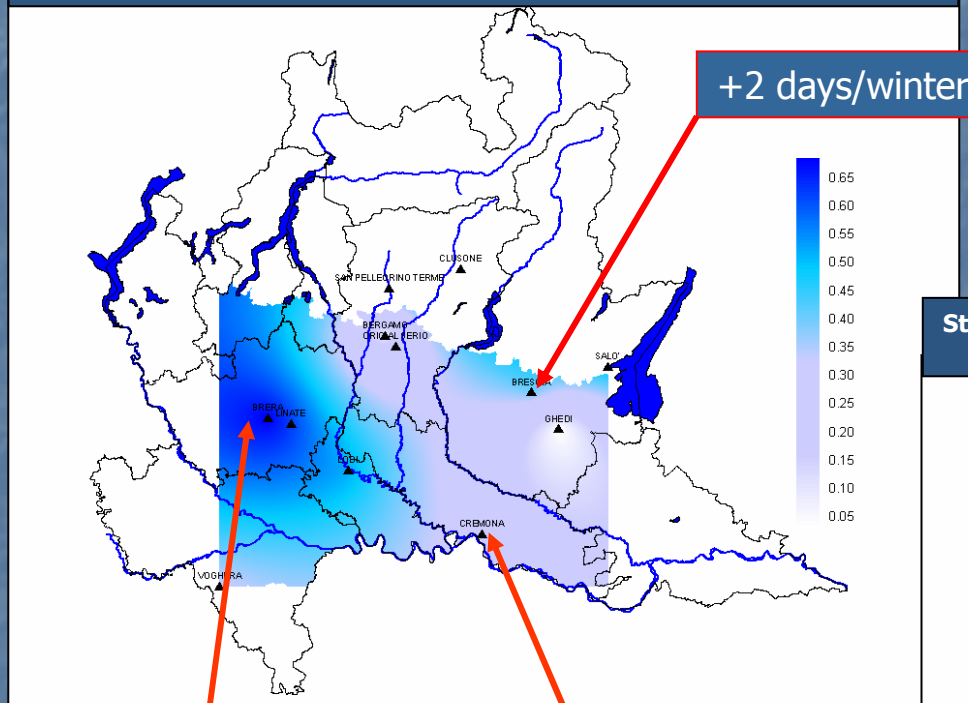


LOW WINTER TEMPERATURES



NUMBER OF FROSTY DAYS VARIATION

Standardized average anomalies of frosty days 1962-1970 in comparison to baseline 1961-1990

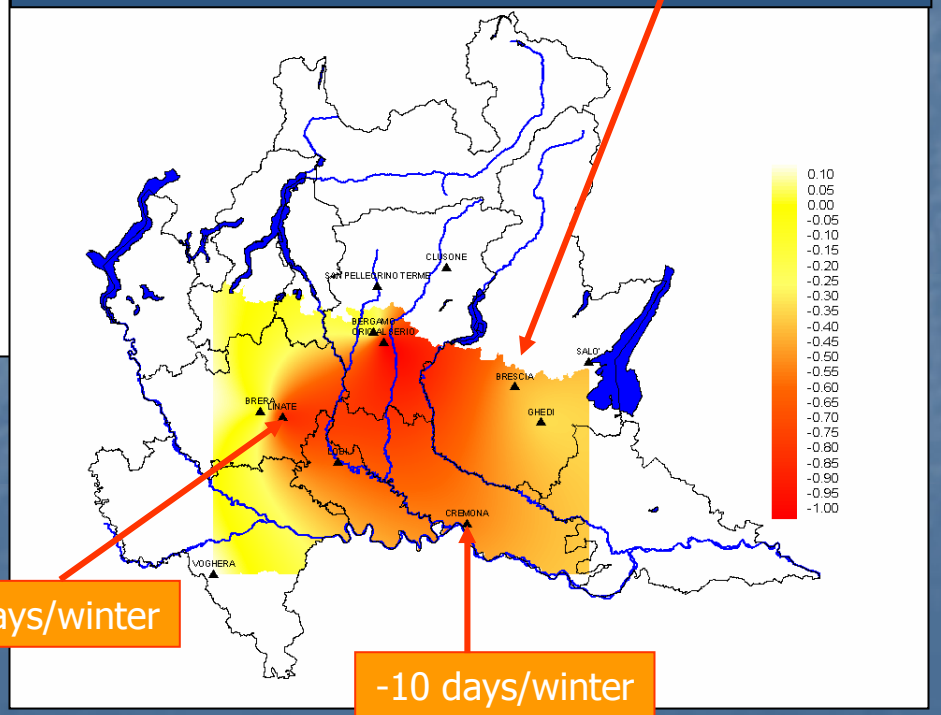


+2 days/winter

+12 days/winter

+5 days/winter

Standardized average anomalies of frosty days 1988-1996 in comparison to baseline 1961-1990

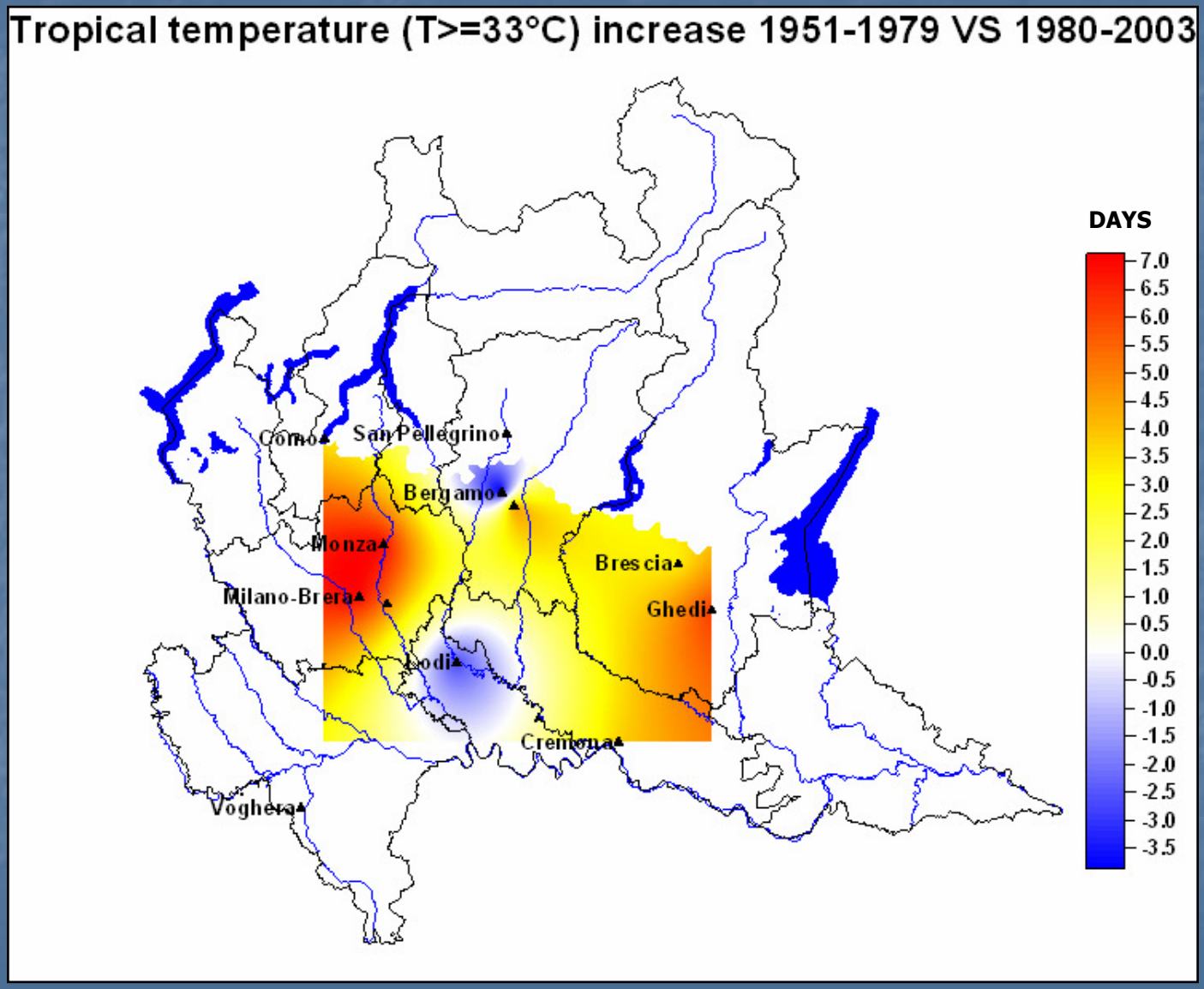


-12 days/winter

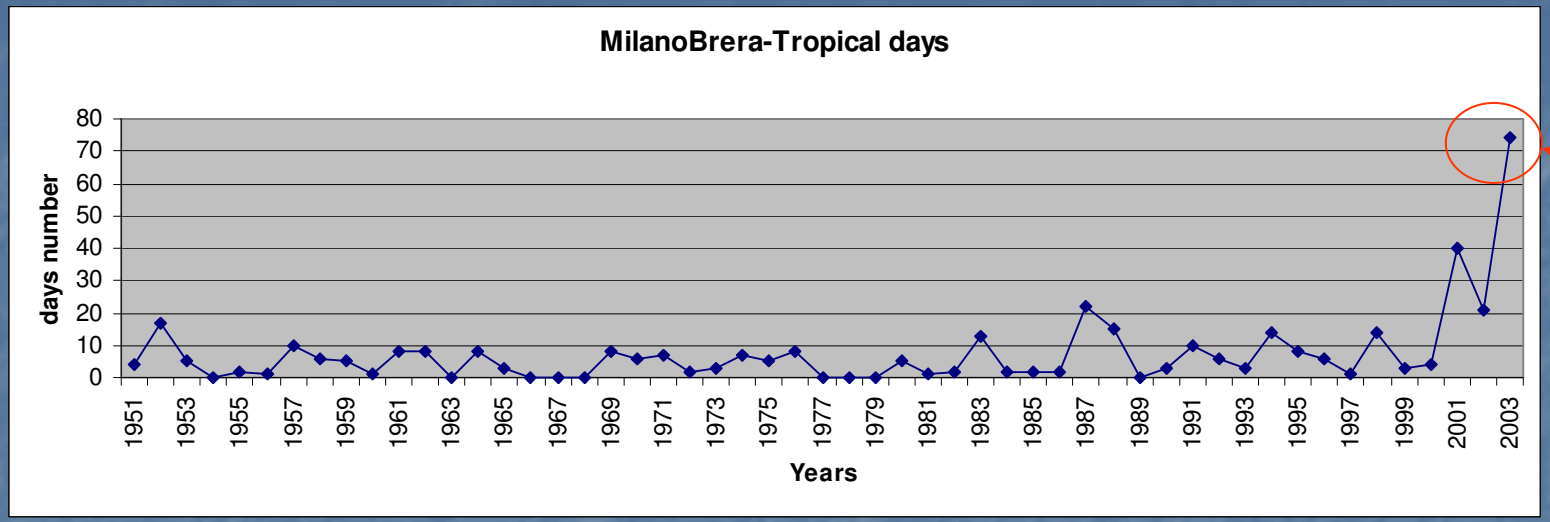
-16 days/winter

-10 days/winter

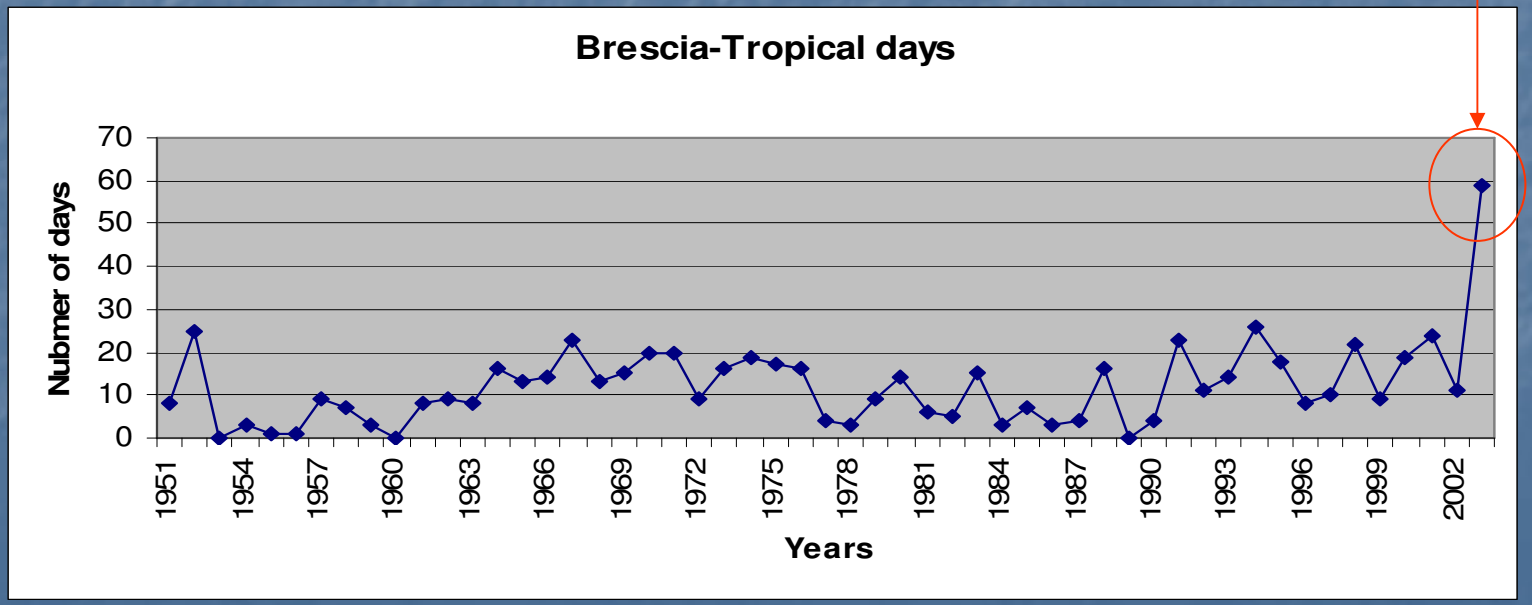
TROPICAL TEMPERATURE DAYS



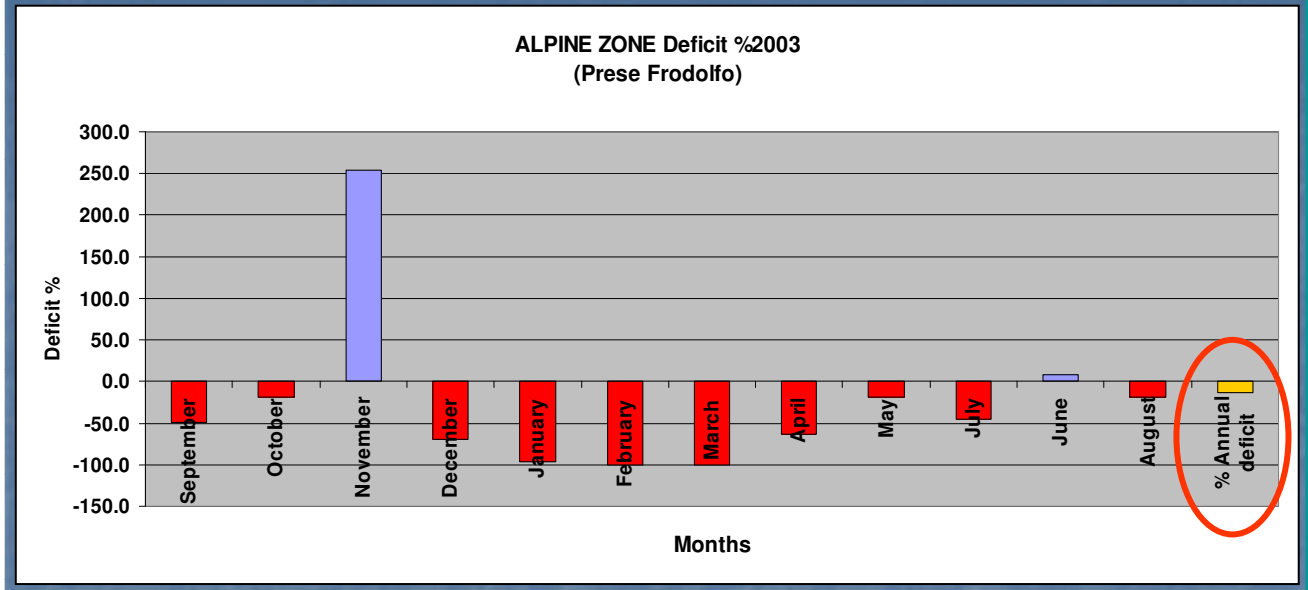
TROPICAL TEMPERATURE DAYS



YEAR 2003

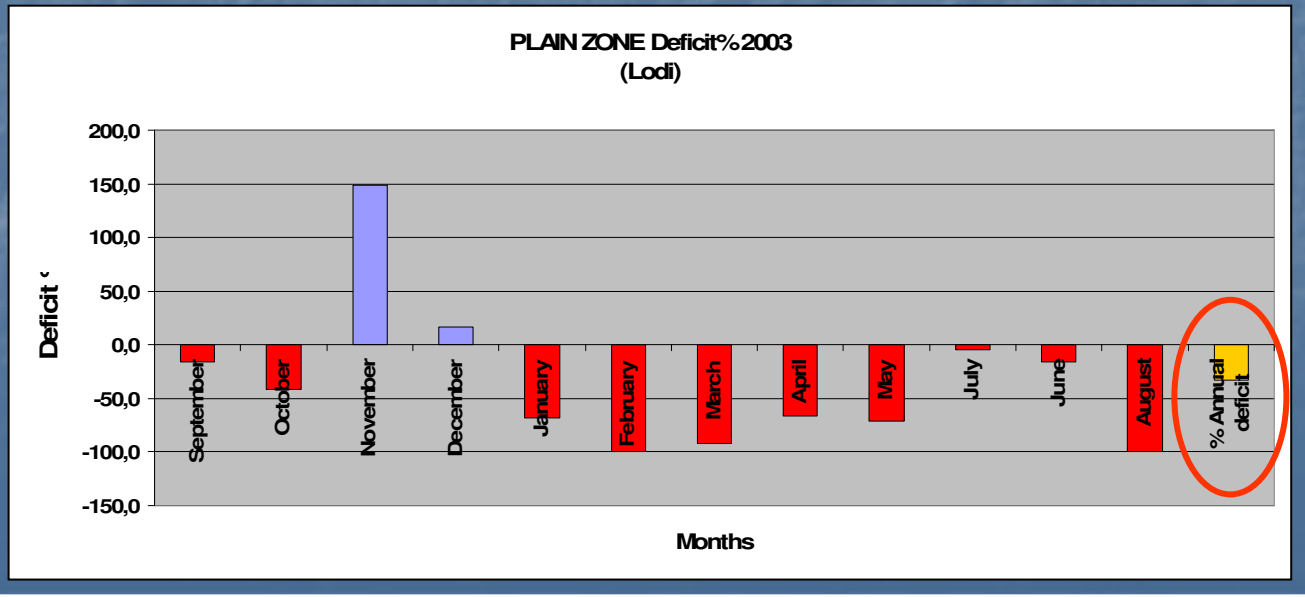


HYDROLOGICAL YEAR 2003: RAINFALL DEFICIT

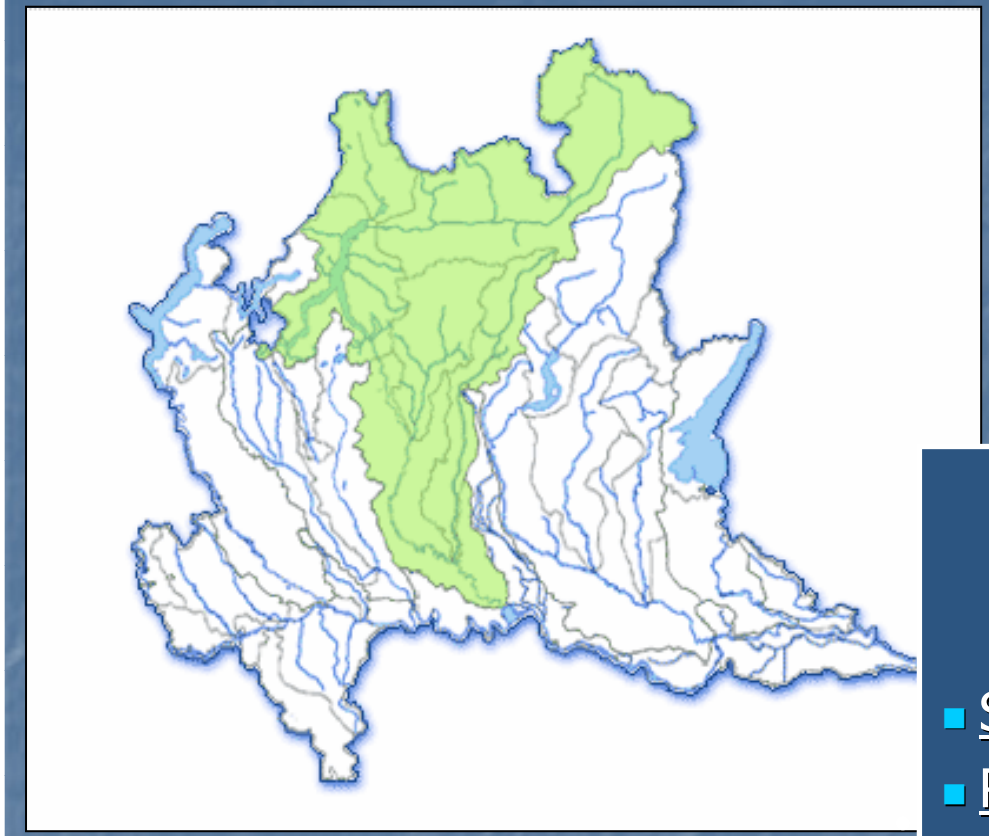


Alpine zone (Prese Frodolfo)	Baseline 1961-1990 (mm)	Year 2003 (mm)	deficit % 2003
September (2002)	73,8	37,0	-49,9
October (2002)	58,4	47,4	-18,9
November (2002)	68,1	241,0	253,9
December (2002)	38,9	11,6	-70,1
January	38,2	1,4	-96,3
February	30,7	0,0	-100,0
March	34,4	0,0	-100,0
April	52,0	19,2	-63,1
May	88,4	72,0	-18,5
July	76,9	42,4	-44,9
June	80,5	87,2	8,3
August	94,0	76,4	-18,7
Annual total	734,3	635,6	
%Annual deficit			-13,4

Plain zone (Lodi)	Baseline 1961-1990 (mm)	Year 2003 (mm)	deficit % 2003
September (2002)	57,3	48,0	-16,2
October (2002)	93,3	54,5	-41,6
November (2002)	81,9	203,5	148,4
December (2002)	54,0	62,7	16,2
January	57,2	18,0	-68,5
February	57,8	0,0	-100,0
March	66,1	5,5	-91,7
April	71,3	24,0	-66,3
May	76,4	22,0	-71,2
July	58,5	56,0	-4,2
June	49,3	41,5	-15,8
August	78,3	0,6	-99,2
Annual total	801,3	536,3	
%Annual deficit			-33,1



ADDA RIVER BASIN



MAIN CHARACTERISTICS

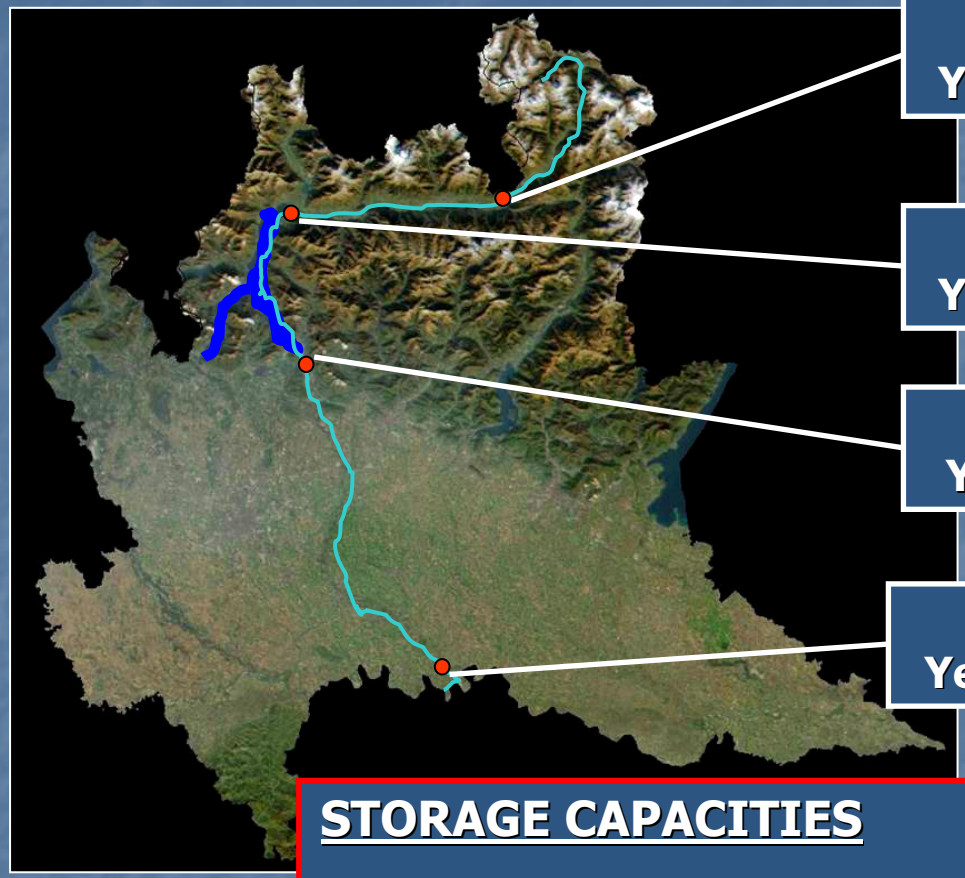
- SURFACE DRAINED: 7.927 kmq
- RIVER LENGHT: 313 km
- ALTITUDE RANGE:

  -Sources of Adda: 2.237 m asl

  -Mean lake Como elevation: 198 m asl

  -Join with Po river: 36 m asl

ADDA RIVER BASIN



TIRANO (441 m asl)
Year average discharge : 26,75 m^3/s

FUENTES (198 m asl)
Year average discharge: 88,0 m^3/s

MALGRATE (198 m asl)
Year average discharge: 158,2 m^3/s

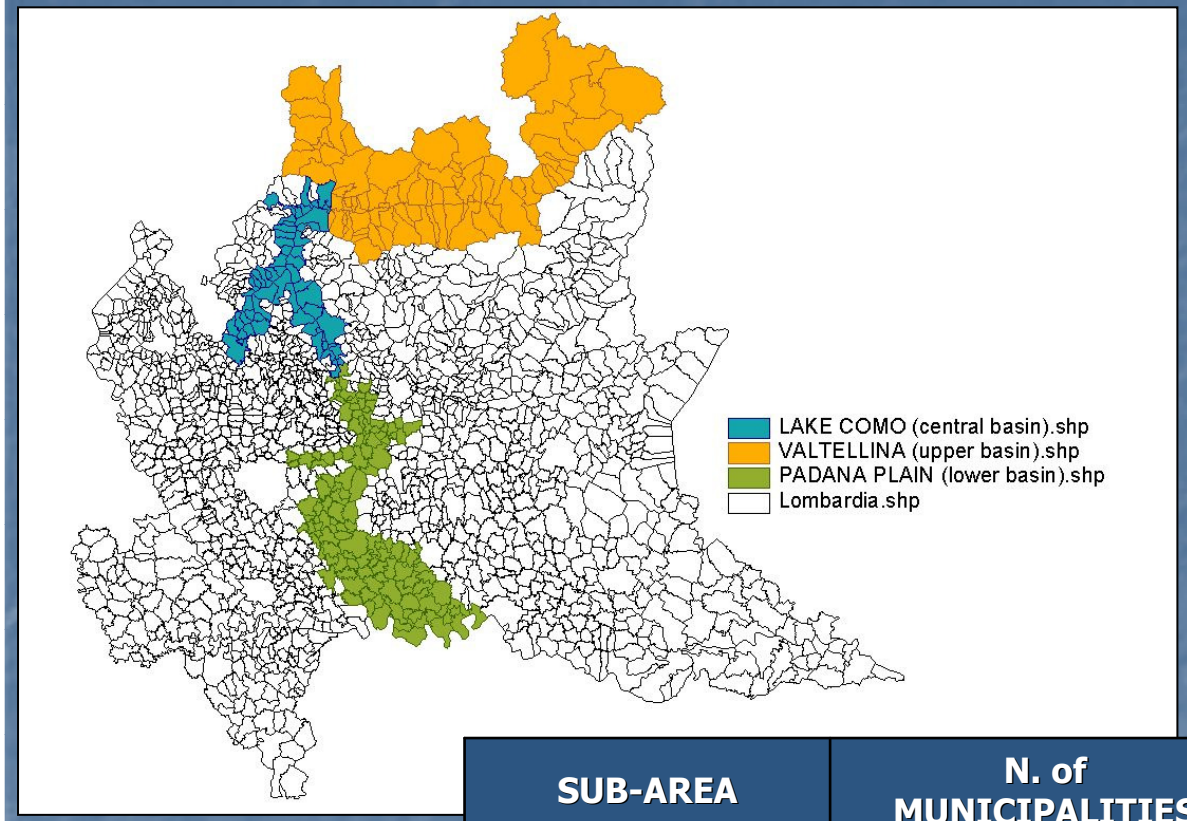
JOIN WITH PO RIVER (36 m asl)
Year average discharge: 287,72 m^3/s

STORAGE CAPACITIES

- **LAKE COMO**
  - **-Absolute capacity: 22.500 Mmc**
  - **-Regulation (available) capacity: 254,3 Mmc**
- **HYDROELECTRIC RESERVOIRS:**
  - **-27 reservoirs (44 power stations): 515 Mmc**

SOURCE:
PTUA Lombardy, 2003.

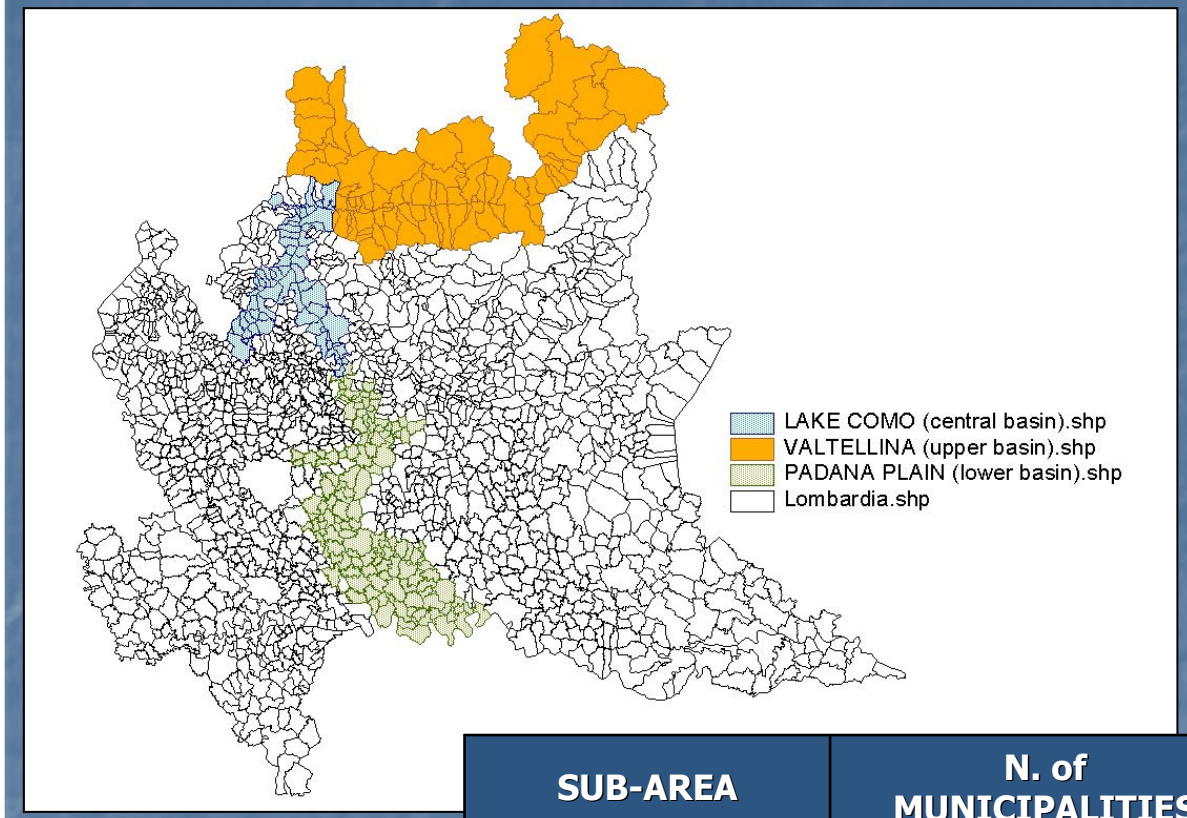
SOCIO-ECONOMIC ANALYSIS – STUDY AREA



SUB-AREA	N. of MUNICIPALITIES	POPULATION	DENSITY (ab/Km^2)
VALTELLINA (UPPER BASIN)	78	174.116	112
LAKE COMO (CENTRAL BASIN)	57	267.344	382
PADANA PLAIN (LOWER BASIN)	125	658.998	589
OVERALL	260	1.100.458	361

SOURCE: ISTAT, 2003.

SOCIO-ECONOMIC ANALYSIS – STUDY AREA



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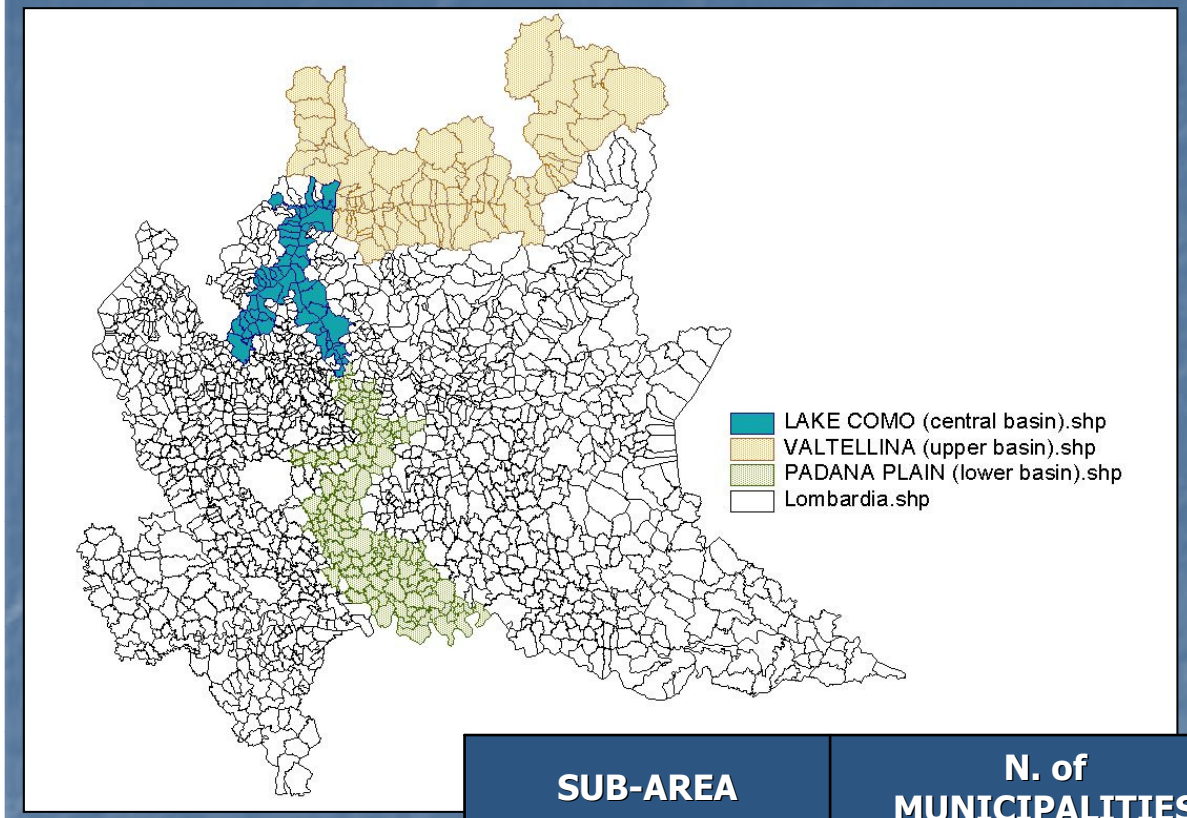

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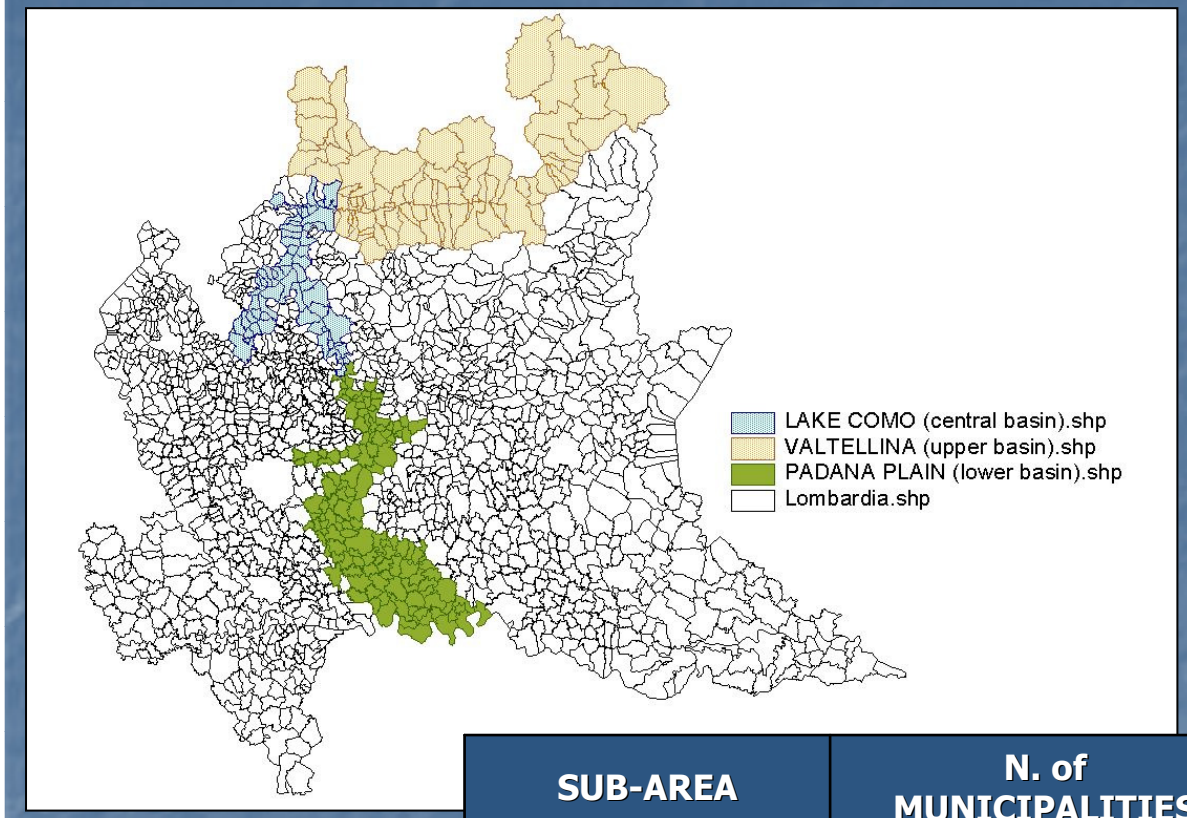

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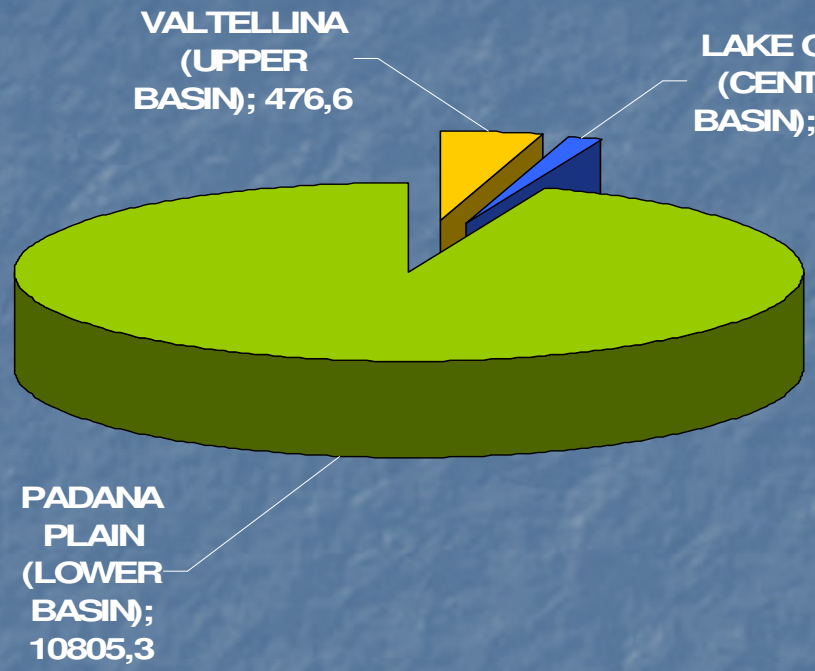
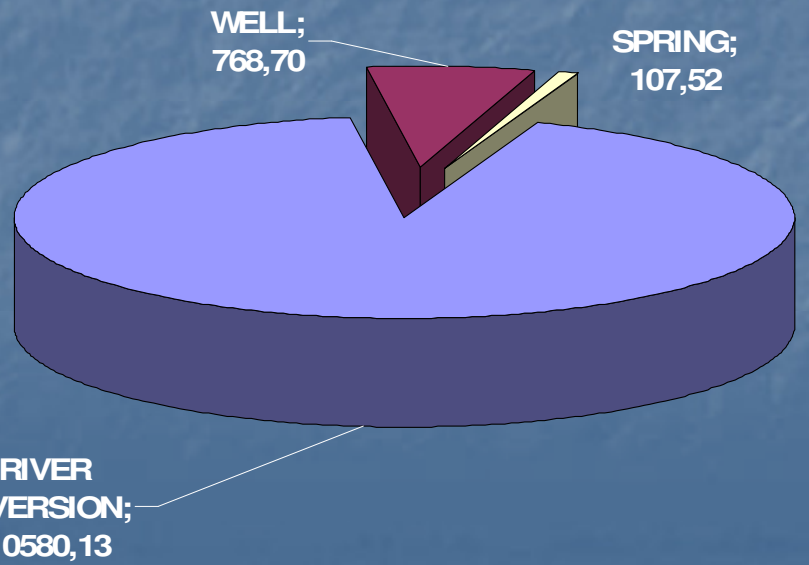
OVERALL SUB-AREAS WATER CONSUMPTION (Mmc/yr WATER RIGHTS)



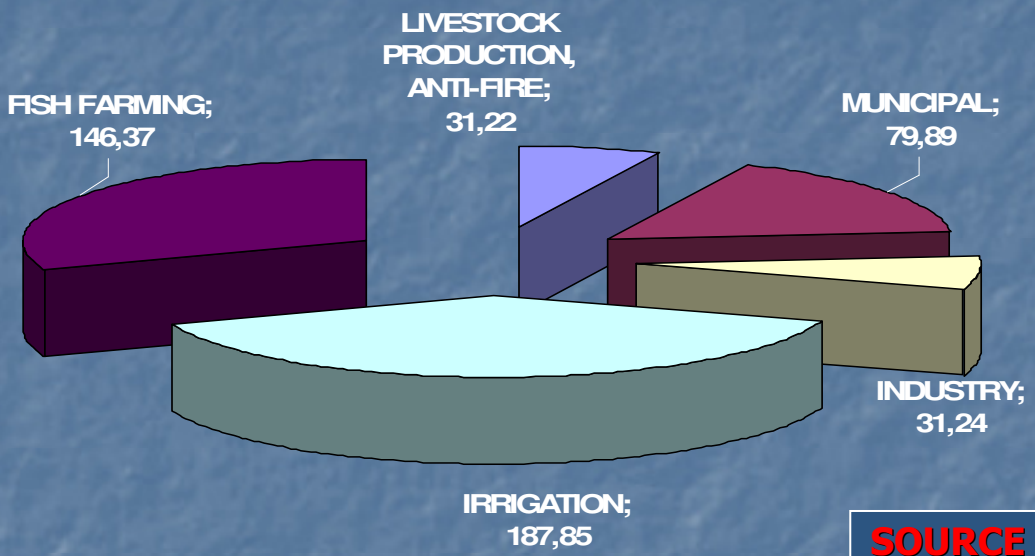
OVERALL SOURCE OF WATER SUPPLY (Mmc/yr WATER RIGHTS)

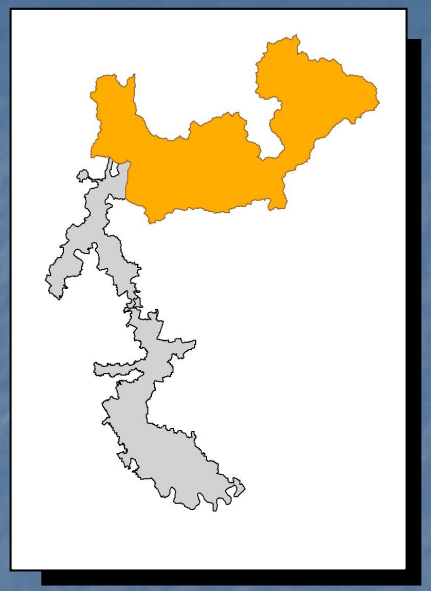


SOURCE: CUI Lombardy, 2003.

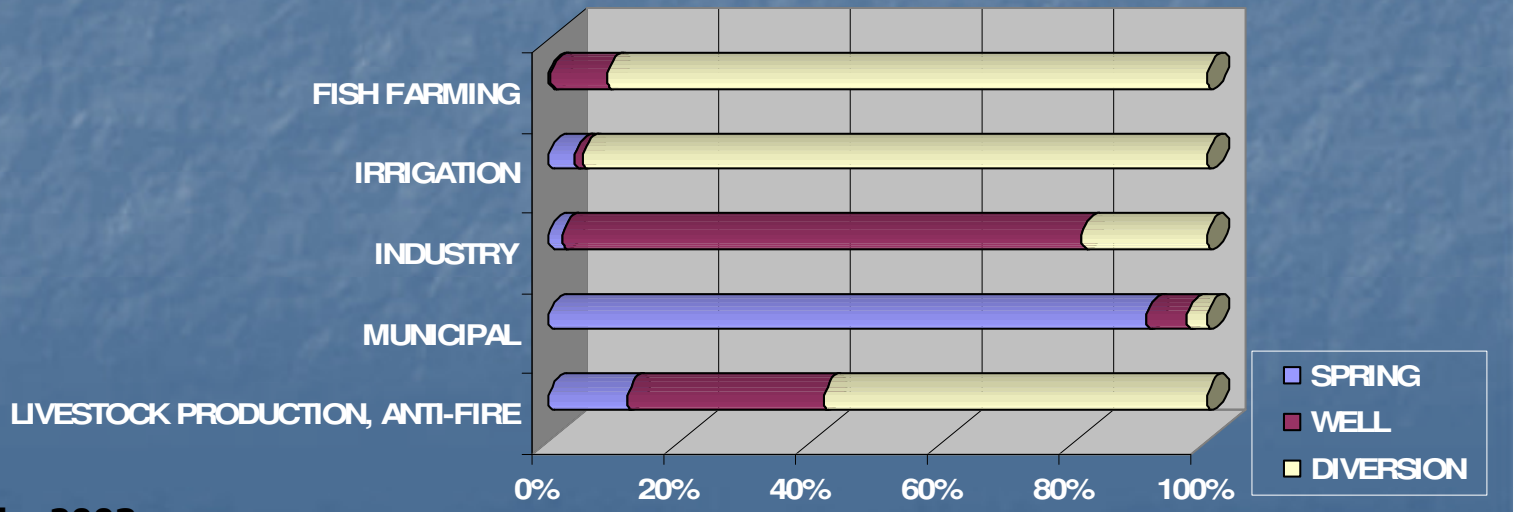
VALTELLINA (UPPER BASIN)

WATER CONSUMPTION (Mmc/yr WATER RIGHTS)





SOURCE OF WATER SUPPLY (% WATER RIGHTS)



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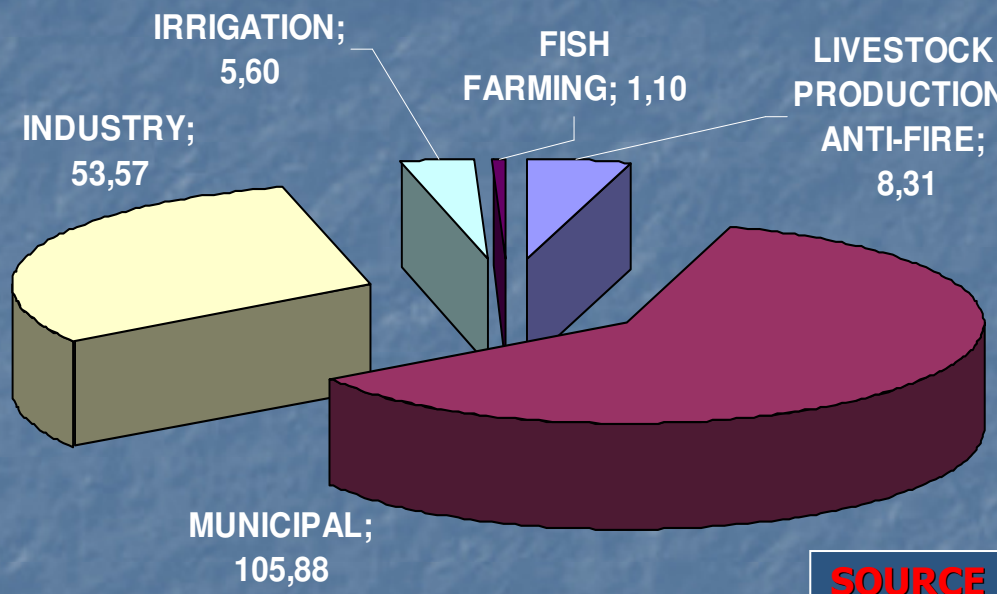
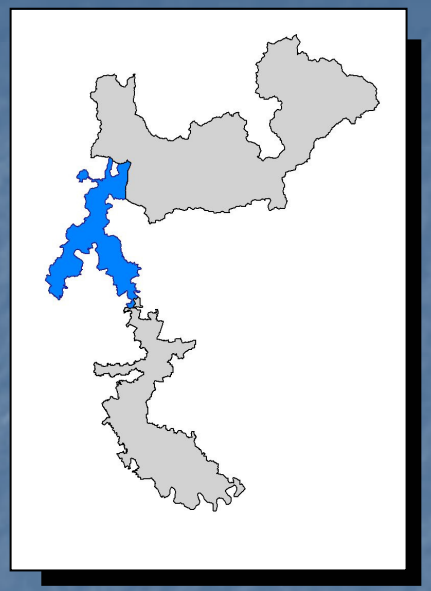
LAKE COMO (CENTRAL BASIN)

WATER CONSUMPTION (Mmc/yr WATER RIGHTS)





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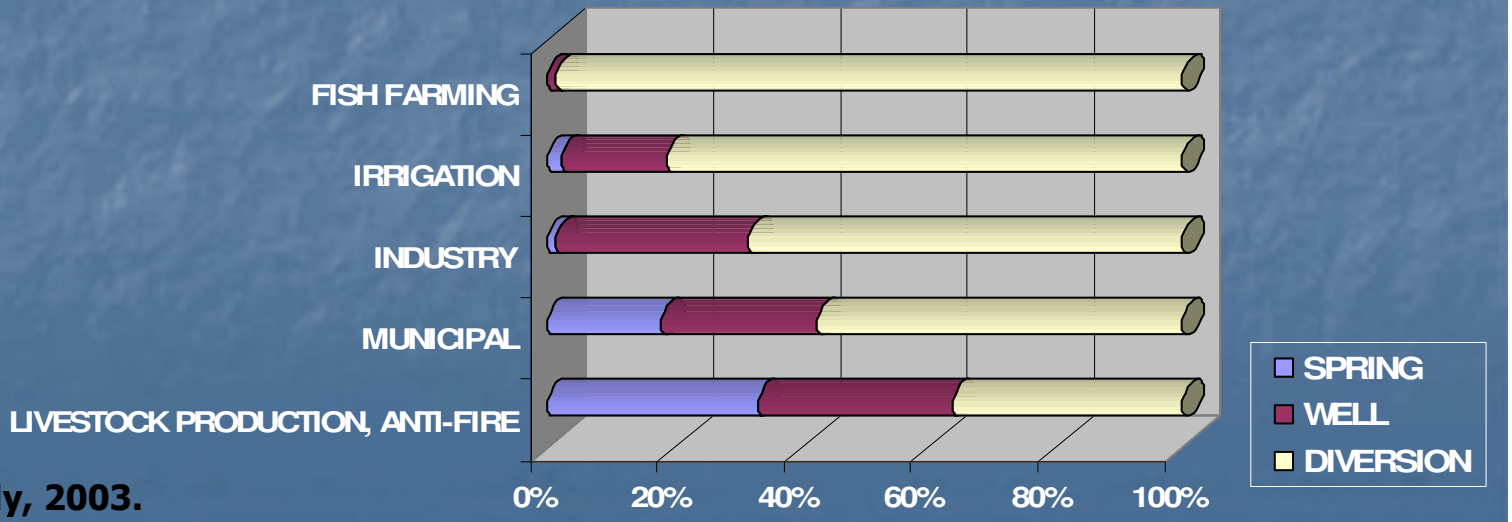
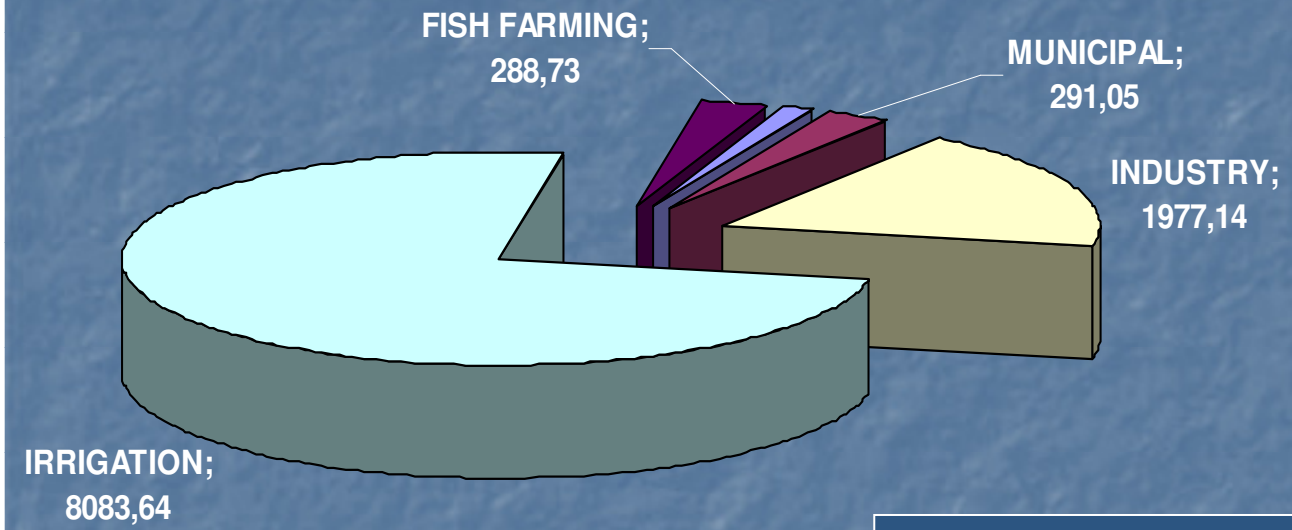
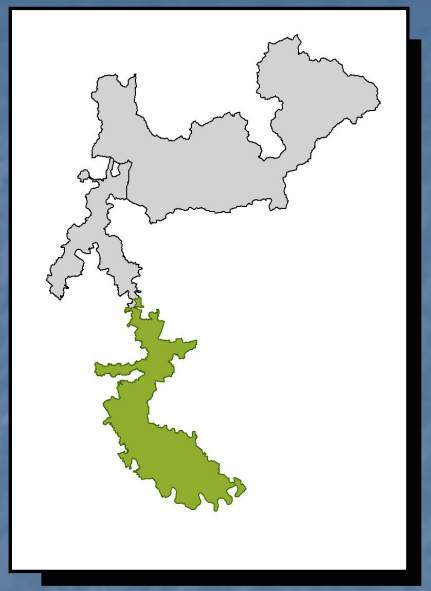


SOURCE: CUI Lombardy, 2003.

PADANA PLAIN (LOWER BASIN)

WATER CONSUMPTION (Mmc/yr WATER RIGHTS)





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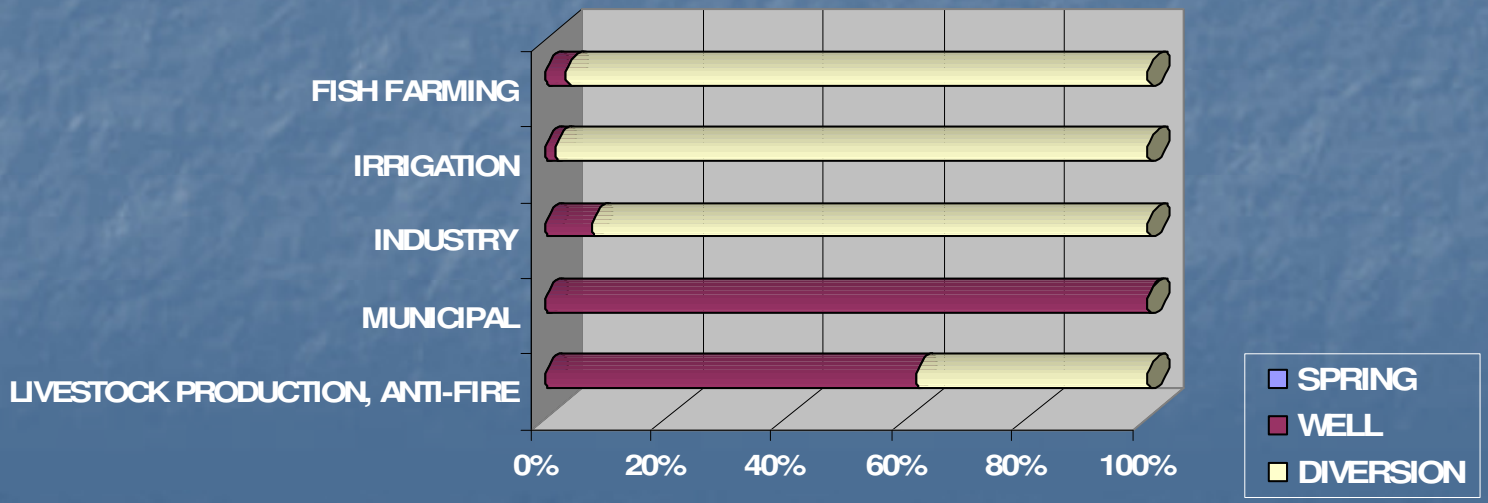

SOURCE: CUI Lombardy, 2003.

CLIMATE CHANGE AND SOCIO-ECONOMIC SYSTEM

STRONG INTER-CONNECTION BETWEEN NATURAL CYCLES AND HUMAN ACTIVITIES

- CLIMATE CHANGE: INFLUENCE ON WATER RESOURCES DISTRIBUTION (STOCKS/FLOWS)
- SOCIO-ECONOMIC SYSTEM: INFLUENCE OF COMPETING WATER USERS ON WATER BALANCES

- HIGH STRESS ON WATER RESOURCES UNDER CURRENT CONDITIONS
- HIGH SENSITIVITY OF THE SOCIO-ECONOMIC SYSTEM TO VARIATIONS ON WATER INPUTS

CLIMATE CHANGE AND SOCIO-ECONOMIC SYSTEM

CAUSE – EFFECT QUANTITATIVE CORRELATION

ASSESSMENT OF THE QUANTITATIVE INTERDEPENDENCE BETWEEN PHYSICAL CAUSES AND ECONOMIC EFFECTS

QUANTITATIVE CAUSE-EFFECT CORRELATION

PHYSICAL ANALYSIS

1st step: Identification of the physical causes;

2nd step: Determination of the physical effects.

SOCIO-ECONOMIC ANALYSIS

3rd step: Evaluation of the main features and the most relevant socio-economic drivers;

4th step: Assessment and evaluation of the economic consequences (i.e. competition and damages).

QUANTITATIVE CAUSE-EFFECT CORRELATION

PHYSICAL ANALYSIS

SOCIO-ECONOMIC ANALYSIS

OVERLAY OF THEMATIC LAYERS AND DATABASE USING GIS TECHNIQUES

IDENTIFICATION OF POTENTIAL DROUGHT SCENARIOS

EVALUATION OF THE ECONOMIC EFFECTS GENERATED FROM THE PHYSICAL IMPACTS

PHYSICAL ANALYSIS

1. PHYSICAL CAUSES:

- Variation on General Atmospheric Circulation;
- Rise of temperature;
- Variation on pluviometric regimes;
- Increase of the frequence of extreme events.

2. PHYSICAL EFFECTS:

- Variations on water flows (rivers) and water stocks (lakes, reservoirs);
- Effects on snow and ice accumulation/melt;
- Effects on groundwater recharge;

"SUPPLY SIDE"

- Effects on the overall water demand;
- Shifts in demand peaks.

"DEMAND SIDE"

SOCIO-ECONOMIC ANALYSIS

3. EVALUATION OF SOCIO-ECONOMIC MAIN FEATURES

- Collection and critical analysis of statistical data about population dynamics and economic sectors;

- Identification of the most sensible socio-economic frames and communities on the territory;

- Comprehension and analysis of (local and/or remote) socio-economic interrelationships between the areas exposed with other areas.

SOCIO-ECONOMIC ANALYSIS

4. ASSESSMENT AND QUANTIFICATION OF SOCIO-ECONOMIC EFFECTS

DIRECT EFFECTS

PRIMARY CONSEQUENCES OF WATER SHORTAGE ON THE SOCIO-ECONOMIC ACTIVITIES

INDIRECT EFFECTS

SECONDARY EFFECTS (LONG-TERM) OF WATER RESOURCES SCARCITY ON THE SOCIO-ECONOMIC SYSTEM

YEAR 2003 – DIRECT EFFECTS OBSERVED

SOME DIRECT EFFECTS OF WATER SHORTAGE ON:

- AGRICULTURE: crop losses, damage to crop quality;
- TOURISM: reduction in recreational uses (e.g.: navigation, bathing) on Lake Como;
- POWER GENERATION: change in hydropower potential through the year, altered potential for run-of-river power;
- PUBLIC WATER SUPPLY: reduction in availability of summer municipal water, increase of water demand.

PROJECT RICLIC–WARM AGENDA

PROJECT KICK-OFF: SEPTEMBER 2005, DURATION 3 YEARS.

1st YEAR OF ACTIVITIES:

- Collection and geocoding of past physical data by every single Work Package.

2nd YEAR OF ACTIVITIES:

- Analysis and modeling of the data collected, integration on a multi-disciplinary level, creation of future scenarios and forecasting;

- Collection and critical analysis of the socio-economic system.

3rd YEAR OF ACTIVITIES:

- Assessment and quantification of socio-economic direct and indirect effects;

- Creation, management and constant update of a scientific multi-disciplinary database;

- Supplying of decision-making instruments for watershed management.

TAKE HOME MESSAGE

PAST SCENARIOS ⟷ FORECASTING

modeling

CAUSE ⟷ EFFECT

quantitative correlation

WATER DEMAND ⟷ WATER SUPPLY

scarcity

TECHNICAL SCIENCES ⟷ ECONOMICS

exchange of knowledge

PROJECT RICLIC – WARM

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THANK YOU FOR YOUR ATTENTION

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