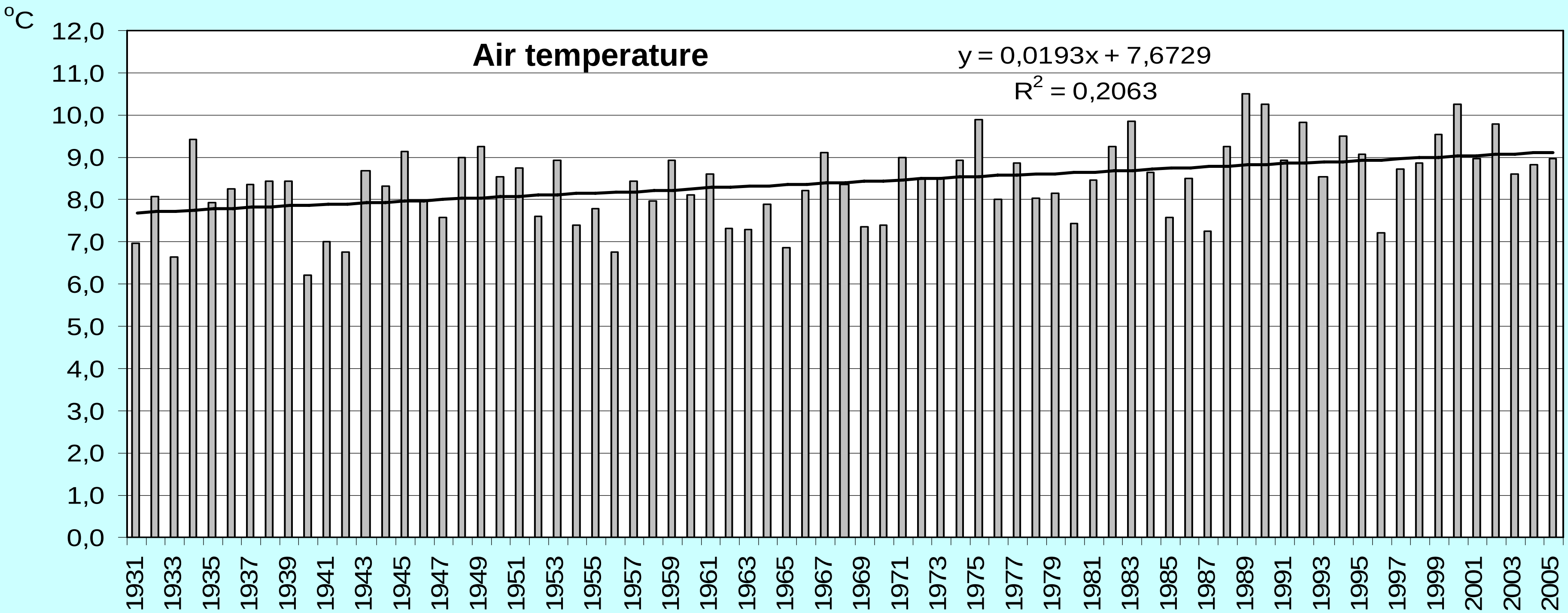
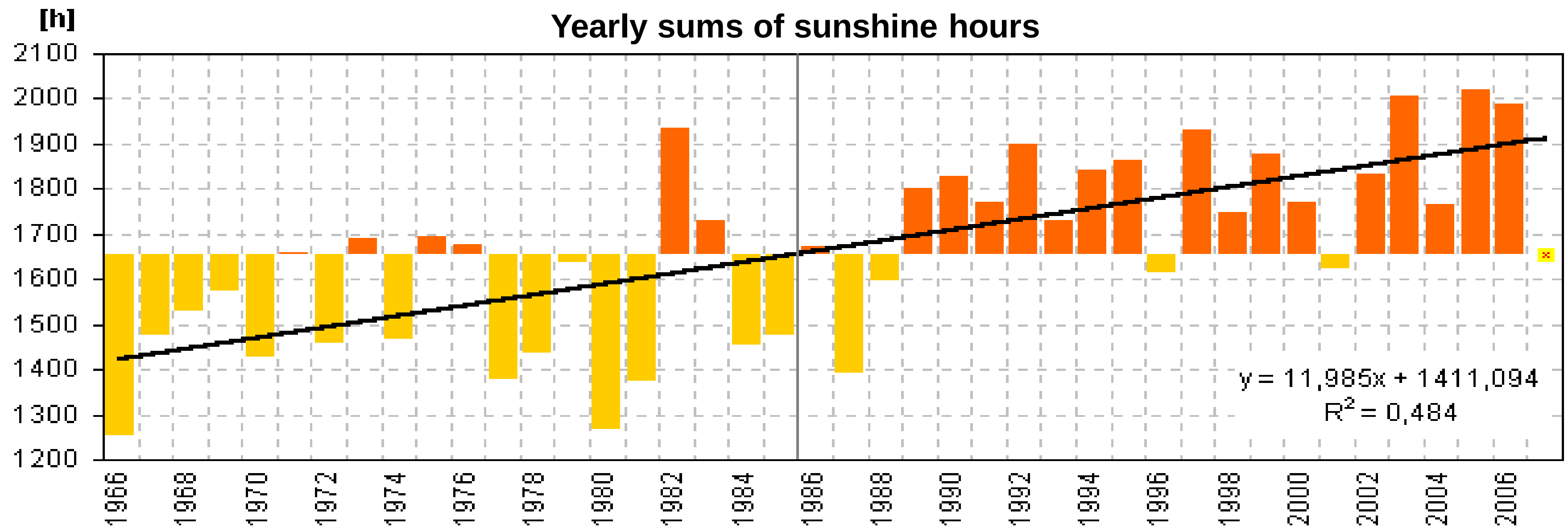
Recommendations for effective water use in agriculture under changing climate – perspectives from Poland

Leszek Labedzki
Institute for Land Reclamation and Grassland Farming
Regional Research Centre in Bydgoszcz, Poland

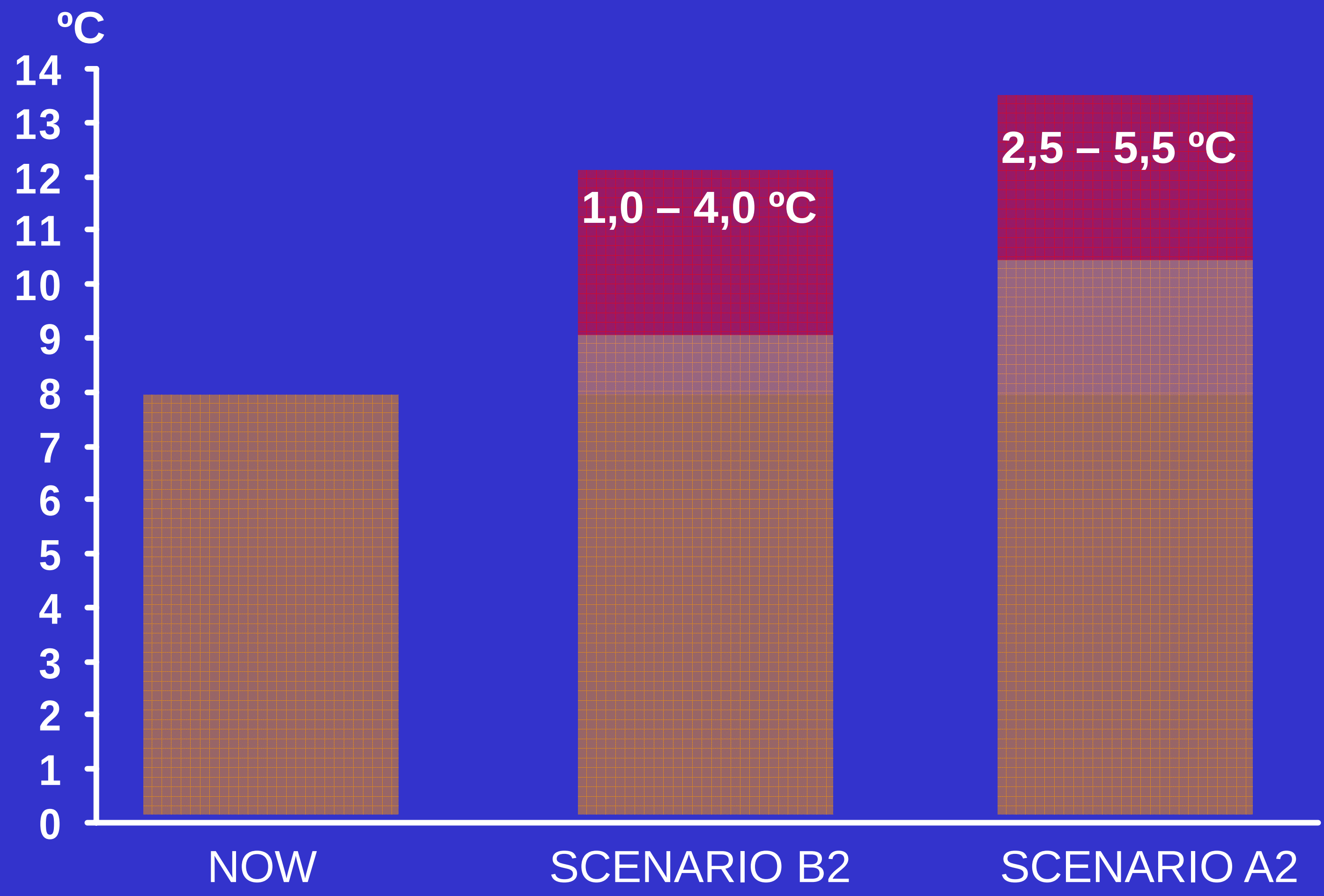


Labedzki (2006)



Kasprowicz, Mager (2007)

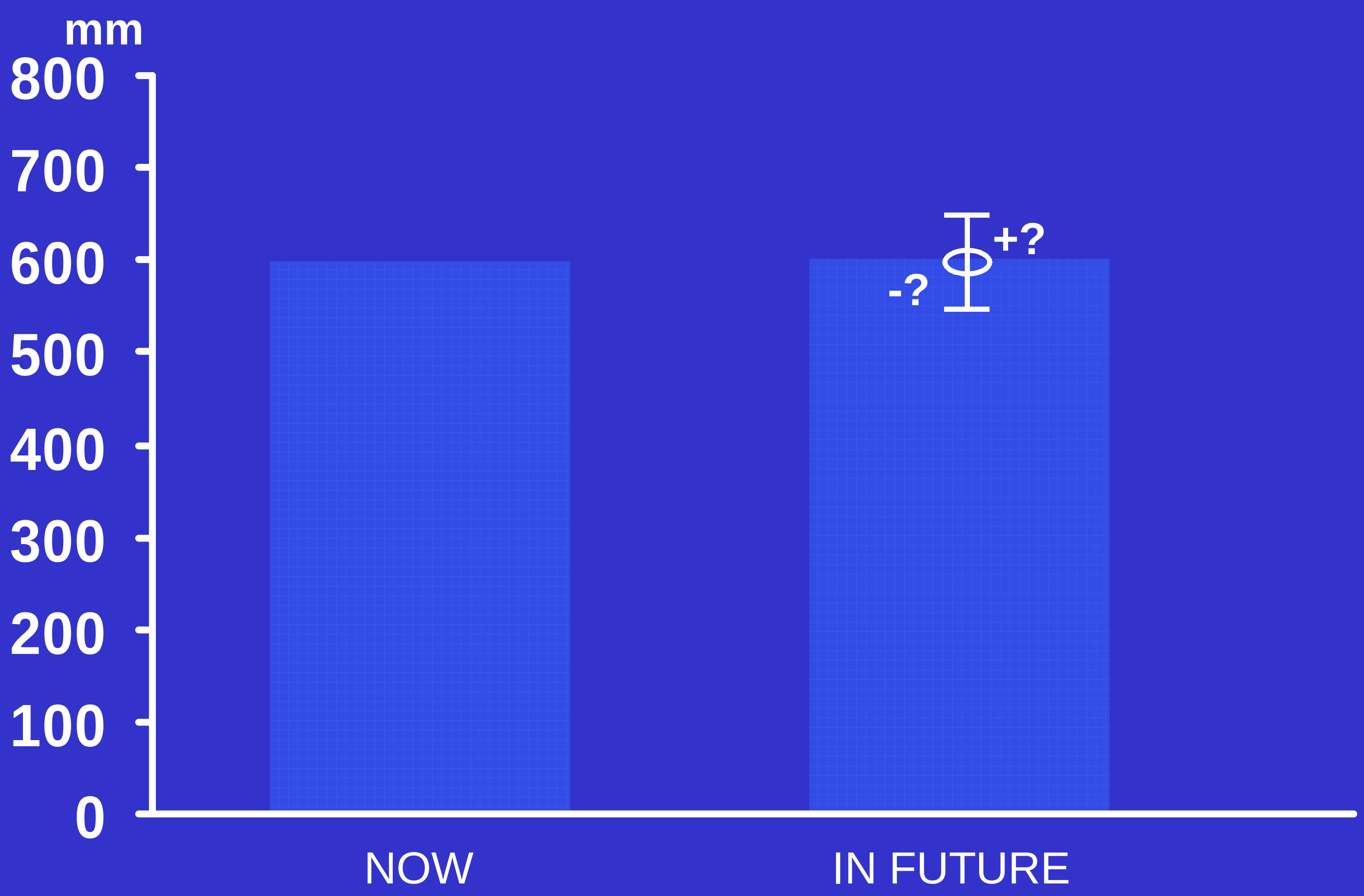
IPCC 2001, 2007
EEA 2005



Air temperature

Prep. by Lesny (2007)

IPCC 2001, 2007
EEA 2005



Precipitation

Prep. by Lesny (2007)

Jaworski 2004

Precipitation increase

GFDL scenario: 20-60 mm/year

GISS scenario: 100-160 mm/year

Jaworski 2004

Evapotranspiration increase:

GFDL scenario: 50-80 mm/year
GISS scenario: 70-100 mm/year

IPCC 2001, 2007
EEA 2005
Olsen and Bindi 2004

Crop water demand increase:

maize	**2 – 4%**
potato	**6 – 10%**

More water will be required per unit area and probably for unit crop productivity, decreasing crop water productivity

Drought on meadows in August 2000

Soil drought in the sugar beet field in June 2005

Flood on meadows in June 1980

Flooded arable fields – Spring 2005

WATER RESOURCES

precipitation - 600 mm (197 km^3/yr)

annual runoff - 65 km^3/yr

variability of runoff: from 38 km^3 in 1954 to 90 km^3 in 1980

available water resources (40% of mean runoff) - 26 km^3/yr

capacity of natural lakes - 17 km^3

capacity of reservoirs - 4.5 km^3

renewable groundwater resources in usable layers - 16 km^3

renewable surface water resources - <u>1600 m^3/cap/yr</u>

the average in Europe - 4560 m^3/cap/yr

Adaptation strategies for agriculture

- short-term adjustments

  (e.g. earlier planting or sowing, deep plowing)

- long-term adaptations

  (e.g. changes of land use, changes in farming systems, new land management techniques, new irrigation management strategies)

Because of possible increase in water shortage in agriculture, the main actions and measures should lead to:

- increase of local water resources and their availability
- increase in water use efficiency
- decrease in water needs for crops
- intensification of irrigation

1. increasing water resources retention (in open waters) available for agriculture, mainly for irrigation

2. increasing soil water retention and its availability for plants

3. modification of the technology of water use on farms and in fields

1. increasing water resources retention (in open waters) available for agriculture, mainly for irrigation

by

water retention in the periods of its excess - in the spring and after abundant intensive precipitation

- construction of small retention reservoirs
- construction of water structures to restrict water outflow from fields

2. increasing soil water retention and its availability for plants

by

- technologies of soil cultivation that increase soil moisture and the degree of water utilization
  - soil loosening
  - deep plowing
  - improvement of soil structure
  - improvement of physical and water properties of deeper soil layers
  - retention of localized precipitation
  - increased infiltration
  - enlarging the active layer of roots water uptake
  - deeper rooting
  - increased amout of water available for plants

2. increasing soil water retention and its availability for plants

by

- plant species selection in crop rotation (drought resistance, a shorter vegetative period meaning lower water requirements, a deeper root system)
- fertilization and reclamation measures that aid the development of a strong root system
- introduction of deep-rooted plants with low water requirements

3. modification of the technology of water use on farms and in fields

towards

- saving water
- increase water use efficiency by multiple use of water
- minimizing useleess water discharges from reclamation systems, including drainage outflows
- limiting water consumption for evapotranspiration

by

e.g. improvement of irrigation management

IRRIGATION IN POLAND – CURRENT STATUS

Irrigation in Poland has supplemental character, used in short periods during the growing season.
Statistically irrigation is needed once in three years.

The role of irrigation in agriculture is marginal because of very small irrigated area.

0.5% of the total agricultural land area is irrigated

METHODS OF IRRIGATION

Systems of gravitational (gravity fed - without pressure - systems)

irrigation on permanent grassland, situated in the direct vicinity of lowland rivers on vast reclaimed lowland post-swampy territories, in which subsoil irrigation (subirrigation) from ditches is applied

Systems with pressure irrigation (pumped systems)

include sprinkler and drip irrigation of intensive and semi-intensive root crops, industrial crops, horticulture crops in open air, greenhouse crops and orchards

Flood and border irrigation

applied in small areas, used in a very small extend because of great water demand and low irrigation effectiveness

Irrigable land (equipped with irrigation systems) in 2006 – 452 000 ha

of which: 401 000 ha with gravity systems on grasslands
51 000 ha with pumped systems on arable land

Area irrigated

Year	Total	Irrigation method				
		subirrigation	sprinkling	microirrigation	flood irrigation	border irrigation
	Irrigated area (ha)					
1990	301 500	284 950	10 300	-	2 550	3 700
2006	78 792	73 930	4 756	5 000 – 10 000*	48	58
	Water withdrawal (hm^3)					
1990	519	-	-	-		-
2006	91.5	84.6	6.8	-	0.02	0.06

Irrigated area decreased by 75% in comparison with the 1990

Net irrigation water requirement *N* in a growing period in Central Poland

Crop	**Growing period**	***N*, in mm**
Rye	April – July	0 – 50
Winter wheat	April – July	50 - 100
Oat	April – July	0 – 50
Early potatoes	April – July	50 - 100
Late potatoes	April - September	100 - 150
Grass	April - September	160 - 210
Yellow lupine	April – July	100 - 150
Vetch	April – July	200 - 250
Sugar beet	April – September	150 - 200
Fodder beet	April – September	200 - 250
Carrot	May - September	190 - 240
Maize	April – September	100 - 150
Alfalfa	April – September	80 - 130
Early vegetables	May – July	50 - 200
Late vegetables	May – September	200 - 300
Berry crops	various	170 - 250
Orchards	various	200 - 400
Permanent grassland	April – September	150-200

Irrigation economic efficiency (profitability)

Crop	Profitability index (%)
Cereals	30
Clover, alfalfa	40
Sugar beet	50
Maize	60
Potatoes	150
Vegetables	
carrot	90-100
pea	125
bean	140
cabbage	160
cauliflower	200
onion	230
cucumber	250
berry crops	300-400

Accor. to J. Gruszka, IMUZ Bydgoszcz and E.Rumasz-Rudnicka, AU Szczecin

Required adaptation of irrigation and water systems to future climate conditions

- modernization of irrigation and water distribution systems to increase their effectiveness for supply and out-flow of water
- improvement of O&M of irrigation and water systems
- usage of modern energy- and water-saving methods and techniques of irrigation
- improvement in the efficiency of irrigation
- improvement of water use efficiency by crops
- improvement of existing infrastructure for storage and distribution of water
- increasing available water resources (in soils, streams, reservoirs)
- implementation of new irrigation management techniques

Required adaptation of irrigation and water systems to future climate conditions

- improvement and implementation of water distribution procedures towards dynamic and flexible water resources management with the use of multi-criteria optimization and modern automatic systems of monitoring of the state of water systems (groundwater table depths, stream water stages and stream flow discharge, monitoring of water structures)
- adjustment of water system control algorithms to changing climate conditions and extreme weather events
- development of regional (local) systems of monitoring climate for the need of water system management
- development of telecommunication systems
- usage of remote-sensing methods and GIS in water system control

Factors accelerating the development of irrigation

- increased frequency and intensity of droughts
- the intensification of agricultural production, being forced by the internal domestic and all-European free-market competition
- the necessity of reaching high quality of the majority of agricultural products

FUTUTRE DEVELOPMENT OF IRRIGATION IN THE CONTEXT OF CLIMATE CHANGES

1. The significance of irrigation will increase with the intensification of agriculture (e.g. in horticulture, orchards, seed crops) and with negative effects of climate changes.
2. Under conditions of climatic and economical changes, the irrigation area will increase up to 2.1 mln ha, of which 1.6 mln ha on permanent grasslands and 0.5 mln ha on arable land and in orchards.
3. 3-4% of arable land (without subirrigated area) should be irrigated in the near future.

Thank you !!!

Leszek Labedzki
Institute for Land Reclamation and Grassland Farming, Poland
http://www.imuz.edu.pl