Adapting to climate change in Cyprus with focus on water resources

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Facts about Cyprus

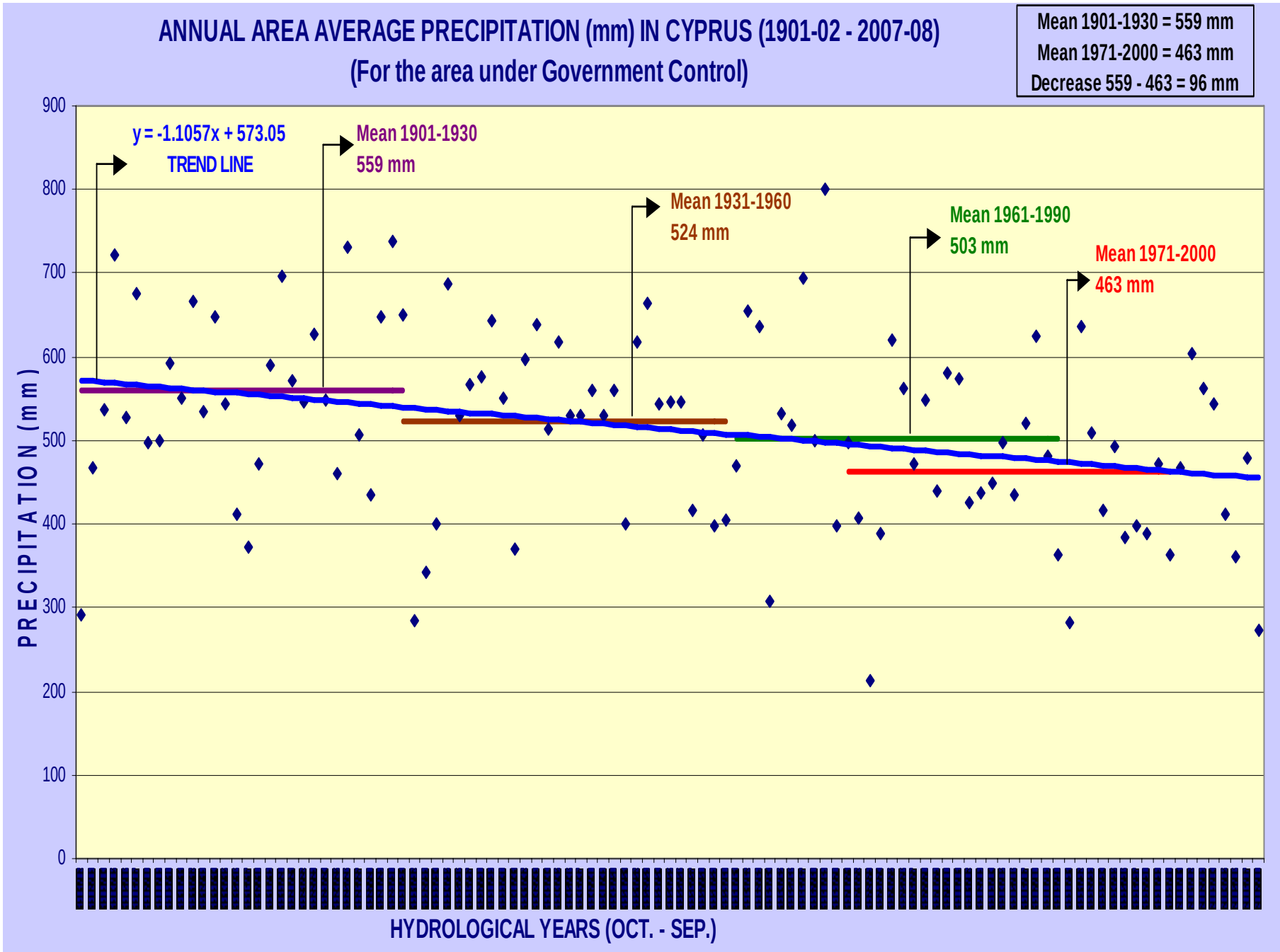
- Area 9,240 km², about 33% under Turkish occupation
- Population approx. 750,000
- More than 2 million tourists annually
- No natural lakes or perennial rivers
- Forested area, including high forests, high bushes and shrubs (maqui vegetation) approx. 32,3%

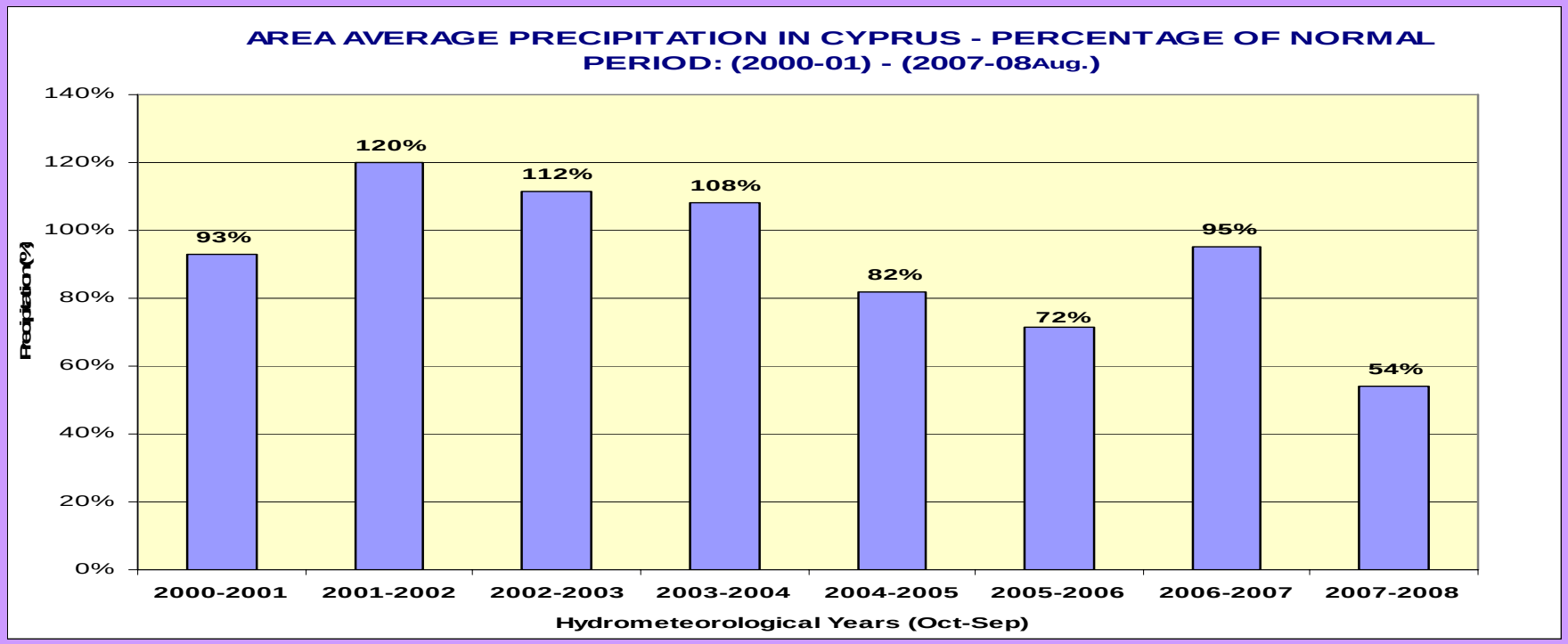
Facts about Cyprus (ctd..)

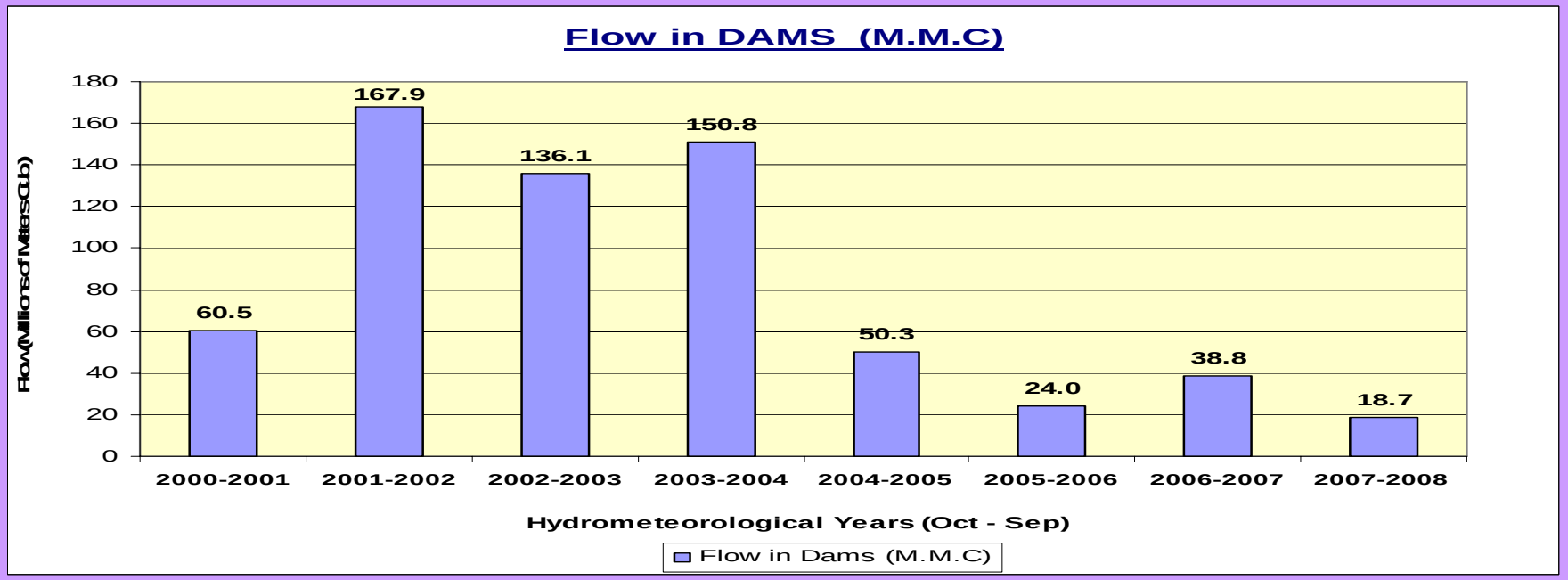
- Scarcity of water resources identified early
- Initial reaction was to try and store in dams as much rain water as possible
- Cyprus has 107 dams (56 of which are large dams) with a total capacity of 327,5 m^3
- Cyprus is ranked first among European countries in the ICOLD (International Commission on Large Dams) register, with a ratio of fifty large dams for every 10.000 km^2
- Two desalination plants have been in operation since 1997 and 2001, which cover about 50% of the total needs for drinking water

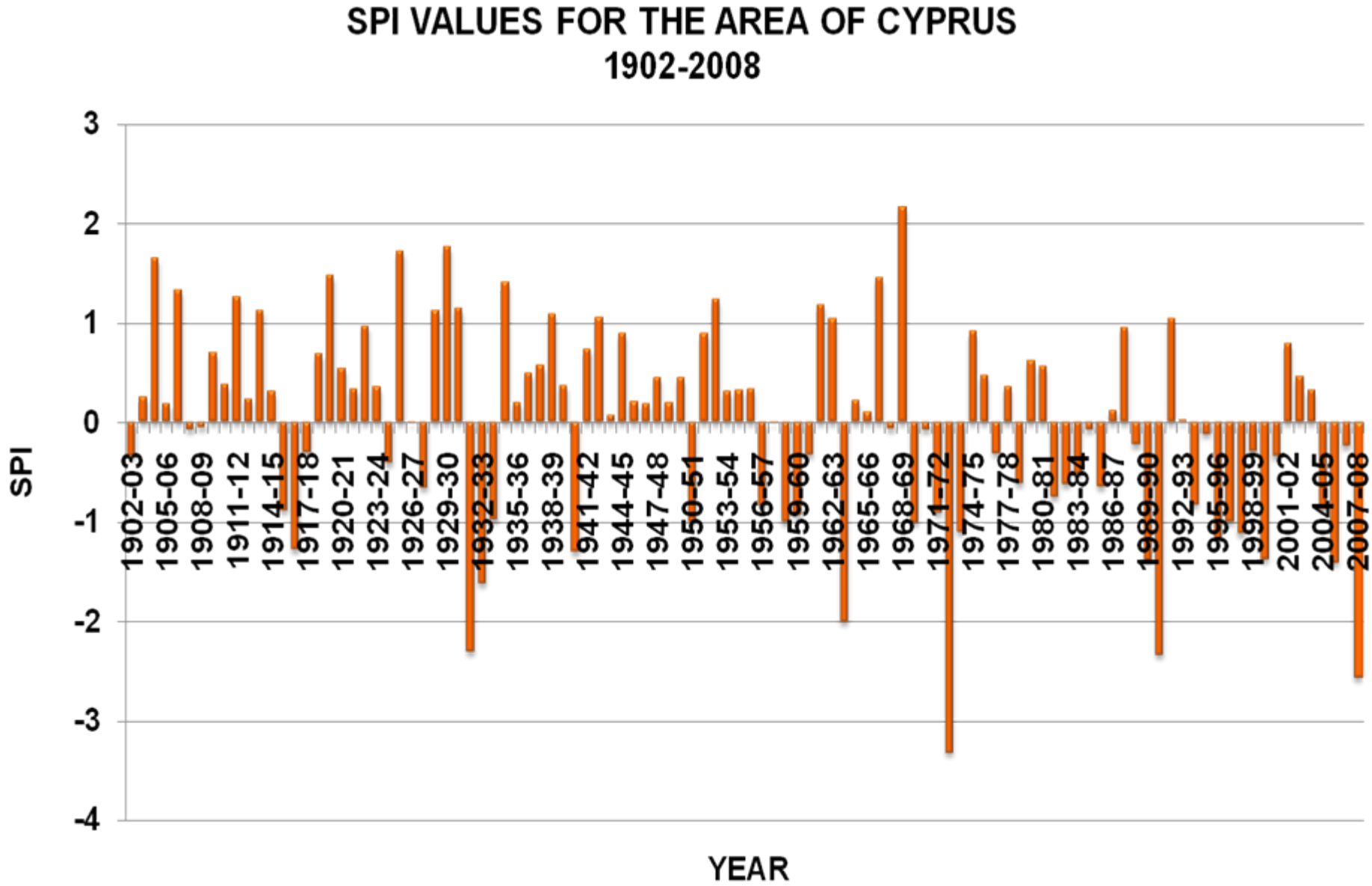
Climate change is a reality in Cyprus

- Average temperatures have increased by 1°c.
- Average rainfall has fallen by 17% as compared to the period 1901-1930.
- Periods of drought are becoming longer and more frequent
- Extreme natural phenomena (dust suspension, floods, hail storms) are becoming more frequent


ANNUAL AREA AVERAGE PRECIPITATION (mm) IN CYPRUS (1901-02 - 2007-08)
(For the area under Government Control)
Mean 1901-1930 = 559 mm
Mean 1971-2000 = 463 mm
Decrease 559 - 463 = 96 mm
y = -1.1057x + 573.05
TREND LINE
Mean 1901-1930
559 mm
Mean 1931-1960
524 mm
Mean 1961-1990
503 mm
Mean 1971-2000
463 mm
PRECIPITATION (mm)
900
800
700
600
500
400
300
200
100
0
HYDROLOGICAL YEARS (OCT. - SEP.)


AREA AVERAGE PRECIPITATION IN CYPRUS - PERCENTAGE OF NORMAL
PERIOD: (2000-01) - (2007-08Aug.)
140%
120%
100%
80%
60%
40%
20%
0%
93%
120%
112%
108%
82%
72%
95%
54%
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008
Hydrometeorological Years (Oct-Sep)


Flow in DAMS (M.M.C)
180
160
140
120
100
80
60
40
20
0
60.5
167.9
136.1
150.8
50.3
24.0
38.8
18.7
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008
Hydrometeorological Years (Oct - Sep)
Flow in Dams (M.M.C)


SPI VALUES FOR THE AREA OF CYPRUS
1902-2008
SPI
YEAR
3
2
1
0
-1
-2
-3
-4
1902-03
1905-06
1908-09
1911-12
1914-15
1917-18
1920-21
1923-24
1926-27
1929-30
1932-33
1935-36
1938-39
1941-42
1944-45
1947-48
1950-51
1953-54
1956-57
1959-60
1962-63
1965-66
1968-69
1971-72
1974-75
1977-78
1980-81
1983-84
1986-87
1989-90
1992-93
1995-96
1998-99
2001-02
2004-05
2007-08

Extreme natural phenomena (dust suspension, floods, hail storms) are becoming more frequent

MAXIMUM NUMBER OF CONSECUTIVE DAYS WITH DUST IN SUSPENSION IN CYPRUS FROM OBSERVATIONS AT LARNAKA AIRPORT, PERIOD OF YEARS: 1990 - 2007

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
			12/03/92		06/04/94	09/04/95	08/02/96	22/04/97	16/03/98	17/02/99	13/04/00	27/02/01	31/03/02	13/01/03	16/01/04	27/01/05	25/02/06	24/02/07
			28/03/92		07/04/94		09/02/96	08/12/97	27/03/98	19/03/99	18/04/00	28/02/01	05/04/02	02/02/03	28/02/04	28/01/05	26/02/06	25/02/07
			29/03/92						28/03/98	30/03/99	19/04/00	01/03/01	06/04/02	18/02/03	05/03/04	29/01/05	27/02/06	26/02/07
			30/03/92								18/11/00	19/04/01	15/04/02	02/03/03	27/04/04	30/01/05	28/02/06	23/03/07
			07/05/92								30/12/00	22/04/01	01/10/02	18/03/03	07/05/04	01/03/05	01/03/06	03/05/07
												01/05/01	19/10/02	19/03/03	10/05/04	02/03/05	13/03/06	07/05/07
												13/05/01	20/10/02	03/04/03		03/03/05	14/03/06	20/05/07
													10/11/02	04/04/03		01/04/05	06/04/06	29/05/07
														05/04/03		09/04/05	07/04/06	06/06/07
														06/04/03		10/04/05	16/04/06	10/06/07
														17/04/03		17/04/05	17/04/06	
														24/04/03		18/04/05	18/04/06	
														29/05/03		21/04/05	06/05/06	
														30/05/03				
														11/09/03				
														17/09/03				
Number of Days	0	0	5	0	2	1	2	2	3	3	5	7	8	16	6	13	13	10
Max.No.of Consecutive Days	0	0	3	0	2	0	2	0	2	0	2	2	2	3	0	4	5	3

At the same time .....

- Expansion of tourist industry. Number of tourists increased significantly since mid – nineties
- Changes in lifestyle that led to an increase in average household consumption of water


Image © 2010 DigitalGlobe
©2009 Google
Imagery Date: Jun 26, 2008
34°54'08.70" N
32°19'42.88" E
elev 0 m
Eye alt 610 m

Therefore .....

- Although needs for water keep increasing ...
- Available water reserves are diminishing

Effect of climate changes on water reserves

- Extended drought period during 2005 – 2008. Lower than average rainfall resulted in minimal flow of water in the dams.
- By the beginning of 2008 water reserves in dams were almost depleted, giving rise to the need to adopt costly temporary measures in order to meet consumers' needs for drinking water during the summer of 2008 (eg import of drinking water with tankers from Greece, imposition of severe cuts in water supply to households and no water allocated for agricultural purposes, which resulted in the dramatic reduction of farmers' yields. Consequently, compensations of €67mln were paid to farmers).
- Deterioration of most aquifers


KALAVASOS DAM
APRIL 2004


KALAVASOS DAM
APRIL 2008


OROUNTA VILLAGE
APRIL 2004


OROUNTA VILLAGE
APRIL 2008

Objectives of a sustainable and adaptive water development strategy

- Independence of drinking water supply from weather conditions (mainly through the construction of desalination plants)
- Agricultural practices in line with weather conditions
- Maximum usage of recycled water
- Prevention of further deterioration of aquifers / restoration of their condition

Risk areas

- Failure / delay to achieve independence from weather conditions – risk of not having adequate water reserves to cover basic needs of consumers for drinking water
- Agricultural practices that consume a lot of water
- Recycled water not being utilised
- Further deterioration of aquifers

Scope of the audit

- Measures taken to ensure adequate quantities of drinking water will be available to meet consumers' needs, independently of weather conditions - design and construction of adequate desalination plants
- Measures taken to encourage water-efficient agricultural practices
- Utilisation of recycled water
- Measures taken to prevent further deterioration of aquifers at risk

Methodology followed

- Identification of risk areas and relevant ‘players’ (ministries/departments)
- Review of relevant records from Water Development Department (WDD)
- Study of relevant decisions of Council of Ministers (no legal framework exists – national strategy for adaptation is currently under preparation)
- Interviews with responsible officials and the Head of the WDD

Findings of the audit

- Despite the inadequate rainfall of the period 2005 – 2008 and the continuous decline in water reserves in dams, restrictions in the supply of drinking water were imposed very late (in 2008)
- The control exercised over the drilling of boreholes and over the quantities of water pumped therefrom was inadequate. As a result, the condition of most of the aquifers of the island was deteriorated, with 17 out of the 19 being currently at risk.

Findings of the audit (ctd..)

- Construction of one desalination plant was suspended due to the euphoria that followed a period of good rainfall (2002 -2004) which resulted in the overflow of all dams in Cyprus – Long term planning proved inadequate.
- Delays were observed in the construction of additional desalination plants (community reactions, tender procedures). As a result, the desired independence of drinking water needs from weather conditions will not be achieved until 2012.

Findings of the audit (ctd...)

- Although many water saving agricultural practices have been adopted (such as improved on-farm irrigation systems – sprinklers/drip irrigation), there is still room for improvement, especially through the education of farmers and the encouragement of the production of less water demanding crops.
- Pricing of water for both irrigation and drinking purposes should reflect its scarcity and cost.
- Use of recycled water should be encouraged further by educating the farmers and by adopting an attractive pricing strategy

Findings of the audit (ctd...)

- Irrigation of golf courses from water reserves in dams should not be allowed
- Filling of swimming pools with potable water should not be allowed
- Car wash services should be encouraged to install water recycling systems
- Recycled water should be used for the irrigation of football grounds and public gardens
- Legal framework inadequate – responsibility for management / development of water resources is dispersed in many ministries/department

Lessons learned

- New climate conditions are a fact: we should not be encouraged to think otherwise because of certain periods of adequate rainfall. Planning should be long term.
- Measures taken should be proactive, not reactive. Reactive measures are usually more costly and less effective.

Lessons learned (ctd...)

- People should be educated to adapt to the new climate conditions prevailing.
- Adequacy/effectiveness of relevant legal framework plays an important role