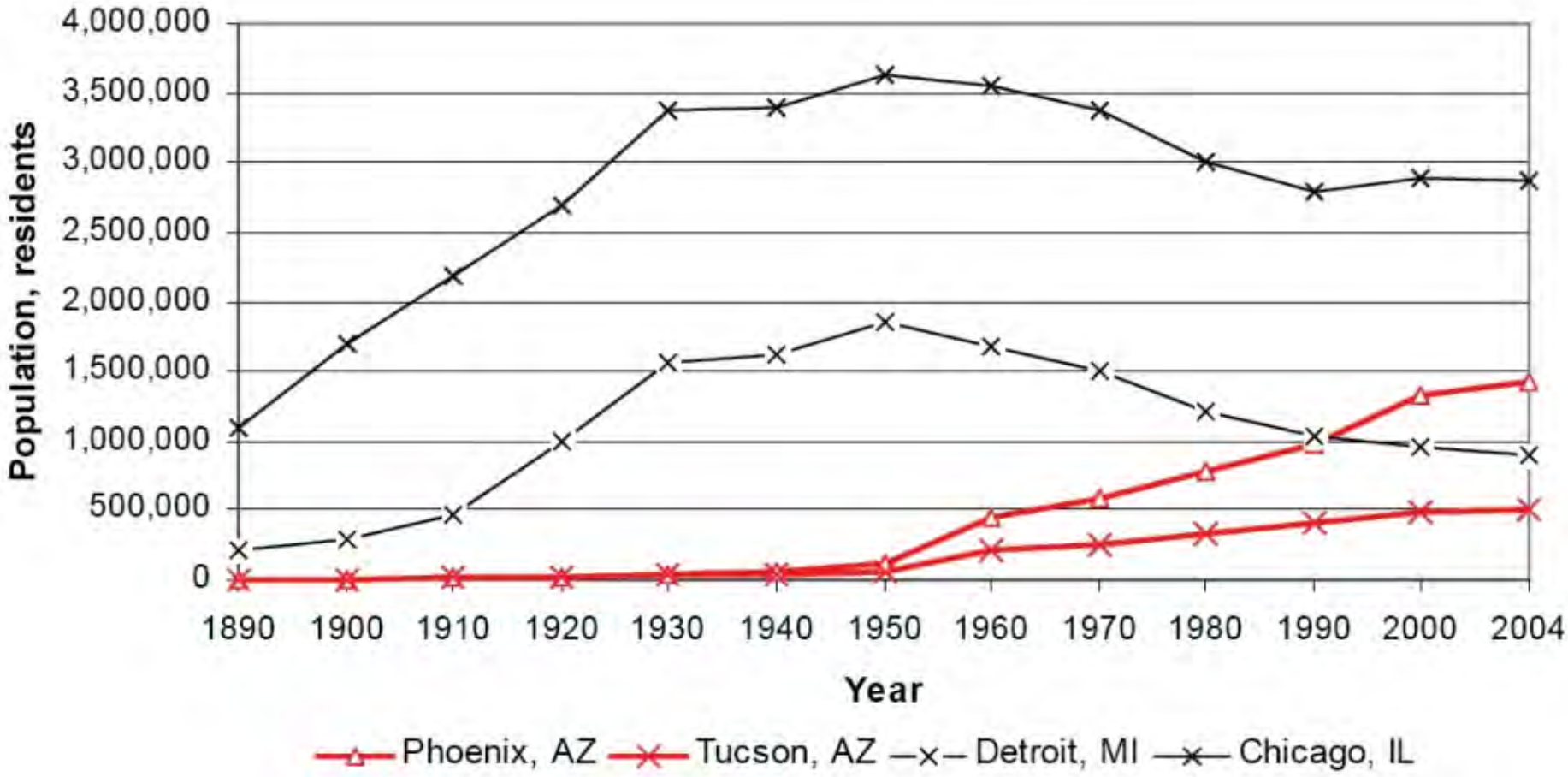
Sustainable water use in the Californias' border region

How will urban growth and climate change impact the water resources in San Diego County - and how are citizens and businesses adapting now to prevent water shortages in the future?

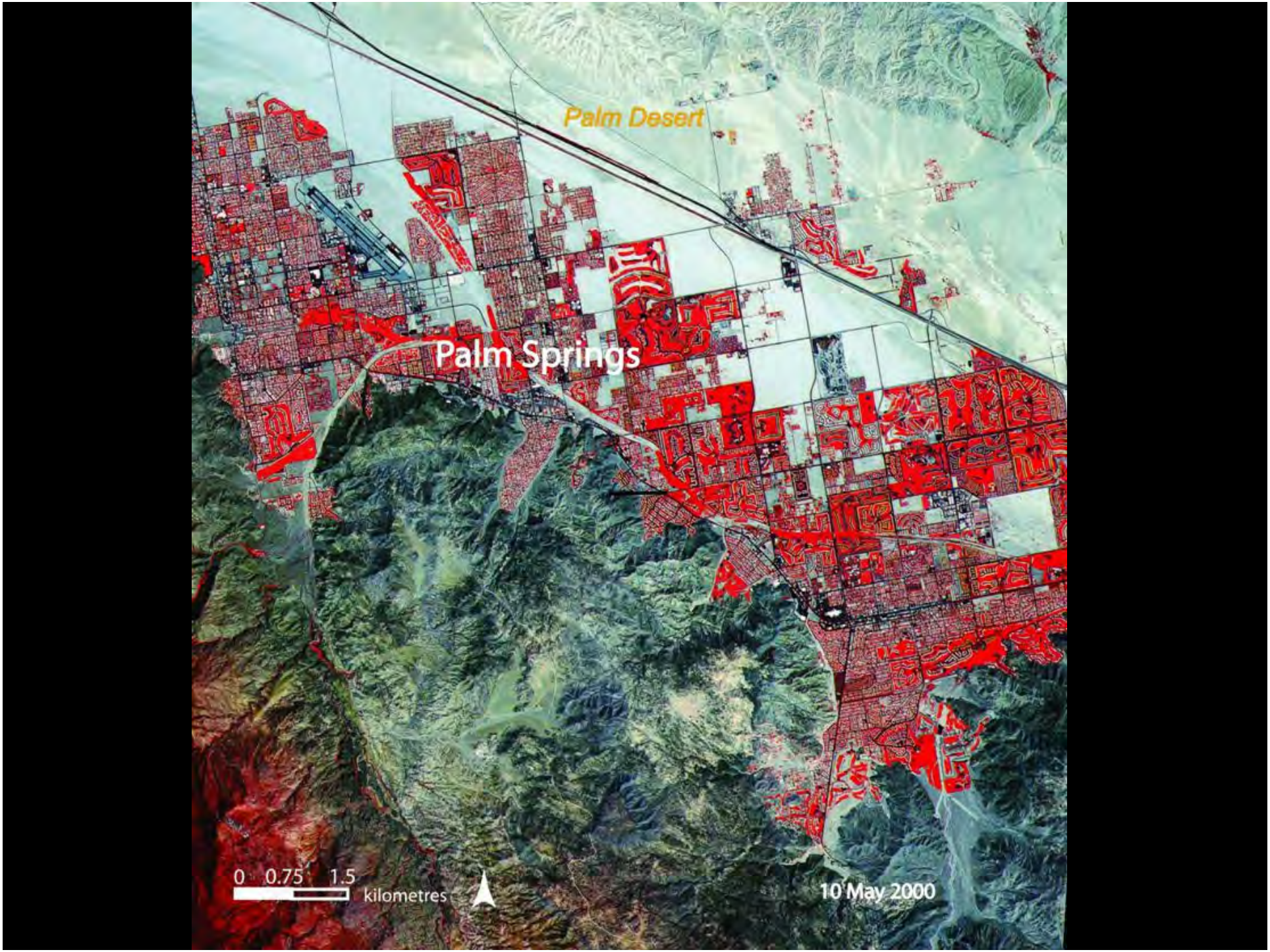
Exequiel Ezcurra

Cities and water


4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Population, residents
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2004
Year
Phoenix, AZ
Tucson, AZ
Detroit, MI
Chicago, IL


San Diego River


Desert National Wildlife Range
Nellis Air Force Range
Nellis Air Force Range
Floyd R. Lamb State Park
U N I T E D S T A T E S
Nevada
3 May 2000


Palm Desert
Palm Springs
0 0.75 1.5
kilometres
10 May 2000


STOP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Cost of moving water

a.- Raising 1 m^3 of water a height of 100 meters, demands aprox. 1 Mjoule (980 kJ), which is equal to 0.28 kW-h or 1000 BTUs, and is equal to the energy contained in 0.046 L of gasoline.

b.- In practice, taking into acount friction in the pipes and the energy efficiency of engines and pumps, the energy contained in aprox. 0.1 L of gas is needed to raise 1 m^3 of water 100 meters, or some 0.6 kW-h.

Seawater desalination

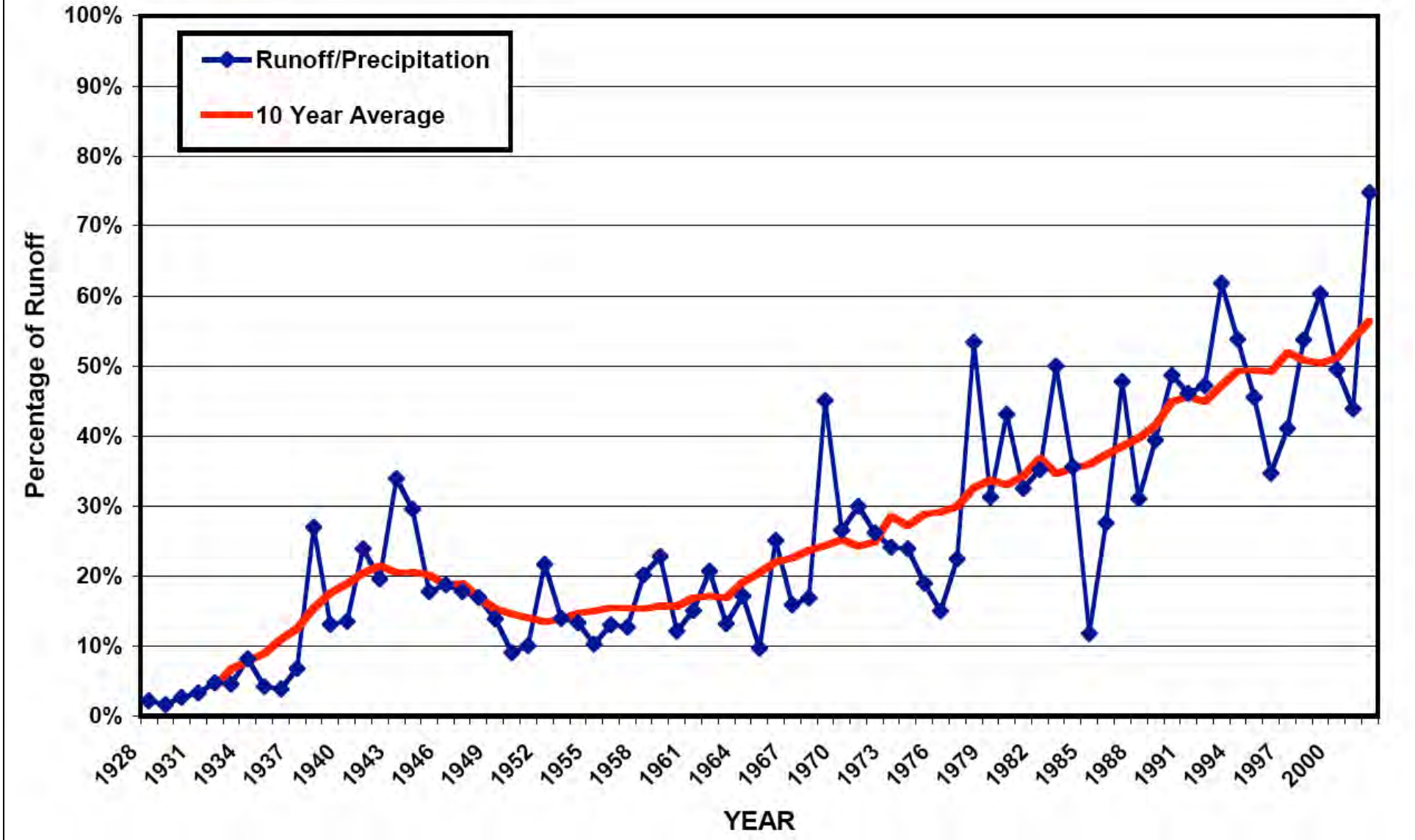
Osmotic pressure of seawater: 2.75 Mpa (27 atmospheres)

Energy differential between seawater and freshwater: 2.75 MJ per m^3

Work needed to desalinate 1 m^3: 27 MJ = 7.5 kW-h (aprox. 1.2 L gasoline/m^3 of water)

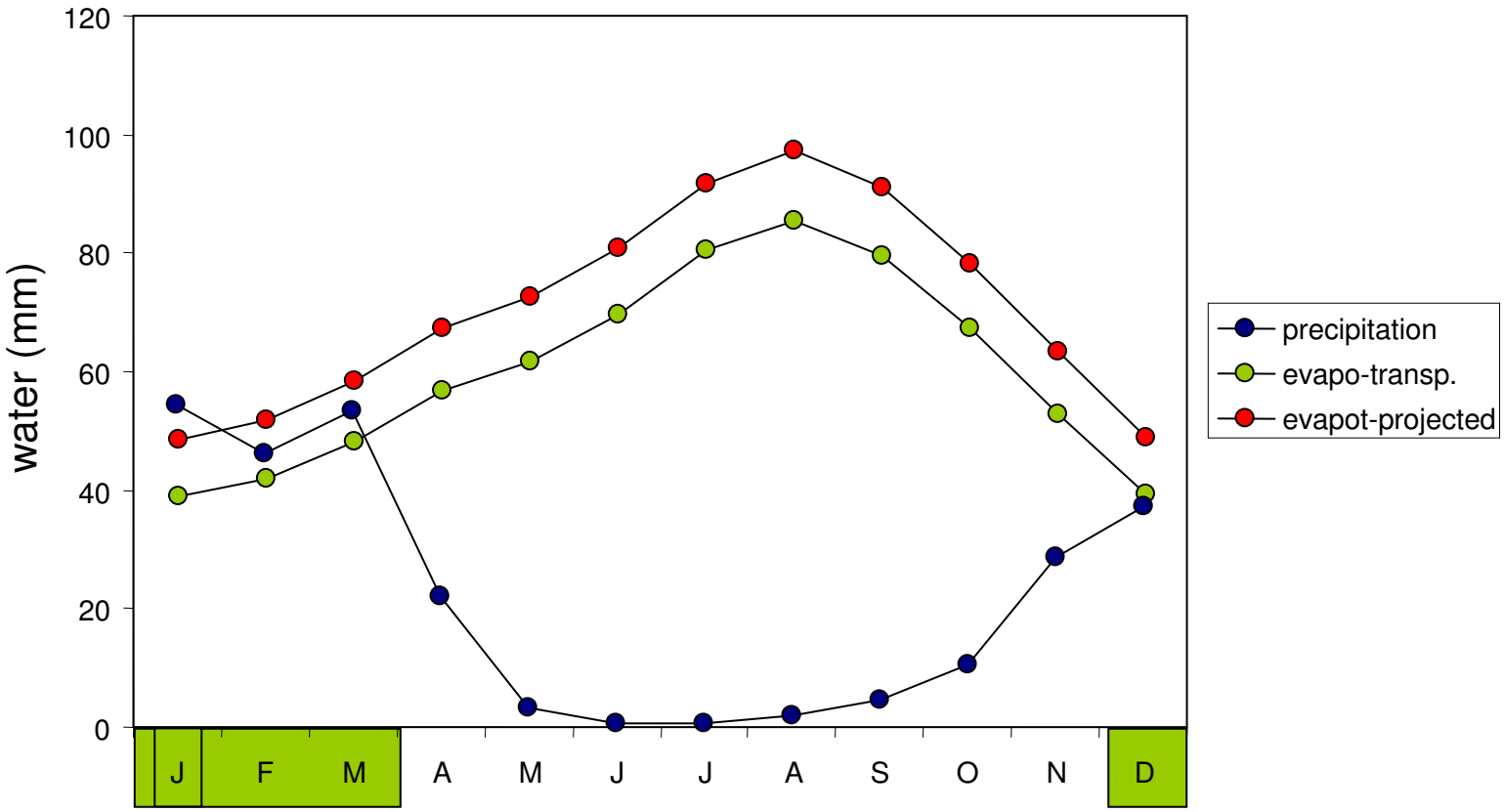
Desalination cost: aprox. \$1/m^3 of water

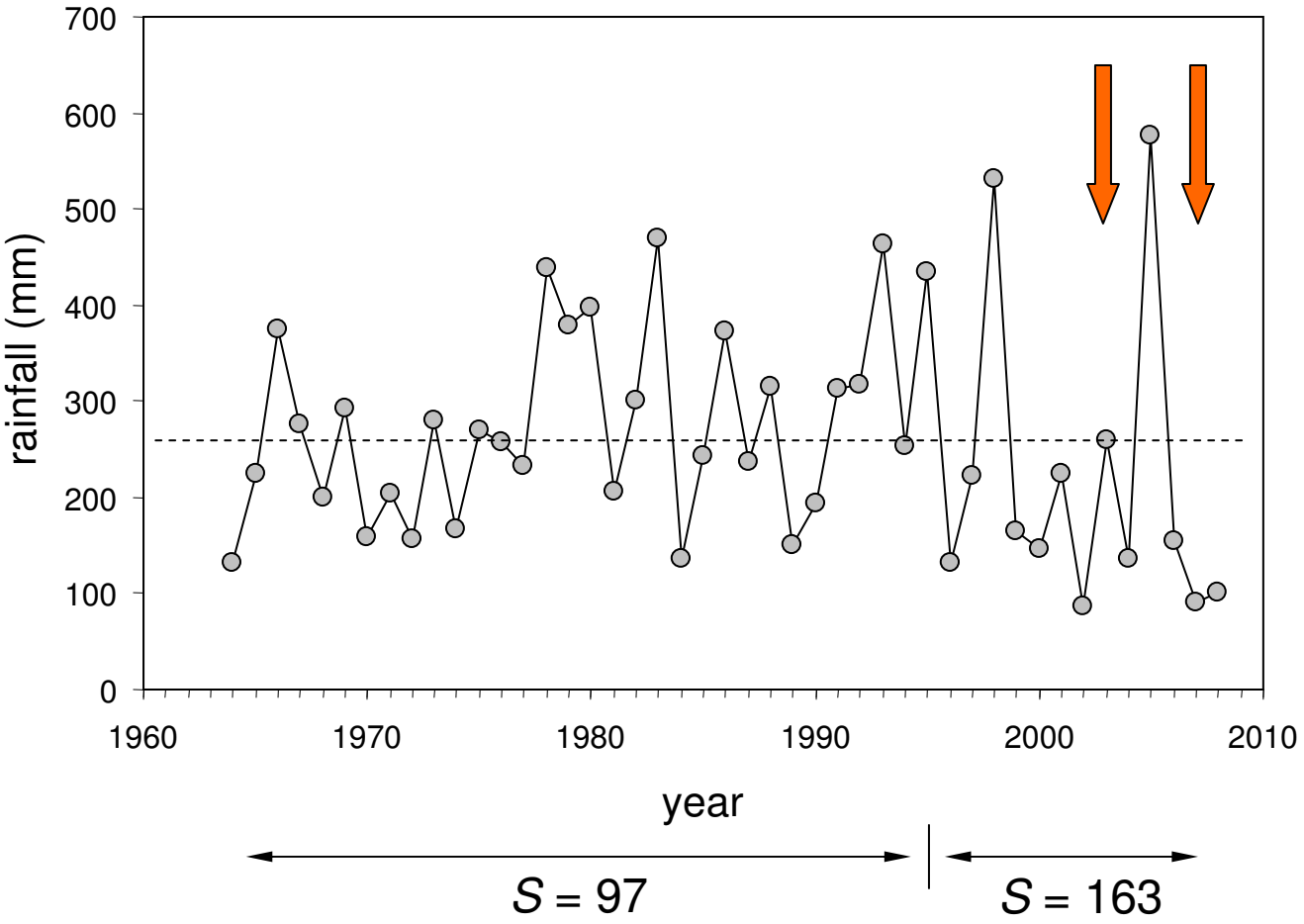

1 16 '93


Runoff/Precipitation
10 Year Average
Percentage of Runoff
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
YEAR

1. Water is an environmental service provided by natural ecosystems.
2. Modern urban growth has impaired our ability to obtain water from native sources.
3. Obtaining water from non-native sources is extremely expensive in terms of energy.
4. As a society, we have evolved towards an energy-intensive and hence highly expensive system of water appropriation and supply.

Water and climate change


120
100
80
60
40
20
0
water (mm)
J
F
M
A
M
J
J
A
S
O
N
D
precipitation
evapo-transp.
evapot-projected

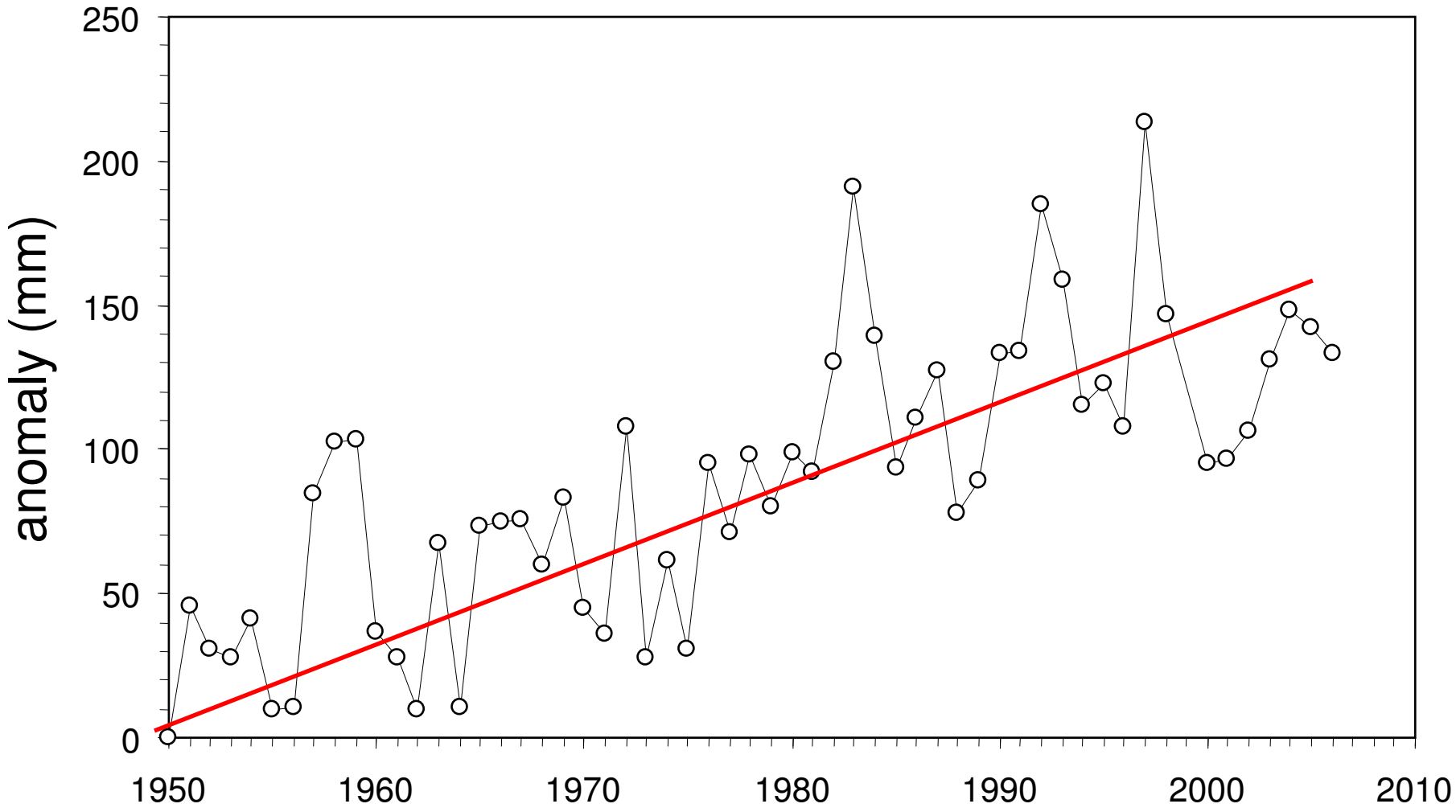

700
600
500
400
300
200
100
0
rainfall (mm)
1960
1970
1980
1990
2000
2010
year
S = 97
S = 163

1. Climate change will increase annual mean temperatures in some 1–2°C, with marked bursts of heat waves in summer
2. This apparently small temperature change can induce serious water deficiencies in our native ecosystems
3. Predicted increased variation ranges in climate may also add significant fire risk to our native scrubs, putting at risk the catchment capacity of our natural basins

The plight of coastal wetlands

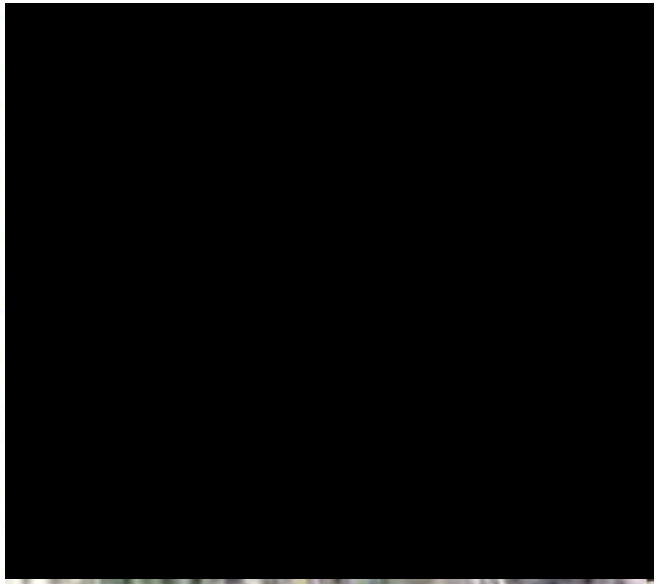

2007 ©
Aburto

mean tide level anomalies



1. Sea-level rise will induce significant changes in the dynamics of our coastal wetlands, and in the way freshwater discharge into the ocean operates
2. This may affect the dynamics of fisheries, wildlife, and of the ecosystems and vegetation that protect our coasts

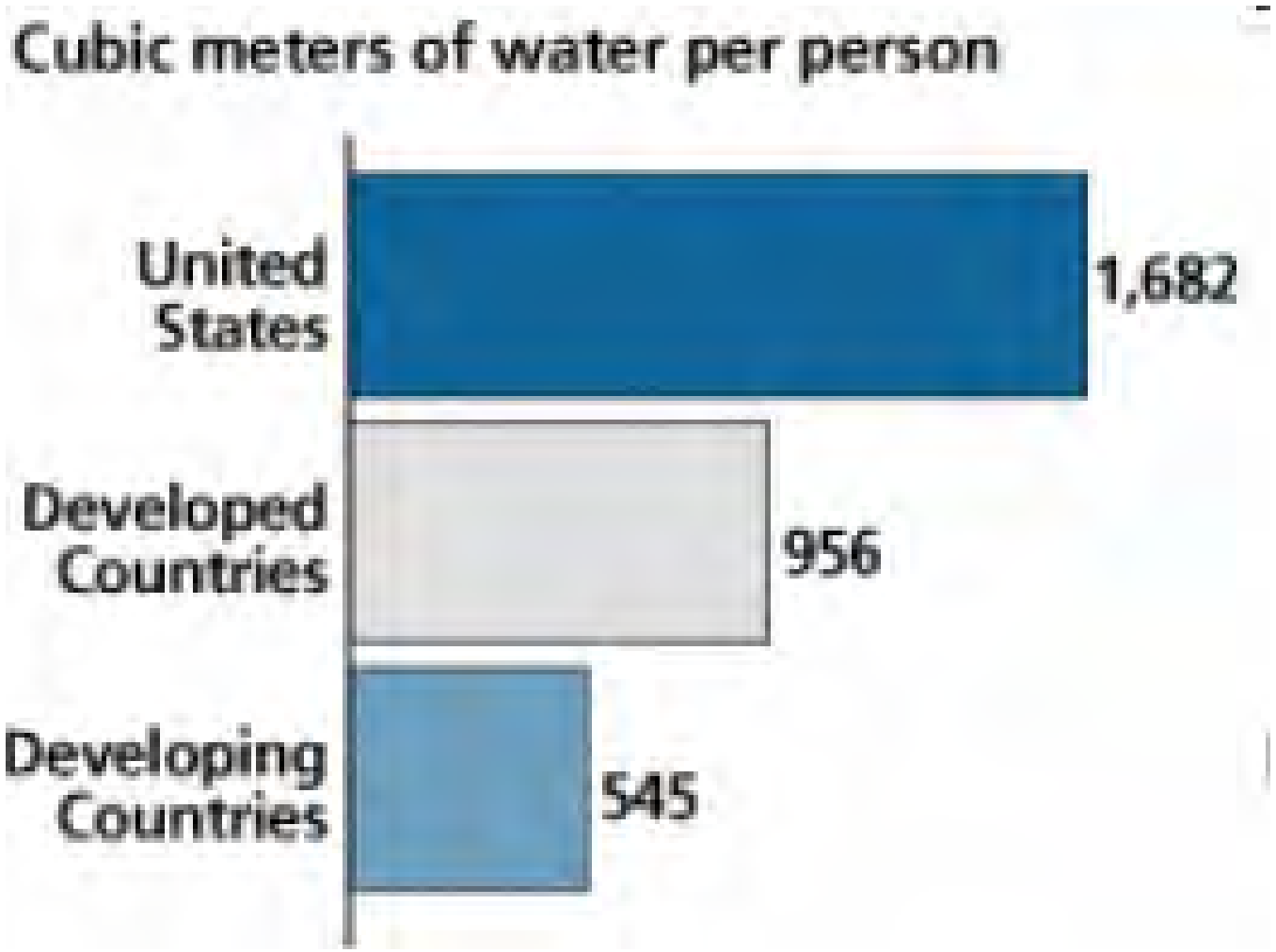
The surprising ramifications of air pollution



The Nation Park Service's Exotic Plant Management Team removes satellite infestations of Centaurea solstitialis *(yellow starthistle) to prevent the plant's spread. (Photo by Bobbi Simpson, Point Reyes National Seashore)*

1. Atmospheric pollution is a major driver of native forest die-back
2. Nitrogen deposition from the burning of fossil fuels will induce large-scale transformations of our native scrubs into more flammable grass-invaded ecosystems
3. Forest decline and increased fire frequency may impair the capacity of our native watersheds to harvest water for human consumption

Leeway for optimism


Cubic meters of water per person
United States
1,682
Developed Countries
956
Developing Countries
545

Per capita water consumption in selected US cities in liters per day (compiled by www.ucan.org from various sources).

398	Tucson, AZ.
496	Boulder, CO
663	Davis, CA (metering started in the 1990s)
686	San Diego (13,500 gallons/household/month)
1023	Sacramento, CA (no metering, starting in 2010)
1069	City of Fresno, CA (no metering)

There is a large leeway for increased efficiency of water use…

it is simply a matter of deciding to be more efficient!