

Conserving North America's Natural Heritage in a Rapidly Changing World

How is climate change already impacting water resources and ecosystem services in North America - and what can we do to adapt now and prevent a deeper crisis in the future?

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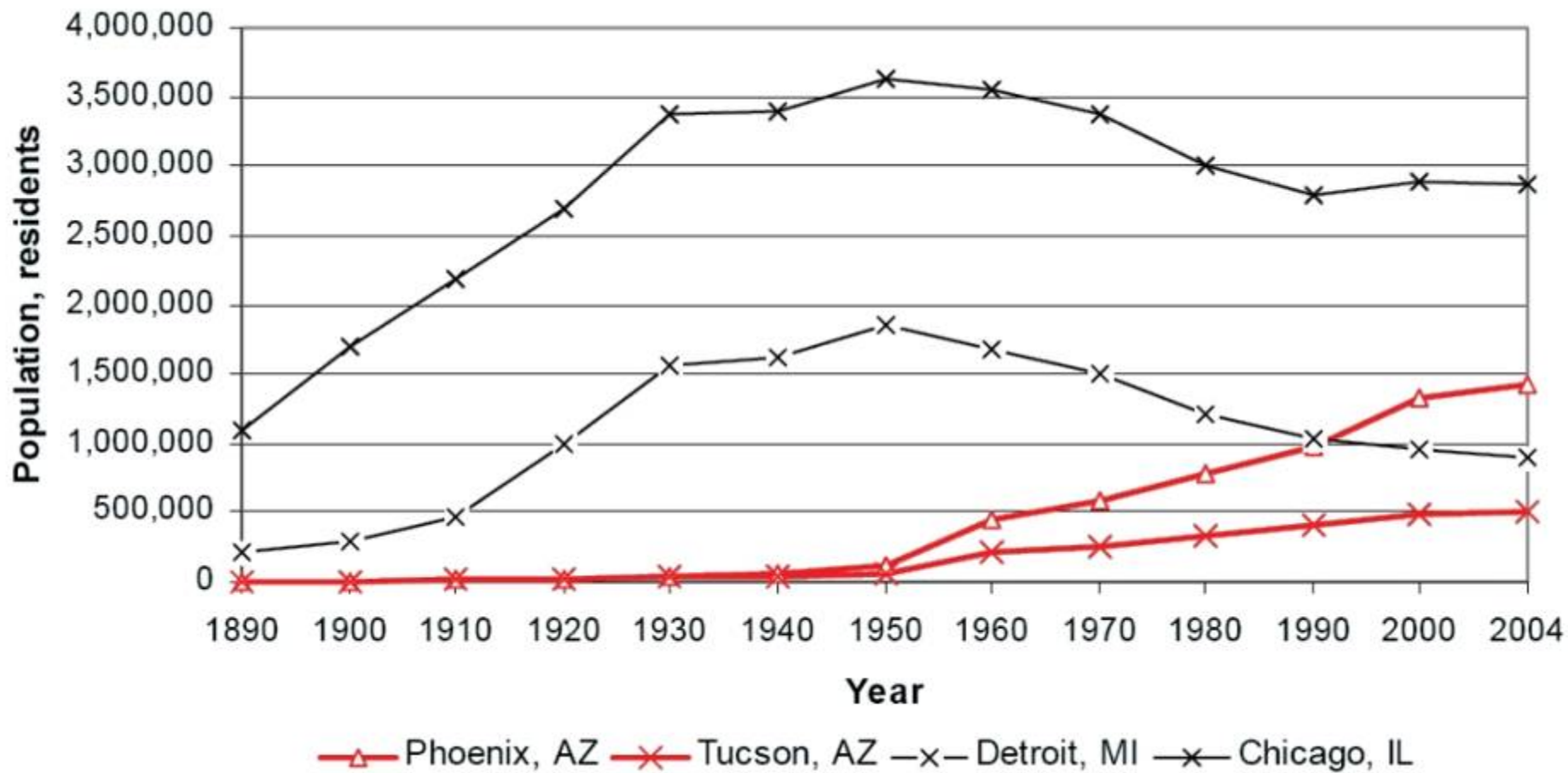
The water crisis

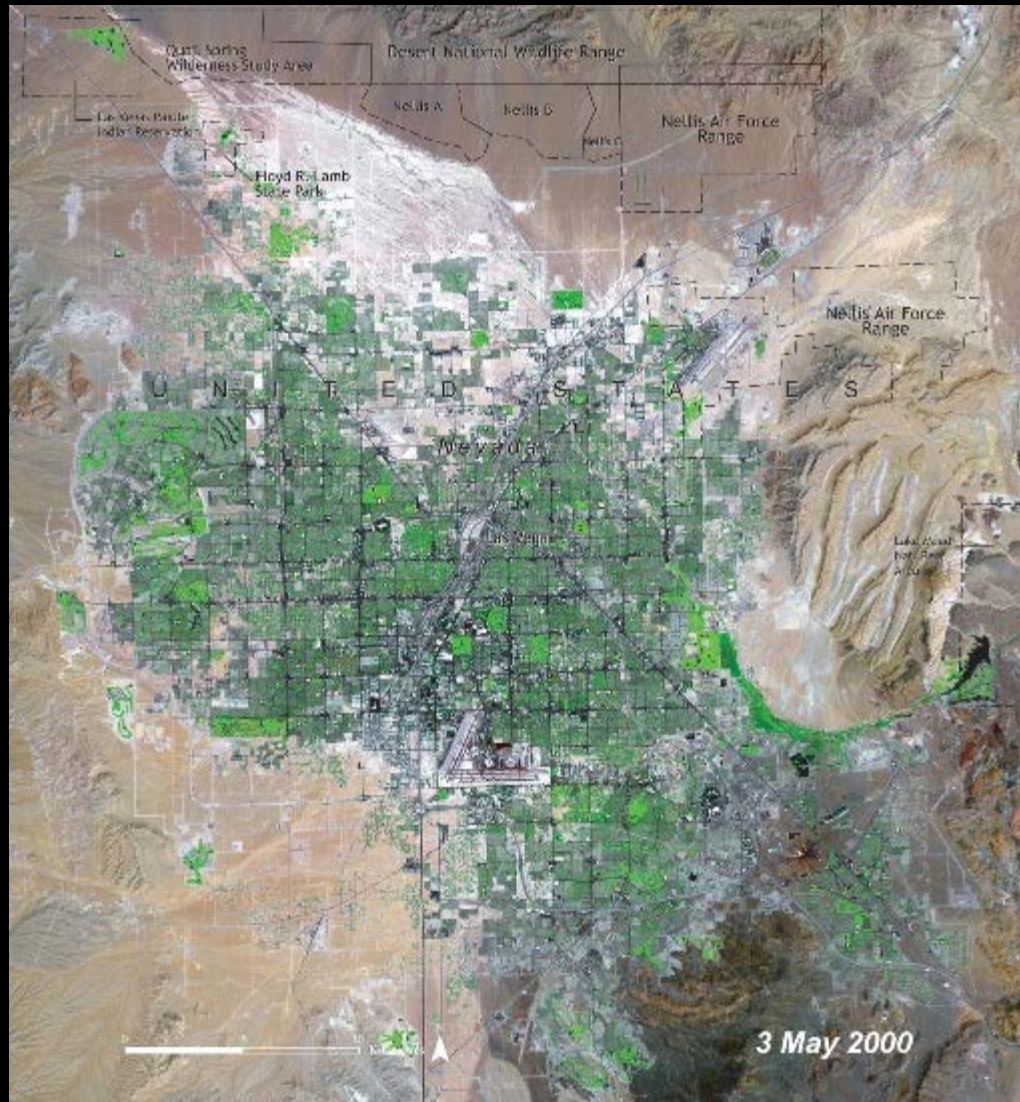






San Diego River







Palm Desert

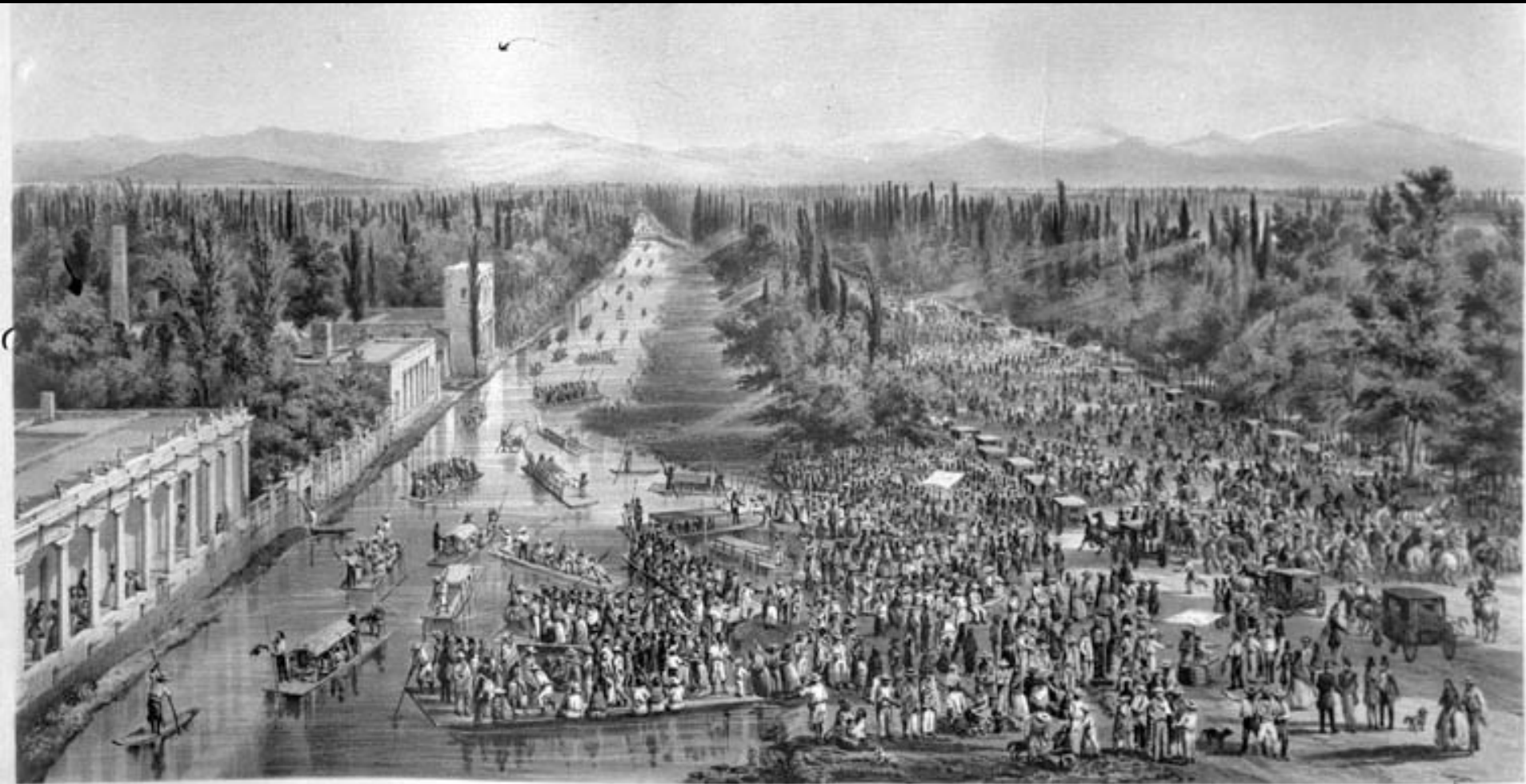
Palm Springs

0 0.75 1.5
kilometres



10 May 2000





C. Gervy y J. Campillo, del y lit.

Litog. de Don Juan editores, Mexico Portal del Coliseo Vaya.

Propiedad del editor.

THE VIGA PROMENADE.

EL PASEO DE LA VIGA.

LA PROMENADE DE LA VIGA.







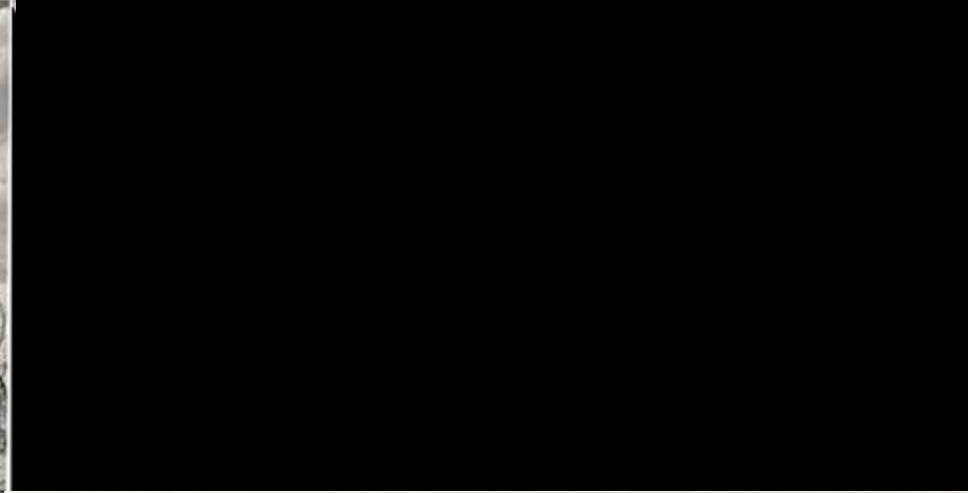




Cost of moving water

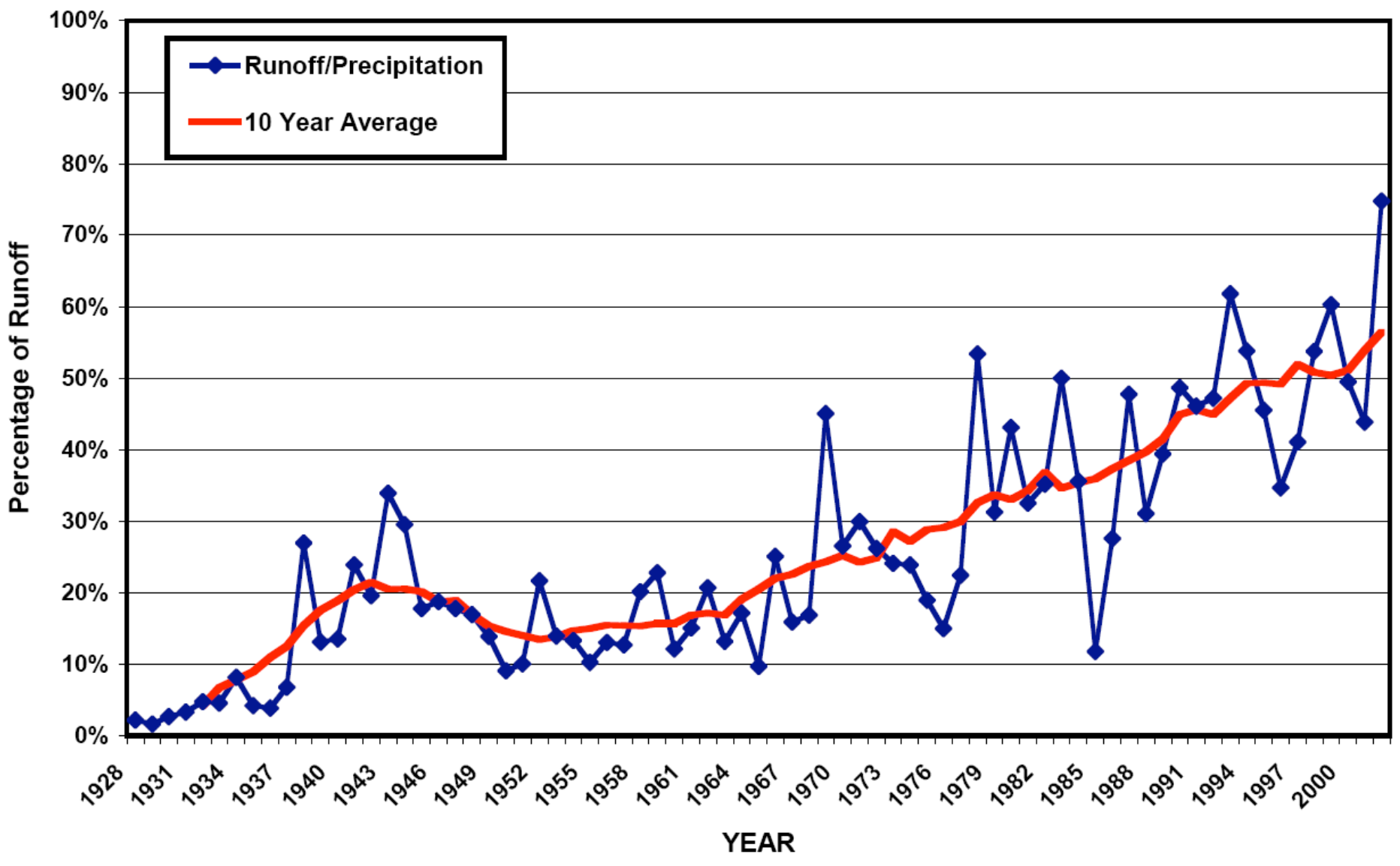
- a.- Raising 1 m^3 of water a height of 100 meters, demands approx. 1 Mjoule (980 kJ), which is equal to 0.28 kW-h or 1000 BTUs, and is equal to the energy contained in 0.046 L of gasoline.
- b.- In practice, taking into account friction in the pipes and the energy efficiency of engines and pumps, the energy contained in approx. 0.1 L of gas is needed to raise 1 m^3 of water 100 meters, or some 0.6 kW-h.

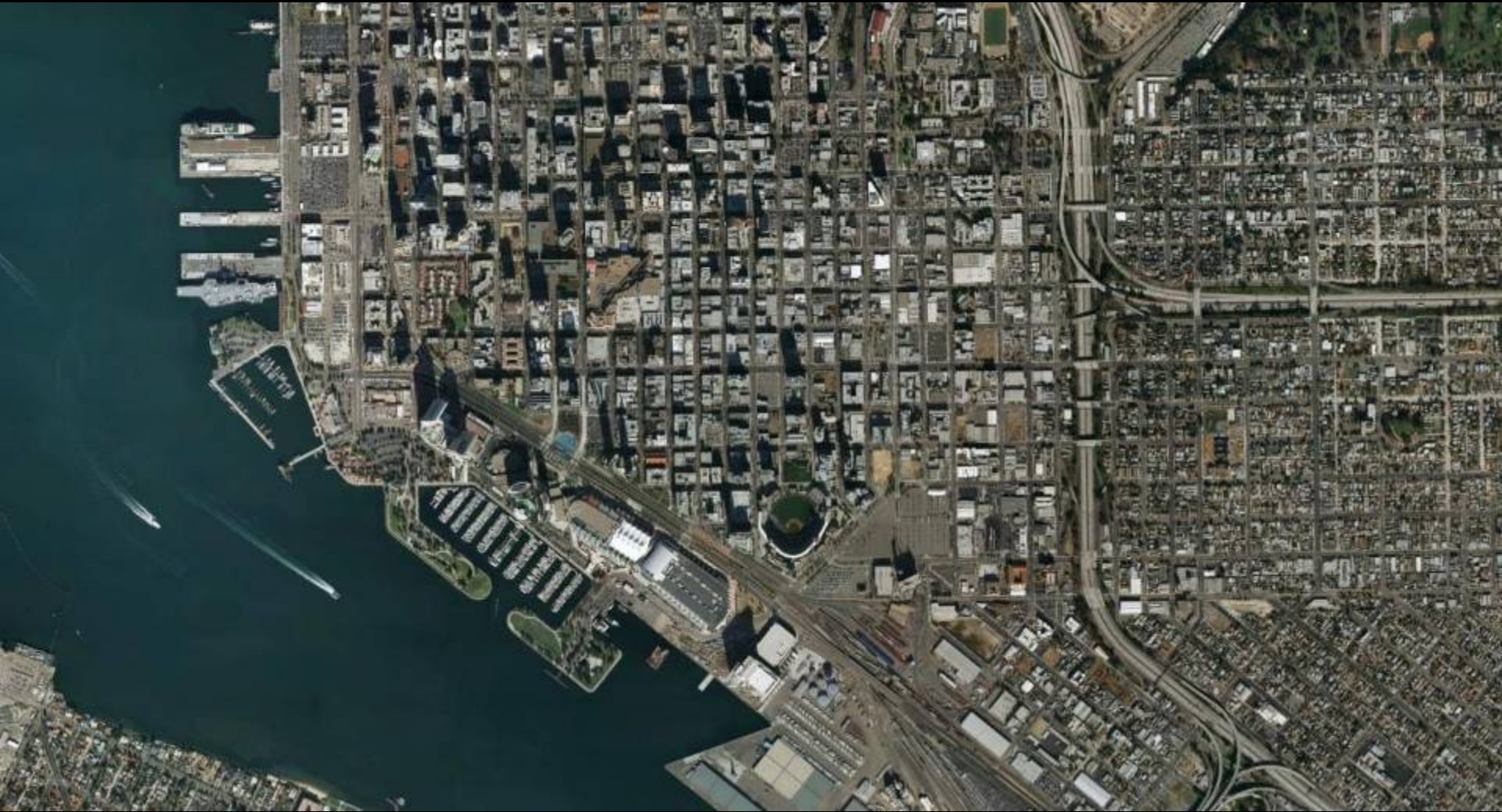












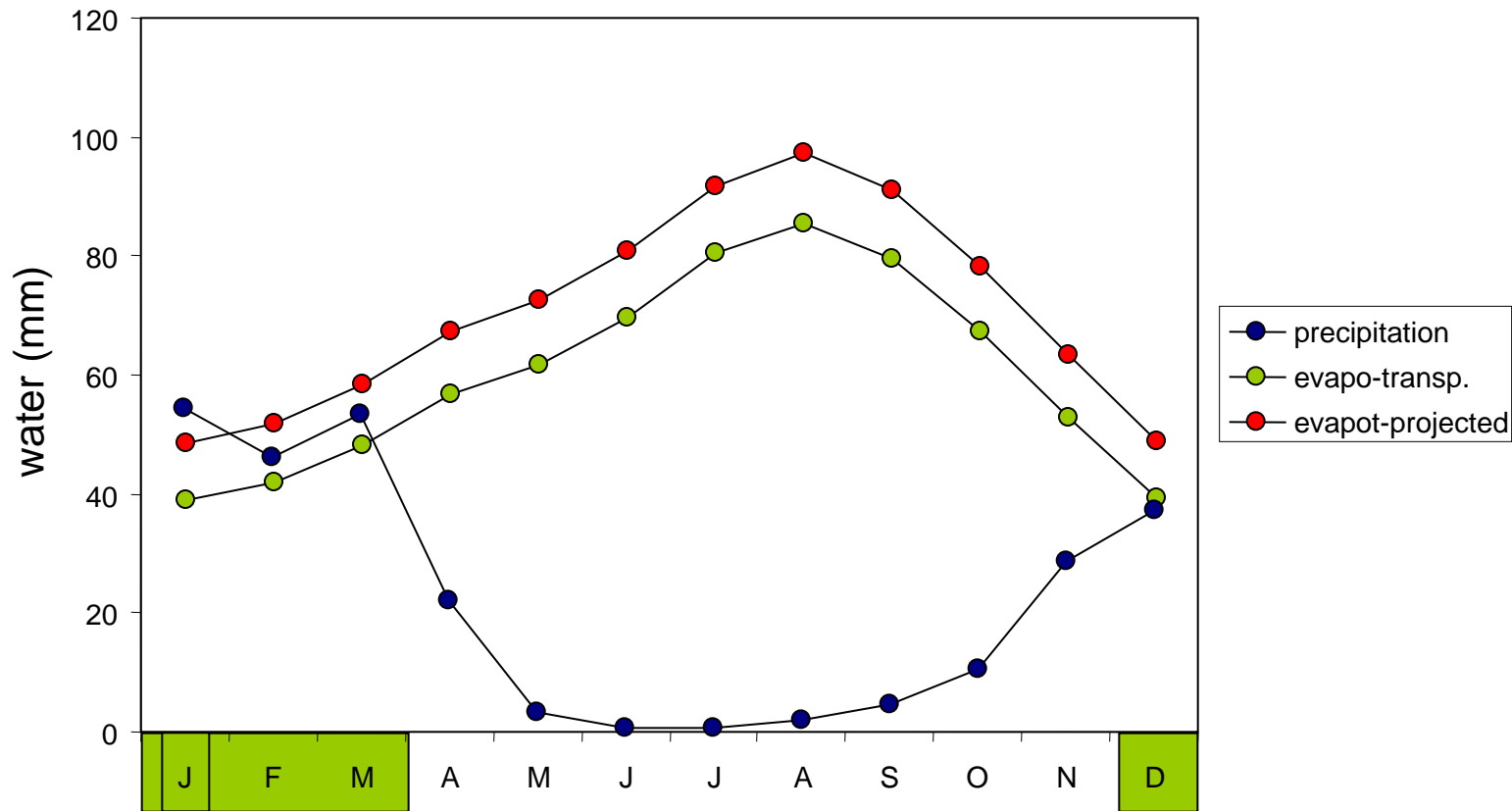


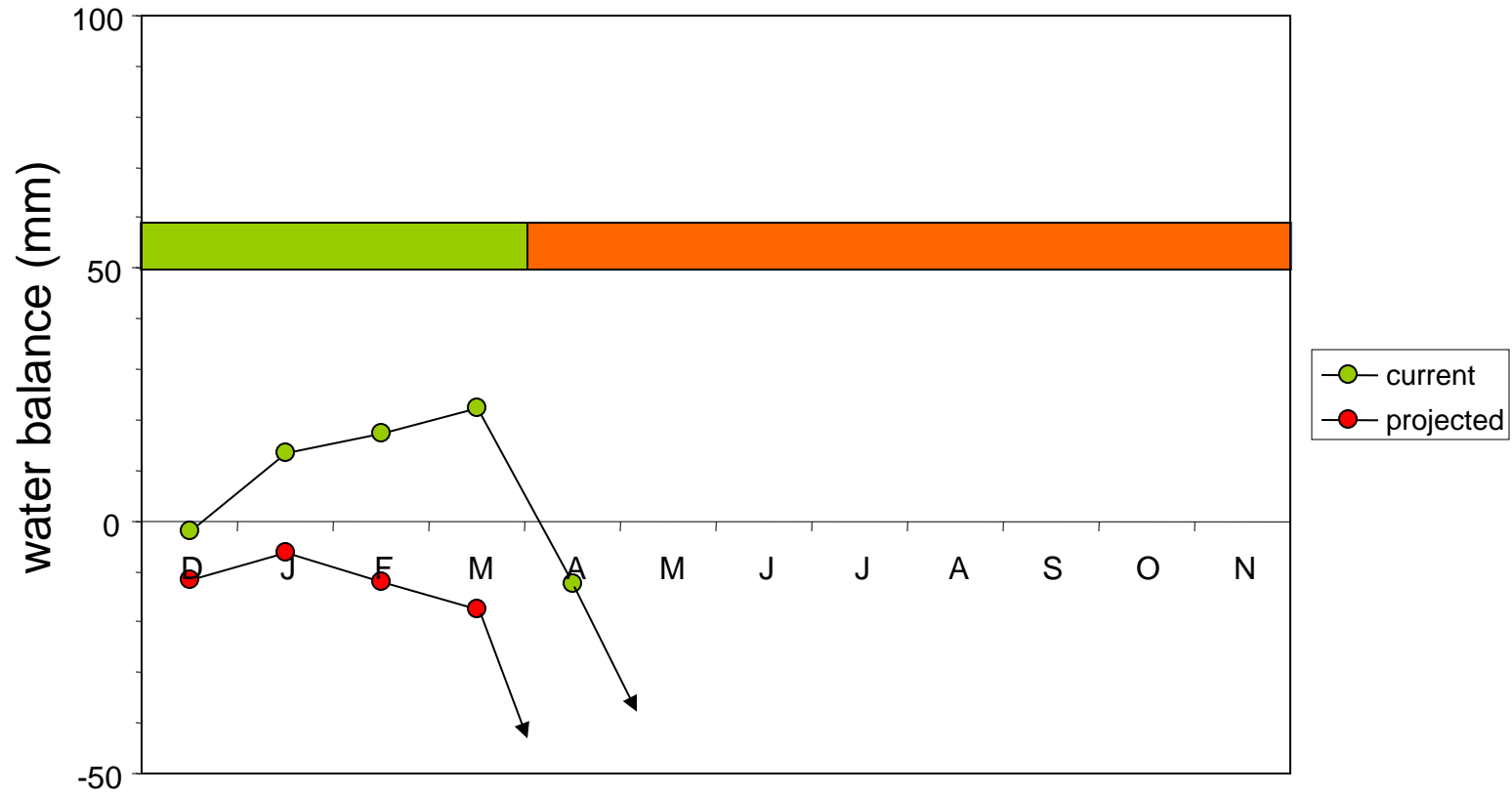




1. Water is an environmental service provided by natural ecosystems.
2. Modern urban growth has impaired our ability to obtain water from native sources.
3. Obtaining water from non-native sources is extremely expensive in terms of energy.
4. As a society, we have evolved towards an energy-intensive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

Extreme events:
Cycles and pulses





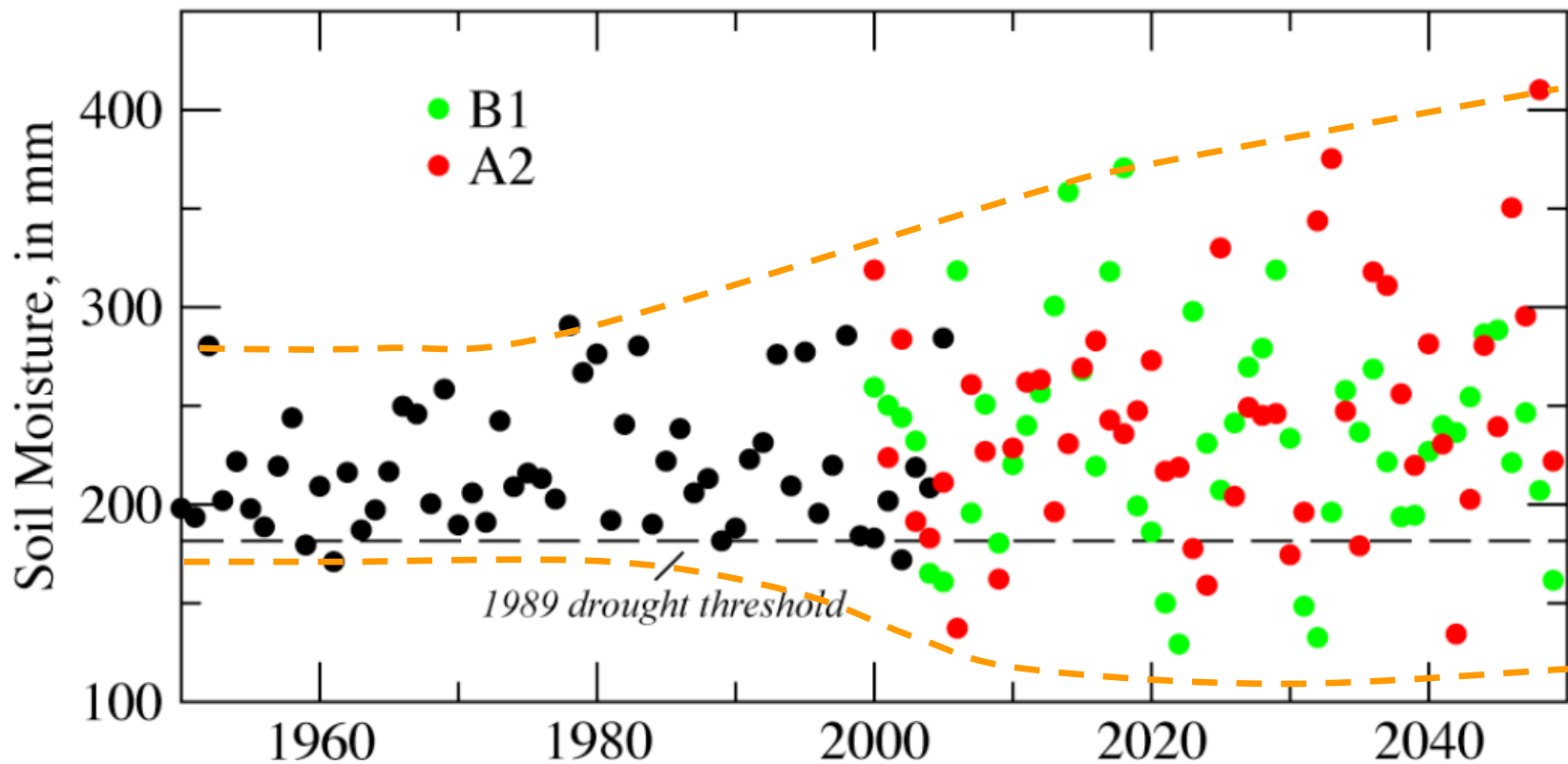
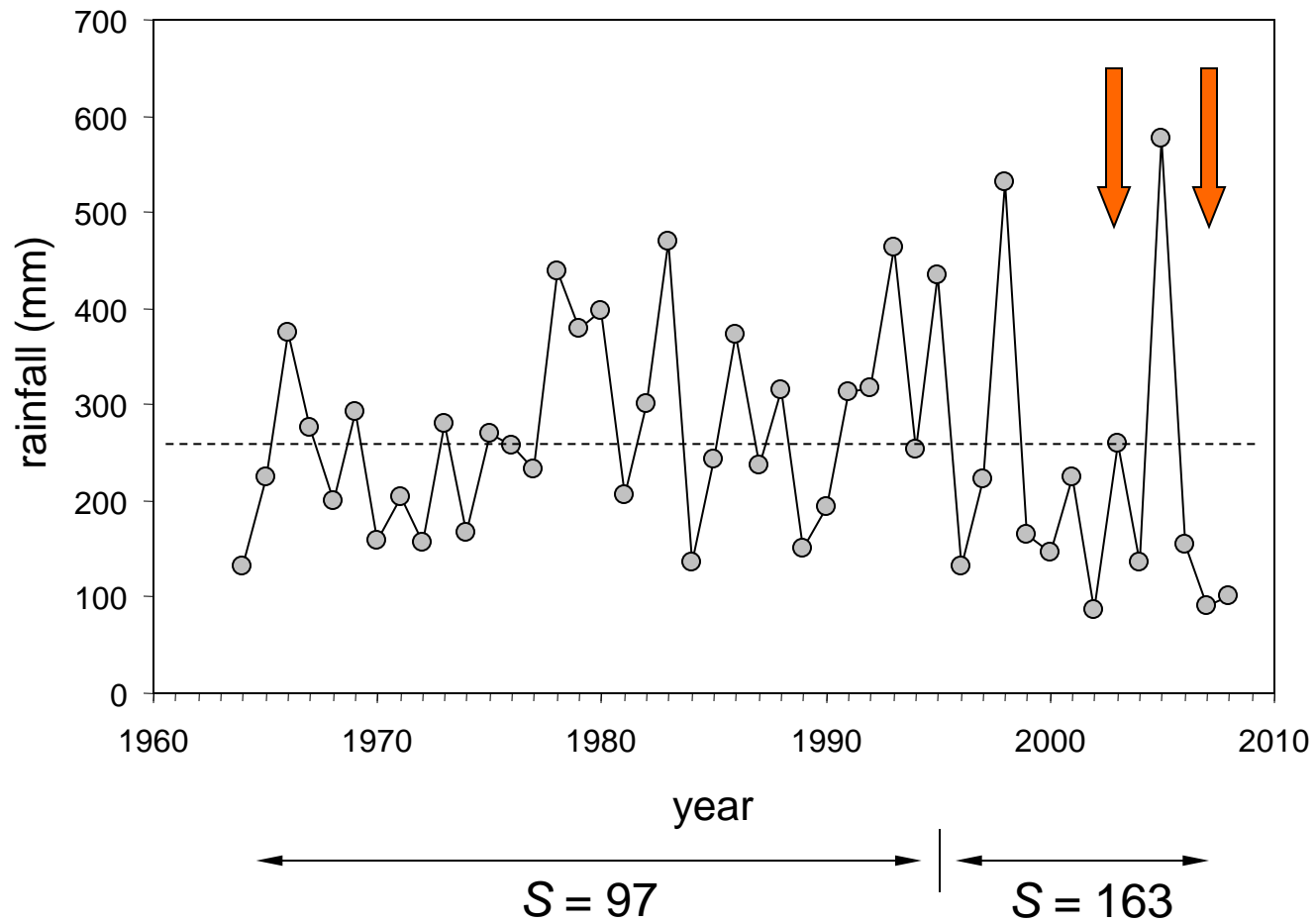


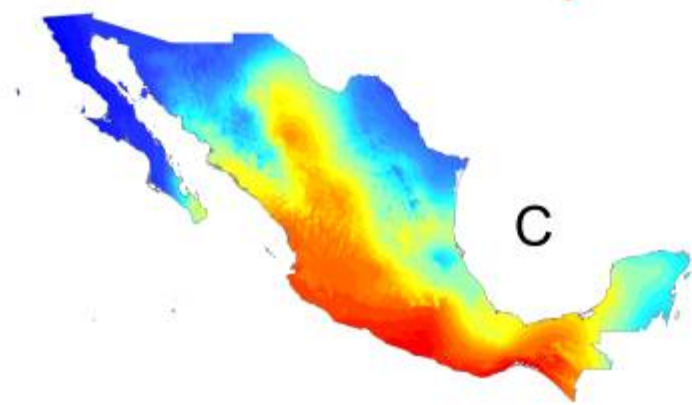
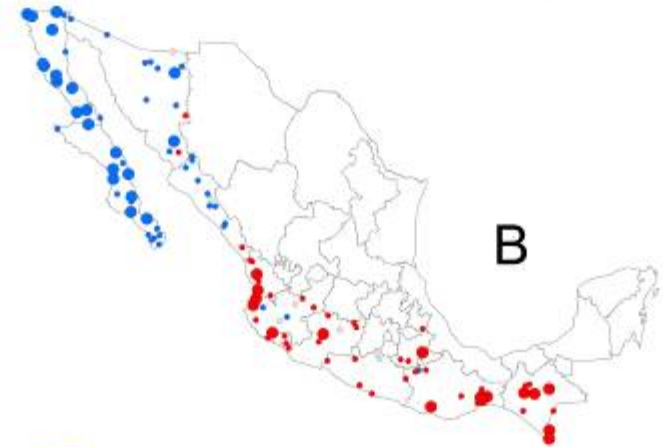
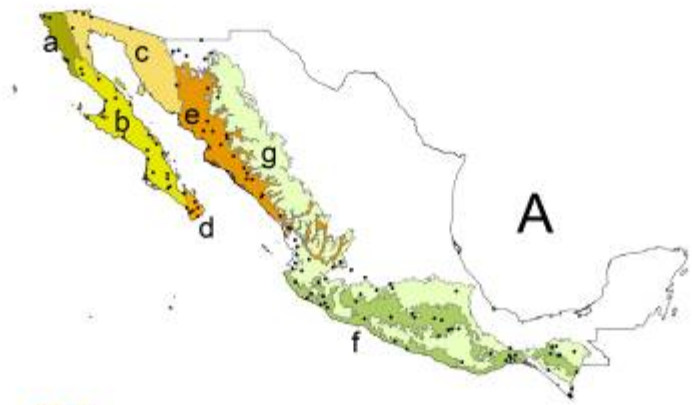
Figure 4-3. Simulated annual-mean soil moisture, western San Diego County⁴. Note increased numbers of years (dots) below the 1989 drought threshold in the future 50 years compared to the historical 50 years, indicating increased numbers of significant droughts under climate change. Black dots are simulated soil moisture contents using historical observed meteorology; historical climate-model meteorology results in a somewhat broader range of highs and lows (not shown), with about 50% less lows than among the green (B1) and red (A2) projected soil moistures.

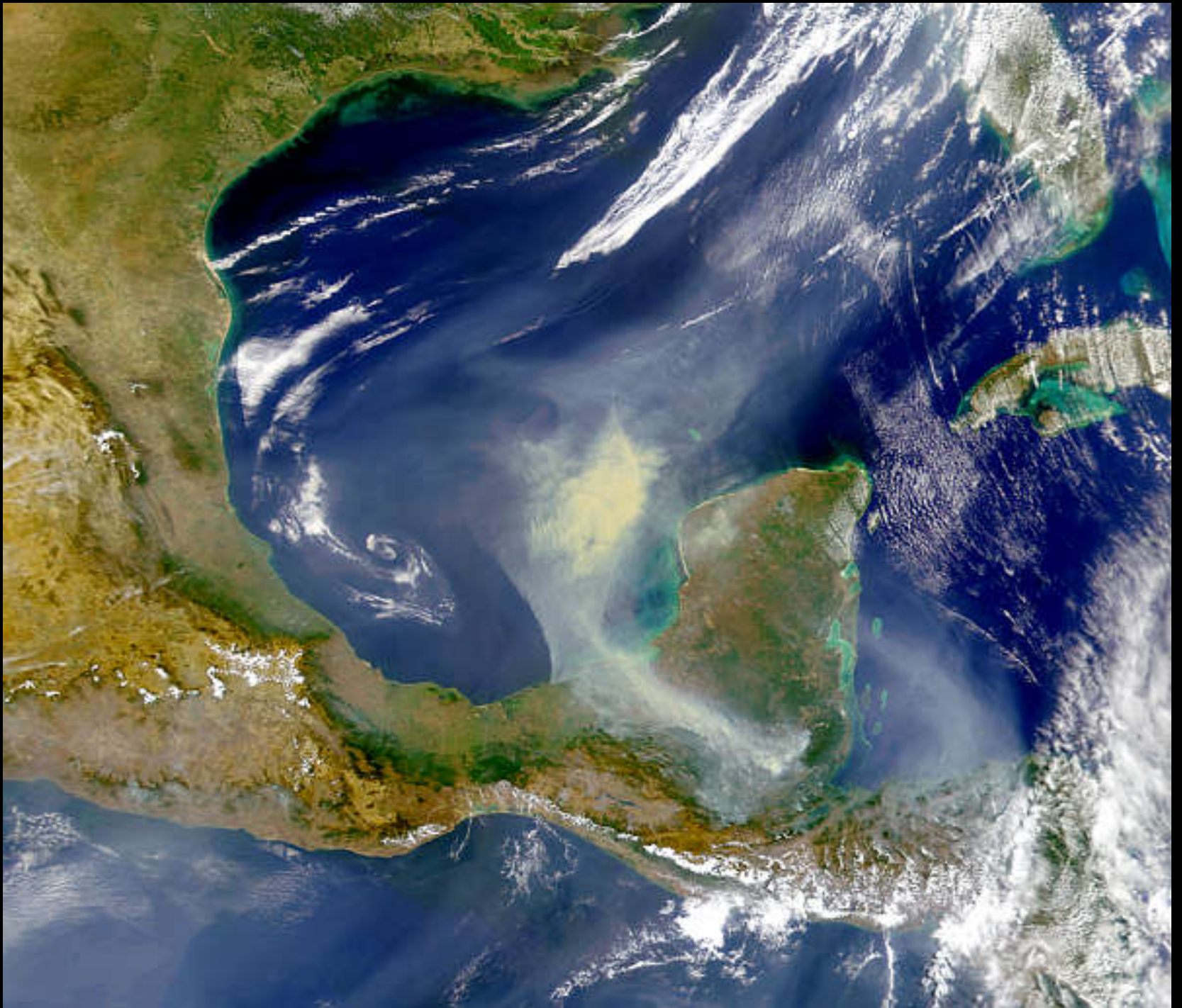


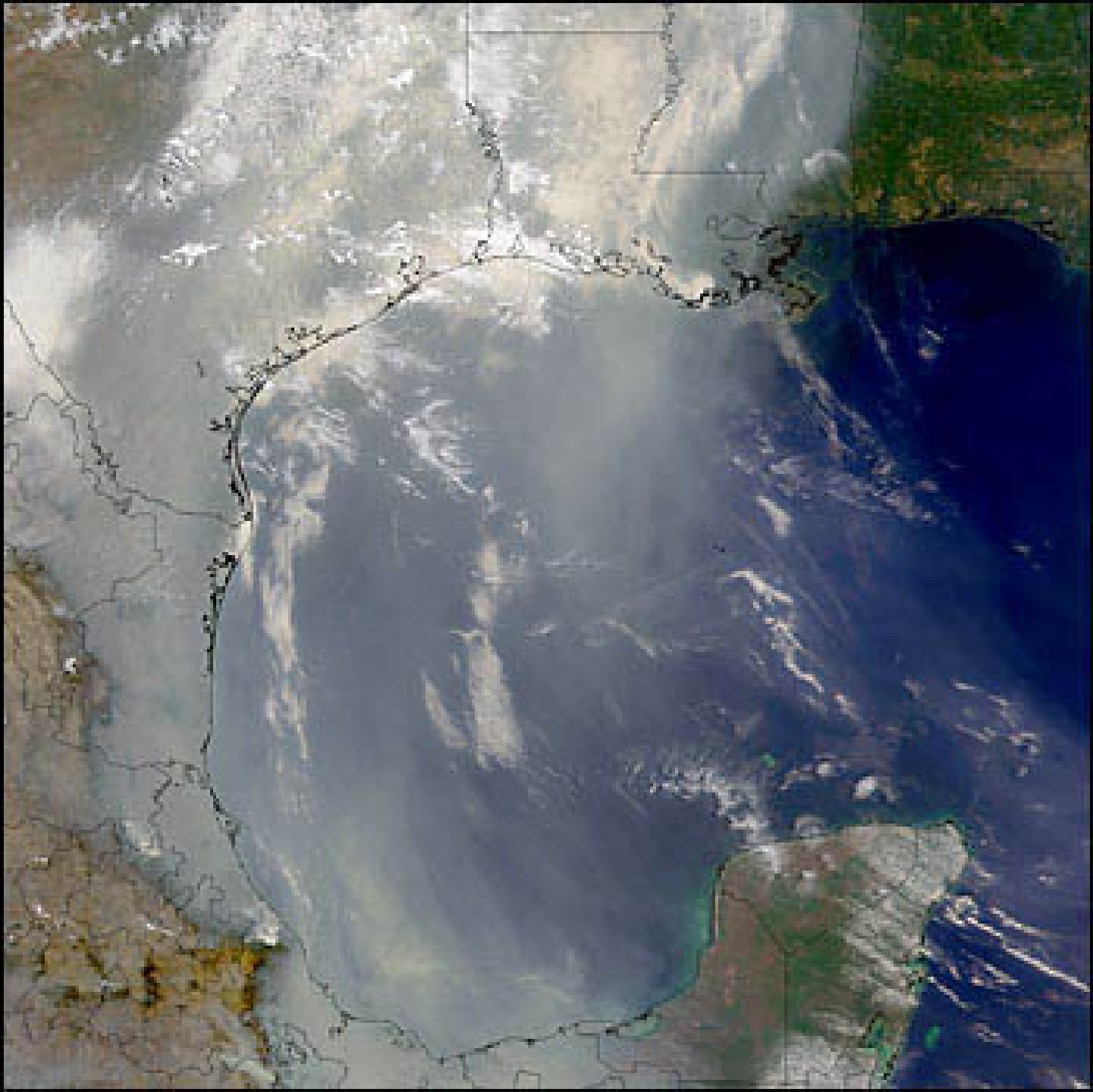


September 2003









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. Increased variation in climate events is adding a significant fire risk to our native ecosystems, putting at risk the catchment capacity of our natural basins

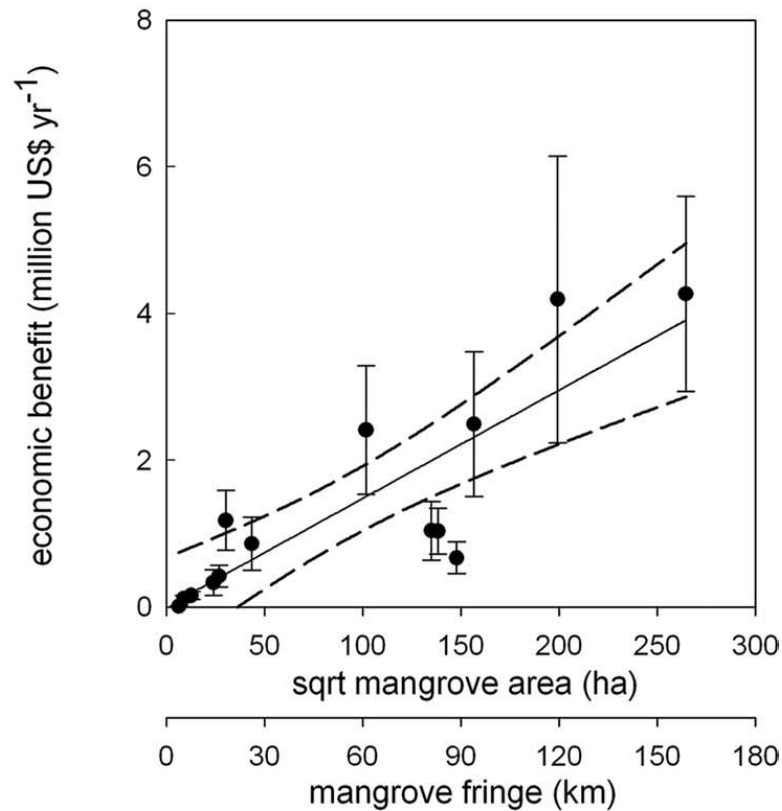
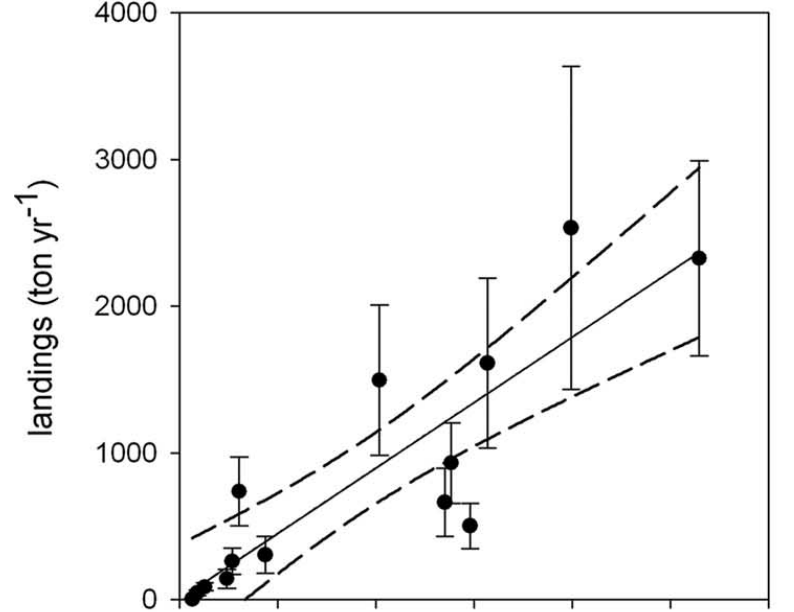
The plight of coastal wetlands

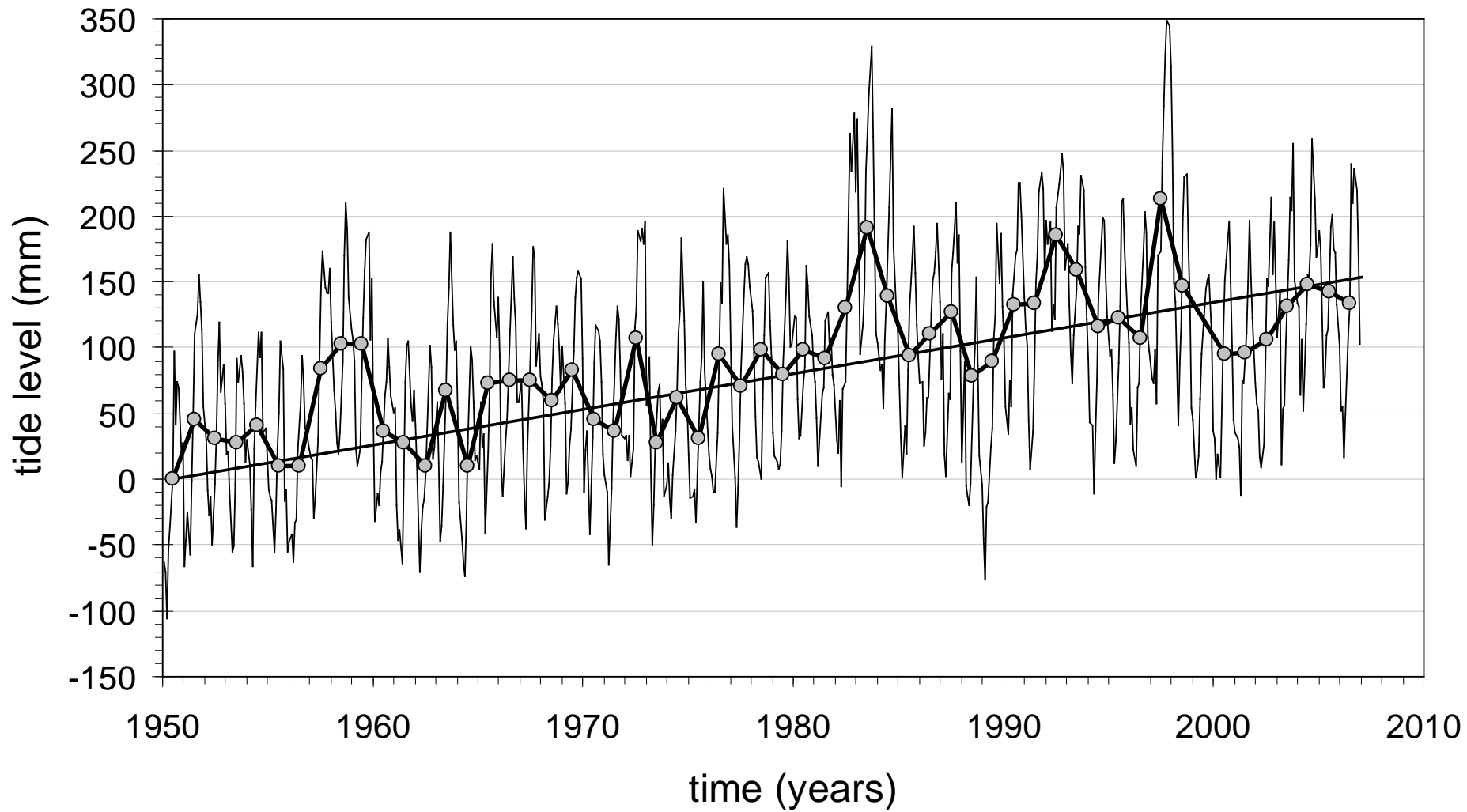




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1. Sea-level rise will induce significant changes in the dynamics of our coastal wetlands, and in the way freshwater discharge into the ocean operates
2. This may affect the dynamics of fisheries, wildlife, and of the ecosystems and vegetation that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

The surprising ramifications of air pollution

The nitrogen deposition cycle

1. The burning of fossil fuels generates NO_x as byproducts.
2. Nitrogen oxides eventually fall on surrounding ecosystems, increasing the nitrogen content.
3. In wild ecosystems, nitrogen-enrichment induces the growth of nitrophylic plants, mostly annual weedy invaders such as *Avena fatua*, *Bromus* sp., or *Brassica nigra*.
4. In the hot summers, the dry stub of these annual invaders is a primary source of combustible material.
5. This, in turn, makes the soil more prone to erosion and diminishes the ability of the natural vegetation to regulate water interception.



PLATE 1. The roots of *Agropyron repens* (left), the winner species at Cedar Creek, are much finer than those of *Andropogon gerardii* (right). Plants with fine roots are generally less mycotrophic than those with coarse roots. Photo credit: Rick Johnson, Jana Johnson, and Claire Johnson.



*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)*





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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



