A show of hands please? If you could travel back in time to see the world before the transformation of the planet by the Industrial Revolution, would you go? One way to take a walk into the past is to visit an ancient swamp forest. These forests feel frozen in time, with little change for thousands of years.

Ancient baldcypress with knees, Goose Lake, White River National Wildlife Refuge, Arkansas, USA.

Another style of time travel is to read old data, books, records, and historical accounts. An example of the power of such data to illuminate climate change questions comes from the ancient records of the flood levels of the White Nile River, which extends back to 641 AD. These data are so old that the measurements are in cubits and fingers. The overall flood level data for the White Nile spans several thousands of years, and this wisdom of the ancients is invaluable to the understanding of climate change (Hassan 1981). Old data are a gold standard in climate change research, and much more use should be made of these data sets to document changes in wetlands in recent decades.

Historical Data In Monsoonal Wetlands

Key data sets for the study of climate or land use change effects on wetlands may include historical field studies. One useful source is baseline data for monsoonal wetlands collected in 1983-1987 in the Keoladeo National Park in India. At that time, my research colleagues at Iowa State University and I collected data on the function of these wetlands during a normal hydrological period in their history and before upstream diversion of water had occurred. For my Ph.D. dissertation research, I collected seed bank data related to my studies of goose grazing and vegetation dynamics (Middleton et al. 1991). This work has been valuable in recent years to identify relict populations of aquatic species after years of dry conditions in the park following water diversion (Middleton 2009).

Water Diversion and Aquatic Biodiversity

Historically, Keoladeo National Park was flooded during the monsoon and winter season, and dry during the summer time (April through September) with much inter-annual variation (Figure 1, 2A). In 1996, water was diverted for agriculture and other uses upstream of the Keoladeo National Park. Even though monsoonal wetlands naturally have high inter-annual variation in water level, local observers noted that after the diversion of water, the monsoonal wetlands in the park were dry in most years (Laxmi Mudgal, Brijendra Singh, and others, pers. comm.).

In the 1980s, the aquatic blocks of the Keoladeo National Park were flooded during most years from October to March. The vegetation consisted of seasonally floating *Paspalum distichum*, *Vetiveria–Acacia* savanna, and shallow meadows of native rice (*Oryza rufipogon*).

The Iowa State Project, 1983-1987

Old data sets such as those from Iowa State University in the 1980s have immense value for assessing long term vegetation change over time. These data sets include classic studies of biomass production, decomposition, vegetation composition, water level tolerance, and seed bank structure (Middleton et al. 1991, 1992).
Figure 1. Water delivery to the Keoladeo National Park from 1965 to 2008 via reservoir release and precipitation. Water is released from the reservoir to the park after the annual monsoon (September through February). Additional water comes from precipitation. Data are from the Irrigation Department, Bharatpur, Rajasthan, India. After 1996, the water in the park decreased because of increased water usage along the Gambhir River.

Figure 2. A) Monsoonal wetlands in northern India flood during the monsoon (October through March) and drawdown during the dry season (April through July), thereby completing a vegetation cycle in one year. If the monsoon fails, the wetland stays dry until the next monsoon, unless water floods the floodplain from the river. B) The vegetation cycle in prairie potholes in North America occurs over a 5-25 year interval, and is also driven by periodic drought. Some species of monsoonal wetlands and prairie potholes live for decades in the seed bank, which pre-adapt these species to survive any long-term drought related to climate change.
Water snowflake (*Nymphoides indica*) is an increasingly rare floating aquatic plant, here pictured on a mudflat. The species is more commonly found flowering in shallow water.

Kleberg’s bluestem (*Dichanthium annulatum*) is a forage species of the savanna woodland edges in northern India. The species was noted as declining in the national park after extended drought.

Kadam (*Mitragyna parvifolia*) is a tree of floodplain savanna in northern India. The flowers are sweet scented and bloom just before the monsoon. Kadam is in the family Rubiaceae, along with bedstraw, its diminutive relative from temperate wetlands.

**Drought Biodiversity in 2009**

A field search was conducted for eighteen aquatic species of concern in the Keoladeo National Park in 2009. These species had been present in the seed banks in specific locations in the 1980s (Figure 3), but had become uncommon in the dry periods subsequent to the 1980s surveys. These locations were checked for adult plants in 2009. All but five of the species of concern were located as adults in these locations (Middleton 2009).

Fourteen savanna species were sought in the 2009 survey, and seven of these were located. These species were not necessarily “missing”. The savanna seed banks were not formally sampled in the 1980s, so their locations were unknown in 2009.

While the “lost” species were no longer as widespread as in the 1980s, many of the species were relocated in 2009. The majority of these once common species persist as seeds in the seed bank. Old data can be critical to the understanding of new problems associated with climate change.

**Seed Banks Support Biodiversity**

Figure 3. A field search for missing species was conducted in aquatic blocks (numbered areas with viable seed banks in the 1980s) in the Keoladeo National Park in 2009. These valuable seed banks could be useful in restoring the vegetation in sites invaded by *Prosopis juliflora* or *Eichhornia crassipes*.

Long-term data sets can document changes in vegetation.
Additional Information

Citations:


Acknowledgments: The author would like to thank the Keoladeo Naturalists Society and others (pictured above) for their continued interest and support in research related to the conservation of Keoladeo National Park, Bharatpur, India.

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