ENSO BASED CLIMATE FORECASTING FOR EARLY IMPOUNDMENT OF LARGE RESERVOIRS, CASE STUDY: KARKHEH DAM IN IRAN

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ENSO BASE PRÉVISION CLIMATIQUE POUR MINIERS EARLY DE GRANDS RÉSERVOIRS, ÉTUDE DE CAS: KARKHEH DAM EN IRAN

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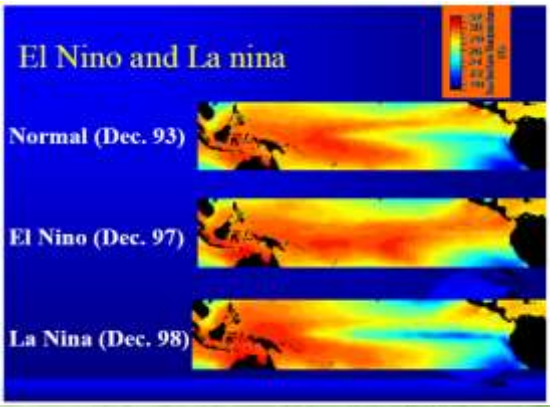
Presentation outlines

1. ENSO (The El Niño Southern Oscillation)
2. Background
3. Monitoring the ENSO Indices
4. The early Impoundment of Karkheh dam
5. Conclusions and current strong El Nino

ENSO

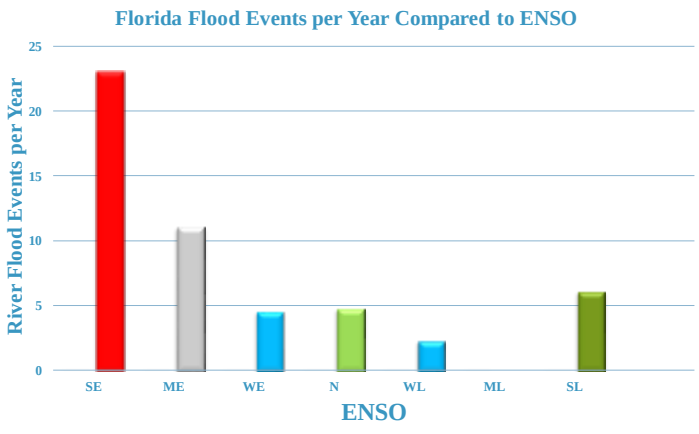
E`l Niño, which occurs every 2 to 7 years, is an abnormal warming of the eastern Pacific waters that interferes with the normal trade wind patterns. ENSO is perhaps the most important mechanism affecting weather patterns on time scales of a season out to a few years



Presentation outlines

Teleconnection in atmospheric science refers to climate anomalies being related to each other at large distances (typically thousands of kilometers

ENSO teleconnection with Floods in Florida



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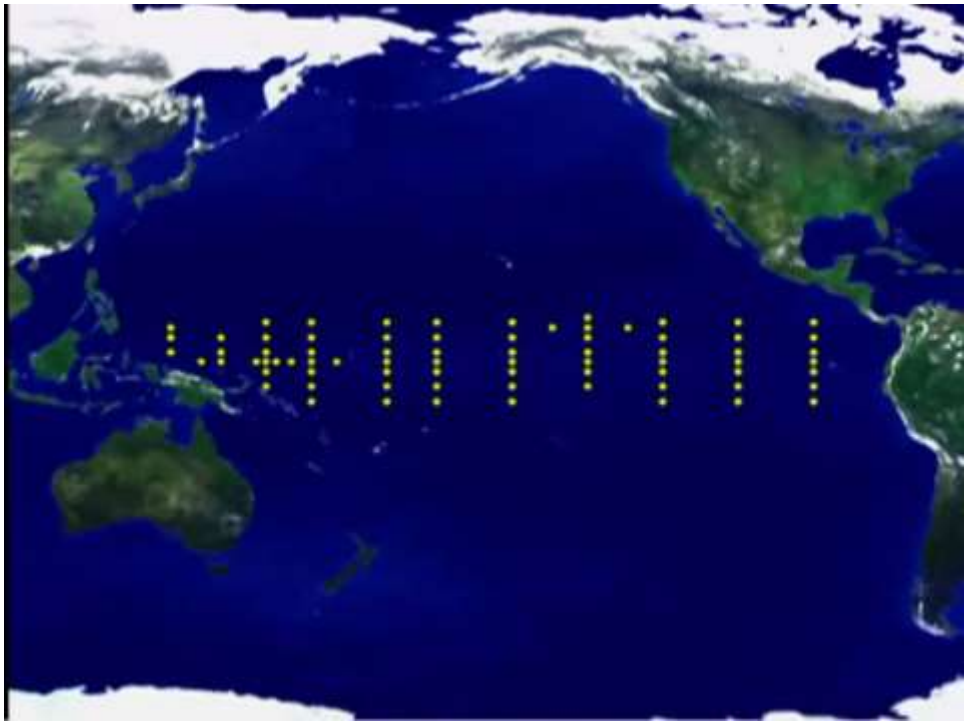
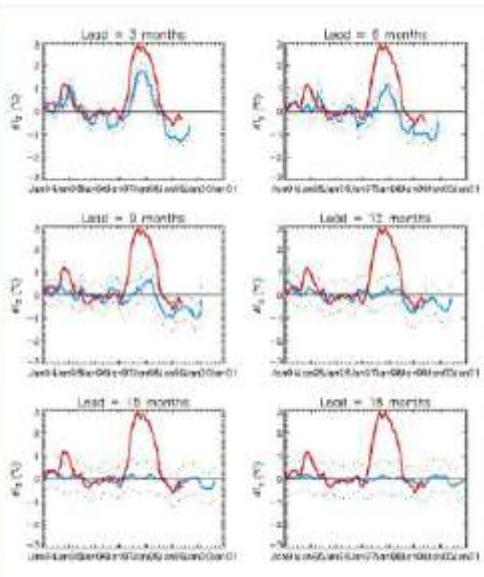
Forest Fires in Indonesia (1998)



- SST forecasting
- Dynamic
- Statistical

Models



Economic Gain of $15 Billion in U.S. in 1997-98

Impacts of 1997–98 El Niño–Generated Weather in the United States

Stanley A. Changnon
Changnon Climatologist, Mahomet, Illinois

TABLE 1. National tally of impacts from weather conditions attributed to El Niño, 1997–98.

LOSSES

Human lives lost = 189
Economic losses and costs = $4.2–$4.5 billion

BENEFITS

Human lives saved = 850
Economic gains = $19.6–$19.9 billion

An important caveat!

In any variable pattern of weather, El Niño is only part of the story.
But for Strong events, the ENSO effects would be more pronounced and forecasting skills would be improved.

. In the United States alone, the benefit versus cost for the forecasting capability proposed by NOAA is about 300 to 1.

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Karkheh, The largest reservoir in Iran

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Teleconnection of ENSO and Karkheh Flow in Fall

Water year	Mean Discharge Oct-Nov	Mean Discharge Nov-Dec	ENSO
1957-1958	165	259	W+
1965-1966	132	90	W+
1972-1973	132	228	W+
1982-1983	170	180	W+
1986-1987	97	220	W+
1991-1992	54	284	W+
1997-1998	190	125	W+
Long-Range Average	104	182	-

Teleconnection of ENSO and Karkheh Flow in Fall

Water year	Mean Discharge oct-nov	Mean Discharge nov-Dec	ENSO
1954-1955	83	148	C+
1970-1971	53	110	C+
1973-1974	54	73	C+
1975-1976	87	129	C+
1964-1965	40.5	102	C+
1988-1989	87	105	C+
1998-1999	68	101	C+
Long-Range Average	104	182	-

Teleconnection of ENSO and Karkheh Flow in Fall

ENSO	Number of Years	Montly Average in Oct. and Nov.
Strong EL Nino	7	In 7 years the average monthly flows were more than long term average in Oct. or Nov. or Both
Strong La Nina	6	In 6 years the average monthly flows were less than long term average in Oct. and Nov.
Weak EL nino	10	In 8 years the average monthly flows were more than long term average in Oct. or Nov. or Both
Weak La Nina	7	In 5 years the average monthly flows were less than long term average in Oct. and Nov.

Non-structural approaches for a Safe impoundment

1. **Seasonal flood characteristics:**

Season	Autumn	Winter	Spring
Flood Potential	High	Low	High

2. **Forecasting models (climate and hydrological forecasting models)**
3. In the summer of 2000, a La Nina event was forecasted for the next autumn and winter. Consequently the models forecasted a dry autumn and these forecasts facilitated a safe impoundment

•The following spring was one of the driest seasons in the history of the river but a volume of 400 MCM of water stored in the reservoir in the previous winter substantially mitigated

Non-structural approaches for a Safe impoundment

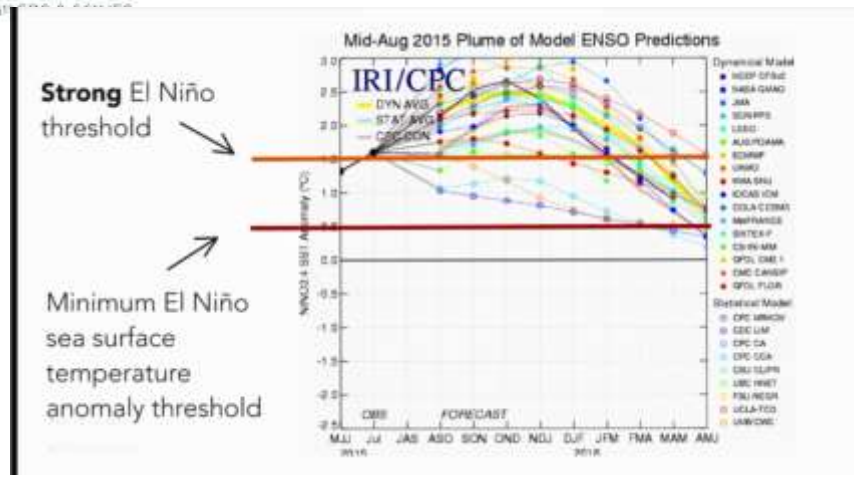
Dry Fall+ Low Potential of Floods in Winter → Enhanced accuracy of Hydrological-Climate Models → Dry Spring forecasted and the reservoir was imponded

impoundment with no spillway!

The following spring was one of the driest seasons in the history of the river but a volume of 400 MCM of water stored in the reservoir in the previous winter substantially mitigated the adverse impacts of the drought.

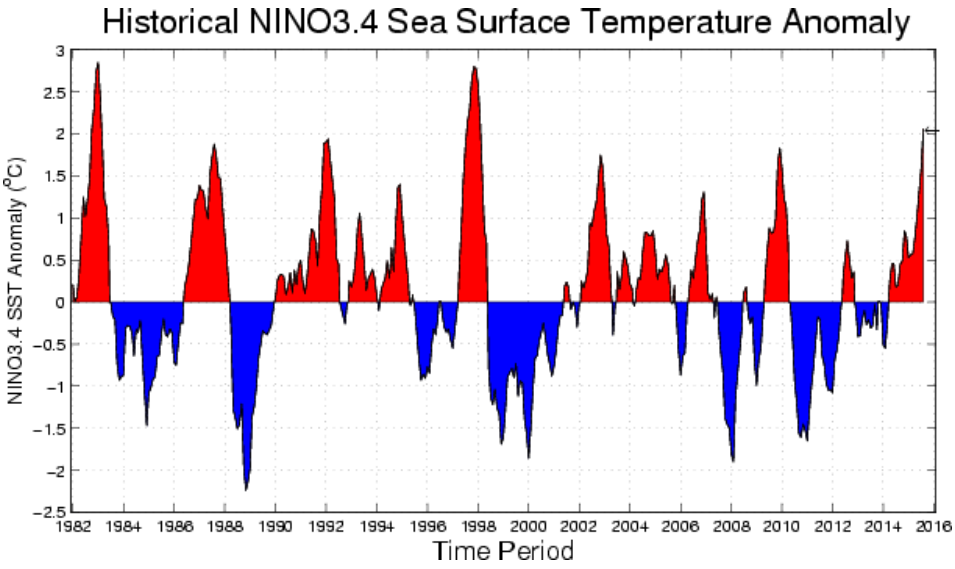
Value of Stored Water about 400 million Euros

Strong El Nino Forecasted for



CPC/IRI Early-Month Consensus ENSO Forecast Probabilities

Season	La Niña	Neutral	El Niño
ASO 2015	~0%	~0%	100%
SON 2015	~0%	1%	99%
OND 2015	~0%	1%	99%
NDJ 2015	~0%	2%	98%
DJF 2015	~0%	3%	97%
JFM 2016	1%	5%	94%
FMA 2016	1%	12%	87%
MAM 2016	2%	23%	75%
AMJ 2016	5%	40%	55%



اخرین پیش‌بینی ال‌نینو در سپتامبر

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
10 September 2015

ENSO Alert System Status: El Niño Advisory

Synopsis: There is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016.

During August, sea surface temperature (SST) anomalies were near or greater than +2.0°C across the eastern half of the tropical Pacific (Fig. 1). SST anomalies increased in the Niño-3.4 and Niño 3-regions, were approximately unchanged in the Niño-4 region, and decreased in the Niño-1+2 region (Fig. 2). Large positive subsurface temperature anomalies persisted in the central and east-central equatorial Pacific during the month (Fig. 3), with the largest departures exceeding 6°C (Fig. 4). The atmosphere remained coupled to the anomalous oceanic warmth, with significant low-level westerly wind anomalies and upper-level easterly wind anomalies persisting from the western to east-central tropical Pacific. Also, the traditional and equatorial Southern Oscillation Index (SOI) were again negative, consistent with enhanced convection over the central and eastern equatorial Pacific and suppressed convection over Indonesia (Fig. 5). Collectively, these atmospheric and oceanic anomalies reflect a strong El Niño.

All models surveyed predict El Niño to continue into the Northern Hemisphere spring 2016, and all multi-model averages predict a peak in late fall/early winter (3-month values of the Niño-3.4 index of +1.5°C or greater; Fig. 6). The forecaster consensus unanimously favors a strong El Niño, with peak 3-month SST departures in the Niño 3.4 [redacted] exceeding +2.0°C. Overall, there is an approximately 95% chance that El Niño will continue through Northern Hemisphere winter 2015-16, gradually weakening through spring 2016 (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period).

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The basins used for climate forecasting (2015)

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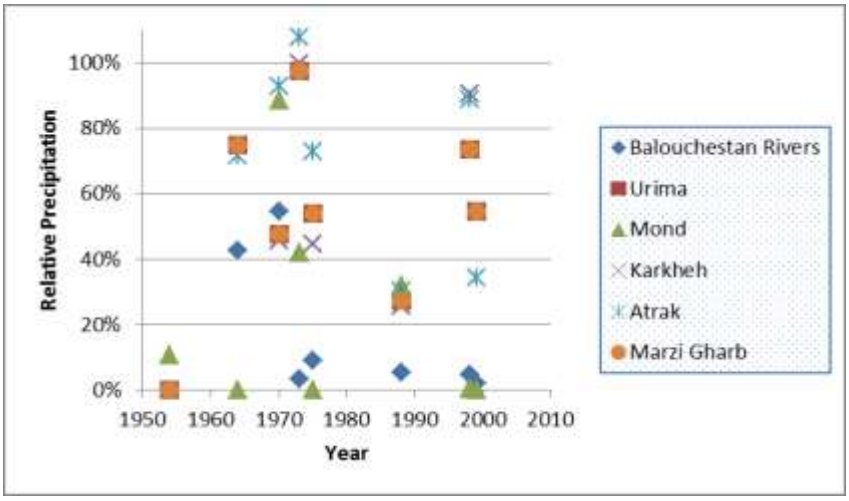
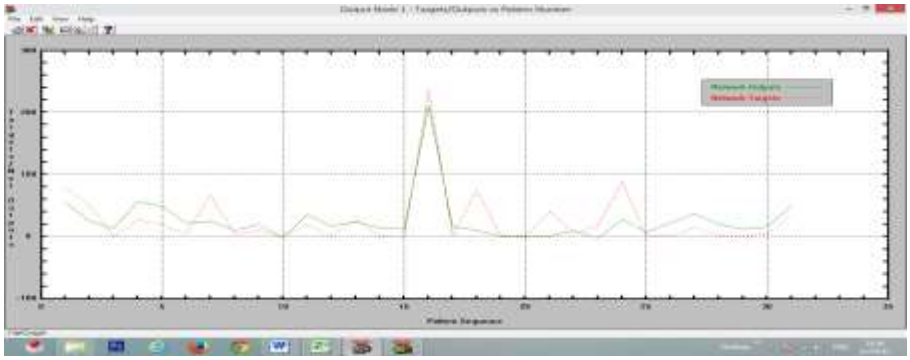
The relative precipitations observed in strong La Nina years compared to the long-term average (100%)



The ANN modeling



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Conclusions:

1. In view of worldwide experiences, it has become obvious that the approach to flood management is increasingly non-structural: structural solutions appear as indispensable complements to the increasing non-structural, integrated water resources management.
2. In the last 2 decades, the climate forecasting models have been effectively used for efficient management of floods and droughts. The early impoundment of Karkheh reservoir in early 2001 is an illustrating case study.
3. In View of current strong El Nino, wet autumn was forecasted for most of the basins of Iran in early summer.