WORLD AFFAIRS ASSANGE
Whistle-blower's victory 53

HERITAGE AIHOLE
The Chalukyas' gift 67

FRONTLINE

MARCH 4, 2016 INDIA'S NATIONAL MAGAZINE WWW.FRONTLINE.IN RS.60

Dying villages

Two consecutive droughts and three back-to-back crop failures are driving farmers and agricultural workers to the brink of a catastrophe across large parts of India

FRONTLINE

VOLUME 33 NUMBER 04 FEBRUARY 20-MARCH 04, 2016 ISSN 0970-1710 WWW.FRONTLINE.IN

On the Cover

Artistic reproduction of a photograph taken in Bolangir district, Odisha.

COVER DESIGN: T.S. VIJAYANANDAN

PHOTOGRAPH: THE HINDU ARCHIVES

Air Surcharge:

Colombo - Rs.20.00 and Port Blair - Rs.15.00

For subscription queries and delivery related issues Contact: Pan-India Toll Free No: **1800 3000 1878** or customercare@thehindu.co.in

Published by N. RAM, Kasturi Buildings, 859 & 860, Anna Salai, Chennai-600 002 and Printed by T. Ravi at Kala Jyothi Process Private Limited, Survey No. 185, Kondapur, Ranga Reddy District-500 133, Andhra Pradesh on behalf of Kasturi & Sons Ltd., Chennai-600 002.

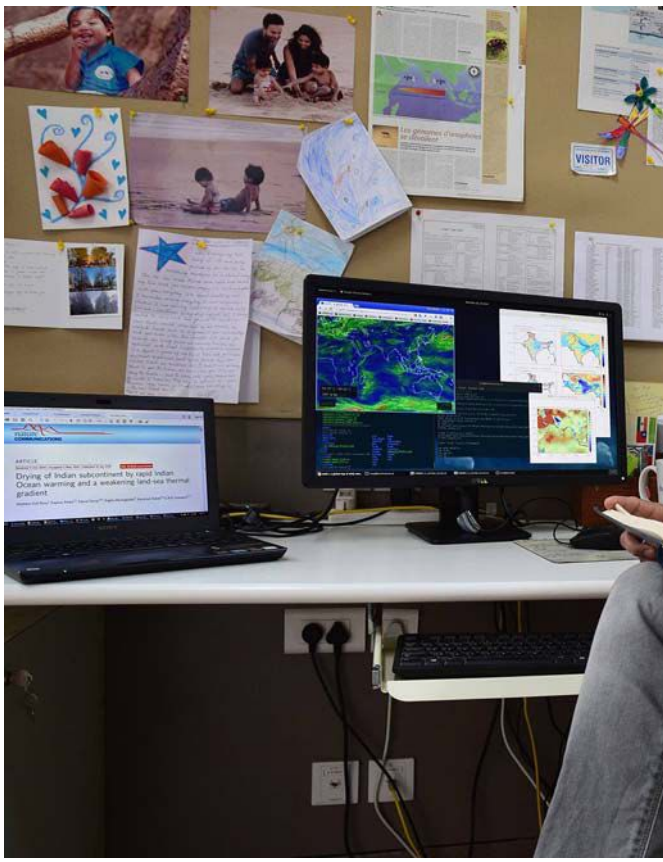
EDITOR: R. VIJAYA SANKAR (Editor responsible for selection of news under the PRB Act).

e-mail: frontline@thehindu.co.in

Frontline is not responsible for the content of external Internet sites.

‘We need to be prepared to

Interview with Roxy Mathew Koll, scientist at the Centre for Climate Change Research. BY **KUNAL SHANKAR**



A STUDY COMMISSIONED BY THE UNION Ministry of Earth Sciences for its Monsoon Mission of India programme, aimed at improving monsoon forecasts, blames the “rapid warming” of the Indian Ocean, partly fuelled by greenhouse gases, for the steady decline in the summer monsoon over most of South and Central Asia, leading to the gradual drying of the land mass. The study, which analysed the monsoon data of the past century, found a decrease of nearly a fifth of the rainfall over the central-east and northern regions of South Asia, ranging from south-west Pakistan to the Himalayan foothills and Bangladesh to the east, suggesting that this could be the reason for the drought conditions in the past three decades.

The south-west monsoon occurs between June and September and contributes 80 to 90 per cent of the overall rainfall in Central-South Asia, where agriculture is still largely rain-fed. Any disruption in this rainfall pattern, as the study notes, is a shock to the entire rural economy of the region. The study led by Roxy Mathew Koll, a scientist at the Centre for Climate Change Research in the Pune-based Indian Institute of Tropical Meteorology, included his student Ritika Kapoor and scientists from the University of Maryland, United States, and Paris-Sorbonne University, France. It was published in June 2015 in *Nature Communications,* an initiative of the journal *Nature.*

In an interview to *Frontline,* Koll said: “The results are significant, considering that we have had back-to-back drought in the country and that one-third of the past 15 years have been drought-hit.” He said severe weather conditions, such as the Chennai rains of November-December 2015, would be a common feature in the years to come, interspersed with prolonged spells of deficient rainfall. He said last year’s El Nino, one of the strongest in recorded history, coupled with the warming of the Indian Ocean contributed to the severity of the rainfall that hit almost the entire south-eastern coastline of India.

El Nino is the phenomenon of warming of the east-equatorial Pacific Ocean, which then raises temperatures across much of the planet at intermittent intervals of two to seven years, wrecking lives and livelihoods. The presence of El Nino can significantly influence weather patterns, ocean conditions, and marine fisheries across large portions of the globe for an extended period of time. For instance, California recorded its worst drought in decades last year. But this was followed by unprecedented storms and floods in 2015-16, an El Nino year wreaking havoc on the U.S.’ main agriculture State.

Excerpts:

Dr Koll, one of the main findings of the study you led is that the Indian Ocean has been warming at an alarming rate, much faster than the other oceans. Could you explain why this is taking place?

The rapid warming of the Indian Ocean can be partly attributed to human-induced activities leading to increased greenhouse gases in the atmosphere. A large share of the increased heat due to global warming has been absorbed by the oceans. The Indian Ocean is peculiar because it is landlocked in the north, unlike the

adjust to drier conditions'

BY SPECIAL ARRANGEMENT

Pacific and the Atlantic Oceans. This means that the ocean circulation is restricted from flushing out the heat to the poles. Therefore, any heat pile-up due to greenhouse gases or other processes persists for a longer time. Apart from this, whenever you have El Nino-like conditions in the Pacific, heat accumulates in the Indian Ocean through atmospheric circulation. We find that the magnitude and frequency of El Ninos have gone up in the recent decades, and so has the ocean temperatures in the Indian Ocean.

Does this explain the heavy rains that lashed Chennai recently?

An El Nino, manifested by unusually warm ocean temperatures in the east Pacific Ocean, can impact the tropical atmospheric circulation, including the monsoon. While an El Nino can weaken the south-west monsoon winds in summer, it can strengthen the north-east monsoon winds the following winter. This is what happened in the summer of 2015, with most of the regions of India experiencing a dry monsoon. Typically, an El Nino is defined by a rise in ocean temperature by 0.5° Celsius or more. This time the temperature anomalies went up to almost 3° Celsius, making 2015 one of the strongest El Ninos in recorded history. It is significant to note that in the past 140 years, the three strongest El Nino years were 1982, 1997 and 2015.

Moreover, the north-east monsoon winds, in the winter of 2015, were strong and persistent due to El Nino, bringing heavy rains to the east coast, including Chennai. This was aggravated by a warm Indian Ocean, resulting in increased moisture availability for the strong monsoon winds. A warmer climate means that the atmosphere can hold more moisture for a longer time, and this would mean long dry spells interspersed with extreme rainfall events.

This increased warming of the Indian Ocean must translate into increased monsoon rains over South Asia. Why is this not happening? Which are the regions that this change affects geographically?

The monsoon can be considered as this huge movement of water from over the oceans to the Indian land mass. The movements of these moisture-laden monsoon winds are governed by the temperature difference between the ocean and the land. In summer, the land is warmer and the ocean is cooler, driving these winds to the land. Our recent research has shown that this contrast could be weakening. This is mainly because of the increased warming of the Indian Ocean. The weakening is also partly due to suppressed warming of the land, possibly due to increased pollutants in the air, which reflect the solar radiation.

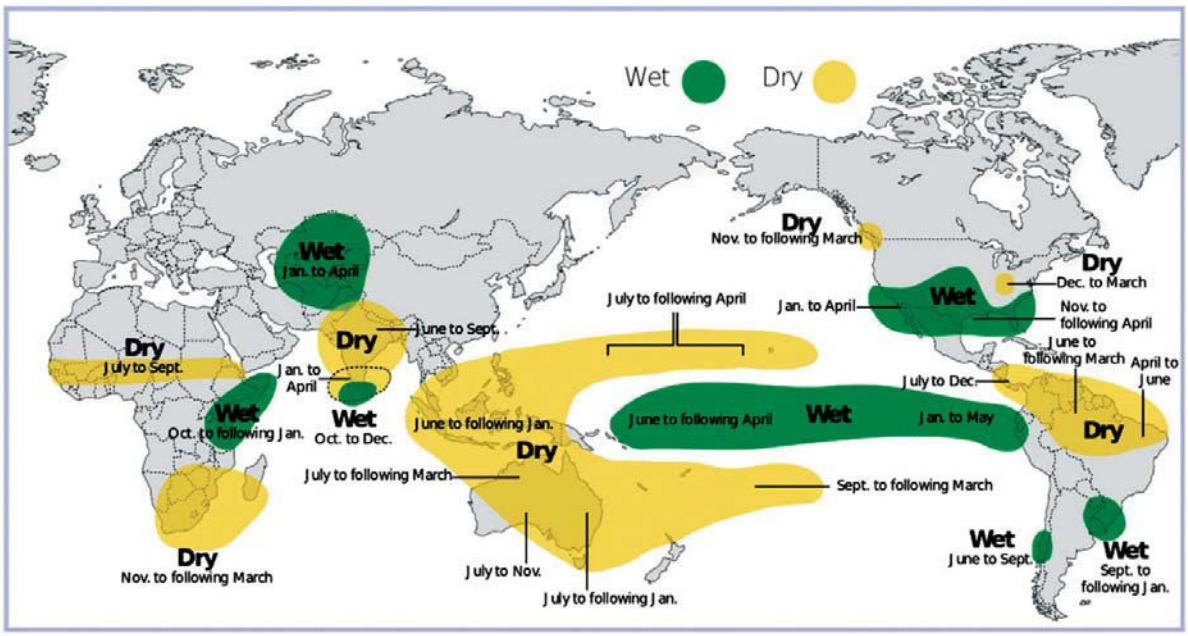
Although increased warming of the Indian Ocean translates into more moisture in the atmosphere and more rains, these rains are not brought to the land due to weakened monsoon winds. Instead, it rains more over the ocean itself. We see that there is a decline in rainfall over central South Asia, from south of Pakistan through central India to Bangladesh. This decline is larger and significant over central-east India, with 10-20 per cent decline in the past half-century.

Would you blame this phenomenon for the severe drought that several parts of India are facing now?

The impact of the Indian Ocean warming is on a longer time scale, resulting in a gradual decline of the monsoon rainfall in the past half a century. It is difficult to separate the impact of the long-term ocean warming on the rainfall of a particular year. However, the El Nino conditions in the Pacific in 2015-16 [which also weakens the monsoon], together with the warming of the Indian

El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



Source: http://iri.columbia.edu/enso

Ocean, must have exacerbated the drought conditions in India.

How will this change impact the agro industry and the entire population? Are we going to see a gradual process of desertification?

An earlier analysis by Professor Sulochana Gadgil from the Indian Institute of Science shows that despite large investments in irrigation, more than 60 per cent of the cultivated lands are still rain-fed.

Hence, rainfall changes—both long droughts and extreme rainfall events—can have a massive impact on the agricultural sector.

What long-term measures are necessary for the agriculture sector?

Drought-resilient crops along with judicious use of water through an improved irrigation system could help. Indigenous crops, which can withstand drought and flood conditions, could be brought up along with hybrid varieties. It is for the Agriculture Department to devise these measures. I am sure there is a lot of research going on in this respect already.

Has your analysis been used by the Central and State governments to devise steps to tackle drought?

Several studies have demonstrated that there has been a decline in the monsoon rainfall and that there are higher chances of extreme rains. Although we are not clear about the future, some of our climate models indicate a potential decline further down the line. Hence, we need to be strategically prepared to adapt and adjust to drier conditions.

From the scientific side, we are trying to improve our climate models so that they can better predict future changes in the monsoon. The Ministry of Earth Sciences has constituted the Monsoon Mission of India to improve monsoon forecasts—on short-term, seasonal and longer time scales. This should help the agriculture sector in the long run and give the State governments time to be prepared. For example, the India Meteorological Department's seasonal forecasts for the summer rainfall of 2015 were accurate and helped the agricultural and industrial sectors take adaptive measures.

Would focussing on reducing greenhouse gas emissions help bring down the Indian Ocean warming? Should it not be a global endeavour?

Greenhouse gases like carbon dioxide, which are released through emissions, have a lifetime of a few centuries or more. So, even if we stop all the emissions now, it is likely that the climate system will keep warming for several more years. Global warming has gone beyond the reach and responsibility of individual nations. Reducing greenhouse gas emissions should be a global effort and a legally binding and universal agreement.

A recent study by Dr R. Krishnan from the Indian Institute of Tropical Meteorology indicates that along with the Indian Ocean warming, air pollutants and changes in land use can also impact monsoon rains. The study found that crop-fraction over India increased by about 45 per cent and tree-fraction declined by about 30 per cent, along with a rise in atmospheric pollutants. These air pollutants and land use changes can affect the absorption and scattering rates of solar radiation, thereby interacting with the monsoon-climate system. It may be possible for India to regulate pollutants and land use changes to secure a better climate for the future. □