Carbon source-sink characteristics of a semi-deciduous forest in northeast India

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Abstract

Tropical forest ecosystems play a significant role in controlling the global carbon cycle. Several bio-meteorological parameters control the carbon balance processes of a forest ecosystem. We have employed an eddy-covariance-based technique and studied the bio-meteorological processes at Kaziranga National Park, a tropical semi-deciduous forest of northeast India, to understand the dynamics of the net ecosystem exchange (NEE). We observed that the leaf area index, incoming radiation, vapor pressure deficit, and air temperature mainly control the carbon transfer processes on a monthly scale. The daily pattern of rainfall and associated cloudiness indirectly control the carbon uptake by modulating the incoming radiation. The pre-monsoon season is the most preferred, while winter is the least favorite time for carbon uptake by the forest. We found the respiration component of this forest ecosystem higher than the other similar ecosystems in India. Analysis of three years of observational data shows that the Kaziranga forest ecosystem may act as a moderate carbon source to the atmosphere.

Ganges river drying: insights from surface water-groundwater interactions

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The mega-Himalayan river Ganges (or Ganga), one of the largest in the world and the lifeline of northern India for the last several thousand years, hosting almost 10% of the present global and half of Indian population on its fertile banks, has been found to have unprecedented low levels of river water (drying up) in several lower reaches in the summers of recent years. Evaluation of the available, Ganges water level information (including satellite-based information and some in-situ data), for almost the last two decades, confirms this observation of recent summer drying. Using a combination of satellite-based and in-situ measurements of river water and groundwater levels, isotopic and chemical analyses of Ganges river and groundwater, simulation results from global hydrologic models and regional groundwater flow models, we demonstrate that the present-day summer drying of the river Ganges is possibly dependent on ongoing the well-documented groundwater depletion in the Gangetic aquifers of north India. We suggest that a decrease in groundwater inflow (baseflow) has a severe impact on the health of the river. We demonstrate that the present-day baseflow to the Ganges from the adjoining aquifers, which may be up to a third of total river volume during pre-monsoon months, might have decreased by >50% from the beginning of irrigation-pumping age in the 1970s. Future predictive analyses of Ganges river water-groundwater interactions, without effects of climate change or human interferences, provides an alarming but conservative scenario that in forthcoming summers for the next 30 years, groundwater contribution to Ganges river water flow would continue decreasing in impending years, and can decrease up to ~75% of the 1970s. Thus, a continuation of the groundwater exploitation at similar per-capita rates might jeopardize the existence of the Ganges River in several reaches in near future, thereby leading to disastrous carbohydrate and other food scarcity for ~ 115 million people inhabiting in the study region by 2050.

Clumped isotope thermometry; exploring theoretical and experimental approaches during analysis of natural carbonates

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Carbon dioxide isotopologues involved in the isotope exchange between the doubly substituted $^{13}C^{16}O^{18}O$ molecule and $^{12}C^{16}O_2$ in solid and gaseous compounds provides an exciting new tool for geochemical, atmospheric and paleoclimatic research with applications ranging from Cosmochemistry to carbonate-based palaeothermometry. Full exploitation of this isotope proxy and thermometer is possible with combination of experimental and theoretical understanding of reaction mechanism during formation of minerals and analysis. At IISc, Bangalore we explored the artefact of phosphoric acid digestion protocol during reaction of carbonate reference materials in a new break seal method for high precision analysis of stable and clumped isotopes (Fosu et al., 2019). Experimental observation using the new method and subsequent theoretical explanation (using ab-initio calculation of carbonate and phosphoric acid reaction) (Pramanik et al., 2020) showed the reliability of old experimental results on clumped isotope thermometry calibration at Caltech (Ghosh et al., 2006) using McCrea type reaction vessel as compared to other calibrations proposed afterwards using diverse experimental approaches.

Extreme rainfall deficits were not the cause of recurring colonial era famines of southern Indian semi-arid regions.

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Using information contained in the eighteenth to twentieth century British administrative documents, preserved in the National Archives of India (NAI), we present a 218-year (1729–1947 AD) record of socioeconomic disruptions and human impacts (famines) associated with 'rain failures' that affected the semi-arid regions (SARs) of southern India. By mapping the southern Indian famine record onto long-term spatiotemporal measures of regional rainfall variability, we demonstrate that the SARs of southern India repeatedly experienced famines when annual rainfall reduced by ~ one standard deviation (1 SD), or more, from long-term averages. In other words, 'rain failures' listed in the colonial documents as causes of extreme socioeconomic disruptions, food shortages and human distress (famines) in the southern Indian SARs were fluctuations in precipitation well within the normal range of regional rainfall variability and not extreme rainfall deficits (≥ 3 SD). Our study demonstrates that extreme climate events were not necessary conditions for extreme socioeconomic disruptions and human impacts rendered by the colonial era famines in peninsular India. Based on our findings, we suggest that climate change risk assessement should consider the potential impacts of more frequent low-level anomalies (e.g. 1 SD) in drought prone semi-arid regions.

Predicting Arctic sea ice in near future climate using mid-Pliocene records

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The Arctic sea ice is undergoing dramatic decline and projected to be ice-free near mid-century under mid and high GHG emissions scenarios (IPCC AR6, 2021). Relative roles of atmospheric versus oceanic forcing and timing of ice free Arctic in future have been topic of a great debate in recent years. The computer based model simulations for Arctic Sea are associated with large uncertainty. Quantifying the contribution of poleward ocean heat transport to Arctic Ocean sea ice loss is imperative for improving such future climate predictions. In this study[2], we present new records of water-mass exchange and sea ice extent in the Fram-Strait (the major gateway between the Atlantic and the Arctic Oceans), during the mid-Piacenzian warm period (mPWP; 3.264–3.025 Ma), the most recent geological analogue for future climate change. Our semi-quantitative estimates of volume transport of North Atlantic warm waters into the Arctic Ocean suggests orbitally-forced changes, with near complete “Atlantification” of the Eurasian sector of the Arctic Ocean during the mPWP and consequential reduction in Arctic summer sea ice by ~30-35%[2]. This study highlights the need for validation of current generation models against proxy data of Atlantification and provides critical input for improving the robustness of future climate modelling in the Arctic.

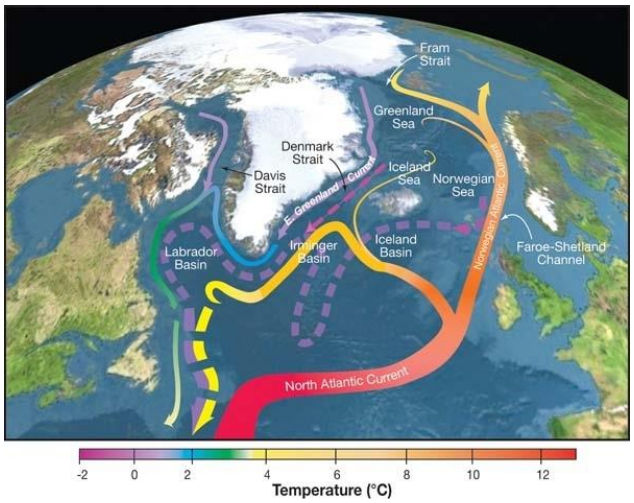

Fig 1: North Atlantic current and Arctic sea ice. https://editors.eol.org/eoearth/wiki/File:OCP07_Fig-6.jpg

References:

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Soft sediment deformation in the Late Pleistocene-Holocene glacio-fluvial lake in NW Himalaya: evidence of past earthquake along seismically active Kaurik Chango Fault or climate transition?

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Abstract

Late Quaternary-Holocene fluvio-lacustrine varved sediments in the high-altitude cold desert environment in the northwest Himalaya are the important repository of paleoclimate and contemporary tectonic records. A >16 m thick lacustrine section of the Hurling palaeolake along the Spiti river shows a large translation of 12.3-8.4 ka BP old sediment column along a discreet, horizontal, low angle thrust-type fault with antiformal up-warp in the hanging wall over the >11.8 ka BP undeformed footwall sequence in downstream direction. The small-scale constrictional faults with top-to-SE synthetic shear sense at the fault toe are suggestive of brittle plastic deformation in the sediment column. A kilometer downstream at an equivalent level, a debris flow deposit was observed with lenses of lacustrine sediment embedded in thinly laminate sand is overlain by massive matrix-supported debris flow deposits. The section resembles a typical lake-dam breach deposit with lower volume of water in the palaeolake. On correlation with the similar sequence in upstream direction, this horizontal translation attribute as a partially wet lacustrine sediment column on a decollement surface to the strong ground shaking by an earthquake on the seismically active Kaurik-Chango (K-C) Fault. This led to the lake-dam breach causing small flash flood producing debris-flow deposits along the Spiti River. The result also discussed with reference to a trigger by the extreme climatic event during Younger Dryas-Holocene climatic transition.

Keywords; Late Pleistocene-Holocene; lacustrine deposit; soft-sediment deformation; seismic shaking; Kaurik-Chango Fault (K-C), active tectonics.

Prolonged repercussions of ground water overdraft in Chhattisgarh state.

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Ground **W**ater is the essence of life, the most precious gem on mother earth. The groundwater which is only a part of 2.5% of total available fresh water on the Earth, is the lifeline of approx. 90% of life forms are present on the Earth. Chhattisgarh-The Rice bowl of India, the land of Paddy cropping is facing a very serious issue of groundwater levels for the last ten years. The study shows the declining groundwater level in the state of Chhattisgarh due to overdraft. Paddy is the major crop that is extensively cultivated in the state and it demands a huge chunk of freshwater for its nourishment. Recently, agricultural practises have been mechanized and framers are using heavily mechanized pumps to pump the groundwater for irrigation practises. As the Indian stratigraphy suggests Chhattisgarh is mainly a hard rock terrain and aquifer system in the state is mainly fractured therefore groundwater in these areas need to be stored for future purpose. The regional geomorphology of the area shows a very undulating topography therefore it can be seen that there is a big difference in groundwater levels in a short density of areas. For the study water level, the various regions of Chhattisgarh have been analysed through a series of wells which includes dug wells and piezometers. These wells have been established as key wells for monitoring purposes. Monitoring is done four times a year which represents the water level fluctuation of Pre-monsoon, monsoonal spire, post-monsoon, and its downturn. Although of the fact that irrigation leads to recharge, the groundwater level is seriously being affected which is highly indicating towards the drastic climate change patterns which can be seen through changing rainfall patterns in these areas. The data suggests that in the past couple of years the number of abstraction structures has been increased. This is a very serious issue right now which is to be of concern.

Observation of changes in local-onset in Indian Summer Monsoon Rainfall

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ABSTRACT

Accurate assessment of water resources of a region is of highly valuable for regional developmental, planning activities and efficient water management of a region. The rainfall analysis is the starting point for all the activities in this context. The knowledge about spatial and temporal variability of rainfall is essential from both the scientific and management perspectives.

Indian Monsoon is an important component of the Asian monsoon affecting the livelihood of a large part of global population. The southwest monsoon from June to September well known as Indian Summer Monsoon Rainfall (ISMR). ISMR contributes to about 80 percent of rainfall over Indian land. IPCC AR6 (2020) states a likely increase in variability of ISMR strength and extreme events. This study is undertaken to examine variability in ISMR local onset. Local-onset varies from less few days for core monsoon zone and Western Ghats, to about a month over the north western parts of the country. Assessment of ISMR local-scale onset dates at 0.25^0 spatial resolution for the time period 1901 to 2015 is made by applying agronomic definition following Moron and Robertson, 2014. Time series of local monsoon onset and heavy rainfall climatology is worked out for entire Indian sub continental region. Statistical analysis of local monsoon onset and heavy rainfall climatology is carried out in spatiotemporal domain. The analysis reveals increase in significant changes in local-onset-related trends in second half of century from first half. Increasing number of grid cells shows delay in local onset for recent half of the century. High annual spatial variability of local monsoon onset over the country indicating possible role of the local scale processes such as urbanisation towards triggering local-onset.

Reducing the stage of groundwater extraction through incentivizing the Recharge

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An area of 507 sq. km of Dongargaon block of Rajnandgaon district has been considered for Aquifer Mapping and Management Plans. The major aquifer groups are Gunderdehi Shale, Charmuria Limestone, Chandrapur Sandstone, Dongargarh Granite, and Bijili Rhyolite. The total groundwater resource is 13923.3 Ham with the stage of groundwater development 81.54 % and categorized as "Semi Critical". 71.5 % of the area is irrigated which uses groundwater for irrigation. During summer, Dugwells in villages is dry except in few locations. Several hand pumps also stop yielding water. Drying Dugwells and depletion of groundwater level during premonsoon in Dongargaon blocks is due to excessive groundwater withdrawal. In Dongargaon block Ground Water Draft for Irrigation is 4727.98 ham which is 93% of the Gross draft i.e. 5073.7. It has been observed that the demand for groundwater is increasing for irrigation, industrial and domestic uses. At locations near urban areas water level is declining, so we have to go for artificial recharge on a long-term sustainability basis. Artificial Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the groundwater storage in the area. The different types of artificial structures feasible in the block are described in the table. 1.45 MCM water can be recharged.

Aquifer wise space availability

Block	**Area Identified for Artificial Recharge (Sq.Km)**	**Average Depth to Postmonsoon water level (mbgl)-3**			**Sy**	**Sub surface storage potential (mcm)**	**Surface Water Requirement (mcm)**
		3 to 5	5 to 10	10 to 15			
Dongargaon	92.11	1	-	-	0.016	1.09	1.45

Types of Artificial Recharge structures feasible

Name of Block	Area Feasible for recharge (sq.km)	Sub surface storage potential (mcm)	Types of Structures Feasible and their Numbers		
			P	NB & CD	G
Dongargaon	92.11	1.45	3	22	25
	Recharge Capacity		0.6	0.66	0.125
	Estimated cost (Appx. 8.45 million rupees)		6	2.2	0.25

Interaction of Indian Summer Monsoon with global climatic events during the Holocene epoch: An Overview

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The Indian Summer Monsoon (ISM) is one of the prime components of atmospheric circulation which regulates the global climate system and determines the socio-economics and agricultural productivity of India by contributing >70% of rainfall over the country. Despite plenitude of attempts that investigated the ISM variability in the past, the response of ISM towards global climate variables remains poorly understood and thus invokes the necessity to delineate the ISM fluctuations vis-à-vis climate perturbations during the Holocene Epoch (~11.8 ka). The recent ratification of the Holocene period into Greenlandian (11.8–8.2 ka), Northgrippian (8.2–4.2 ka) and Meghalayan (4.2 ka–1950 AD) Stages based on the two abrupt climatic events viz. 8.2 ka and 4.2 ka, invoked the need to decipher the response of ISM towards abrupt climatic events observed in global records. The present study offers an account of ISM signatures during globally recognised abrupt climatic events and its possible linkage with climatic variables and forcing factors. The study revealed that the dry climate resulted from weak ISM, persisted during 4.2 ka whereas dearth of adequate studies from continental archives underscored 8.2 ka dry event. Both the dry events (4.2 ka and 8.2 ka events) of the Holocene Epoch were traceable in the region over the Indian subcontinent that witness the northernmost extent of Intertropical Convergence Zone (ITCZ). Further, the Little Ice Age (LIA: ~500 yr BP), witnessed wet climate over northern and central India due to the influence of winter precipitation associated with the southward migration of ITCZ, however, most of the peninsular region remained dry as a result of weak ISM. The study reiterates the crucial role of ITCZ migration and raises the need to explore the response and linkage of ISM with the global climate system.

Isotopic constraints on relative contributions of the Himalayan and Peninsular rivers to the Ganga plain

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The Ganga plain receives sediments through rivers draining both the Himalaya as well as the Indian peninsula. However, distinguishing Himalayan and peninsular signatures in the Ganga plain particularly in the middle Ganga plain is a major challenge due to the unavailability of isotopic data for the peninsular rivers. The fluvial sediments (channel, overbank, suspended) of the major peninsular rivers (Chambal, Betwa, Ken and Son) of the Ganga river basin have been studied here to understand the role of the peninsula in the evolution of the Ganga plain and to better constrain the sediment sources. The $^{87}Sr/^{86}Sr$ and $\varepsilon_{Nd(0)}$ isotopic values of the sediments in silicate fraction ranges from 0.72609 to 0.73955 and -21.96 to -12.25, respectively, for the Chambal river; 0.73167 to 0.80934 and -29.08 to -14.67, respectively, for the Betwa river; 0.72890 to 0.78076 and -22.12 to -10.92, respectively for the Ken and 0.74927 to 0.77213 and -19.27 to -13.38, respectively, for the Son river. Our study shows substantial sediment contribution from peninsular rivers to the middle Ganga plain at present as well as during the Quaternary. The higher radiogenic $^{87}Sr/^{86}Sr$ (≥ 0.74) values of the middle Ganga plain sediments were always believed to be derived from the Himalaya considering Deccan Trap (<0.72) as the only major end member for the Peninsula. The Vindhyan and Bundelkhand lithologies of the peninsula were generally not accounted despite exhibiting isotopic compositions similar to the Himalayan lithologies. The isotopic composition of the studied peninsular sediments show a considerable overlap with the Himalayan sediments. Therefore, we suggest that accounting contributions by the peninsular rivers to the Ganga plain could lead to a clear understanding of sediment provenances and erosional history of the catchments in the Ganga river basin.

Indian Hydrometeorological Processes: Insights from Precipitation Isotopes

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Hydrometeorological processes govern the availability and distribution of water in space and time. In the current global climate change scenario, various trends in amount, intensity, and spatial distribution of precipitation are well recognised with reference to rising temperatures (IPCC 2021). However, the underlying hydrometeorological processes governing precipitation pattern and distribution are still not clearly understood. Understanding the contemporary hydrometeorological processes is important because it serves as an early warning system. Precipitation variability in terms of extreme amounts and shifts in timings is one of the significant factors adversely affecting the socio-economy, especially for an agrarian country like India. Precipitation systems are governed by synoptic (source variation, rainout history, admixture of vapour masses, atmospheric circulations) as well as regional and local (effect of land-use and land-cover, evapotranspiration, localised convection, evaporation from the falling raindrops) hydrometeorological processes. Understanding these processes is not possible using traditional approaches because of its vast spatiotemporal range and dependence on synoptic and local processes and factors. However, stable isotopes of oxygen and hydrogen in precipitation can be advantageously used to identify and understand these hydrometeorological processes because their relative ratios vary predictably during the movement of water molecules through the hydrological cycle. In this backdrop, isotopic analysis of the precipitation samples collected from four stations, viz., Jammu, Jorhat, Ahmedabad and Hyderabad, as part of a National Programme of Isotope fingerprinting of Waters of India (IWIN). Some of the key findings are: (i) Continentally recycled moisture contributes significantly to the precipitation, with a maximum contribution of 87% in annual precipitation at Jammu and a minimum of 19% in that of Ahmedabad. (ii) Aonother prominent hydrometeorological process is secondary evaporation from falling raindrops, with a maximum of 52% at Jammu and a minimum of 4% at Jorhat.

The late Miocene monsoon evolution and erosion history of the western Himalaya: insight from IODP Site U1457

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ABSTRACT

Sediment transported from the western Himalaya and its flood plains through Indus river system forms the submarine Indus Fan in the Arabian Sea. The Indus catchment weathering histories and erosional patterns are useful for understanding the past hydro-climatic condition of the Indian subcontinent and its adjoining areas. The sediments collected during the International Ocean Discovery Program (IODP), Arabian Sea Monsoon (IODP-355) expedition from Site U1457, located in the north-eastern Arabian Sea, is measured for bulk sediment geochemistry, mineral magnetic analysis and sedimentological parameters to decipher the sediment provenance and erosion history of Indus catchment and its links with the hydroclimatic conditions since Late Miocene. The study reveals that the dominant source of the sediment during Late Miocene and Pliocene was Indus canyon while during Pleistocene, the Arabian Sea received sediments from mixed source through western Indian Peninsular region, Indus canyon and Indus tributaries. The hydro-climatic conditions were predominantly arid during late Miocene, except relatively humid intervals during 7.6 Myr–7.0 Myr and 6.1 Myr–5.6 Myr. The proxy records suggest that the hydro-climatic condition during Pliocene indicate a cyclicity (wet, 4.12–3.4 Myr; dry, 3.4–2.6 Myr; wet, 2.6–2.13 Myr) due to the variation in the palaeoceanography of the world ocean driven by tectonic rearrangement of seaways. The study suggest the Pleistocene period experiencing the humid condition with an intense humid phase during 1.87 Myr–1.2 Myr with an observed cyclicity consistent with glacial-interglacial periods.

Isotopic characterization of groundwater of Kerala: Insights into hydrological processes

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The groundwater is an important component of the global hydrological cycle and the primary reservoir of freshwater. One-third of the global freshwater demand is fulfilled by groundwater and it supplies nearly 36% of water for domestic usage, 42% for agriculture purposes, and 27% for industrial usage. India, one of the nations in the Indian subcontinent comprises 3% of the global land area and accommodates 19% of the global population largely depend on groundwater to fulfil the freshwater demand. Due to the unplanned abstraction of groundwater, this freshwater reservoir faces serious issues related to groundwater quality and quantity in different parts of the country. The state of Kerala, located in the southwestern tip of India is bounded by the Arabian Sea in the west and the Western Ghats in the east, occupies only 1.2% of the total area of the country, it accommodates 3% of the country's population. Despite copious annual average rainfall of ~3000 mm, the state of Kerala has a high level of dependency on groundwater for agriculture and drinking purposes, due to geohydrological reasons compounded by the high population density and agrarian economy. For effective groundwater management, it is important to understand the relationship between rainwater and groundwater, groundwater recharge sources, their contribution to recharge, and inter-aquifer transfer of water.to understand this stable isotopes of oxygen ($\delta^{18}O$) and hydrogen ($\delta^{2}H$) and their Spatio-temporal variation were used. Based on these variations following important inferences were made: (1) Groundwater recharge during pre-monsoon is in some places not for the entire area (2) Although the entire area receives NEM (October to December) recharge occurs only in 15% of the total area (3) The coastal area (above 10º lat.) shows isotopic enrichment in the pre-monsoon season because of marine water intrusion which was flush out by freshwater in the post-monsoon season (4) The rainfall occurs from May to October is a major groundwater recharge source and contributes ~46% in recharge rest 54% (5.90 BCM) is pre-monsoon groundwater (5) The huge amount of recharge during the post-monsoon season favours the inter aquifer transfer of water and leads to submarine groundwater discharge.

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Performance of PRL-AURiS for Radiocarbon measurements

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Accelerator Mass Spectrometer(AMS) is a highly sensitive technique for measurement of radioisotopes like ^{14}C, ^{10}Be and ^{26}Al with long half-life and low abundance. Radiocarbon dating is one of the major applications of AMS. PRL-AURiS (Accelerator Unit for Radio-isotope Studies) had set up protocols for dating various geological and archaeological samples. Radiocarbon measurements for samples up to 51,000 yr BP can be analysed by PRL-AURiS.

Solid graphite samples for radiocarbon to be measured in AMS are prepared using AGE3 (Automated Graphitisation Equipment). For every batch of samples, processed blank (anthracite), standards (NBS-Oxalic Acid) and check standards (procured from Radiocarbon Inter-comparison Exercise) are graphitised and measured for ^{14}C using AMS to validate accuracy and precision of measurement. Various inter-comparison check standards are routinely run during measurements, the results of which have already been reported in various publications from PRL-AURiS. The statistical uncertainty for radiocarbon measurement with PRL-AURiS was found below 0.5% with relative standard deviation for $^{14}C/^{12}C$ below 0.6% for samples with blank levels below 2.00×10^{-15}. Inter-comparison reference standards (FIRI-E, VIRI-U) measured with PRL-AURiS show good agreement with the consensus values which are routinely reported. The accuracy of measurement and data reproducibility of PRL-AURiS with respect to the International Inter-comparison reference standard will be presented.

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Ground water level monitoring in the state of Gujarat (1997-2017)

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Abstract

Ground water is one of the most important source of fresh water in tropical countries. Sustainable ground water management is beneficial for maintaining ground water quality as well as ensuring future water security. The observation of changes in ground water level is helpful to clearly understand usage and replenishment of ground water resources in the region. This study provides the observation of variation in ground water level in the state of Gujarat during 1997 to 2017. The observations are made for four different seasons namely; summer season, pre-monsoon, post-monsoon and winter season. The ground water level data is collected from Central Ground Water Board data distribution portal (http://cgwb.gov.in/gw_profiles/st_Gujarat.htm). The collected ground water data is rectified for the consistency and missing observations. The stations providing consistent seasonal ground water level observations are identified and used for this study. The trend in ground water level changes are estimated with the help of standard statistical indices namely Mann Kendall Rank test and Sen Slope estimator. Spatiotemporal analysis of estimated trend and slope is carried out with the help of geospatial technology. The observations identifies the areas of high ground water depletion and balance of ground water usage in the state of Gujarat. The findings of this study are helpful for ground water management and policy making to guide sustainable use of ground water in the state of Gujarat.

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Evidence of Poorly Ventilated Deep Central Indian Ocean during the Last Glaciation.

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The Indian Ocean accounts for over 20% of the global ocean volume, nearly on par with the Atlantic, and possesses unique hydrography characterised by turn-over entirely through exchange with the Southern Ocean, Pacific and Atlantic. Despite its volumetric and hydrographic importance, the role of the Indian Ocean in glacial-interglacial carbon cycle dynamics remains poorly constrained. Radiocarbon dates on foraminifera from two marine sediment cores have been used to decipher past changes in the 'radiocarbon ventilation age' of deep waters from the Central Indian Ocean (CIO) basin. Time-series spanning the last 37 ka show coherent variations in both sediment cores, and indicate greatly enhanced ocean-atmosphere radiocarbon disequilibrium in the region during the last glaciation, with peak ocean-atmosphere radiocarbon age offsets occurring during Heinrich stadial-1 (HS-1) and Heinrich Stadial-2 (HS-2). Uniquely, as compared to the bulk of existing radiocarbon data for the last deglaciation, CIO radiocarbon ventilation ages only approach modern values during the Holocene, with B-Atm offsets remaining >3000 ^{14}C yrs during the Bølling-Allerød period ~15 ka BP. The more gradual rejuvenation of the CIO is supported by parallel oxygenation indicators, as well as existing stable isotope data and Nd isotope trends. Together, the data suggest that the CIO was isolated from well-ventilated North Atlantic sourced waters during the last glacial, and particularly during Heinrich stadials 2 and 1. These findings underline the important role played by the Indian Ocean in deglacial carbon cycle change, particularly in the latter half of the last deglaciation.

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Mean monsoon climate shift at the edge of Roman Warm Period

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Abstract

Paleoclimatic archives showed linkages between monsoon fluctuations and cultural enrichment/societal demise during the Holocene. Since the early Holocene, monsoon strength appears to follow the precision-based solar insolation. This close relationship has been weakened in the last two millennia (Annapureddy et al. 2021). Abrupt climate transitions for shorter time scales have been recorded (Cheng 2004), and other unusual monsoon climate transitions often coincided with global climatic shifts (Deplazes et al. 2014). However, change in monsoon's mean state in the last three millennia has not been reported. Indian summer monsoon rainfall (ISMR) variations for the last ~3.2 thousand years (kyr) B.P. (Before Present; relative to AD 1950), derived from the oxygen isotopic data of two stalagmites collected from the peninsular Indian cave, are presented here (Figure 1). The 3.2 kyr record of ISMR shows the mean state of monsoon climate shifted around the edge of the Roman Warm Period (RWP), i.e.,~1.7-1.8 kyr BP (Figure 1). Signature of such climate shift is available in the different proxy records from the sub-continent, yet this monsoon climate shift remains overlooked. This monsoon climate shift was rapid and took a few decades to a century and was a departure from the solar insolation-driven drying trend, continuing since the mid-to-late Holocene. Our analyses suggest that the shift related to an increase in El Niño/Southern Oscillation (ENSO) variability and intensification of El Niño and La Niña events around 1.75-2 kyr BP (Thompson et al. 2017). Though the Solar forcing remains the primary driver of long-term ISMR variations, on shorter time scales and during weekend Solar Insolation, internal forcings (such as ENSO) intensification may dominate and dictate the ISMR variability.

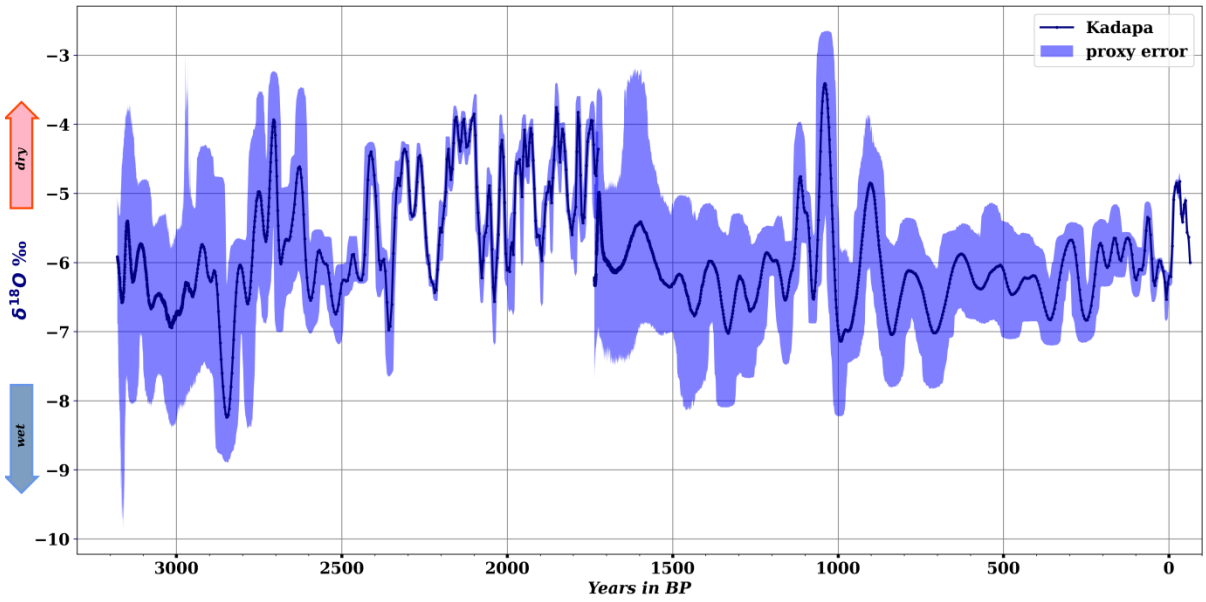

Fig.1. ISMR reconstruction for the last ~3.2 kyr using composite of two Kadapa cave stalagmites. Dotted continuous lines are Kadapa composite and blue shades are proxy uncertainties at 0.5 percentile calculated from COPRA age model (Breitenbach et al. 2012).

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Reconstructing the variability of deep water circulation in the Indian sector of the Southern Ocean during the last glacial cycle

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Deep Water Circulation (DWC) in the Southern Ocean is a crucial component of thermohaline circulation that modulates the transport of heat, carbon, and other nutrients around the globe and plays a significant role in global climate. The prevailing hypothesis states that relative changes in the formation and export of deep water masses (the North Atlantic Deep Water (NADW) and the Antarctic Bottom Water (AABW)) to the Southern Ocean in the past affected the basin's carbon sink capacity and resulted in the glacial-interglacial CO_2 variability. The Indian sector of the Southern Ocean is an ideal location to test this hypothesis as it does not have any deep water mass formation but only acts as a host for two deep water masses; NADW and AABW. However, limited proxy evidence for the DWC from the Indian sector of the Southern Ocean restricts the understanding of past deep water circulation of the region. In this study, we have reconstructed the DWC in the Indian sector of the Southern Ocean using authigenic Nd isotopes (ε_{Nd}) of a sediment core SK200/33 (55°01′S-45°09′E, 4204m) for the last glacial cycle. Our DWC record, together with published records of Winter sea ice and productivity, also enables us to test the influence of sea ice in the formation of AABW. The ε_{Nd} values of the core vary between -5.3 and -8.1, with more radiogenic values during the glacial periods and less radiogenic values during the interglacial periods, reflecting a change in the water mass sourcing during glacial-interglacial periods. More radiogenic ε_{Nd} values during glacial periods suggest incursion of a dominant Pacific sourced water to the Southern Ocean. The similarity in the glacial ε_{Nd} values of our record with South Atlantic and Pacific records further corroborates our observation of dominant Pacific water input. The higher proportion of Pacific waters to the Southern Ocean has significant implications for global atmospheric CO_2 variability.

Continuous Measurements of Atmospheric Water Vapour Isotopic Composition from Western India

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Isotopic composition of atmospheric water vapour is a natural tracer of the hydrological cycle and provides valuable information regarding moisture sources, atmospheric transport patterns and mixing. We present the water vapour isotopic composition measurements conducted from July 2017 to December 2019 at Physical Research Laboratory, Ahmedabad. Continuous high resolution monitoring of stable isotopic composition of ambient air is performed using laser absorption spectroscopic techniques. The high resolution data is averaged at ~ 8 minutes based on the results of Allan deviation to minimise the noise in the setup and calibrated as per standard protocols.

Further analysis was performed on post monsoon data from September 2018 to November 2018. The decreasing trend in the mixing ratio indicates the withdrawal of monsoon and onset of dry conditions. The d-excess is observed to increase and has large variablility which is attributed to the dominance of the locally recycled evaporated components over weak contribution from oceanic sources. The kinetic process of evaporation has strong dependence on atmospheric parameters whose diurnal variation is reflected in a strong 24 hour component in the wavelet analysis of d-excess.

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Siliciclastic paleosol revealed paleoclimatic and provenance geochemistry during Gondwana sedimentation; featuring Permo-Triassic sequences of Satpura Basin, Madhya Pradesh, India

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Abstract: Geochemical study in the siliciclastic paleosol of a basin reveals the paleoclimates, provenance and subsequently can reconstruct paleotectonic and evolution of the basin. Sedimentation in the Gondwana basins, worldwide, writes down a record of climatic fluctuations and evidence of the Permo-Triassic mass extinction. The archives documenting in the sedimentation of Gondwana Satpura basin during the time interval of Permian to cretaceous are explored. Major-trace element compositions of the siliciclastic paleosol from the Denwa Formation along with the existing geochemical data of other formations are examined here. The composition of the sediments in the lowermost Talchir Formation have disclosed the cold and

dry climatic conditions at the sources, whereas the sources of the sediments for the overlying formations have seasoned a warm, humid and semiarid climate. Therefore, the Satpura basin covers from the Phanerozoic ice-house to green-house condition during the Permo-Cretaceous time interval. A quantitative geochemical provenance analysis in our study helps in establishing a model for the evolution of the Permo-Traissic Satpura basin. The contributions of the mafic rock-derived sediments are relatively higher in the Talchir, Barakar and Motur formations compared to the overlying formations. Approximately 60% of the sediments in the overlying Bijori, Pachmarhi and Denwa formations come from the felsic volcanic rocks and granites of the Sausar and Betul-Chindwara mobile belts (B-CMB) with minor inputs from mafic volcanic rocks of the B-CMB. Furthermore, the sediments of the Talchir Formation came from the B-CMB when they became tectonically active, which marked the initial stage of the sedimentation of the Satpura basin, whereas the sediments in the younger formations have been derived from mixed tectonic settings, which represented the final stage of the sedimentation of the basin.

Key words: Paleoclimate; provenance; tectonic setting; basin evolution; Gondwana Satpura basin.

Timing and mechanism for the onset of modern like deep water circulation in the Indian Ocean

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The global overturning circulation (GOC) underwent significant changes since the late Miocene driven by tectonic and/or climate forcing. Absence of any major deep water formations, Indian Ocean only acts as a host for GOC and hence provides an ideal location to test prevailing hypothesis related to the timings and mechanisms for the onset of modern like deep water circulation (DWC) system. In present study, we tried to reconstruct the DWC in the Western Indian Ocean from the IODP 355 site U1457 (17°9.94'N, 67°55.81'E, 3523 m) in the Arabian Sea, since late Miocene to early Pleistocene (11.3-2 Ma) using authigenic neodymium isotopic compositions (ε_{Nd}) to test the prevailing hypothesis. Overall trend in the authigenic ε_{Nd} record shows steady decline from more radiogenic values -5 ± 0.5 during to 11.2 to 8.3 Ma to less radiogenic values -9 ± 0.3, similar to that of the modern deep water value during Miocene-Pliocene transition at ~6 Ma. Since then, the modern day like deep water e_{Nd} signature have been stable within the Quaternary glacial-interglacial variability reported from the Arabian Sea(Lathika et al., 2021). This shift and onset of modern day like DWC during the Miocene-Pliocene transition was caused by the constriction of Central American Seaway (CAS) and restriction of Pacific water inflow to mid-latitude Atlantic.

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Revised calibration for otolith clumped isotope thermometry: An extended application to determine growth temperature of travertine

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Abstract

The empirical relationships of clumped isotope thermometry[1] useful in paleotemperature determination from natural carbonates can be categorized into biogenic and abiogenic types. The mechanism of precipitation for these sets of carbonates differs, depending on presence or absence of enzymatic reactions which govern the reaction kinetics. In this study, we have revisited the clumped isotope analysis using Break seal method[2] on six aragonitic otolith specimens with known growth temperature (2-25℃), which were analyzed earlier for the calibration[3] purposes. Previous calibration results are re-evaluated from raw data incorporating updated scaling factors and compared with the present study. The revised calibration for aragonitic otoliths proposed here is given by the equation with temperature (T) expressed in degree Kelvin:

$$\Delta_{47} = 0.0594 \pm 0.0049 * \frac{10^6}{T^2} + 0.0541 \pm 0.0576$$

The revised calibration is extended to include abiogenic travertines[4] (containing aragonite and calcite) from Fitero thermal spring, Spain, grown at a temperature range between 33-40℃. We have also compared the offset of estimated clumped temperature from actual or observed growth temperatures for travertines adapting different empirical relationship proposed for calcite and aragonite minerals. Our observations showed the role of acid digestion protocol and reaction

temperature during experimentation in controlling the extent of deviation of clumped temperature from the actual depositional temperature. A systematic offset in clumped isotope values for different acid digestion temperatures and reaction protocols is established here and can serve as a tool to compare and correct results from using different acid digestion protocol and temperature.

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Paleoclimatic Implications of Thermocline Variation in the Equatorial Indian Ocean Region

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The Equatorial Indian Ocean (EIO) region is quite unique in nature in terms of its geography and oceanographic settings compared to the other global oceans. The characteristic distribution of the Indian ocean along with the Indian subcontinent near to the equator has helped develop a distinct and dynamic climatic pattern attributed to this region. A number of studies have been carried out so far in understanding the surface oceanographic evolution of the EIO and the associated climatic variability, but little is known about the subsurface intermediate water masses.

The ocean thermocline represents the subsurface intermediate water transition zone, where the oceanic temperature profile observes a sharp decline in its value, from the surface Mixed layer to the cold Deep water masses. The variation in the strength of thermocline is governed by the different surface and subsurface oceanographic processes operating over it. Study of thermocline variations over the past in the EIO region can thus help us understand the surface as well as the subsurface intermediate water paleoceanography of the region and the paleoclimatic implications associated with it. Two sediment cores chosen from the western Equatorial Indian Ocean from the open ocean environment have been dated using the planktonic foraminifers from the surface Mixed Layer, using the radiocarbon dating technique using Accelerator Mass Spectrometer (AMS). Planktonic foraminifers from specific ocean depths (Mixed Layer, Upper Thermocline and Lower Thermocline) are chosen in requisite amount for stable isotopic analyses and Mg/Ca- paleo thermometry.

The current understandings about the EIO thermocline and the new insights obtained from our study to understand the evolution of the intermediate water mass and its paleoclimatic implications in the EIO region would be discussed.

Stable isotopes and nitrogen functionalities in coals and their crafty responses to coal metamorphism

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The present study reports the stable carbon ($\delta^{13}C$) and nitrogen isotopic ($\delta^{15}N$) paradigms in coal and the plausible relations between the stable nitrogen isotope and nitrogen functionalities with the increasing coal rank. The $\delta^{13}C$ values (-27.44 to -25.51 ‰) in the Paleogene lignite samples indicate angiospermic sources of organic matter, while the Gondwana bituminous (-23.13 to -21.67 ‰) and the anthracite samples (-23.91 to -21.39 ‰) depict the $\delta^{13}C$ signature of the gymnosperms (Anwita et al., 2020; Kumar et al., 2021). The non-linear trend of the $\delta^{13}C$ values with increasing coal rank implies that the coalification did not alter the source signature of the organic carbon (Fig.1). Further, the non-linear trend of the $\delta^{15}N$ parameter from bituminous (1.64 – 2.81 ‰) to anthracite (1.07 – 3.44 ‰) may suggest that the organic nitrogen was not totally depleted with the coalification (Fig.1). Meanwhile, the organic carbon to organic nitrogen ratio (C_{org}/N_{org}) increases from the Paleogene lignites (48.70 – 78.05) to the Paleogene bituminous coals (77.04 – 156.79) implying the plausible influences of the coalification where organic nitrogen is expelled from coal microstructure with the increasing coal rank. Interestingly, the Gondwana bituminous coals exhibit a lower C_{org}/N_{org} ratio (33.49 – 43.69) than the Paleogene bituminous coals. These may result from disparities in the sources, depositional environments and concentrations of nitrogen in porewaters of peats of two different ages. Besides, the anthracite samples show an almost similar range of the C_{org}/N_{org} ratio (34.74 – 76.92) to that of the bituminous rank, which may be explained by the crafty responses of the nitrogen functionalities (Fig.2). At the lignite rank, the dominance of pyridines occurs due to transformations of amine and amide and oxygen removal from pyridones (Mitra-Kirtley et al., 1993). At the bituminous rank, when the coals reach oil

window, the pyridinic nitrogen again dominates over the other moieties due to cyclization of pyrroles, loss of oxygen and deprotonation of cyclazines caused by the thermal stress (Valentim et al., 2011). The large intensities of the pyrrolic nitrogen in both lignite and bituminous rank may imply the presence of π-electron excessive heterocyclic structure, which behaves as a highly reactive nucleophile and thus, may in turn suggest reactive coal microstructure. However, with increasing coal metamorphism towards the anthracite stage, the pyrrolic nitrogen alleviates, but the pyridines and cyclazine nitrogen intensify (Fig.2). During the anchizonal metamorphism at the anthracite rank, the pyrrolic structure being most susceptible, reacted with the metamorphic fluid entered in the coal microstructure and thermochemically converted to cyclazine. Further, protonation of pyridines formed the cyclazines and cyclization of pyrroles again formed the pyridines. However, with increasing aromaticity and subsequent rise in hydrophobicity, the metamorphic fluid could not alter the cyclazine and pyridinic moieties. So, instead of leaving the coal microstructure, the organic nitrogen was encapsulated within the stable functionalities, which may substantiate the low C_{org}/N_{org} ratio in the anthracite samples. This preserved organic nitrogen represents the bulk $\delta^{15}N$ values in the anthracite, which may explain the non-linear trend of this isotopic parameter with increasing coal rank (Anwita et al., 2020).

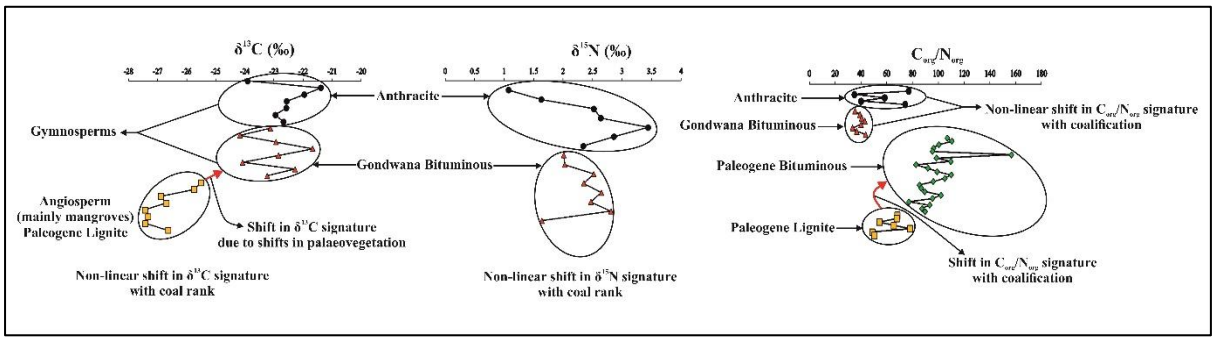

Fig.1. Paradigms of stable carbon, nitrogen and organic carbon to organic nitrogen ratio with the coalification (coal metamorphism).

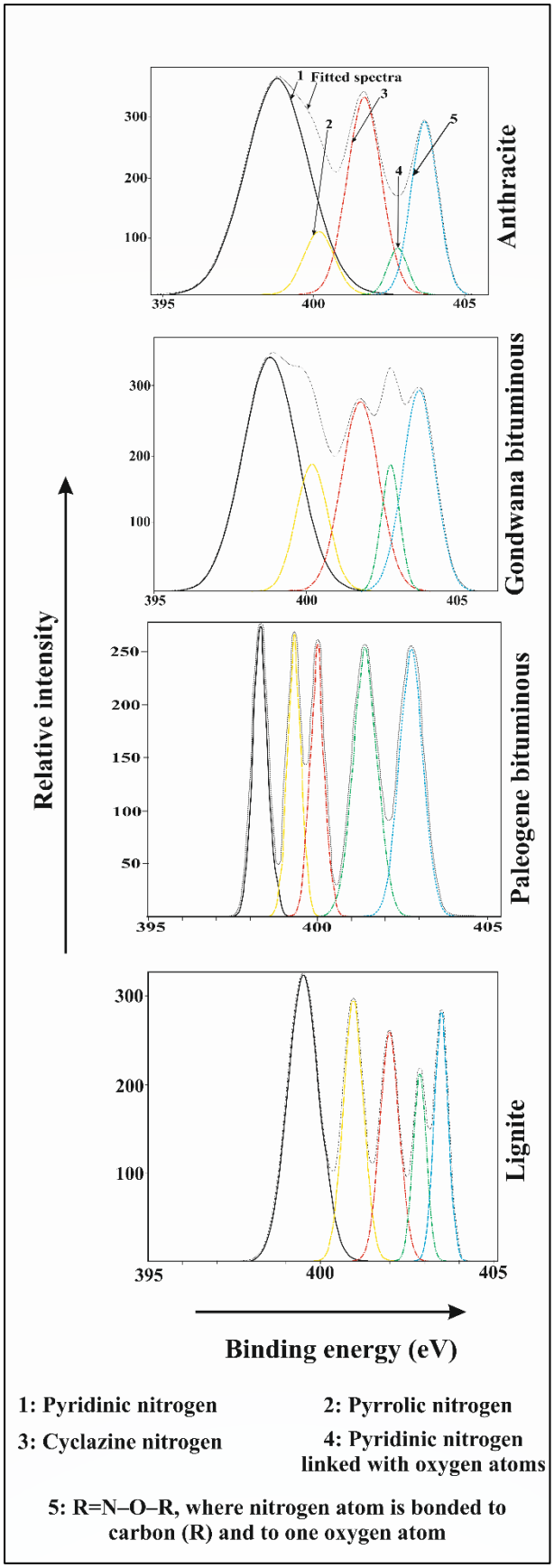

Fig.2. N1s X-ray photoelectron spectra (XPS) of the representative coal samples from lignite to anthracite rank revealing the responses of nitrogen functionalities to the coal metamorphism.

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Tracing the impact of basin topography on the hydrological processes in a Himalayan River: A stable isotopic (δD and $\delta^{18}O$) approach

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Abstract

The stable isotopic compositional variation in a flowing river can be brought by changes in moisture sources and ongoing hydrological processes in the basin. Out of these two variables, the former can be easily traced through the δD and $\delta^{18}O$ compositions of the river water and that of the precipitation. But delineating the later requires a clear scenario regarding the many hydrometeorological components including topography, vegetation pattern, glacial cover and precipitation pattern. The present study traces the various hydrological processes in the Teesta River basin (Sikkim Himalaya) through the spatial distribution of stable hydrogen and oxygen isotopes (δD and $\delta^{18}O$) in river water. The $\delta^{18}O$ compositions of the water samples varies between -12.2‰ and -5.4‰ (mean: -8.01‰ ± 1.81‰) and that of δD between -95.1‰ and -38.5‰ (mean: -57.6‰ ± 15.6‰). Snowmelt input, evaporation, and recycled moisture contribution seem to govern the observed $\delta^{18}O$, δD and *d*-excess compositional variation in river water. The isotopic values point towards an early melting of snow in the basin and a significant contribution of snowmelt to the river water. The trend between *d* values and elevation indicates a dominant control of orography on the hydrological regimes of the basin. The study suggests that the differential degree of recycled moisture contributed to the local precipitation from uneven distribution of evapotranspiration and surface water evaporation is also a key component in bringing the stable isotopic variation in the river water. Study found that different hydrometeorological conditions prevail along the course of the Teesta River due to rapid change in the altitude of the basin, which favours the operation of major hydrological processes and a complex isotopic compositional variation in the river water. Also, owing to this rapid rate of elevation increase the rainout percentage in the Teesta basin is found to be higher than other Himalayan River system. Finally, the impact of artificially constructed dam/water reservoir on the river water isotopic composition is well documented.

FIRST RESULTS OF BERYLLIUM ISOTOPE MEASUREMENTS FROM PRL-AURIS

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The cosmogenic produced Beryllium-10 (^{10}Be, half-life - 1.39 Ma) has proven to be an essential tool for building chronology and understanding millennial-scale earth surface processes. The in-situ produced ^{10}Be is mainly applied for exposure age dating of past glaciation events, while the meteoric ^{10}Be is widely used for past magnetic field intensity variations and building chronology of marine sediment cores.

The PRL-AURiS (Accelerator Unit for Radioisotope Studies) is a state-of-the-art 1MV Accelerator Mass Spectrometer, which has been tested for ^{14}C, ^{10}Be and ^{26}Al radioisotope measurements. The instrument is capable of beryllium isotopic ratio blank levels (^{10}Be/^{9}Be) in the range of 10^{-16}. AMS is routinely making measurement of ^{14}C for radiocarbon dating and its application in various scientific programmes. Recently, processing was established for in-situ and meteoric beryllium isotope samples, which have been measured in the PRL-AURiS for the first time after installation, and have been used to understand paleomagnetic and paleoclimatic processes. Isotopic ratios in the laboratory processed blanks (^{10}Be/^{9}Be) were obtained in the range of 10^{-15} to 10^{-14} and are almost order of magnitude (10^{2} to 10^{3} times) lower when compared to the ratio measured in samples (^{10}Be/^{9}Be of which vary between 10^{-11} to 10^{-12}). The precision for individual samples is usually less than 5% and efforts are being made for further improvement. The demonstrated accuracy and precision of ^{10}Be with PRL-AURiS would find applications in the field of exposure age determination, soil denudation rates, chronology and reconstruction of past magnetic field intensity.

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Title: Hydrogeochemistry of two tributaries of the Brahmaputra river (Pagladia and Kulsi) in Assam,India

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Abstract

In order to understand the weathering intensities of a north bank and a south bank tributary of the Brahmaputra (Pagladia and Kulsi) ,the grain size distribution of bank sediments of both the rivers and chemical index of alteration (CIA) was measured. The waters in both the tributaries were Na-HCO_3 dominated (piper plots). The grain size analysis showed Pagladia sediments sandy silt and Kulsi river sediments indicated silty sand. Most of the samples were poorly sorted and the skewness values of the samples indicated the coarser fractions in Pagladia and finer fractions in Kulsi.The sediment results suggested CIA for Pagladia and Kulsi were 46.5 and 31.33 respectively, indicating that the weathering in both the basins is of moderate intensity. Pagladia sediments were found to be more weathered than Kulsi. Suspended sediments were much more in Pagladia than Kulsi, presumably due to enhanced physical erosion.The content of percentage silt-clay is much greater in Pagladia than Kulsi.

Keywords: Pagladia river,Kulsi river,grain size, weathering.

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STRUCTURAL CONTROL ON GROUNDWATER FLOW IN TRANS YAMUNA REGION PRAYAGRAJ AS INFERRED USING REMOTE SENSING AND GIS

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Abstract

Trans Yamuna, Prayagraj region has very severe problem related to water scarcity. In this area, the drinking water problem is very drastic since Groundwater level is poor and water quality is contaminated. Major rivers in this area are Yamuna, Tons and Belan. The lithology of this area is covered by the Younger Alluvium, Older Alluvium and Vindhyan Sandstone. Vindhyan sandstone covers less part than Older Alluvium but it shows fractures in the area. This area consists of four Tehsils namely, Karchhana, Bara, Meja and Koraon. Landsat 8 OLI bands are used to digitized lineament map in Arc GIS 10.4 software and rose diagram of lineament has been prepared using Rockworks software. Results show that the lineaments orientation is correlated to the Groundwater flow, in this area, which is also supported by the rose diagram trend. Trans Yamuna region consists of fractured hard rock on the surface and as well as below the surface. Thus, fracture is one of the factors which controls the Groundwater flow and also shows the potential zone of Groundwater.

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Perturbations in the Rainfall Trends in India: New Insights from a Different Approach

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Hydrological cycle in different parts of the world has been changing due to natural climatic and anthropogenic factors which are region specific and vary with time. The large volume of peer reviewed literature reveals very complex rainfall variability involving contrasting behaviour in terms of amount of rainfall in different parts of India at the same time. The short-term (daily/weekly) rainfall variation at a given location and time can be explained in terms of local meteorological conditions. However, change in long term (~ 30 years) average regional rainfall and the underlying controlling factors are poorly understood. Lack of understanding about precise causal factors for rainfall variability, over a longer time period, is a major knowledge gap in hydrometeorology. In this scientific backdrop, a study has been initiated by PRL to bridge above knowledge gap by analysing the long-term rainfall data (1901-2020) at a district level with a different approach of identifying the patterns of temporal variation in amount of rainfall, instead of monotonic trend analysis over a long period and large areas. The rainfall patterns are being identified in terms of trends of progressive increase or decrease in 31 years moving average of percentage departure of annual and seasonal rainfall with reference to climatological mean rainfall, the rate of increase/ decrease in moving average of percentage departure (i.e total percentage departure/ years), year of point of inflections in rainfall departure trend, magnitude of total variation in percentage departure during a particular time period. Using such trends and patterns in rainfall variation, this study is focussed on: (1) identification of prominent patters in rainfall variability in different parts of India; (2) identification geographical zones comprising more than one districts with similar patterns of rainfall variability; (3) Identification of the time windows during prominent change in rainfall trends are observed; (4) Identification of possible factors controlling such spatially varied patterns. This study has provided newer insights about the geographical differences in rainfall patterns in India.

Long-term variation of the Sea Surface Temperature over 13 oceanic regions linked to Indian Summer Monsoon Rainfall

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Abstract

The prediction of Indian Summer Monsoon Rainfall (ISMR) has always been challenging due to its complexity and heterogenic nature. Traditionally, prediction models were anticipated on a comparatively smaller irregularity of the average monsoon rainfall over India also commonly known as All India Monsoon Rainfall (AIMR). While this has aid to diminish socioeconomic impacts to some extent, overall prediction skill has remained relatively low (Wang., 2015). Sea Surface Temperature (SST) from June to September (JJAS) show well-defined teleconnections with ISMR. Here, we take SST from the Extended Reconstructed Sea Surface Temperature version 3b (ERSST.v3b) with the resolution of 2° latitude × 2° longitude from Comprehensive Ocean Atmosphere Data Set (COADS) (Smith TM, 2008) for time period of 1901-2010. The 13 oceanic regions linked to ISMR are identified based on (Rishi Sahastrabuddhe and Subimal Ghosh, 2019). The oceanic regions namely Atlantic Niño, Bay of Bengal, Niño 3, Niño 3.4, Niño 4, North Atlantic, North Pacific, North Pacific 2, China sea, Southern Indian Ocean, Western Indian Ocean, Zonal mode, Indian ocean dipole as shown in figure below are delineated from global SST data.

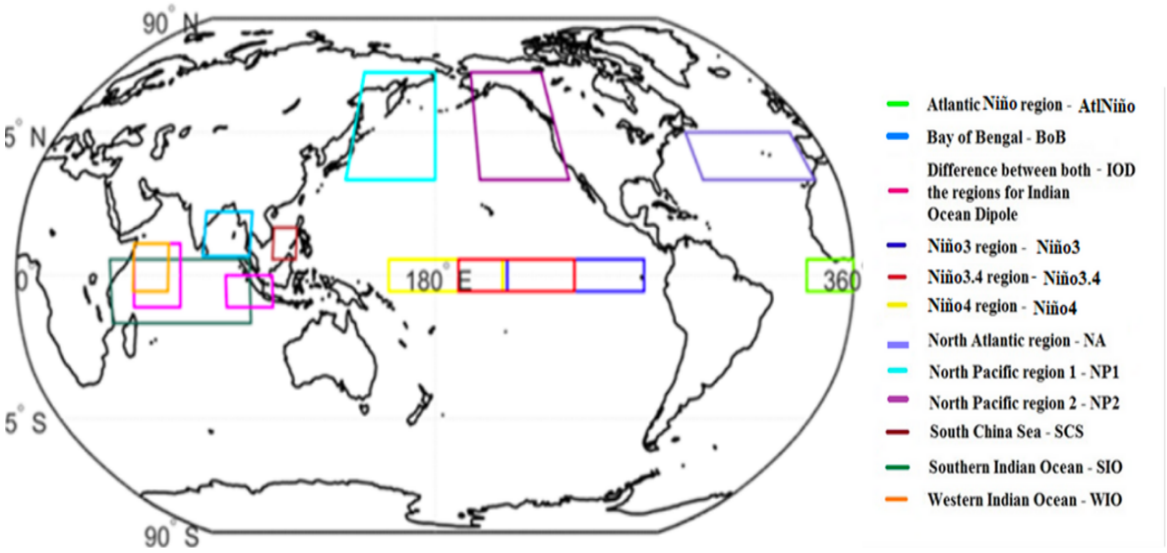

Figure:1 (Rishi Sahastrabuddhe and Subimal Ghosh, 2019)

The presence of trend and its magnitude is evaluated with the help of Mann Kendall Rank test and Sen Slope estimator. The results reveal a positive trend indicating warming for all oceanic regions except for North Pacific 2 which shows a negative trend. The Sen-slope values are recorded highest for North Atlantic region; while, lowest for North Pacific region. The three regions around Indian landmass namely Southern Indian Ocean, Western Indian Ocean and Bay of Bengal which shows statistically significant positive trend with estimated Sen-slope values nearly 0.0285, 0.0292 and 0.0243 respectively.

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Estimation of Seasonal Base Flow Contribution to a Tropical River Using Stable Isotope Analysis

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Abstract

Increase in water demand within the Cauvery River Basin is a cause of serious concern over sustainable utilization and management of water resources. Sustainable, efficient and equitable management and distribution of Cauvery riverwater requires a thorough understanding of the contributing sources and hydrological processes influencing availability of water resources. The study investigates the seasonal contribution of surface runoff and baseflow to the Cauvery streamflow using isotope mass balance approach. Stable Isotope measurements (δ^2H, $\delta^{18}O$) of Cauvery river water along with groundwater are carried during seasonal time intervals spanning from 2014 - 2016, covering pre-monsoon (PM), south-west monsoon (SWM) and north-east monsoon (NEM) seasons. Field campaigns yielded seasonal isotopic datasets of Cauvery riverwater and groundwater. Stable isotope analysis showed a seasonal shift in the river water isotopic composition (δ^2H 8‰, $\delta^{18}O$ 0.95‰) between pre-monsoon (PM) and south-west monsoon (SWM) seasons. Isotopically heavier values are recorded during the pre-monsoon season; coinciding with the period of low flow condition, whereas the monsoon season is characterized by high discharge and recorded isotopically lighter values. The Krishna Raja Sagar (KRS) Reservoir controls the isotopic composition of riverwater by evaporative process, during the pre-monsoon season resulting in river water becoming isotopically lighter. We utilized two-component mixing model to estimate the seasonal base flow contribution to the Cauvery River, for which the river is segmented into three sectors. The average base flow contribution to river flow during pre-monsoon (PM) season in sector I is 85 ± 5%, whereas in sector II and III the average groundwater contribution drops to 59 ± 3% and 39 ± 3% respectively. Similarly, the

average base flow contribution to the river flow during south-west monsoon (SWM) season drops to 32 ± 7% in sector I, whereas in sector II and III the average base flow contribution is estimated at 42 ± 7% and 47 ± 7% respectively. The base flow contribution is appreciably high in the upper Cauvery Basin comprising the Western Ghats, which plays a crucial role in sustaining stream flow during the pre-monsoon season. Assessment of spatial and temporal variability of surface water and groundwater isotopic composition within the Cauvery River Basin provides an important dataset for developing a sustainable river management plan in this tropical mesoscale riverine system.

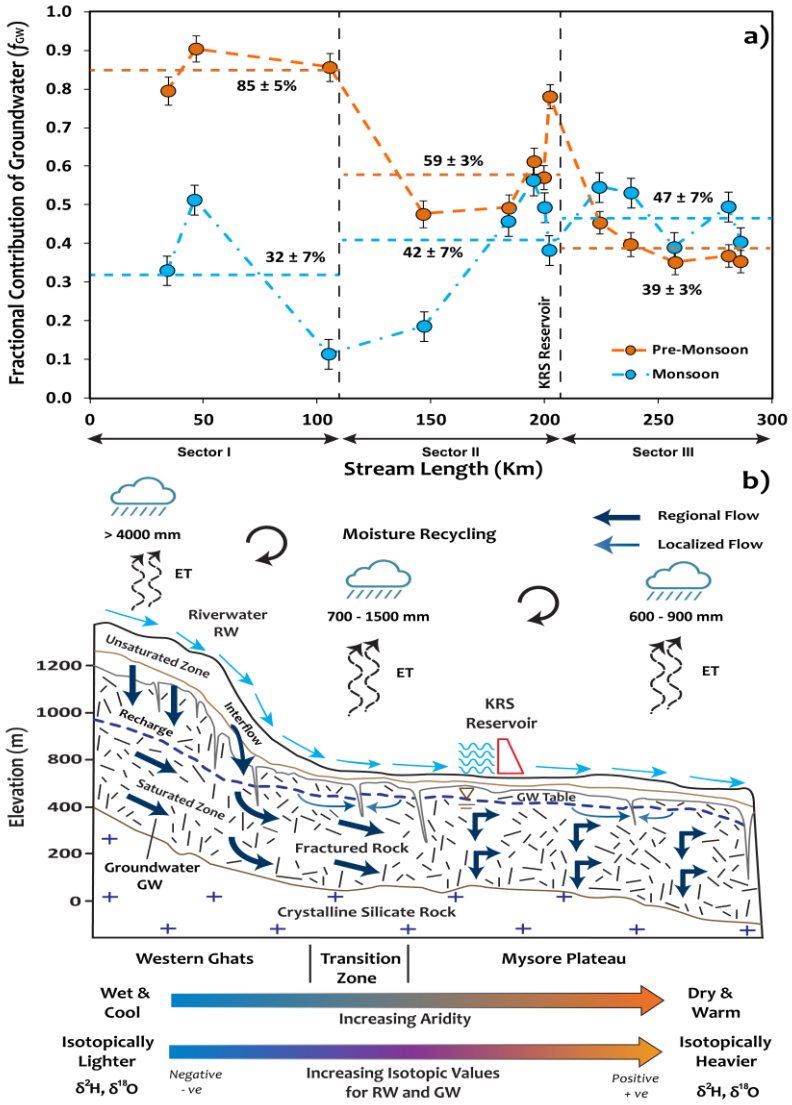

Figure 1. (a) Fractional base flow contribution (f_{GW}) estimated for the Cauvery main channel during Pre-Monsoon (PM) and South-West Monsoon (SWM) seasons. (b) Schematic diagram of a conceptual model showing the hydrological processes such as modification of catchment rainwater due to infiltration, evaporation and moisture recycling of source waters in upper and middle reaches of the Cauvery River Basin. Lighter isotopic composition in Western Ghats indicates groundwater recharge whereas heavier isotopic values in the Mysore plateau indicate groundwater mixing and evaporative enrichment. Moving eastwards, both riverwater (RW) and groundwater (GW) transition from wet to dry regimes and eventually from isotopically lighter to isotopically heavier values.

Influence of climate change on precipitation patterns on watersheds of Central Suvarnamukhi Basin, South Interior Karnataka, India

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Abstract: Climate change has affected India by causing extreme weather conditions in the past few decades. The severity and frequency of rainfall are evident in seasonal and regional scales as the climate changes (Kim et, al. 2020). Since India is a land with differing geomorphology, the monsoon patterns are largely influenced by varying meteorological parameters (Parthasarathy et, al. 1995). The southern portion of the country is a peninsular region with three different marine bodies namely; The Arabian Sea, Indian Ocean, and Bay of Bengal. Even though these three regions have different Sea Surface Temperatures (SST) all of them show an increasing trend (Fig 1). Land surface temperatures are changed due to these fluctuations in SST (Mukherjee et, al. 2018) and thus also change Indian Ocean Dipole (Dash et, al. 2002). This, in turn, influences normal rainfall conditions resulting in floods and droughts. This case-study includes overseeing climatic extremes in the three watersheds of Central Suvarnamuki Basin. By three different methods (IMD, SPI, RAI), a comparative drought analysis is done for 25 years and the increase in number of drought years is seen (Fig 2a, 2b, 2c). The drought intensity has been fluctuating because of changing wind patterns and temperature extremes (Fig 3). This study shows the relation between climate and precipitation extremes in corelation to SST and Precipitation.

Keywords: Climate change, Rainfall, Drought, Flood, Watershed

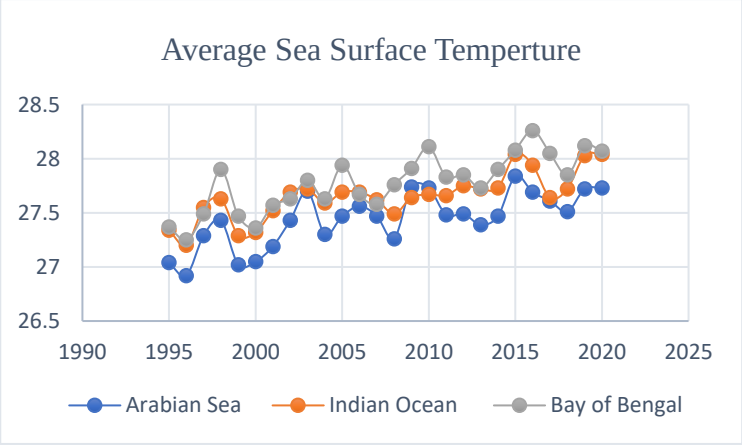

Fig 1: Sea surface temperature

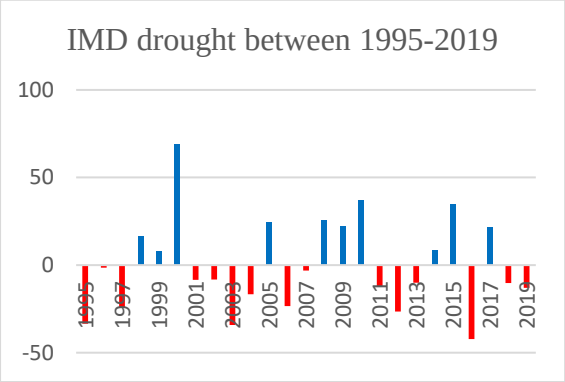

Fig 2a: IMD Drought condition

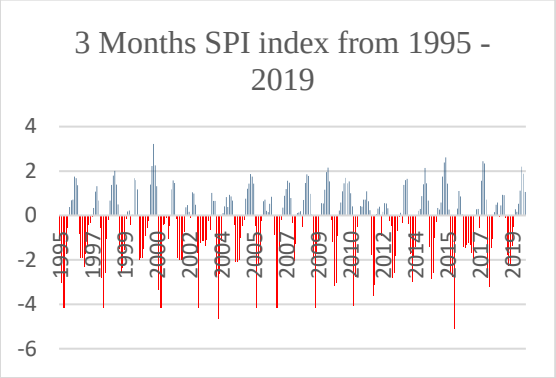

Fig 2b: SPI Drought condition

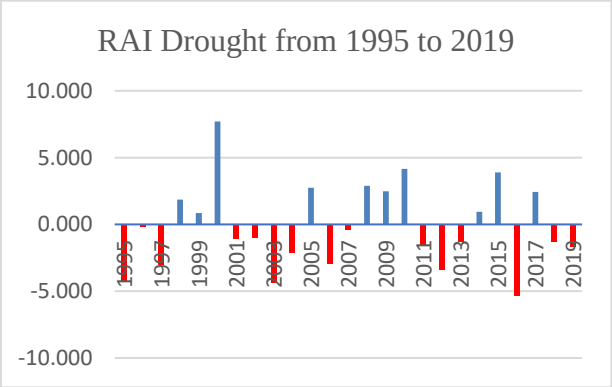

Fig 2b: RAI Drought condition

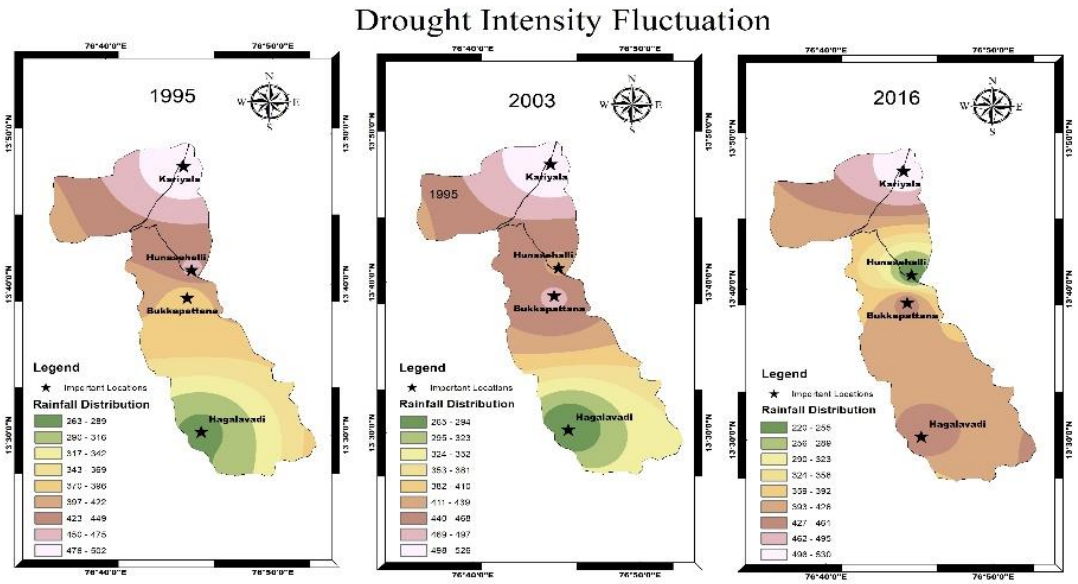

Fig 3: Drought Intensity fluctuation

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Thermal state of Eocene-Oligocene tropical Indian Ocean based on carbonate clumped isotope thermometry of planktonic foraminifera from DSDP site 237

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Abstract:

During Eocene and Oligocene, the Indian Ocean basin was well connected with the Pacific and Atlantic without any land boundary. It makes the Indian ocean the representative candidate recording the surface hydrography similar to the other global ocean. During this period, the Sea Surface Temperature (SST) is the subject of several studies and the DSDP, ODP, and IODP programs. The physical state of the Indian Ocean from the Middle Eocene to the Early Miocene is poorly understood due to a lack of data defining the temperature of the surface ocean. In our study, we compiled the tropical SST record from various proxies available from the Atlantic and Pacific oceans. It includes TEX_{86} [1,2], Mg/Ca of foraminifera [3] and clumped isotope of foraminifera [4]. It is further compared with the present study carbonate clumped isotope of planktonic foraminifera (*Dentoglobigerina galavisi*) based SST reconstruction from Central Indian Ocean DSDP site 237 (Paleolatitude ~1°S at 35 Ma). The thermometry equation used to reconstruct temperature in the present study is adopted from the inorganic calcite experiment [5] and using the 25°C reaction protocol without any acid fractionation factor correction. Our SST estimates ranges between 22±4°C and 34±3°C, which matches with the global tropical SST record during this time, conforming to our proposal of ocean connectivity and near similar thermal state.

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PALEOMONSOONAL RECONSTRUCTION USING LAKE SEDIMENTS FROM COASTAL KARNATAKA, SOUTHERN INDIA: A MULTI-PROXY APPROACH

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There is a dearth of high-resolution paleomonsoonal records from southern India. This study attempts to reconstruct the past changes in climate, in particular, the Indian Summer Monsoon (ISM) variability in southern India. Environmental magnetic, sedimentological and loss-on-ignition (LOI) properties of a 154-cm long sediment core from Lake Ramasamudra (RSL) in the Udupi district of Karnataka were studied. Based on the preliminary data, two distinct climatic zones are identified, Zone I (154-60 cm depth) and Zone II (60-35 cm depth). The magnetic minerals present in the RSL sediments are mainly magnetite (high S-ratio values). High values of concentration-dependent magnetic parameters in the Zone I (χ_{lf} = 16.1±1.8 x $10^{-8}m^3kg^{-1}$; χ_{fd}=1.72±0.68 x $10^{-8}m^3kg^{-1}$; χ_{ARM}=0.45±0.08 x $10^{-5}m^3kg^{-1}$; SIRM=160.72±21.16 x $10^{-5}Am^2kg^{-1}$; S-ratio=0.94±0.07) indicated a high terrigenous input of iron minerals into the lake, which might have resulted from a strong monsoon precipitation in the region. The low percent values of sand

in the zone explains a high lake level and high precipitation, due to which the finer particles get deposited far from the shore within the lake, where the hydrodynamic conditions are weak. A cyclic pattern of climatic variability was observed with peaks and troughs in monsoon precipitation recurring at 138, 116, 85 and 46.5 cm and 144, 125 and 37 cm respectively. Zone II is characterized by an inconsistent hydrodynamic condition, which shows an overall drying trend. This interval starts with an abrupt weakening of monsoon and a low lake level, and a shift in climatic condition from humid to arid, evidenced by a steep decline in concentration-dependent magnetic parameters (χ_{lf}=11.34±3.33 x $10^{-8}m^3kg^{-1}$; χ_{fd}=0.94±0.52 x $10^{-8}m^3kg^{-1}$; χ_{ARM}=0.31±0.08 x $10^{-5}Am^2kg^{-1}$; SIRM=116.33±27.4 x $10^{-5}Am^2kg^{-1}$; S-ratio=0.91±0.05) and an increase in percent values of sand. Generally, organic matter tends to reside in fine sediment particles. But in Zone II of RSL, a statistically significant inverse correlation is observed between % TOC and % clay, which might have resulted from agricultural practices near the catchment or other anthropogenic activities. The magnetic grains present in the sediments are mostly Stable Single Domain (SSD) and Superparamagnetic (SP) indicating a relatively stronger intensity of pedogenesis in the catchment in response to the monsoonal conditions.

Keywords: magnetic susceptibility, lake sediments, paleomonsoon, pedogenesis, lake-level, southern India.

AMS-based ^{14}C Age Chronology for Stalagmites from Dandak Cave

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Speleothems are valuable archives that are important proxies for terrestrial paleoclimate. We have developed revised age chronology for stalagmites from Dandak cave, Chhattisgarh, for a comprehensive study on paleomonsoon reconstruction using high resolution $\delta^{18}O$ data. The age chronology developed in the previous study was based on a small number of age estimates by conventional method (liquid scintiallation spectrometry), due to which age models produced could not reliably capture the variations in the growth rate of the stalagmites. In this study, we have developed robust age chronology based on well-resolved age estimates made possible by the AMS method of radiocarbon dating due to the small amount of sample required for age estimation. All the samples were processed using in-house developed CO_2 extraction and Fe-Zn graphitisation setup followed by analysis in 1 MV AMS at PRL. Conventional radiocarbon ages were obtained using in-house developed web application 'SPADE' and age-depth models were constructed using OxCal. Higher resolution of radiocarbon age estimates will help in assigning more precise ages to the variations in $\delta^{18}O$ and understanding events occuring on smaller timescales.

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