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Physicochemical and Spectroscopic Methods for Remediation of Water Pollution by Catalytic Oxidants & Development of Climate and Ocean Forecasts Models (COFM).

Invited Presenter at Ocean Salinity Conference,07 JUN'22 (Virtual)

INTRODUCTION:@WMO-Climate Change Report,18May'22

Four key climate change indicators, greenhouse gas concentration, sea level rise, ocean heat and ocean acidification set new records in 2021, in a clear sign that human activities are causing planetary scale changes on land, in the ocean, and in the atmosphere.

@Air Pollution in Vedas:

The balance of Air, water Energy maintains the balance of Environment & if the balance is not sustained then Environment gets polluted.

@AthravanVed (10/2/13)& (4/3/i);Breathing Process has been explained.In 24hours one person inhales 40,000 cc of Oxygen & exhale 40Kg of Carbon Dioxide.

@One person can pollute a room size of 9'x10'x10',the air of 900cc in 15 minutes.

@A person generates 500 gm waste per day.

1.INTRODUCTION :Air Pollutants & Antibiotics Thrown In Rivers Breed Superbugs (Water Pollutants).

@AIIMS reports that the Antibiotics, painkillers and other leftover medicines thrown in the Water bodies directly or through the garbage; come back to us in milk, vegetables and other agricultural produce and also give rise to SUPEUGS that most antibiotics can not kill.

@The concentration of dissolved drugs increased manifold along the river's course e.g.in Delhi's Yamuna river there was 121 times increase in Diclofenac (painkiller) in its water and 96 times increase in Ofloxacin(antibiotic).

@Ground water contamination takes place from the motor pumps and borewells resulted due to seeping of Chromium into the water by the industrial units over the decade.

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1.INTRODUCTION (Chemical Contaminants, Contaminated , Global Warming & Climate Change)

@Types of Chemical Contaminants: Chemical Contaminants can be separated into eight contaminant groups as follows:

- Nonhalogenated volatile organic compounds (VOCs).
- Halogenated volatile organic compounds.
- Nonhalogenated semivolatile organic compounds (SVOCs).
- Halogenated semivolatile organic compounds
- Fuels. Inorganics.Radionuclides.Explosives.

@The contaminated water not only give rise to water born diseases but, also results Climate change is altering our environment affecting agriculture, water availability, and sea-levels. It's increasing the intensity of natural disasters like Tsunami, Cyclonic Storms ,droughts, floods, species extinction particularly marine live & diseases. The too much water causes River Banking Erosion while too less water affects Water Management, River Water Channelization & Dams& Rise of Sea level due to Global Warming i.e. Climate Change.

1.INTRODUCTION :@Climate change is altering our environment affecting agriculture, water availability, and sea-levels. It's increasing the intensity of natural disasters, rate of species extinction& diseases. This increase in earth's average temperature is called Global warming.

@ Water gets polluted due to the toxin, toxic gases, and toxic entities viz. Chemical (e. g. lead, mercury, hydrofluoric acid, and chlorine gas), Biological, Physical, and Radiations.

@The Ocean Circulations, Marine Biogeochemistry, Ocean-Air interactions, and Physiochemical characteristics comprising in-situ chemical speciation of the inorganic contaminants get affected by the Ocean Salinity. It's an important parameter for studying the Changing Water and Carbon Cycles as well as the Ocean-Atmospheric-Cryosphere (OAC) interactions.

@ Also, the Ocean Salinity changes the marine biogeochemistry very rapidly especially over the areas of strong gradients, effecting the marine life. These areas of strong gradients are known as Oceanic Transitional Areas (OTAs)

OBJECTIVES: @The seminal scientific research is needed to develop Ocean Climate and Ocean Forecasts Models (COFM), to understand the major environmental challenges due to Global Carbon Cycle and Ocean Salinity, Marine Pollution resulting due to the toxin, toxic gases, Global Warming caused by Green House Gases over the sub-surface Oceanic regions, and Ocean-Climate-intractions.

@ It aims to develop Physicochemical and spectroscopic methods to characterize the in-situ chemical speciation of the inorganic contaminants and develop technologies for remediation of water pollution by catalytic oxidants over Oceanic Transitional Areas (OTAs).

OBJECTIVES:@ Next, to control Water Pollution resulting due to the toxin, toxic gases, Green House Gases over the subsurface oceanic regions, by making use of Catalytic Oxides of the first-row transition metal oxides in order to save marine life by inhibiting the effect of Global Warming and controlling the marine pollution through the remediation of the water treatment processes.

@The studies are focused to explore Multiple Stressors on the ocean, Sea-level Variability Mechanism, Sub-Mesoscale Dynamics, by the comprehensive studies of Ocean Systems Interactions, Risks, Instabilities and Synergies (OSIRIS). Also, to investigate the aquifer materials, target and non-target contaminants in water treatment processes, and their Correlation with Climate Variability.

@Next, the physicochemical and spectroscopic methods would be used to characterize the in-situ chemical speciation of the inorganic contaminants and develop technologies for remediation of water pollution by catalytic-oxidants.

OBJECTIVES: @To control Water Pollution resulting due to the toxin, toxic gases, GHG over the sub-surface oceanic regions, by Catalytic Oxides of the first row- transition metal oxides in order to inhibit GW, the marine pollution by Water treatment processes viz. Chemical Oxidation to treat groundwater contaminants in subsurface systems, above ground water by regeneration of Granular Activated Carbon (GAC)using High Affinity Toxin Receptors (HART)to entrap toxins &develop the COFM.

@ Next, to control Marine Pollution over Oceanic Transitional Areas (TAs), the studies are focused to explore Multiple Stressors on the ocean, Sea-level Variability Mechanisms, Sub-Mesoscale Dynamics, by the comprehensive studies of Ocean Systems Interactions, Risks, Instabilities, and Synergies (OSIRIS)

@It aims to understand air-sea exchange during extreme atmospheric forcing to correlate Air–Sea CO_2 exchange with Climate Variability for estimating energy and material(e.g Carbon, Nitrogen) exchange between the upper and deep ocean as well, over the OTAs .

@The correlation of climate variability with sea level-variability-mechanism & sub-mesoscale dynamics would be computed through the study of,multi–scale–ocean–atmosphere–coupled processes e. g.

@Sea-level rise,

@Rise of Green House Gases (GHG) level and its control by chemical processes viz.

#Temperature Absorption,

#Carbon Absorption Sinks,

#GHG- Detoxifiers to check the rising levels of Carbon Dioxide and other GHG, in order to develop the Sea-Level Variability Forecasting Models (SLVFM) ,along with Climate Oceanic Forecasting Models (COFM) .

@**Next,through Sea-Level Variability Forecasting Models (SLVFM) and (COFM);**Over Tropical **Oceanic Sections, the studies would be made to investigate major Atmospheric challenges due to extreme weather events caused due to :**

 # mesoscale convective systems,

 # Global Carbon Cycle,

 # Ocean Salinity, and

 # Marine Pollution resulting due to the toxin, toxin gases over the Oceanic and sub-surface Oceanic regions.

@The Ocean Circulations, Ocean-Atmospheric (OA) interactions, and the inorganic contaminants get affected by the Ocean Salinity.

2.BACKGROUND & RELEVANCE TO PREVIOUS WORK

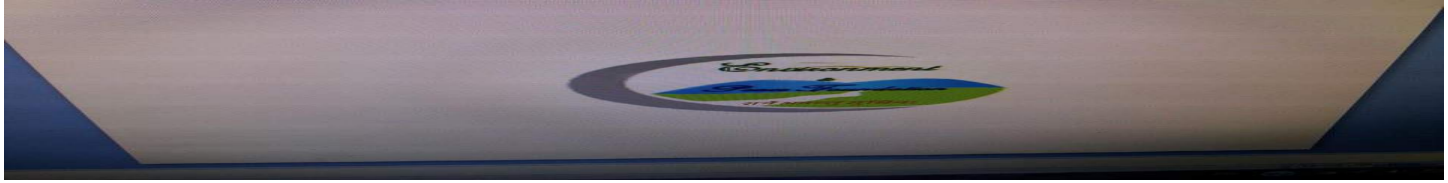
@Researchers found that the Sea-level rise was due to rising levels of Carbon Dioxide and other GHG, as opposed to other types of forces. Hence, it's imperative to analyse Satellite imageries (IR & VR) over the Oceanic regions comprising Transitional areas (TAs) & (WBCs).

@Transitional areas (TAs) are areas of strong gradients in the physical environment that challenge biological communities, exposed to their physiological limits. These areas are associated with Sea-level Variability Mechanism, Sub-Mesoscale Dynamics over the Oceanic areas impacting the Climate change more dramatically and sooner over the Transitional areas (TAs) than of homogeneous areas. (TAs) are the potential oceanic regions of early detection of Climate variability.

2(a). TELECONNECTION OF NH & SH WBCs & TAs . **@ Goswami, VK (Tropmet-1993,1999): Studied The Tele-connection of Southern Hemisphere Cyclonic Storm with NH-Precipitation in NE-Monsoon over Indian Southern Peninsula' as well as Satellite observed cloud fields and inter-hemispheric (NH & SH) confluence zones during summer Monsoon and found the increase of precipitation over Indian Southern Peninsula(1993).**

@Next, NH- Confluence zones are more of mesoscale convective nature than that of SH (1999). This may be attributed to the different Sea-level variability, WBCs, TAs, and SSTs and otherNH & SH features.

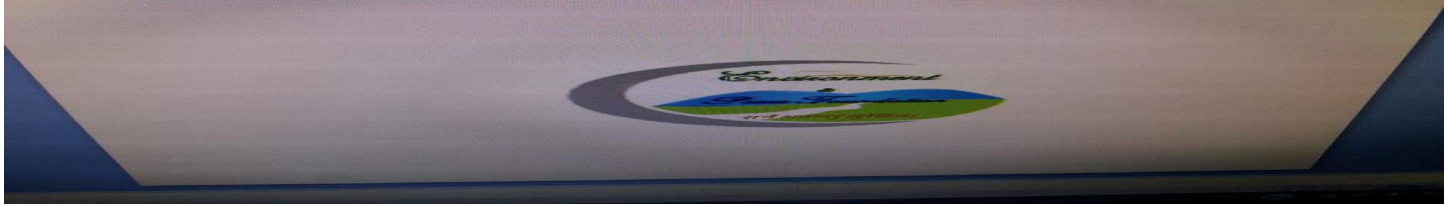
@ Therefore, it's imperative to study the correlation of these TAs (Areas of strong gradients challenging the marine life/ biological communities), associated with Sea-level Variability Mechanism, Sub-Mesoscale Dynamics over the Oceanic areas of NH & SH impacting the Climate change more dramatically over the potential oceanic regions of early detection of Climate variability.



2(b).Lately, in May'21:CLIVAR-Tropical Pacific Observing Needs to Advance Process Understanding and Representation in Models Workshop (Virtual),was held, to discuss on Tropical Pacific Observing needs to understand: # multi-scale ocean-atmosphere coupled processes,# biogeochemical models, and #improve satellite retrievals, data assimilation, and climate, forecast.

@ *Anna-Lena Deppenmeier et.al*. studied he role of Tropical Instability Waves in modulating water mass transformation and concluded that tropical Pacific plays an integral role in the coupled global climate system.

@ *Dr. Kakha NADIRADZE et.al*, studied Eutrophication and Acidification problems of the Black Sea and found that Climate Change, Overfishing, Pollution, Rising atmospheric carbon dioxide (CO 2 levels, from fossil fuel combustion and deforestation, are causing wholesale increases in Black Sea water CO 2 and inorganic carbon levels.



3.MARINE POLLUTION & OCEAN ACIDIFICATION.

@ There are generally two types of Pollutants comprising toxic entities, and Contaminants from water, to result Marine Environmental Pollution. Also, due to:

@ CO_2 absorption by the Sea.

@ Over 25 million tons of CO_2 dissolve in Seawater everyday.

@ Carbonic acid leads to fall in p H.

@ The slower dynamics of the Ocean means that some changes such as ocean acidification will be irreversible this century.

@ Soft corals of reef environments, are simply melting and wasting away.

3@ Water Pollution due to Toxin

@ Water gets polluted due to four types of toxic entities;

Chemical, # Biological,
Physical # Radiation .

@Water gets polluted due to:

Particulate matter, # Disinfectants or Herbicides,
Pesticides and Contaminants from water e. g
Microbial pathogens, # Viruses and #Bacteria.

@ Water gets polluted due to Micro Plastic has penetrated tap water in countries across the world.

@ Micro plastics absorb toxic chemicals linked to illness when consumed by fish and mammals.

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3.@Water Pollution due to Micro Plastics

@ Micro Plastic has penetrated tap water in countries across the world.

@ Micro plastics absorb toxic chemicals linked to illness when consumed by fish and mammals

@ Microscopic fibers might originate in the everyday abrasion of clothes, upholstery and carpets. They could reach into water taps, tanks and contaminate treatment distribution system.

@The other Water Contaminants are : microbial pathogens, viruses, bacteria, herbicides, and pesticides

@Water Pollution Due to Plastic Waste

- ***4@ Remediation of Water & Plastic Pollution:***
- ***Develop innovative methods to entrap toxins*** **viz. Chemical : (a)inorganic e.g. lead, mercury , hydrofluoric acid & chlorine(b) organic compounds eg. methyl alcohol, by using High Affinity Toxin Receptors .**
- **Develop Strategies to control Water & Environment Pollution Recycling of Plastic resulting due to toxin, toxic gases (GHG), by Catalytic oxides to control GW and save Marine life (Under Water) by Water treatment process (catalytic oxidants).**
- ***Plastic Waste by converting into Plastic Fakes and Pet Chips*** **by using high speed grinders in order to use in Polyester Fiber Yarn (PFY) manufacturing and future Road Laying by mixing into Coal Tar as mandated by CRRI.**
- **Laying of Polymer-Bitumen Roads**

Construction of Polymer (Plastics) Coated Bitumen Road

Plastic waste collection, segregation & storage.

Cleaning & drying of Plastic waste .

Shredding plastic waste into required size (2 to 4 mm).

Stone aggregate (granite, ceramic) heated to around 160°C-170°C.

Shredded polymer waste (5-10% w/w) is added to heated stone aggregate for 30- 40 sec and mixed for uniform coating at surface of aggregate

The coated aggregate is mixed with hot bitumen at temperature ranges from 155°C-163°C.

The mix (composite) known as waste plastic- aggregate- bitumen mix (130°C-140°C). This composite used for road laying at temperature between 110°C-130°C.

4.Remediation of Water Pollution

- Develop innovative methods to entrap toxins viz. Chemical : (a)inorganic e.g. lead, mercury , hydrofluoric acid & chlorine(b) organic compounds eg. methyl alcohol, by using High Affinity Toxin Receptors .
- In May 17 Canada, Prof. Pierre Berube has developed a low maintenance water filtration system using the technology which combines microbes and gravity using ultra-filtration membranes, which is very fine screen that removes not just particulate matter but, also large molecules ,e .g. disinfectants or herbicides, pesticides and contaminants from water e.g. microbial pathogens, viruses and bacteria

4.General Methodology: Water Treatment Processes (Oxydation Processes)

@Next, the Oxidation process would be employed in subsurface systems and in above ground water treatment systems involving chemical oxidation regeneration of Granular Activated Carbon (GAC) & to treat Groundwater contaminants by making use of the chemical oxidant s viz. hydrogen peroxide, persulfate, permanganate & ozone causing chemical destruction of toxic organic chemicals.
@To entrap Chemical toxicants (lead, mercury, hydrofluoric acid, chlorine gas, and methyl alcohol), the High Affinity Toxin Receptors (HART) would be developed.

@Also, physicochemical and spectroscopic methods are to be employed to characterize the in-situ chemical speciation of the inorganic contaminants and Catalytic Oxidants (hydrogen peroxide, persulfate, permanganate & ozone) to control Water&Environmental pollution as well as to investigate process fundamentals and assess contaminant transformation through Chemical Reaction Kinetics.

4.General Methodology:Water Treatment Process

@ **Remediation of Water Treatment Process (WTP):** by making use of **catalytic chemical oxidants:**

It has been observed that matching the oxidant and in situ delivery system to the contaminants of concern (COCs) and the site conditions is the key to successful implementation and achieving best results in **Water Treatment Process** .

@ In situ treatments the ground water is treated without being brought to the surface. These processes are slower but economical. The general methods and procedures to be followed for remediation of **Water treatment processes.**

4.General Methodology: Water Treatment Processes (PRT & CRT).

@ Physical/Chemical Remediation Water Treatment Technologies.(PRT): The Physical Remediation Technology (PRT) involves the use of physical properties of the contaminants and separation of contamination.

@ In Chemical Remediation Technology (CRT); the contaminated medium is destroyed by Chemically Convert (CC).It may use Chemical oxidant and Catalytic Oxidants to either separate the contaminants or destroy the contamination. Passive treatment walls separate and destroy the contaminant from in situ ground water. PRTs are economical than CRTs.

@ In the CRTs (i.e. Chemical oxidation) due attention be paid to reaction chemistry and transport processes and management of remediation wastes.

4.General Methodology: Water Treatment Processes (PRT & CRT).

@ This investigation intends to employ the following well tested PRTs & CRTs as regards ground water, surface water, and leachate:

air sparging & bio slurping,

directional wells & dual phase extraction,

thermal treatment & hydrofracturing,

in-well air stripping & passive/reactive treatment walls.

@The rate and extent of degradation of a target COC are dictated by the properties of the chemical itself and its susceptibility to oxidative degradation.

Processes.(Matrix Conditions) & (Ozone Oxidation)

@ Matrix conditions e.g., pH, temperature, the concentration of oxidant, and the concentration of other oxidant-consuming substances (e. g. organic matter, reduced minerals, carbonate and other free radical scavengers.)

@ In these processes; Oxidant delivery systems often employ vertical or horizontal injection wells and sparge points with forced advection to rapidly move the oxidant into the subsurface.

@Ozone Oxidation: Ozone gas oxidizes contaminants directly or through the formation of hydroxyl radicals e.g. peroxide.These reactions are most effective in systems with acidic pH. Ozone oxidation reaction proceeds with extremely fast, pseudo first order kinetics. Due to ozone's high reactivity and instability, O_3 is produced onsite, and it requires closely spaced delivery points (e.g., air sparging wells).

4. General Methodology: Water Treatment Processes (Ozone Oxidation) Continued.

@ Composition of the ozone can lead to beneficial oxygenation and bio stimulation.

@ Peroxide Oxidation i.e. Fenton's Reagent oxidation :Oxidation using liquid hydrogen peroxide (H_2O_2) in the presence of native or supplemental ferrous iron (Fe^{+2}) produces Fenton's Reagent which yields free hydroxyl radicals (OH^-).

@These strong, nonspecific oxidants can rapidly degrade a variety of organic compounds. Fenton's Reagent oxidation is most effective under very acidic pH (e.g., pH 2 to 4) and becomes ineffective under moderate to strongly alkaline conditions. The reactions are extremely rapid and follow second-order kinetics.

4.General Methodology: Water Treatment Processes (To Save Underwater Marine life).

@Dr.VK Goswami et.al. found that catalytic oxides of first row transition metal oxides e.g. Cobalt oxide should optimize the process of subsurface remediation and above-ground water treatment systems depending on a variety of site-specific conditions e.g. reaction rate kinetics.

@ Hence , the efforts are focused to discuss strategies to save underwater marine life and environment by controlling Water & Environmental pollution resulting due to toxins (*chemical, biological, physical and radiation*), toxic gases(GHG,CO), by Catalytic oxides of first row transition metal oxides and employing High Affinity Toxin Receptors (HART)for depolluting water& detoxifying GHG (CH_4, CO_2,N_2O,CFC), e.g. converting CH_4 to ethanol by catalytic processes and developing hybrid fuels like bio-ethanol and bio-diesel and go for electricity from biomass as well as to subsequent bioremediation.

@ Next, to evaluate correlation of chemical oxidants with chemical species associated with soil and aquifer materials, and with target and non-target contaminants during water treatment processes.

4.General Methodology:('Correlational Predictive Model of Chemical Reaction Kinetics(MCRK)'

@Next, to evaluate correlation of chemical oxidants with chemical species associated with soil and aquifer materials, and with target and non-target contaminants during water treatment processes.

@ to develop physicochemical and spectroscopic methods to characterize the in-situ chemical speciation of the inorganic contaminants, to entrap water contaminants, toxins, and develop @Catalyst – Absorption – Beds, 'carbon sinks', Cobalt Oxide Catalyst Converters for limiting Green House Gases (CO_2, CH_4, CO, H_2, N_2O, SF_6, $14CO_2$) and inhibit the generation and widespread release of toxic chemical substances in waterbodies and optimize the remediation of water treatment process by chemical oxidation & regeneration of granular activated carbon (GAC) to save marine life .

@ Finally, develop Correlational Predictive Model of Chemical Reaction Kinetics(MCRK) in order to investigate process fundamentals & assess contaminant transformation.

5.GENERAL METHODOLOGY :Development of Numerical Climatic & Ocean Forecasting Model-(NCOFM)

@ The integration of Satellite and Surface Sounding data would be accomplished through plausible model in which the section strips are treated as space sections.

@ The physicochemical and spectroscopic methods would be used to characterize the in-situ chemical speciation of the inorganic contaminants and develop technologies for remediation of Water Pollution by catalytic-oxidants, and by regeneration of Granular Activated Carbon (GAC) using High Affinity Toxin Receptors (HART) to entrap toxins.

@The process of Initialization, Computation, Parameterization, within the (1 x 1) deg. grid-box by the computer algorithm, would be employed in order to develop the ((NCOFM)) by using Satellite data fitted with Lightning sensors & CubeSats carrying high-frequency passive microwave sensors.

6.SCOPE:(Water Car & Water Harnessing From Fog & Humid Atmosphere (Feb'2020)

@ Lately, A Car has been run on Water energy in Gujrat, India.

@ By using specially designed Mesh-Curtains, the fog particles i.e. Low clouds are entrapped, and water is produced.

@ Also, by condensation of water available in the humid atmosphere the water has been produced by Indian Innovators. Water ATM's machines may be designed in future.

@ Tree plantation Drone developed by BioCarbon Engg,Australia.

@ (InJul'20), Zero Mass Water: US firm uses technology to harvest drinking water out of thin air, using a combination of materials science, solar power, and predictive data.

@ In Dubai , UAE Arabian Desert, A US-based 'Zero Mass Water', firm harvests drinking water out of thin air, using a combination of materials science, solar power, and predictive data , instead of the traditional method of drilling wells into the ground or purifying seawater.

6. SCOPE OF WORK:@(NCOFM)would be improved through Numerical Weather Prediction (NWP) technology using mathematical models of the atmosphere and oceans to predict the weather based on:

 # current weather conditions by producing realistic results through the initialization, Computation, Parameterization, within the (1 x 1)deg. grid-box by the computer algorithm, in the selected Domains of horizontal /vertical coordination system by making use of above derived results of morphological and dynamical properties of meso-scale convective systems , for developing –Numerical Climate & Oceanic Forecasting Models (NOCFM) for Oceanic regions.

<THANKS & STAY BLESSED EVER>