

ISBN: 97881-931247-2-7

Water Research and Technology

Associate Editors

Dr. (Smt.) M. S. Kadam
Dr. Biplab Kumar Das
Dr. (Smt.) P. S. Desai
Dr. (Smt.) Shakun Mishra
Mr. Rahul Dev Behera

Managing Editors

Dr. Sagar A. Vhanalakar
Dr. Sharadrao A. Vanalakar



First Edition
2016



Water Research and Technology

Associate Editors

Dr. (Smt.) M. S. Kadam P. G. Research Centre, Department of Zoology, Yeshwant Mahavidyalaya, Nanded, M.S., INDIA	Dr. Biplab Kumar Das Department of Zoology, Silapathar Science College, Silapathar, Dhemaji, Assam
Dr. (Smt.) P. S. Desai Acharaya Jawadekar College of Education, Gargoti, Tal - Bhudargad, Dist - Kolhapur, M.S. India	Dr. (Smt.) Shakun Mishra Department of Botany, Govt. S. N. P. G. College, Khandwa (M.P.) INDIA
Mr. Rahul Dev Behera Program Assistant, KVK, Malkangiri, Odisha, INDIA	

Managing Editors

Dr. Sagar A. Vhanalakar

Department of Zoology

Shri. Mouni Vidyapeeth's Karmaveer Hire Arts, Science, Commerce and Education College, Gargoti,

Tal – Bhudargad, Dist – Kolhapur, 416209 M.S., INDIA

Dr. Sharadrao A. Vanalakar

Department of Physics



Bhumi Publishing

Bhumi Publishing

Nigave Khalasa, Kolhapur 416207, Maharashtra, INDIA

2016

First Edition: 2016

ISBN: 97881-931247-2-7



© Copyright reserved by the managing editors

Publication, Distribution and Promotion Rights reserved by Bhumi Publishing, Nigave Khalasa, Kolhapur.

Despite every effort, there may still be chances for some errors and omissions to have crept in inadvertently.

No part of this publication may be reproduced in any form or by any means, electronically, mechanically, by photocopying, recording or otherwise, without the prior permission of the publishers.

The views and results expressed in various articles are those of the authors and not of editors or publisher of the book.

Published by:

Bhumi Publishing,

Nigave Khalasa, Kolhapur 416207, Maharashtra, India

Website: www.bhumipublishing.com

E-mail: bhumipublishing@gmail.com

Available online at: www.bhumipublishing.com/books/water_research_and_technology

Editorial Board



Dr. (Smt.) M. S. Kadam

Dr. (Smt.) M. S. Kadam is currently associated with the P. G. Department of Zoology of Yeshwant Mahavidyalaya, Nanded, M.S., INDIA as an Assistant Professor. She completed her Doctorate degree on the subject “Studies on Biodiversity and Fisheries Management of Mosoli Reservoir in Parbhani Dist. M.S. (India)”. She is presently working on a research project relating to “Quantitative assessment of Zooplankton and Morphometrics- meristics of Rotifers from fresh water Reservoir in Nanded Dist. (M.S.) – As a study tool to rejuvenate the reservoir fishery”. Along with her Zoology, she also holds a diploma in computer programming. She has 14 years of teaching experience.

Dr. Kadam has published 67 research papers in the field of limnology and fishery science in various national and international journals. She also attended and presented research papers in 68 conferences and delivered lecture on Zoology for “Vidnyan Manch”. She has achieved several recognitions in academic career, as a P.G. Teacher, Research Guide in Zoology, S.R.T.M. University, Nanded. She is a Life Member of various national level research societies. She has Authored **one** reference book and **one** U.G.C patterns book published by Educational Publisher and Distribution, Aurangabad, during 2008.



Dr. Biplab Kumar Das

Dr. Biplab Kumar Das did his Ph. D. in the year 2015 from Department of Life Science and Bioinformatics of Assam University, Silchar and currently engaged as an Assistant Professor of Department of Zoology in Silapathar Science College, Dhemaji, Assam. Dr. Biplab Kumar Das has significantly contributed in the field of Fish Biodiversity, Entomology, Remote Sensing and Geographic Information System (GIS). His topic of Research is Biodiversity, Entomology, Remote Sensing and GIS. He had presented many research papers in National and International Conference/Seminar/Symposia and also he had attended numbers of National and International Workshop, Training Programmes etc.

Dr. Das had been awarded with Young Scientist of the Year -2014 and Eminent Young Scientist of the Year Award 2015 by Foundation for Science and Environment and International Conference on Environment and Ecology and also with Young Scientist Award-2014 by the Academic Council of the International Consortium of Contemporary Biologists and the Board of Trustees of Madhawi – Shyam Educational Trust (ICCB-MSET), Jharkhand for his outstanding contribution in the field of Biodiversity, Remote Sensing and GIS. He had also selected for Best Poster and also Best Oral Presentation in different International and National Conferences. He had published 41 numbers of Research Papers in National and International Journals having NASS Rating and Impact Factor. He has also contributed number of Book Chapters in Edited books by the others. He is also members of many scientific professional bodies and besides that he is also reviewer of many international journals.



Dr. (Smt.) P. S. Desai

Dr. (Smt.) P. S. Desai is presently working as assistant professor at Shri Mouni Vidyapeeth's Acharya Jawadekar College of Education, Gargoti, Dist – Kolhapur, M. S., India. She has 24 years of experience in teaching and four years of administration experience as Principal. She is actively engaged in research and extension work from last decade. Dr. Desai published 45 research papers in various state, national and international journals and books. She attended and presented research papers in 30 national and 05 international conferences.

Dr. Desai received 'Excellent Research Paper' Award at MSSTEA Annual National Conference for two times. She is working as a course coordinator for YCMOU (Open University on Maharashtra) from last 10 years in education faculty. She contributed actively in curriculum framing for B. Ed. (Shivaji University, Kolhapur). She is members of many scientific professional bodies and societies. She delivered more than 15 invited talks on various subjects including Science, Mathematics, and Education etc. Apart from academic record, Dr. Desai also worked as examiner for various science exhibitions and other examinations carried out by district and state level bodies.



Dr. (Smt.) Shakun Mishra

Dr. (Smt.) Shakun Mishra is working as Head Department of Botany, Govt. S. N. P. G. College, Khandwa (M.P.) INDIA. She obtained his Ph. D. in 2011. Her topic of research was “Ethnobotany of Korku, Gond and Nihal Tribes of East Nimar (M.P.)” She has more than 33 years of teaching experience at UG level. She is actively engaged in research and extension work from last decade. Dr. Mishra published 46 research paper in various journals (34 national and 12 international). She attended and presented research papers in 27 national and 02 international conferences. In 2006, Dr. Shakun Mishra represented three districts in Biodiversity Board Bhopal (M.P.). In her academic and research career she contributed her active participation in various activities and committees.

Presently, she is Fellow/Life Member of more than 08 national and international research societies such as Society of Life Sciences, Satna, (M.P.), Indian Hydrobiology, Chennai, Indian Association for Angiosperm Taxonomy, etc. She received some prestigious awards like Fellow of the Society of Ethenobotanists in 2013, FICCE award in 2004, Fellow of Society of Life Sciences award in 2004. She successfully completed one research project funded by University Grants Commission, India. The area of research of Dr. Shakun Mishra is Ethnobotany and Limnology. Presently she focused in the research area of Floristic diversity assessment of Angiosperms. For her academic contribution she received gold medal from former Lok Sabha Speaker Mr. Balram Jhakhad.



Mr. Rahul Dev Behera

Mr. Rahul Dev Behera completed B. Sc. And M. Sc. (Agriculture) with good academic record. He did his M. Sc. (Agriculture) in the year 2014 and presently doing his Ph. D. He has diverse experience in curricular and co-curricular sectors. He has experience of programme assistant in soil science at KVK Malkangiri. Mr. Behera is member of various societies and institutions like Indian institute of Soil Science, Asian journal of Soil Science, etc. He presented more than 20 research papers in various national and international conferences like Global Social Science Conference, Annual Convention of Indian Society of Soil Science, etc. He published more than 15 research publications in various reputed journals, books and other research monographs. He has good fluency in computer programming and soil science.



Dr. Sagar A. Vhanalakar

Dr. Sagar A. Vhanalakar is presently working as a Head, Department of Zoology, Shri. Mouni Vidyapeeth's Karmaveer Hire Arts, Science, Commerce and Education College, Gargoti, Tal – Bhudargad, Dist – Kolhapur, 416209 M.S., INDIA. He did his Ph. D. in the year 2010 from Shivaji University, Kolhapur (M.S.) India. Dr. Vhanalakar has 10 years of teaching experience and 09 years of research experience. The main area of his research is aquaculture and fisheries, limnology and biodiversity.

There are 35 research papers, 06 book chapters and two books on the name of Dr. Vhanalakar. He attended and presented research papers in more than 50 national and international research conferences. Presently he is working as a principal investigator of one research project funded by University Grants Commission, New Delhi.

He worked as an organizing secretary for one international, one National and 06 university level conferences and seminars. He is presently working as a managing editor for Bhumi Publication, Kolhapur, M.S., India.



Dr. Sharadrao A. Vanalakar

Dr. Sharadrao A. Vanalakar is presently working as a Head, Department of Physics, Shri. Mouni Vidyapeeth's Karmaveer Hire Arts, Science, Commerce and Education College, Gargoti, Tal – Bhudargad, Dist – Kolhapur, 416209 M.S., INDIA. He did his Ph. D. in the year 2010 from Shivaji University, Kolhapur (M.S.) India. He is post-doc fellow of Chonnam National University, Gwangju, South Korea. Dr. Vhanalakar has 15 years of teaching experience and 09 years of research experience.

The main area of his research is thin film solar cell. He is actively engaged in research. Dr. Sharadrao Vanalakar has published more than 100 research papers in various international journals having more than 400 citations and 'h' index is near to 16. He is awarded by prestigious 'Raman Post-Doc Research Fellowship in USA' by University Grants Commission, New Delhi in year 2016. He is recipient of 'Young Scientist Award' by Department of Science and Technology, Government of India in 2014. He is working as a principal investigator of one research project funded by Department of Science and Technology, Government of India.

PREFACE

We are delighted to publish about our book entitled "Water Research and Technology".

This book is the compilation of esteemed articles of acknowledged experts in the various fields of basic and applied science providing a sufficient depth of the subject to satisfy the need of a level which will be comprehensive and interesting. It is an assemblage of up to date information of rapid advances and developments taking place in the field of science. With its application oriented and interdisciplinary approach, we hope that the students, teachers, researchers, scientists and policy makers in India and abroad will find this book much more useful.

The articles in the book have been contributed by eminent scientists, academicians. Our special thanks and appreciation goes to experts and research workers whose contributions have enriched this book. We thank our publisher Bhumi Publishing, Nigave Khalasa for taking pains in bringing out the book.

Finally, we will always remain a debtor to all our well-wishers for their blessings, without which this book would not have come into existence.

- Editorial Team

Water Research and Technology

CONTENT

No.	Article and Author(s)
1	PHYSICO-CHEMICAL PROFILE IN RELATION OF FIVE PONDS AT KHANDWA (M.P.), INDIA Shakun Mishra
2	STUDIES ON ALGAL DIVERSITY, MORPHOMETRY OF PONDS AND NYGAARD'S TROPHIC STATE OF INDICES: IN RELATION OF FIVE PONDS AT KHANDWA (M.P.), INDIA Shakun Mishra and Deepika Mishra
3	A SENSING BEHAVIOR SYNERGISTIC LIQUID-LIQUID EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF NICKEL (II) BY USING 1-(2',4'-DINITRO AMINOPHENYL)-4,4,6-TRIMETHYL-1,4-DIHYDROPYRIMIDINE-2-THIOL: ANALYSIS OF FOUNDRY AND NICKEL ELECTROPLATING WASTE WATER Ganesh S. Kamble, Sunil S. Joshi, Mansing A. Anuse
4	PLANKTON COLLECTION, PRESERVATION AND MOUNTING WITH CASE STUDY OF COASTAL WATERS OF DIGHA, BAY OF BENGAL Saumya Dash, Rajesh Kumar Behera, Anupama Pati, Pradipta Kumar Mohapatra, R. K. Sarangi, Dipti Raut and Lipika Patnaik
5	SEA WATER NUTRIENT ANALYSIS METHODS Saumya Dash, Rajesh Kumar Behera, Anupama Pati, Pradipta Kumar Mohapatra, R. K. Sarangi, Dipti Raut and Lipika Patnaik
6	PHYSICO-CHEMICAL PARAMETERS OF RIVER SIANG IN ARUNACHAL PRADESH, INDIA Biplab Kumar Das
7	METHODS AND REASONS OF ADOPTIONS FOR VEGETABLE INNOVATION BY THE TRIBAL FARMERS OF KEONJHAR DISTRICT OF ODISHA Bibhu Santosh Behera, Anama Charan Behera and Rudra Ashish Behera

8	AN ENVIRONMENT FRIENDLY GREEN PROTOCOL FOR THE SYNTHESIS OF NOVEL COMPOUNDS IN AQUEOUS MEDIA WITH THEIR BIOLOGICAL EVALUATION	M. S. Kadam
9	PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER SAMPLES OF JHARIA COAL MINING REGION, DHANBAD, INDIA	B. P. Panigrahy and Prasoon Kumar Singh
10	WATER (H₂O) AT GLANCE	Rajaram Gundu Chougale
11	ASPECTS OF WATER POLLUTION: DATA ANALYSIS	Pratibha Sadashiv Desai
12	SEASONAL VARIATIONS IN PHYSICO- CHEMICAL CHARACTERISTICS OF MUDAL VILLAGE POND FROM BHUDARGAD TAHSIL, KOLHAPUR, (M.S.) INDIA	S. A. Vhanalakar
13	STUDY ON HYDROBIOLOGICAL PARAMETERS OF GODAVARI RIVER AT PAITHAN	D. R. Deshmukh
14	WATER QUALITY ASSESSMENT AND MONITORING	Ch. Vivek and M. Bhaskar
15	ORGANIC FARMING AND CONSERVATION OF RESERVOIRS IN M.P. STATE	Leena Murlidharan and Sanjay Wagode

**PHYSICO-CHEMICAL PROFILE IN RELATION OF FIVE PONDS
AT KHANDWA (M.P.), INDIA**

Shakun Mishra

Department of Botany, Govt. S. N. P. G. College, Khandwa (M.P.) INDIA

Corresponding author E-mail: dr.shakunmishra2012@gmail.com

ABSTRACT:

Khandwa has ponds like Nagchoon Talab, Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund, for a long time they supplied potable water to the residents. They are however not in use now-a-days. No work on their Limnological parameters has so far been reported, with increasing population and depleting sources of potable water their assessment has become a matter of great importance. So it has become highly imperative to conduct such investigation.

KEYWORDS: Limno; Physico-Chemical parameters; East Nimar.

INTRODUCTION:

Water is one of the most vital factors in the existence of living organisms. Water covers about 70% the earth of which more than 95%, exists in gigantic oceans. The term "Limnology" is derived from the Greek word, limne or limnos, meaning "pool, marsh or lake". Limnology is a very complex scientific subject and we owe its first definition (the oceanography of lakes) to Professor F.A. Forel (1892) who has been called the father of "Limnology". Now-a-days limnology is defined as the "science of inland waters," concerned with all the factors that influence living organism within those waters (Singh, H.R. 1989).

One feature that we may find in common in all the bodies of water is the presence of some algal growth in equilibrium with the physico-chemical characteristics. Freshwater system of India received due scientific attention rather late the pioneering works of Prasad (1972), Prescott (1968), Welch (1948), Chacko & Krishnamurthy (1954) and Krishnamurthy V. (1954) the milestones in the history of Indian Limnology. The distribution of the various aquatic organisms are affected by many factors such as temperature, transparency, concentration of oxygen, carbon-di-oxide, nutrients and other dissolved organic substances. The ponds can then be used for pisciculture and cultivation of plants of economic importance. The study of ponds will have a social significance also. Studies on freshwater ecosystem

were started by Gepp (1908). Later on Ghose (1920); Ganapati (1943); Chacko and Ganapathi (1949); Randhawa and Desikachary (1959); Jeejibai (1962); Sarma (1963); Zafar (1967); Verma (1969); Philipose (1969); Vidyavati (1983); Unni (1985); Ventakeshwarlu (1989) and many others contributed to it. Patil and Maratha (1982) reported the diurnal variations in the physico-chemical factors and plankton on the surface layers of three tropical freshwater fish tanks of Nagpur.

Recently Mahajan, S.K.(1987, 1990 a and 1991, 1995 a and b) had conducted in west Nimar, and Mahajan, S.K. and Mishra, S.,(1986, 1988a, 1988b, 1990a, 1990b, 1990c, 1990d, 1991a, 1991b, 1991c, 1993, 1994a, 1994b, 1994c, 2007, 2008) Mishra, S., *et al*(2005) and Mishra, S., (2004,2007a,b&c) had conducted investigation in East Nimar. Thus the literature review suggests that studies on M.P. freshwaters dates back to the later half of the last century and were in the nature of presenting species list and descriptions of taxa, new to then Madhya Pradesh. Attempts on the seasonality of freshwater plankton were made, followed by a long series of Hydrobiological studies of freshwater impoundments, mostly on ponds and reservoirs. However such studies at Khandwa are scanty, keeping this in mind the present study is designed to survey the impact of physico-chemical parameters on the phytoplankton, selecting five ponds, at Khandwa (M.P.).

STUDY AREA:

Khandwa, the district headquarter of East Nimar is a Junction of Central Railway. It has a very long history. Infact its name itself is supposed to originate from Khandwan, a forest mentioned in the epic Mahabharata. It has been a connection between North and South India. Its area is 10779 Km² and is situated at 21⁰, 05' to 22⁰, 25' N latitude and 75⁰, 57' to 77⁰, 33' E longitude and 304 m above MSL. Topographically it lies on the uplands between the Valleys of Narmada and Tapti flowing parallel to each other from East to West. The average annual rainfall is 736.8 mm. The climate is in general hot. The city itself has many ponds in all the directions with rich aquatic flora. The fresh water ecosystems are very important to urban men just like parks etc.

Khandwa district of M.P. has many natural and manmade impoundments. These are among the five ponds selected as a site for monitoring of limnological parameters. These ponds are present in and around Khandwa city, which situated on central railway, namely I. Nagchoon Talab, II. Doodh Talai, III. Singhad Talai, IV. Padam Kund and V. Rameshwar Kund. The better supply of potable water for the town of Khandwa had been a pressing question for years past and numerous schemes had been elaborated and discussed in the report given by Mr. C.S.R. Palmer, E.E. dated 28th may 1890. On 15th July 1890, by J.H. Glass, Esqr., Superintending E. Control provinces on Khandwa water works.

Nagchoon Talab:

Lakes as such in the District are none, but a few ponds exist of which one at Nagchoon situated at a distance of 6.4 Km. North-West of Khandwa city deserves mention. The talab covers an area of about 202.3 hectares (500 acres). This was formed by damming up a stream. Later on its catchments area was enlarged to nearly 23.3 sq. Km. (9 sq. miles) by the construction of a canal 6.4 sq. Km. (4 miles) long to Ajainti. It is one of the water supplying sources of the Khandwa town. The Nagchoon Talab established by R. Mitra E.E., agent of Khandwa Municipality, dated 18th July 1899, agreement with Rajputana Malva Railway company to supply water. The talab has a total surface area about 26,502,000 sq. ft. and a total capacity 275,205,000 in feet. The main source of water is natural. Large Ajainti nallah through which rain water is carried into talab, having one outlet naming small Ajainty nallah. The reservoir is primarily used for drinking purposes and others.

Doodh Talai:

Doodh Talai is situated western part of Khandwa city. Talai has a surface area of 140337 sq. fit. and a shore line of talai is irregular, interrupted at one side by road, colony and a half Km. wide area attached with it. Its basin is shallow with a slight slope. The talai is eutrophic and receives several effluents of domestic sewage. The maximum depth of water in the talai was near about 10 to 12 fit during monsoon (July-August) and minimum 3-5 fit in summer (May-June).

Singhad Talai:

The talai has a total surface area of about 27014 sq. fit. and a peripheral circumference is irregular and completely covered with grass. The main source of water is domestic sewage. Its basin is shallow with a slight slope. The talai is eutrophic and receives domestic, human and animal excreta and city debris. Long time ago, the Trapa (singhada) were harvested in Talai, so place known as Singhad Talai. Now-a-days it is free from macrovegetation. The maximum depth of water in the talai was near about 8 to 10 fit. during monsoon (July-August) and minimum 3-5 fit in summer (May-June). Saify Nagar and Shrinagar colonies are attached with Singhad Talai,

Padam Kund:

The Padam Kund under investigation is in colony Padam Nagar and Sanjay Nagar situated at western part of Khandwa city. The reservoir was constructed approximately 1800 years ago. The reservoir impounds an area of 96 sq. fit. and depth is 15x18 fit. The Kund used to bloom with Lotus flowers and hence it is named as Padam Kund. It is rectangular in shape and embodied with ancient lithics that are as old as Kund itself. It is rectangular in shape and maximum depth of water in the Kund

is 15 to 18 fit. and overflow during monsoon (July-August) and minimum 10-12 fit. in summer (May-June). The Kund is puccka and has straight embankment. Sources of water supply to the Kund are rains.

Rameshwar Kund:

Mr. Palmer, passes in review the several schemes which have from time to time been put forward for Khandwa, and comes to the conclusion that the Rameshwar gravitation scheme, which was first brought to notice in 1871 by Mr. A.R. Binnic, E.E.. Thus the Rameshwar gravitation scheme was projected by Mr. Binnic and Mr. Plaus and estimates were prepared by Mr. Hooper in 1874. The proposals were to construct a reservoir on the Rameshwar Nallah and to lead thence a 9" main to the clock tower. The tank was shown to be able to supply 8 gallons per head for 15,000 people and 2000 gallons per diem for the each of the two Railways, and to have a surplus of 3 million cubic feet. The Rameshwar Kund under investigation at the Rameshwar Nallah, bears many macrophytes at both side. The substratum of the spot is dominated by mud and gravel.

MATERIALS AND METHODS:

The water bodies in general appeared to be relatively similar for many biologist till recently. But with advent of limnology and environmental science, it is established that these water bodies manifest the most amazing physical, chemical and biological diversity. As proposed a survey of the local water bodies were conducted on a fixed duration of every month and different parameter were determined form 01.03.2014 to 28.02.2014. Periodic sampling was done at five sampling stations, naming 1.Nagchoon Talab 2.Doodh Talai 3.Singhad Talai 4.Padam Kund and 5.Rameshwar Kund. A Glass bottle sampler was used to take the water sample from the sampling stations for chemical analysis. The analysis of physico- chemical parameters were carried out by following standard methods as described by Welch (1952); APHA, (1955).

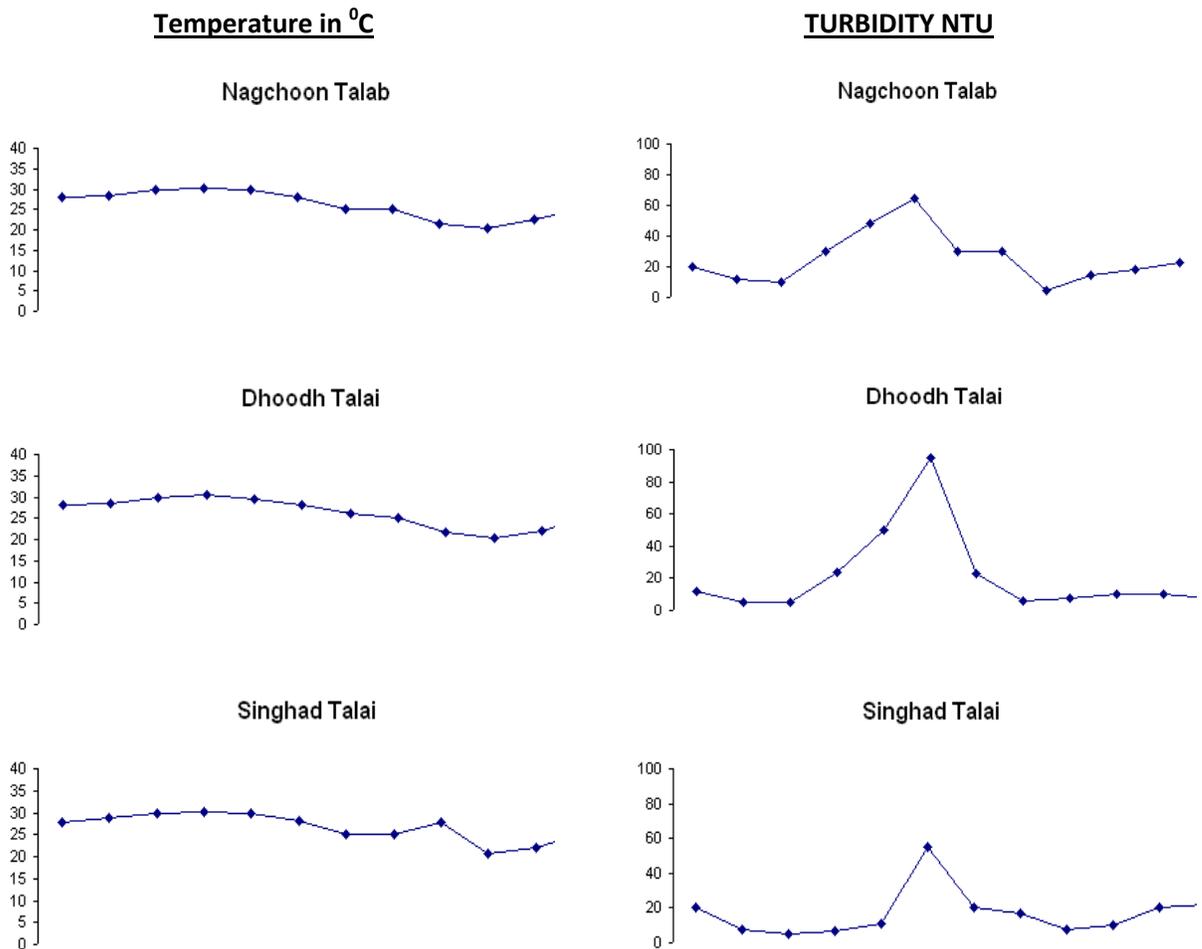
RESULTS AND DISCUSSION:

In the present investigation, characters accounting for the ponds diversity are studied, over a period of 12 months selecting five representative, permanent ponds and results are analyzed on the basis of earlier literature.

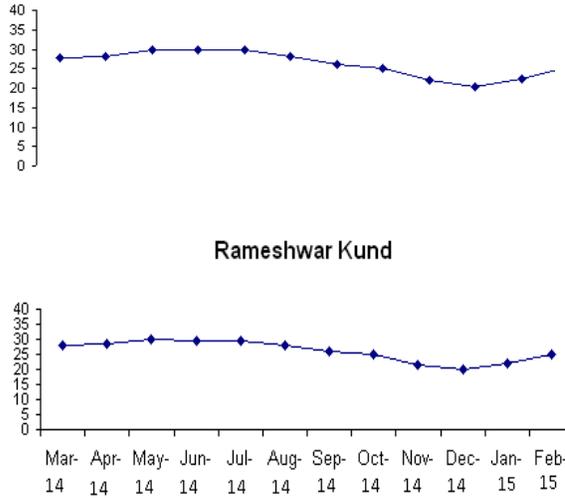


Figure 1: Map showing study area

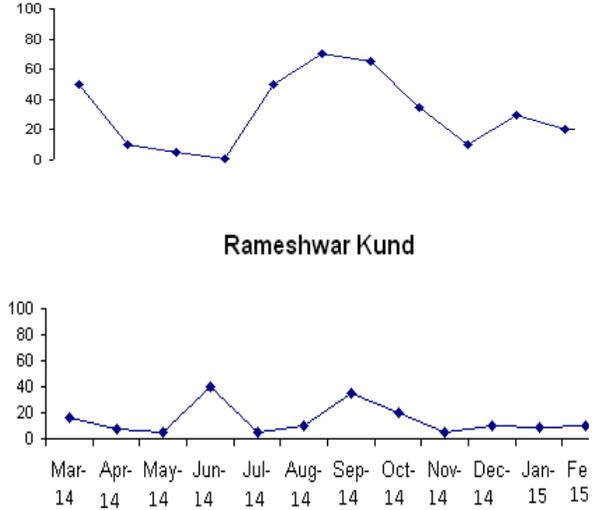
Graphs showing Seasonal variation of Physical Parameters during the year March 2014 to February 2015:



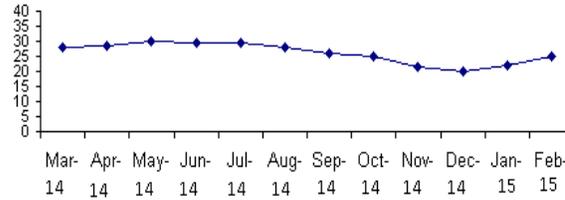
Padam Kund



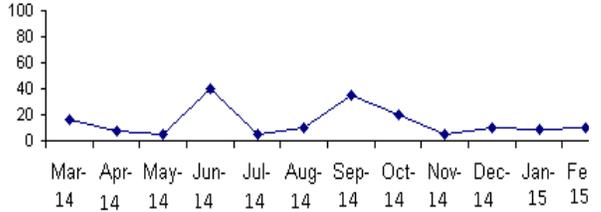
Padam Kund



Rameshwar Kund

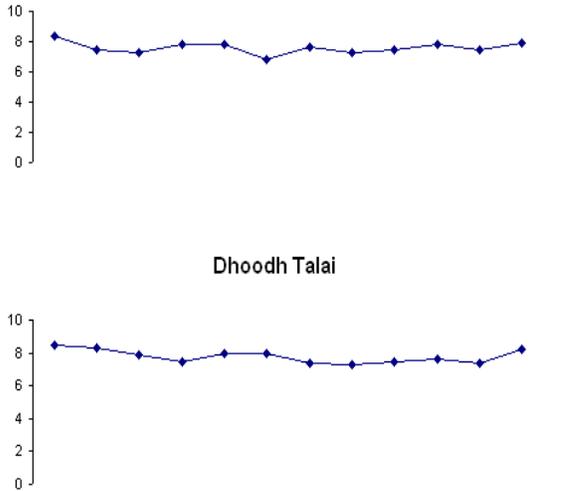


Rameshwar Kund

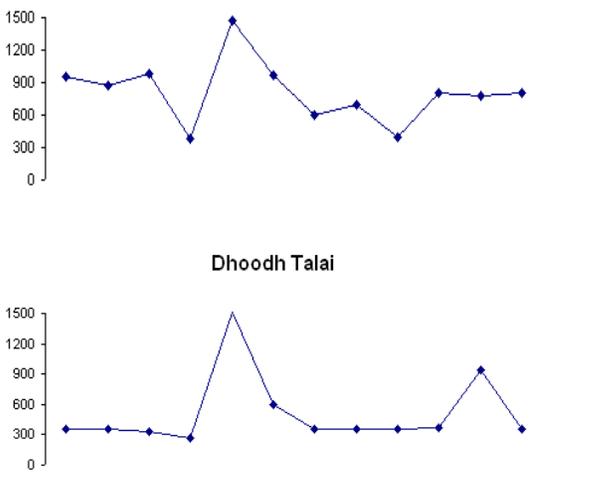


Hydrogen Ion Concentration

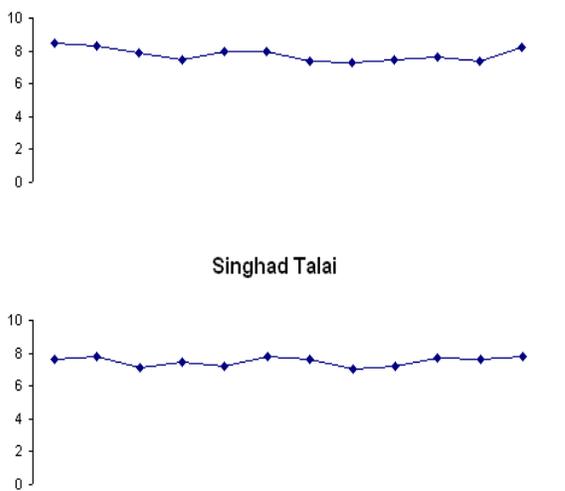
Nagchoon Talab



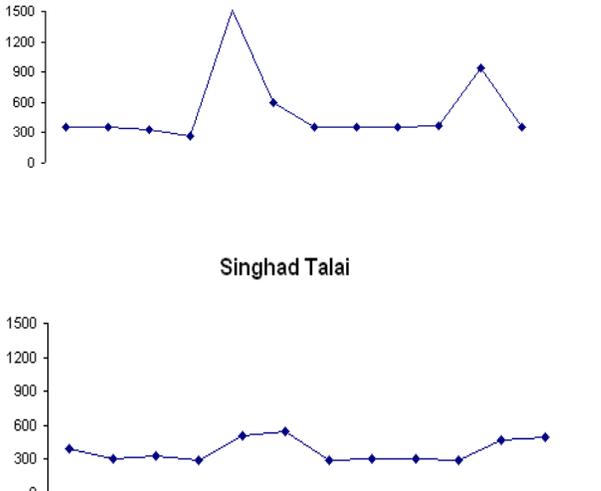
Nagchoon Talab



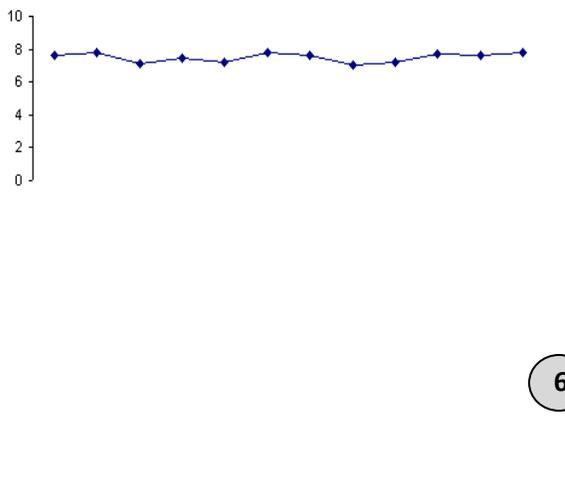
Dhoodh Talai



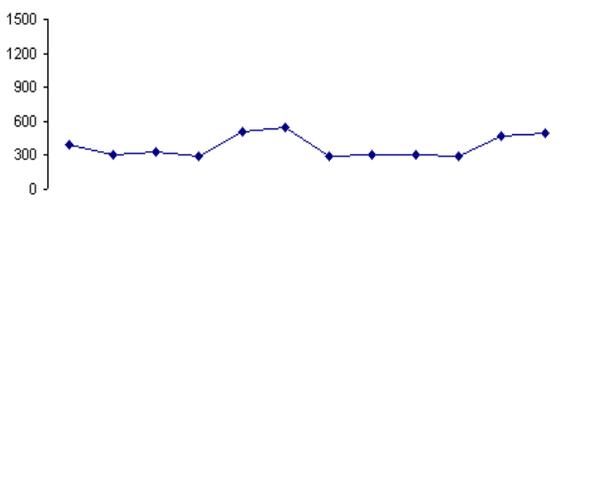
Dhoodh Talai

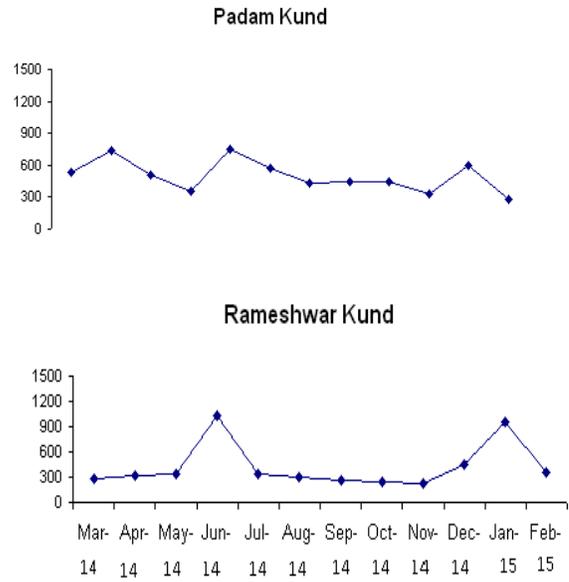
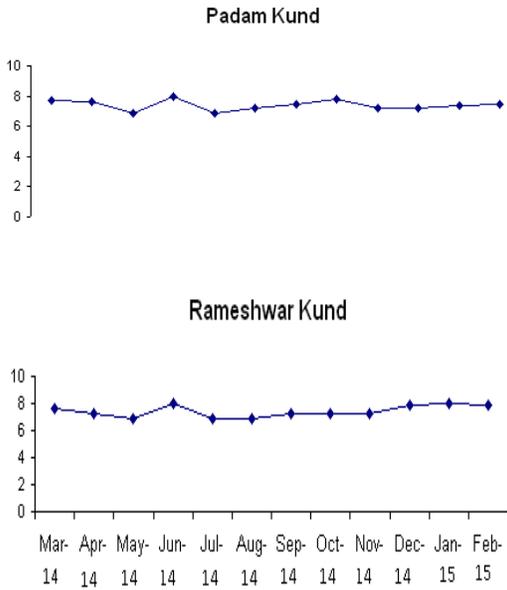


Singhad Talai



Singhad Talai

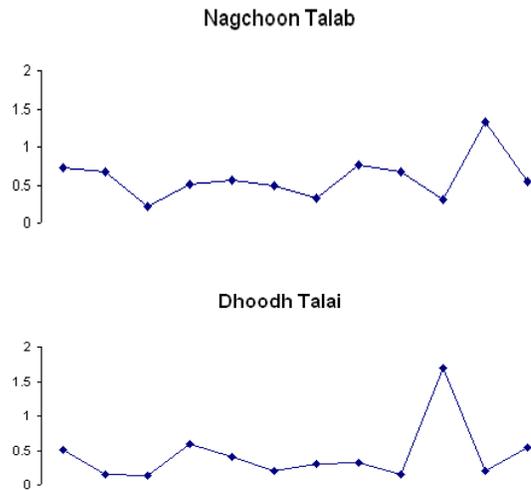
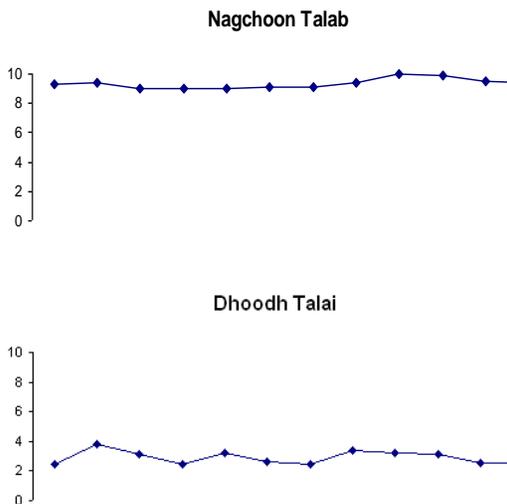




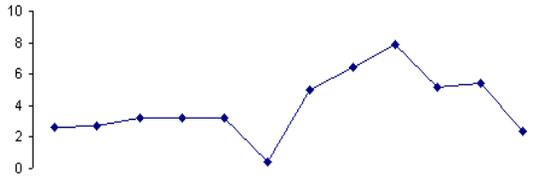
Graphs showing Seasonal variation of Chemical Parameters during the year March 2014 to February 2015:

Dissolved oxygen mg / lit

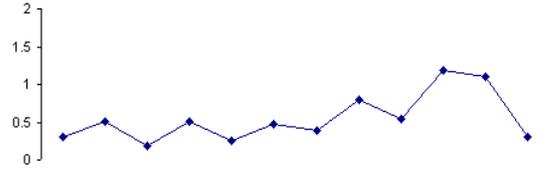
Free carbon - di - oxide mg / lit.



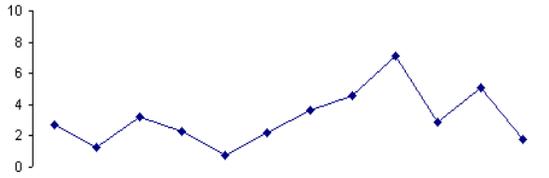
Singhad Talai



Singhad Talai



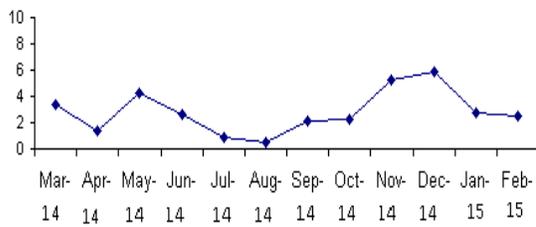
Padam Kund



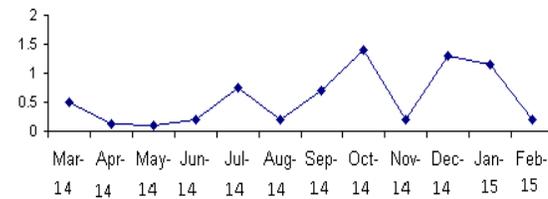
Padam Kund



Rameshwar Kund

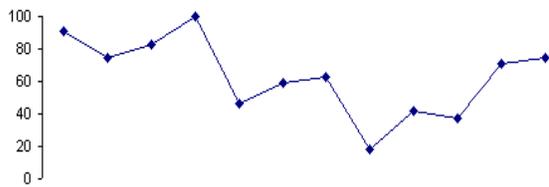


Rameshwar Kund



Total inorganic carbon mg / lit.

Nagchoon Talab



Nagchoon Talab



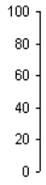
Dhoodh Talai



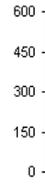
Dhoodh Talai



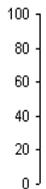
Singhad Talai



Singhad Talai



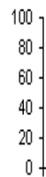
Padam Kund



Padam Kund



Rameshwar Kund



Rameshwar Kund



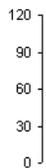
Mar-14 Apr-14 May-14 Jun-14 Jul-14 Aug-14 Sep-14 Oct-14 Nov-14 Dec-14 Jan-15 Feb-15

Mar-14 Apr-14 May-14 Jun-14 Jul-14 Aug-14 Sep-14 Oct-14 Nov-14 Dec-14 Jan-15 Feb-15

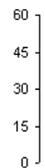
Calcium mg / lit.

Magnesium mg/lit.

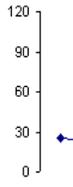
Nagchoon Talab



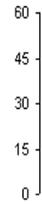
Nagchoon Talab



Dhoodh Talai



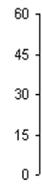
Dhoodh Talai



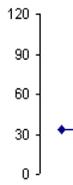
Singhad Talai



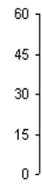
Singhad Talai



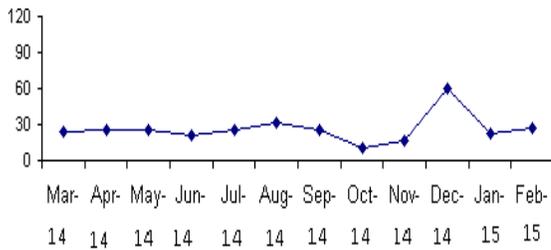
Padam Kund



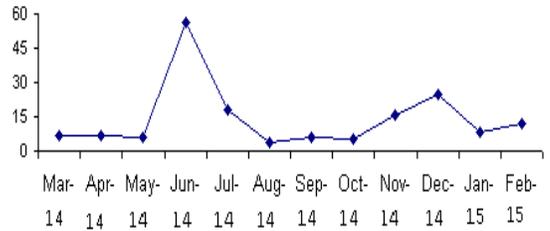
Padam Kund



Rameshwar Kund

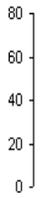


Rameshwar Kund

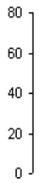


Sodium mg / lit.

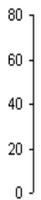
Nagchoon Talab



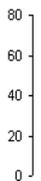
Dhoodh Talai



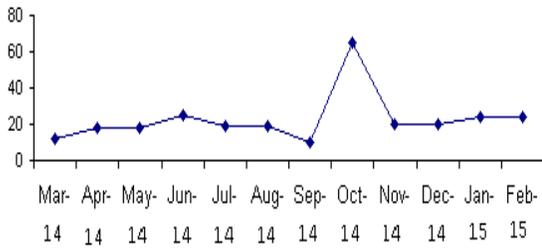
Singhad Talai



Padam Kund



Rameshwar Kund

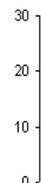


Potassium mg / lit.

Nagchoon Talab



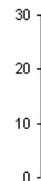
Dhoodh Talai



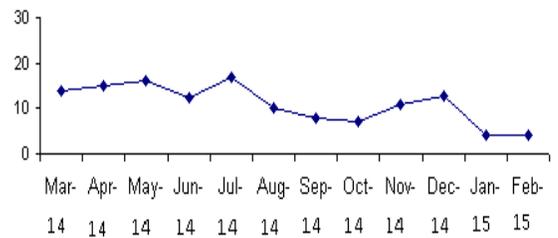
Singhad Talai



Padam Kund

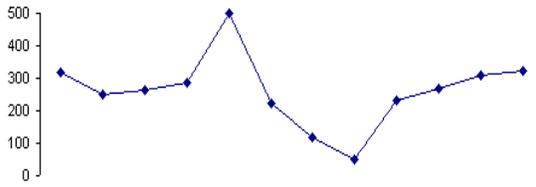


Rameshwar Kund



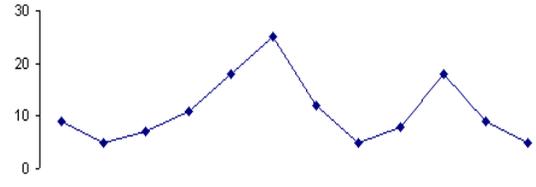
Total hardness mg / lit.

Nagchoon Talab

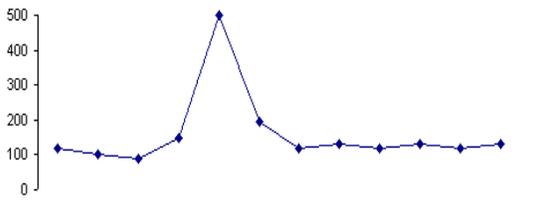


Nitrate mg / lit.

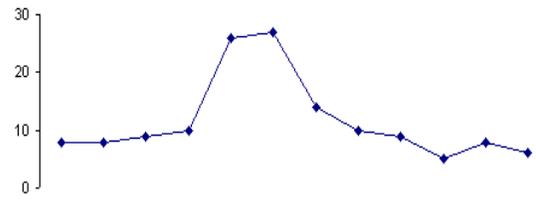
Nagchoon Talab



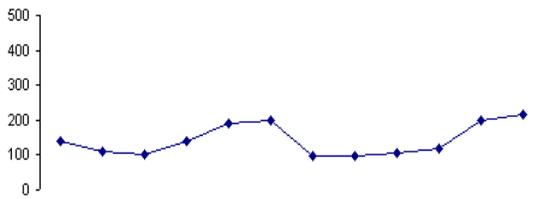
Dhoodh Talai



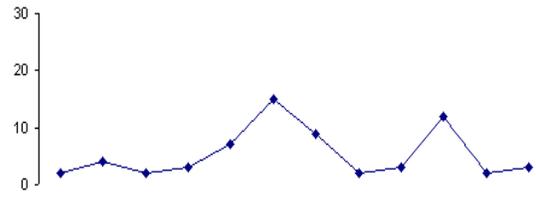
Dhoodh Talai



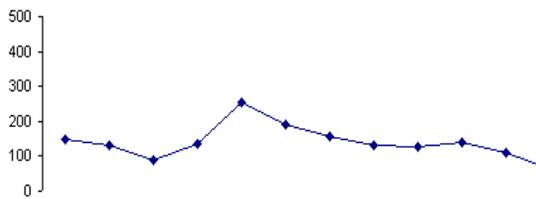
Singhad Talai



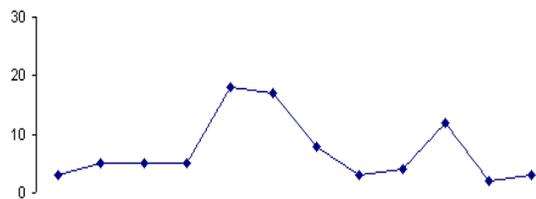
Singhad Talai



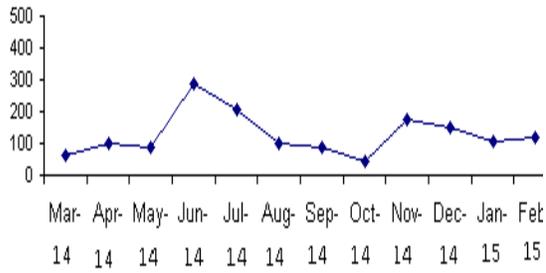
Padam Kund



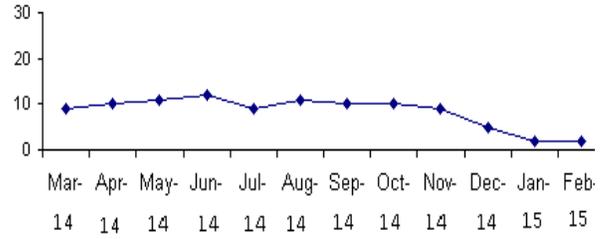
Padam Kund



Rameshwar Kund

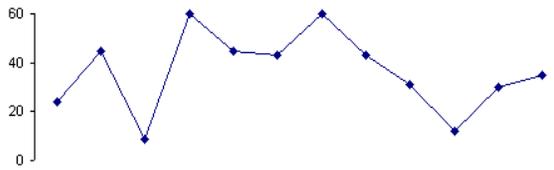


Rameshwar Kund



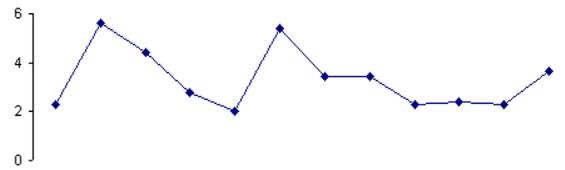
Sulphate mg / lit.

Nagchoon Talab

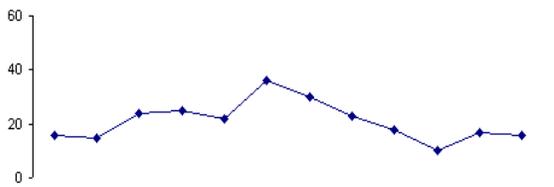


Silicate mg / lit.

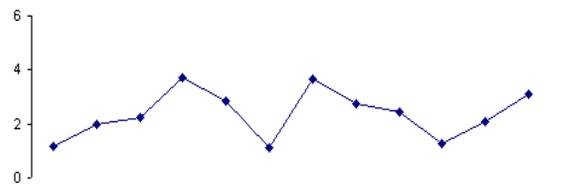
Nagchoon Talab



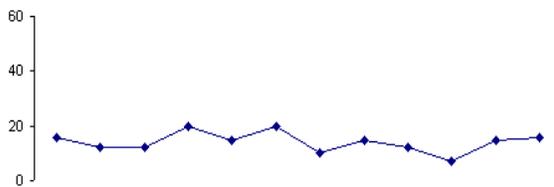
Dhoodh Talai



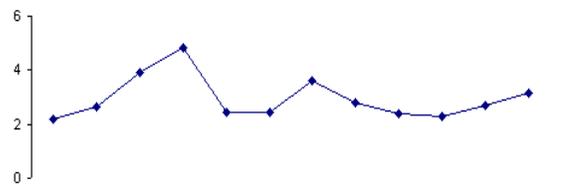
Dhoodh Talai

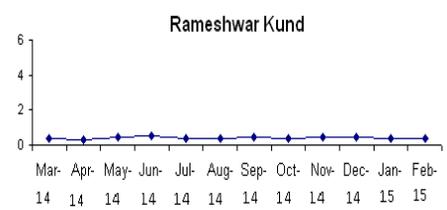
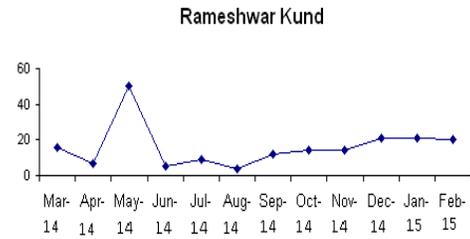
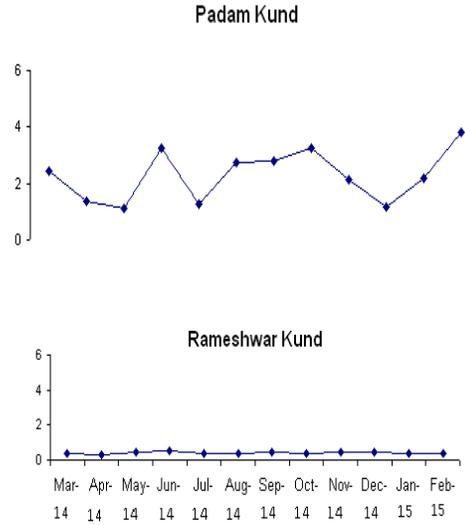
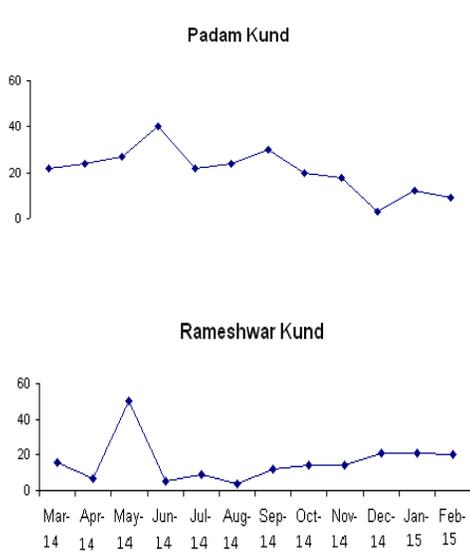


Singhad Talai



Singhad Talai





Chloride mg / lit.

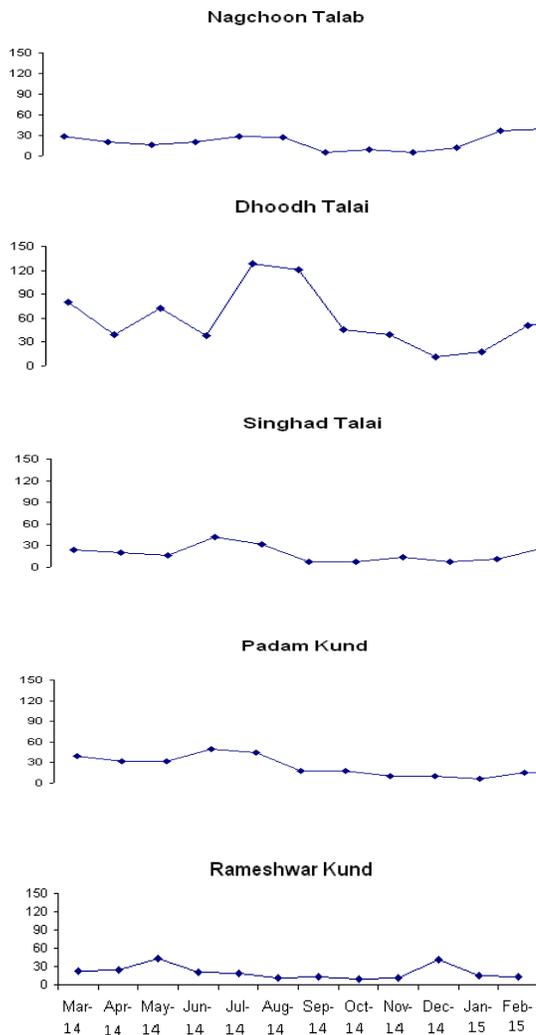


Table 2: Physicochemical Properties of Water collected from five sites during March 2014 to February 2015

Sr. No.	Parameters	Nagchoon Talab	Doodh Talai	Singhad Talai	Padam Kund	Rameshwar Kund
1.	Temperature(⁰ C)	25.2 _± 5	25.45 _± 4.95	25.40 _± 4.8	25.2 _± 4.7	25.15 _± 4.65
2.	PH	7.58 _± 0.74	7.9 _± 0.6	7.31 _± 0.49	7.44 _± 0.6	7.45 _± 0.55
3.	Turbidity(NTU)	35 _± 30	50 _± 45	30 _± 25	35.5 _± 34.5	22.5 _± 17.5
4.	Electrical Conduct. Micromho	Min. Max. 383-1468	Min. Max. 266-1518	Min. Max. 287-545	Min. Max. 275-745	Min. Max. 220-1027
5.	Dissolved Oxygen mgL ⁻¹	9.49 _± 0.47	2.91 _± 0.44	4.16 _± 3.73	3.91 _± 3.18	3.21 _± 2.7
6.	Free Carbon-di-oxide mgL ⁻¹	0.77 _± 0.56	0.92 _± 0.78	0.69 _± 0.5	0.89 _± 0.78	0.70 _± 0.59
7.	Total Inorganic carbon	59.05 _± 40.75	63.4 _± 35	47 _± 16	42 _± 18	31.75 _± 13.45
8.	Alkalinity mgL ⁻¹	156 _± 44	304.5 _± 154	159.5 _± 40.5	169 _± 31	124 _± 56
9.	Calcium mgL ⁻¹	72 _± 48	36.5 _± 18.5	33.5 _± 8.5	33 _± 17	35.5 _± 24.5
10.	Magnesium MgL ⁻¹	30.5 _± 17.5	17 _± 9	17.5 _± 12.5	26.5 _± 21.5	30 _± 26
11.	Sodium mgL ⁻¹	18.5 _± 6.5	48 _± 32	21.5 _± 6.5	24.75 _± 18.25	37.5 _± 27.5
12.	Potassium mgL ⁻¹	19 _± 13	6.5 _± 3.5	3.5 _± 1.5	15.25 _± 10.75	6.5 _± 3.5
13.	Total hardness mgL ⁻¹	275 _± 225	294 _± 206	156 _± 58	159.5 _± 95.5	167.5 _± 122.5
14.	Nitrate mgL ⁻¹	8.5 _± 6.5	16.5 _± 10.5	15 _± 10	10 _± 8	7 _± 5
15.	Sulphate mgL ⁻¹	13.5 _± 6.5	23 _± 13	34.5 _± 25.5	21.5 _± 18.5	27 _± 23
16.	Silicate mgL ⁻¹	3.81 _± 1.81	3.83 _± 1.8	3.5 _± 1.33	2.48 _± 1.34	0.39 _± 0.11
17.	Chloride mgL ⁻¹	22.5 _± 7.50	70.0 _± 58.0	25 _± 17	28 _± 22	27 _± 17

DISCUSSION:**PHYSICAL PARAMETERS:****Temperature:**

In present investigation, water temperature fluctuated between 20.1°C to 30.2°C at the site of Nagchoon. The minimum temperature was recorded during the month December 2014 at all the sampling sites. The maximum temperature was recorded during the month April and May 2014 at all sites. A direct relationship between temperature and inorganic carbon, total hardness, free carbon-dioxide, pH, chloride, calcium, magnesium, total dissolved solids, alkalinity, sodium and inverse relationship with dissolved oxygen in all the 5 ponds, with nitrate in pond III and pond V, with silicate in pond II, and V, with sulphate in pond III and pond V with potassium in pond II and pond III was observed. Studies on the effect of temperature on various physico-chemical as well as biological activities have been studied.

Turbidity:

Turbidity in water is caused by the substances which are not present in the form of true solution. In the study, turbidity values ranged between 5 NTU and 95 NTU in Doodh Talai, 5 NTU and 55 NTU in Singhad Talai, 1 NTU 70 NTU in Padam Kund, 5 NTU and 40 NTU in Nagchoon Talab and 5 NTU and 65 NTU in Rameshwar Kund. High turbidity makes the water unfit for domestic purposes, proper growth of aquatic organisms and many other uses. Turbidity shows seasonal variation, thus in the present study, turbidity was high during spring season (July, August and September 2014). Low in summer and winter seasons. Thus higher turbidity values were recorded in Doodh Talai and lower value in Nagchoon Talab. Present work reveals that turbidity is negatively correlated to dissolved oxygen as observed in Padam Kund and Rameshwar Kund in month of July 2014 and August 2015.

pH (Hydrogen Ion Concentration):

In general the ponds under study showed alkaline pH, however there was a fluctuation during certain months thus the pH range was from 6.85 to 8.32 in Nagchoon Talab 6.82 to 8.03 in Singhad Talai 6.85 to 8.04 in Padam Kund, 6.9 to 8.05 in Rameshwar Kund and 7.3 to 8.5 in Doodh Talai. Verma and Shukla (1970), believed that pH would prove to be an ecological factor of prime importance in controlling the activities and in the distribution of aquatic flora and fauna. In the present study the pH value decreased slightly during monsoon period. Occurrence of large number of Cyanophyta is attributed to alkaline pH (Philipose 1959). High pH also favoured the distribution of Cyanophyta (Prescott 1948; Rao 1955); Adoni (1975), observed changes in pH during different seasons. The present studies are indicative of the fact that the wastes released in ponds to make the water more alkaline.

In the present study, Doodh Talai showed fairly high pH along with their higher values for other parameters like bicarbonates, chloride and calcium. Doodh Talai is one of the storage of domestic sewage and rainy water. The pH of water was reported to be always on alkaline side and showed high range of fluctuation. Anacystis, Anabaena and Staurostrum showed significant positive correlation with total radiation and air temperatures. Gloeocapsa, Tetradron, Nitzschia depicted positive correlation with chlorides, orthrophosphates and negative correlation with dissolved oxygen content, members like Melosira and Synedra did not show any significant relationship with other physicochemical parameters (Adoni and Vaishya 1990). Fritsch has mentioned this to be characteristic of all tropical waters. Cyanophycean abundance coincided with absence of nitrates and they are capable of growing in minimal quantities of nitrates and phosphates (Pearsall 1924)

A direct correlation between pH, bicarbonates, chloride, calcium, was also reported (Y.Singh 1979). Thus in the present study, all ponds showed fairly high pH along with higher values for other parameters like bicarbonates, calcium and chlorides. In the present study, total phytoplankton in all the sampling ponds were found to be more during summer months when the pH was also fairly high.

Electrical Conductivity:

The conductivity of distilled water ranges from 1 to 5 μ mho. The conductivity values of the sampling ponds ranges from 383 μ mho (June 2014) to 1468 μ mho (July 2014) in Nagchoon Talab, 287 μ mho (June 2014) to 510 μ mho (Feb. 2015) in Singhad Talai, 535 μ mho (March 2014) to 275 μ mho (Feb. 2015) in Padam Kund, 360 μ mho (March 2014) to 355 μ mho (Feb.2015) in Doodh Talai, 290 μ mho (March 2014) to 1027 μ mho (June. 2014) in Rameshwar Kund.

CHEMICAL PARAMETERS

Dissolved Oxygen:

Dissolved oxygen is one of the most important parameters in the assessment of water quality. It is essential for the metabolism of all aerobic aquatic organisms. Dissolved Oxygen also affects the solubility and availability of many nutrients and therefore productivity of aquatic ecosystem (Wetzel, 1983). Non polluted surface water remain normally saturated with dissolved oxygen. The oxygen balance in the water becomes poorer as the input of oxygen at the surface and the photosynthetic activity decreases and as the metabolic performance of the heterotrophic organisms becomes greater. Higher temperature during summer months, resulted in low level of DO , due to low temperature during winter and monsoon months resulted in higher level of DO. The present study reveals that the concentration rapidly declines in polluted water. The normal value of 9.49 ± 0.47 mg/l in Nagchoon

Talab-non polluted; reduced to 4.16 ± 3.73 mg/l in Singhad Talai-polluted site; further depleted to 3.9 ± 3.18 mg/l in Padam Kund; 3.21 ± 2.7 mg/l in Rameshwar Kund and 2.91 ± 0.44 mg/l in Doodh Talai (Polluted site). The present investigations also indicates variations in DO concentration at the different sampling stations and was found to decline in the water which contained the effluents.

Maximum dissolved oxygen content was recorded in the month of November 2014, in Nagchoon Talab, 9.96 mg/l and in Padam Kund, 7.069 mg/l and in Rameshwar Kund, 5.19 mg/l and in the month of October, in Doodh Talai, 3.35 mg/l, and Singhad Talai, 6.43 mg/l, respectively. So all the five ponds showed the maximum dissolved oxygen during the rainy period, in the winter season which may be attributed to the phenomenon of reoxygenation of water in monsoon period due to circulation and mixing by inflow of water after monsoon rains. Dissolved oxygen content showed minimum value in Nagchoon Talab, 9.02 mg/l during May and June 2014, whereas Doodh Talai, 2.47 mg/l Singhad Talai, 2.5 mg/l during February 2014; Padam Kund, 0.73 mg/l during July 2014; Rameshwar Kund, 0.52 mg/l, during June 2014. Even through the minimum values of dissolved oxygen were recorded during February 2014 to July 2014. It also shows a negative correlation with carbon-di-oxide, inorganic carbon, total hardness and other ions. The inverse relationship of dissolved oxygen with carbon-di-oxide was also reported by Zafar (1964) and Munawar (1970). This present result was in conformity with Kumar and Singh (2000). Nutrient salts like nitrate, calcium, magnesium attained its maximum values during the rainy months due to inflow of rain water and its minimum value was observed during summer months, showing negative correlation with phytoplankton population. This is in conformity with results of Singh (1993); Mishra and Yadav (1978).

Free Carbon dioxide:

Atmosphere, ground water, decomposition of organic matter, respiration of biota are the main sources of free-carbon-di-oxide in aquatic ecosystem. Minimum values of Carbon dioxide were recorded during May 2014 in Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund and during June 2014 in Nagchoon Talab. This may be attributed to the fact that respiration of aquatic organism is also decreased by increased light and temperature during summer months, resulting in decreased carbon-di-oxide level. Present study also shows minimum level in the months of May in all sites. Carbon-di-oxide was maximum in winter season and minimum in rainy season (Adony and Vaishya, 1990). Arvind Kumar 1996; reported that free carbon-di-oxide was maximum in monsoon months and minimum in the month of May which was attributed to the decomposition of organic matter in the pond.

Table indicates the free carbon-di-oxide values of pond water samples which range from 0.21 mg/l (May 14) to 1.33 mg/l (January 15) in Nagchoon Talab ; 0.14 mg/l (May 14) to 1.7 mg/l (December

15) in Doodh Talai ; 0.19 mg/l (May 14) to 1.19 mg/l (December 15) in Singhad Talai; 0.12 mg/l (May 14) to 1.67 mg/l (December 15) in Padam Kund and 0.11 mg/l (May 14) to 1.41 mg/l (October 15) in Rameshwar Kund.

Total Inorganic Carbon:

Inorganic Carbon is a major nutrient in photosynthetic metabolism. In the present study total Inorganic Carbon showed no seasonal variation. The total Inorganic Carbon varied from 37.5 mg/l (December 2014) to 98.4 mg/l (June 2014) in Doodh Talai, 31 mg/l (September 2014) to 63 mg/l (August 2014) in Singhad Talai, 28.0 mg/l (March 2014) to 60 mg/l (August 2014) in Padam Kund, 24mg/l (March 2014) to 30mg/l (Feb. 2015) in Rameshwar Kund and 18.36mg/l (Oct.2014) to 46.8mg/l (July 2014) in Nagchoon Talab. Statistical data exhibits a significant positive correlation of inorganic carbon with total hardness and calcium in Nagchoon Talab and Doodh Talai; with free carbon-di-oxide alkalinity, magnesium and total hardness in all of five water reservoir; with nitrate and sulphate in Nagchoon Talab and Doodh Talai; and a significant negative correlation with free carbon-di-oxide in all five sites.

Alkalinity:

During the course of observation, there was increase in alkalinity in June 2014 and July 2014 and decrease from January 2015 and February 2015, again up to December 2014, there was a decline trend. The alkalinity was found to be comparatively low during winter season in all ponds, except Rameshwar Kund (68 mg/l, 91 mg/l, 120 mg/l, 132 mg/l, 138 mg/l,) and high during summer seasons (180 mg/l, 238 mg/l, 332 mg/l, 374 mg/l, 458 mg/l,). Alkalinity revealed a direct correlation with temperature, inorganic carbon, total hardness, chloride, calcium, magnesium, nitrate, potassium and sulphate and negative correlation with rainfall, carbon-di-oxide, DO and silicate, represented in Graphs. The present study also infers that the BOD values at site Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund, which receive the wastes, show a rise in the BOD values and can be used as an indicator for investigating the pollution load of water. The value of 2.43 ± 0.14 mg/l at Nagchoon Talab; 3.9 ± 0.35 mg/l at Rameshwar Kund; 3.95 ± 0.37 mg/l; at Singhad Talai; 4.00 ± 0.32 mg/l at Padam Kund with a further enhancement at site Doodh Talai (5.23 ± 0.34 mg/l).

Calcium:

Calcium is one of the most abundant elements in the natural waters. Disposal of sewage and other wastes are important sources of calcium. Concentration of calcium is reduced at higher pH due to its precipitation as calcium carbonate (Trivedy and Goel; 1986). Large amounts of calcium are generally precipitated photosynthetically and phosphorus is also co- precipitated.

Calcium contents of the water sample at different sampling stations are presented in Table. In the present study the values of calcium were ranging from 24 mg/l (June 14) to 120 mg/l (July 14) in Nagchoon Talab; 18 mg/l (May-June 14) and 55 mg/l (August 14) in Doodh Talai ; 25 mg/l (November 14) to 34 mg/l (March 14) in Singhad Talai; 16 mg/l(December 14) and 50 mg/l (July 14) in Padam Kund ; 11 mg/l (October 14) and 60 mg/l (December 14) in Rameshwar Kund. Main water reservoir of Nagchoon is free from phytoplankton and with few macrophytes. Higher values of calcium were recorded during winter season and lower values during summer months by Adony and Vaishya (1990).

Magnesium:

Magnesium also occurs in all kinds of natural water with calcium, but its concentration remains generally lower than calcium. The concentration of magnesium also depends upon the present of sodium. Magnesium contents of water sample at different sampling stations are recorded and tabulated and range was found to be from 10 mg/l (November 14) to 50 mg/l (February 14) in Nagchoon Talab ; 8 mg/l (October 14) to 26 mg/l (June 14) in Doodh Talai; 5 mg/l (May 14) to 32 mg/l (February 14) in Singhad Talai; 5 mg/l (April 14) to 33 mg/l (July 14) ; Padam Kund and 4 mg/l (August 14) to 56 mg/l (June 14) in Rameshwar Kund. Most probably the data that the magnesium level was high during summer months. These values show that magnesium is not the determining factor for population of phytoplankton, other factors also act together.

Sodium:

Sodium content of sampling ponds is tabulated. The sodium content ranged from 15 mg/l (November 14) to 28 mg/l (August 14) in Nagchoon Talab ; 16 mg/l (November 14) to 80 mg/l (August 14) in Doodh Talai ; 12 mg/l (November 14) to 25 mg/l (February 14) in Singhad Talai ; 10 mg/l (November 14) to 43 mg/l (August 14) in Padam Kund and 10 mg/l (September 14) to 65 mg/l (October 14) in Rameshwar Kund. Maximum growth of several blue green algae was found at 40 mg/l of sodium level (Wetzel, 1966). Present study also support their observation as higher levels of sodium support the growth of blue green algae.

Potassium:

The observed values were tabulated. The values of potassium content ranged from 6.0 mg/l (December 14) to 32 mg/l (August 14) in Nagchoon Talab; 2.5 mg/l (February 14) to 10 mg/l (August 14) in Doodh Talai; 2 mg/l (December 14) to 5 mg/l (July 14) in Singhad Talai; 4.5 mg/l (December 14) to 26 mg/l (July 14) in Padam Kund and 4 mg/l (February 14) to 17 mg/l (July 14) in Rameshwar Kund. In the present investigation during months of lower concentration of potassium, higher total phytoplanktons were observed than during months of high potassium content.

Total Hardness:

Principal cations imparting hardness are calcium and magnesium. The anion responsible for hardness may be mainly bicarbonate, carbonate, sulphate, chloride, nitrate and silicate. The values obtained for total hardness at different sampling ponds are tabulated. The values ranged between 50 mg/l (October 14) and 500 mg/l (July 14) in Nagchoon Talab ; 88 mg/l (May 14) and 500 mg/l (July 14) in Doodh Talai ; 98 mg/l (October 14) and 214 mg/l (February 14) in Singhad Talai ; 64 mg/l (February 14) and 190 mg/l (August 14) and 45 mg/l (October 14) to 290 mg/l (June 14) in Rameshwar Kund.

Nitrate:

Nitrate content of the water samples at different sampling ponds are presented in table. The recorded range of nitrate content is between 5 mg/l (February, April and October 14) to 25 mg/l (August 14) in Nagchoon Talab; 5 mg/l (December 14) to 27 mg/l (August 14) in Doodh Talai; 2 mg/l (March and October 14) to 15 mg/l (August 14) in Singhad Talai; 2 mg/l (February 14 and January 15) to 18 mg/l (July 14) Padam Kund and 2 mg/l (February 14 and January 15) to 12 mg/l (June 14) in Rameshwar Kund. Nitrate showed direct relation with temperature, alkalinity, pH, DO and phytoplankton density (Adony and Vaishya, 1990). Present study showed a positive relation with rains in all water reservoirs.

Sulphate:

Sulphate content of water samples collected at different sampling sites are given in table. The Sulphate content varied from 9 mg/l (May 14) to 60 mg/l (September 14) in Nagchoon Talab ; 10 mg/l (December 14) to 36 mg/l (August 14) in Doodh Talai; 7 mg/l (December 14) to 20 mg/l (June and August 14) in Singhad Talai; 3 mg/l (December 14) to 40 mg/l (June 14) in Padam Kund; and 4 mg/l (August 14) to 50 mg/l (May 14) in Rameshwar Kund.

Silicate:

Silicate is naturally occurring content. It is found in lower concentration. It is due to domestic waste. Mostly low concentration of silicate was observed during January and March 14 in all ponds. Silicate content of the sampling ponds ranged between 2.01 mg/l (July 14) to 5.62mg/l (April 14) in Nagchoon Talab; 1.14 mg/l (August 14) to 3.73 mg/l (June 14) in Doodh Talai; 2.18 mg/l (March 14) to 4.83 mg/l (June 14) in Singhad Talai ; 1.14 mg/l (May 14) to 3.82 mg/l (February 14) in Padam Kund and 0.29 mg/l (April 14) to 0.50 mg/l (June 14) in Rameshwar Kund. Maximum range occurs in month of May and June 2014 in all ponds. Due to death and decay of phytoplankton and macrophytes in front of Nagchoon Talab, silicates are increased. Nutrients such as silicate, nitrate and phosphates are necessary for the growth of phytoplankton. Doodh Talai, Singhad Talai and Padam Kund are also showed optimum value of silicates for growth of phytoplankton.

Chloride:

Chloride shows a positive correlation with total phytoplankton, Chlorophyta and Cyanophyta in Doodh Talai, Singhad Talai Padam Kund, Nagchoon Talab and Rameshwar Kund, respectively. The minimum and maximum values of chloride were recorded as 6 mg/l (September and November 14) to 38 mg/l (February 14) in Nagchoon Talab; 12 mg/l (November 14) to 128 mg/l (July 14) in Doodh Talai; 8 mg/l (August, September and November 14) to 42 mg/l (June 14) in Singhad Talai; 10 mg/l (October and November 14) to 50 mg/l (June 14) in Padam Kund and 10 mg/l (October 14) to 44 mg/l (May 14) in Rameshwar Kund.

CONCLUSION:

- Generally the water temperature exhibited variation in the sampling sites (Table-II) and it ranged from 20.2^oC to 30.2^oC in Nagchoon Talab, from 20.5^oC to 30.4^oC in Doodh Talai, from 20.6^oC to 30.2^oC in Singhad Talai, from 20.5^oC to 29.9^oC in Padam Kund and from 20.2 to 29.8^oC in Rameshwar Kund. The blue green algae as a group, generally much more tolerant to higher temperature, than other algal groups, during present study pH of five sites of water reservoir ranges from 6.82 to 8.5 under natural condition. However, the blue green algae are tolerant of high organic matter (Krishnamurthy, 1981).
- This is found to be true with Doodh Talai and Singhad Talai. In the present study the pH values slightly decreased during monsoon period. Besides, direct correlation was found between pH and temperature, inorganic carbon, total hardness, carbon-di-oxide, calcium, magnesium, silicate, alkalinity, potassium and an inverse correlation with nitrate, sodium and sulphate in Nagchoon Talab; a positive correlation with temperature, silicate, alkalinity nitrate, sodium, total hardness and comparatively negative correlation with the other parameters in Doodh Talai; a positive correlation between pH and temperature, total hardness, dissolved oxygen, silicate, alkalinity, sodium and a negative correlation with the other factors in Singhad Talai; a positive correlation with temperature, carbon-di-oxide, magnesium, nitrate, silicate, alkalinity, sulphate and a negative correlation with remaining parameters in Padam Kund; a positive correlation with temperature, total hardness, calcium, magnesium, sodium, sulphate and a negative correlation with other parameters in Rameshwar Kund.
- Total Cyanobacterial forms shows positive correlation with total hardness in all ponds except Nagchoon Talab.

- Eutrophic polluted ponds support luxuriant growth of blue green algae particularly in summer and the occurrence of *Microcystis* bloom in the pond are used as bioindicators of pond ecosystem dynamics.
- Algal species occurring at high concentration so as to discolor the water or produce potent toxins included 'taxonomic groups' comprising-dinoflagellates (Plumley, 1997; Baden *et. al.*, 1998), other flagellates and Cyanophytes.
- The driving forces and mechanism of changes are related to variation in the physical, chemical and biotic environment and to the many possibilities brought about by their mutual interactions, which together affect to growth of hydrophytes and phytoplankton. Through physico-chemical analysis of water and vegetation, strategies and research plan are needed for a better understand, use a protection of ecologically sensitive water ecosystems.
- This region has so far been unexplored from the Limnological point of view. This study will be a step towards greater exploration of the water bodies of the region, leading to many significant findings.
- The present work affords good scope for future limnologists as experimental limnology holds the key to determine water quality, than observational limnology.

ACKNOWLEDGEMENT:

The author is thankful to UGC for providing financial assistance for present work.

REFERENCES:

1. Adoni, A.D. and Vaishya, A.K. (1990); Perspectives in Phycology Ed.: P.171-176
2. APHA, (1985); Standard Methods for the Examination of water and wastes, Washington.
3. APHA, (1989); Standard Methods for the Examination of water and wastewater. 17th ed. American Public Health Association, Washington D.C.
4. Arvind, Kumar (1996); Limnological profiles of a tropical fish farming pond at Dumka, Bihar. J. Ecobiol. 8(2): P.117-122.
5. Baden, D.G., Rein, K.S. and Gawley, R.E. (1998); Marine toxins: How they are studied and what they can tell us? In: Molecular Approaches to the study of the ocean. Edited by Cooksey, K.G. Chapman and Hall, London. P.487-514.
6. Chacko, P.I. and Ganapathi, S.V. (1949); some observations of the Adayar river with special reference to its Hydrobiological conditions. India George. 3(24): P.1-15.

7. Chacko, P.I. and Krishnamurthy (1954); the plankton of three fresh water fish ponds in Madras city India, pacific fish Council. Proc. Sect. 115: P.103-107.
8. Forel, F.A. (1992); Leleman monographie Limnologique Lausanne.1904, 3 Vols.
9. Ganapati, S.V. and Sreenivasan, R. (1983); Hydrobiological conditions of Gangadhraswarer Temple tank, Madras. Journal of the Asiatic Society Science. 19: P.149-159.
10. Jeejibai, N. (1962); Trentepohlia monilia de wild. From Madras Phykos, 1: p.79-83.
11. Krishnamurthy, V. (1954); A contribution to the diatom flora of south India – II, Indian, Bot. Soc. 33: P.354-381
12. Mahajan, S.K. and Mishra, Shakun (1988); Algal flora of Barwani: A Preliminary study. 58th Annual Sess. Acad. Sci. India (Biol. Sect.)P. 32.
13. Mahajan, S.K. and Mishra, Shakun (1990); Biomonitoring indicators of water quality at Khargone. Madhya Pradesh Proc. Natl. Symp. Velavar College for women. Erode. T.N. P.7.
14. Mahajan, S.K. and Mishra Shakun. (1990); Occurrence of Spirulina at Khargone. Madhya Pradesh. Natl. Symp. On Spirulina – ETTA. Sponsored By Sci. and Tech. Res. Devt. Corpn. And supported through Deptt. of Biotechnology. New Delhi and organized by Shri AMM. MCRC. Tharamani. Madras.
15. Mahajan, S.K. and Mishra Shakun. (1991); A Contribution to our knowledge about pond and riverine algae of West Nimar. 2nd work shop on river Narmada. “Pollution and Environmental Problems associated with the river Narmada in Madhya Pradesh” in the light of Narmada valley Development (sponsored by MAPCOST) organized by Govt. Narmada Mahavidyalaya. Hoshangabad. Madhya Pradesh. P.22.
16. Mahajan, S.K. and Mishra Shakun. (1991); Algal Flora of Choolgiri Hills. Madhya Pradesh *Phykos*. 30(1&2): P.87-89.
17. Mahajan, S.K. and Mishra Shakun. (1994); Chlorophyceae of Khargone. Madhya Pradesh Proc. 81st Ind. Sci. Cong. Part. III. P.5.
18. Mahajan, S.K. and Mishra Shakun. (1988); Comparative study of algal flora of Lentic and Lotic systems at Khargone, Madhya Pradesh. Ibid. P.87.
19. Mahajan, S.K. and Mishra Shakun. (1990); Cryptogamic flora of west Nimar district of Madhya Pradesh. Diamond Jubilee Sess. Nat. Acad. Sci. India. (Biol. Sect). P.11.
20. Mahajan, S.K. and Mishra Shakun. (1990); Cyanobacteria of Khargone. Madhya Pradesh. Proc. Natl. Symp. on Cyanobacterial Nit. Fixation NFBGAC, IARI, New Delhi. P.539-540.

21. Mahajan, S.K. and Mishra Shakun. (1991); Myxophyceae of West Nimar Madhya Pradesh Proc. 78th Ann. Sess. Ind. Sci. Cong. Part III. P.2.
22. Mahajan, S.K. and Mishra Shakun. (1993); on the occurrence of *Spirulina turpin em gardner* in Western Madhya Pradesh Professor M.N. Shah Birthday Centenary Sess. Nat. Acad. Sci. India. P.16.
23. Mahajan, S.K. and Mishra Shakun. (1994); Impact of Industrialization and Urbanisation on underground water pollution in West Nimar district of M.P. All India Res. Seminar on Industrialization, deforestation and their impact on the environment (with a special emphasis on the underground water pollution) organized by Dept. of Bot, Govt. P.G. Arts and Science College. Ratlam M.P. P.8.
24. Mahajan, S.K. and Mishra Shakun. (1994); Study of green algae from West Nimar. Madhya Pradesh. Seaweed Res. and Utilisation Association. Silver Jubilee Celebration. Symp. on Algae and their utilization at Dept. of Bot. Presidency College Madras. P.4.
25. Mishra, Shakun. (2004) "A Preliminary report on the algal flora of back water of Harsud (M.P.)", National Journal of Life Sciences, 1(2),(475-476).
26. Mishra, Shakun, Mahajan, S.K., Mahajan, S., Khanuja, P., Shaikh, M., (2005), "Ecological Monitoring for the Development of a Wetland Plants at Backwater in Khandwa District (M.P.) India". Published in Proceeding of ICCE, Indore, p-811 to 814 (with co-authors).
27. Mishra, Shakun. (2007a) "Diversity of algal taxa in certain fresh water ponds of Khandwa (M.P.), India" "Indian Hydrobiology", 10 (2):335-342; Krishnamurthy Institute of Algology, Chennai – 600040.
28. Mishra, Shakun. (2007b) "Preliminary Documentation of Algal Flora of Backwater Under Indira Sagar Project, Khandwa District (M.P.) India", Research Link- 40, Vol-VI (5), July, p-18-19 Indore (M.P)
29. Mishra, Shakun.(2007c) "Study on Cyanobacterial Diversity and Hydrobiology in Relation of Five Ponds at Khandwa (M.P.) India" Research Link-42, Vol-VI (7), Sept. p-19-21; Indore (M.P.).
30. Munawar, M. (1970); Limnological studies on freshwater ponds of Hyderabad, India. I. The biotope. Hydrobiologia. 35(1): P.127-162.
31. Mishra, S.R. and Saksena D.N. (1993); Planktonic fauna in relation to physicochemical characteristics of Gouri tank at Bhind, Madhya Pradesh: P.57-62, ed H.R. Singh, Narendra Publishing House, Delhi.
32. Philipose, M.T. (1967); Chlorococcales ICAR. Monograph. New Delhi.

33. Plumley, F.G. (1997); Marine algal Toxins: Biochemistry, genetics and molecular biology. *Limnology Oceanogr.* 42: P.1252-1264.
34. Prasad, A.K.S.K. (1972); Studies on algal flora and hydrology of a temporary beach pool at Madras. Project work post. M.Sc., Diploma, Univ. Madras.
35. Prescott, G.W. (1968); *The Algae: A Review*. Houghton, Mifflin Co. 436 P.
36. Saiefy, T. Chaghetai, S.A, Ali P. and Durrani. I.A. (1986); Hydrobiology and periodicity of phytoplankton in the sewage fed Moti pond, Bhopal, India. *Geobios.* 13: P.199-203.
37. Singh, S.P. and Singh B.K. (1993); Observations on Hydrobiological features of river Sone at Diyapiper bridge in Shahdol District (M.P.), India. P.135-138. Ed. H.R. Singh, Narendra Publishing House, Delhi.
38. Singh, H.R. (1989); *Advances in Limnology*, Narendra Publishing, House Delhi – 110006 (India). 366 P.
39. Trivedy, R.K. and Goel P.K. (1986); Chemical and biological method for water pollution studies. Environment. Pub. Karad. India. P.215.
40. Ventakeswarlu, V. (1981); Algae as indicators of river water quality and pollution, in WHO workshop. *Biological Indicators and indices of environmental pollution.* P.93-100.
41. Verma, M.N. (1969); Diurnal variation in a fish pond in Seoni, India. *Hydrobiologia.* 30(11): P.129-137.
42. Vidyavati (1983); Scanning Electron Microscopy of certain desmids. A review article pub. in *Advances in Appl. of Phycology.*
43. Wetzel, R.C. (1983); *Limnology*, second, CBS. College Publishing Philadelphia.
44. Zafar, A.R. (1964); on the ecology of algae in certain fish ponds of Hyderabad- India. I. Physico-chemical complex. *Hydrobiologia.* 23: P.179-135.
45. Zafar, A.R. (1967); on the ecology of algae in certain fish ponds of Hyderabad. India. III Periodicity *Hydrobiologia*, 30(1): P.96-112.

**STUDIES ON ALGAL DIVERSITY, MORPHOMETRY OF PONDS AND
NYGAARD'S TROPHIC STATE OF INDICES: IN RELATION OF FIVE PONDS AT
KHANDWA (M.P.), INDIA**

Shakun Mishra^{1*} and Deepika Mishra²

¹Department of Botany, Govt. S. N. P. G. College, Khandwa (M.P.), INDIA

²P.G. Student, Department of Biotechnology, DAVV, Indore, INDIA

*Corresponding author E-mail: dr.shakunmishra2012@gmail.com

ABSTRACT:

Khandwa district of M.P. has many natural and manmade wetlands covered by algal blooms. Algal flora were collected from five ponds present in and around Khandwa city, which situated on central railway. A total of 130 taxa of phytoplankton were collected during the year with Cyanophyceae 44 species belonging 28 genera, Chlorophyceae 52 species belonging 34 genera and Bacillariophyceae 24 species belonging 22 genera being main components; Euglenophyceae, Xanthophyceae and Dinophyceae were represented by a few species. Maximum number of species of Cyanophyceae was encountered during summer season, whereas the species richness of Chlorophyceae was occurred maximum during October.

KEYWORDS: Algal, Diversity & Nygaard's Trophic, Five Ponds, Khandwa (M.P.)

INTRODUCTION:

Water is one of the most vital factors in the existence of living organisms. Water covers about 70% the earth of which more than 95%, exists in gigantic oceans. The term "Limnology" is derived from the Greek word, limne or limnos, meaning "pool, marsh or lake". Limnology is a very complex scientific subject and we owe its first definition (the oceanography of lakes) to Professor F.A. Forel (1892) who has been called the father of "Limnology". Now-a-days limnology is defined as the "science of inland waters," concerned with all the factors that influence living organism within those waters (Singh, H.R. 1989).

Khandwa has ponds like Nagchoon Talab, Doodh Talai, Singhad Talai, Padam Kund and Rameshwar Kund, for a long time they supplied potable water to the residents. They are however not in use now-a-days. No work on their Limnological parameters has so far been reported, with increasing

population and depleting sources of potable water their assessment has become a matter of great importance. So it has become highly imperative to conduct such investigation. The ecological studies encompass not only the various branches of science but humanities also. A study of Limnological parameters and algal flora is a prerequisite for assessment of water quality and its subsequent use. The ponds can then be used for pisciculture and cultivation of plants of economic importance. The study of ponds will have a social significance also.

Recently Mahajan, S.K. and Mishra, S. (1986, 1988a, 1988b, 1990a, 1990b, 1990c, 1990d, 1991a, 1991b, 1991c, 1993, 1994a, 1994b, 1994c) had conducted investigation in East Nimar. Thus the literature review suggests that studies on M.P. freshwaters dates back to the latter half of the last century and were in the nature of presenting species list and descriptions of taxa, new to then Madhya Pradesh. Attempts on the seasonality of freshwater plankton were made, followed by a long series of Hydrobiological studies of freshwater impoundments, mostly on ponds and reservoirs. However such studies at Khandwa are scanty, keeping this in mind the present study is designed to survey the phytoplankton, selecting five ponds, at Khandwa (M.P.).

STUDY AREA:



Figure 1: Map showing study area

Khandwa, the district headquarter of East Nimar is a Junction of Central Railway. It has a very long history. Infact its name itself is supposed to originate from Khandwan, a forest mentioned in the epic Mahabharata. It has been a connection between North and South India. Its area is 10779 Km² and is situated at 21^o, 05' to 22^o, 25' N latitude and 75^o, 57' to 77^o, 33' E longitude and 304 m above MSL. Topographically it lies on the uplands between the Valleys of Narmada and Tapti flowing parallel to each other from East to West. The average annual rainfall is 736.8 mm. The climate is in general hot. The city itself has many ponds is in all the directions with rich aquatic flora. The fresh water ecosystems are very important to urban men just like parks etc.

Khandwa district of M.P. has many natural and manmade impoundments. These are among the five ponds selected as a site for monitoring of limnological parameters. These ponds are present in and around Khandwa city, which situated on central railway, namely I. Nagchoon Talab, II. Doodh Talai, III. Singhad Talai, IV. Padam Kund and V. Rameshwar Kund. The better supply of potable water for the town of Khandwa had been a pressing question for years past and numerous schemes had been elaborated and discussed in the report given by Mr. C.S.R. Palmer, E.E. dated 28th may 1890. On 15th July 1890, by J.H. Glass, Esqr., Superintending E. Control provinces on Khandwa water works.

Nagchoon Talab:

Figure 2: A front view of the Nagchoon Talab, looking in the East-South direction

Lakes as such in the District are none, but a few ponds exist of which one at Nagchoon situated at a distance of 6.4 Km. North-West of Khandwa city deserves mention. The talab covers an area of about 202.3 hectares (500 acres). This was formed by damming up a stream. Later on its catchments area was enlarged to nearly 23.3 sq. Km. (9 sq. miles) by the construction of a canal 6.4 sq. Km. (4 miles) long to Ajainti. It is one of the water supplying sources of the Khandwa town. The water is usually carried from it to the town by gravitation but when the Nagchoon Talab (old name – Mohghat reservoir, before 1884 and New Name – Atal Sarowar, after 2006) runs low, the water is pumped. The pumping station was constructed in the year 1887. The Nagchoon Talab established by R. Mitra E.E., agent of Khandwa Municipality, dated 18th July 1899, agreement with Rajputana Malva Railway company to supply water. The Talab for last few years is being utilized as one of the fish – breeding centres of the district. The substratum of the spot is dominated by sand and gravel. The talab has a total surface area about 26,502,000 sq. ft. and a total capacity 275,205,000 in feet. The main source of water is natural. Large Ajainti nallah through which rain water is carried into talab, having one outlet naming small Ajainty nallah. The reservoir is primarily used for drinking purposes and others.

The left front side of Nagchoon is situated East-South side of talab. The spot is having rich macrophytes and the peripheral zone covered with thick mat of grass, and embankment. The substratum of the spot is dominated by muddy soil. The talab water of this sampling spot is covered by *Typha* sp., *Cyperus* sp., *Ipomoea* sp., etc. In addition to many macrophytes are also present. This spot is covered with decomposed vegetation. It is one of the main sampling sites, with 6 to 10 fit depth during monsoon [July-August]. Sources of main water supply to the body are from Nagchoon talab and rains. The right front side of Nagchoon Talab is situated West-South side of talab. The spot is having scanty macrophytes and the zone covered with thick mat of grass. The substratum of the spot is dominated by muddy soil. The spot is undisturbed by external factors; the water is not covered with *Typha*. It is one of the beautiful picnic spot of the Khandwa city.

Doodh Talai:

Figure 3: View of Doodh Talai

Doodh Talai is situated western part of Khandwa city. Talai has a surface area of 140337 sq. fit. and a shore line of talai is irregular, interrupted at one side by road, colony and a half Km. wide area attached with it. Its basin is shallow with a slight slope. The talai is eutrophic and receives several effluents of domestic sewage. The maximum depth of water in the talai was near about 10 to 12 fit during monsoon (July-August) and minimum 3-5 fit in summer (May-June). Sources of water supply to the talai are rains and domestic sewage from adjoining colonies. It is free from macrovegetation. The water is covered with thick blooms of algae mainly *Spirulina* sp. Municipal Corporation has planned to develop Doodh Talai as picnic spot with swimming pool.

Singhad Talai:**Figure 4: View of Singhad Talai**

The talai has a total surface area of about 27014 sq. fit. and a peripheral circumference is irregular and completely covered with grass. The main source of water is domestic sewage. Its basin is shallow with a slight slope. The talai is eutrophic and receives domestic, human and animal excreta and city debris. Long time ago, the Trapa (singhada) were harvested in Talai, so place known as Singhad Talai. Now-a-days it is free from macrovegetation. Some macrophytes seen at this point like Ipomoea, Cyperus and other grass. The maximum depth of water in the talai was near about 8 to 10 fit. during monsoon (July-August) and minimum 3-5 fit in summer (May-June). Saify Nagar and Shrinagar colonies are attached with Singhad Talai.

Padam Kund:**Figure 5: View of Padam Kund**

The Padam Kund under investigation is in colony Padam Nagar and Sanjay Nagar situated at western part of Khandwa city. The reservoir was constructed approximately 1800 years ago. The reservoir impounds an area of 96 sq. fit. and depth is 15x18 fit. The Kund used to bloom with Lotus flowers and hence it is named as Padam Kund. It is rectangular in shape and embodied with ancient lithics that are as

old as Kund itself. It is rectangular in shape and maximum depth of water in the Kund is 15 to 18 fit. and overflow during monsoon (July-August) and minimum 10-12 fit. in summer (May-June). The Kund is pucca and has straight embankment. Sources of water supply to the Kund are rains. It is free from macrovegetation. The water of the Kund is used for bathing and drinking by the men and animals.

Rameshwar Kund:

Figure 6: View of Rameshwar Kund

Mr. Palmer, passes in review the several schemes which have from time to time been put forward for Khandwa, and comes to the conclusion that the Rameshwar gravitation scheme, which was first brought to notice in 1871 by Mr. A.R. Binnic, E.E.. Thus the Rameshwar gravitation scheme was projected by Mr. Binnic and Mr. Plaus and estimates were prepared by Mr. Hooper in 1874. The proposals were to construct a reservoir on the Rameshwar Nallah and to lead thence a 9" main to the clock tower. The tank was shown to be able to supply 8 gallons per head for 15,000 people and 2000 gallons per diem for the each of the two Railways, and to have a surplus of 3 million cubic feet. The Rameshwar Kund under investigation at the Rameshwar Nallah, bears many macrophytes at both side. The substratum of the spot is dominated by mud and gravel. The colour of the water varied from pinkish grey to brown, dark brown colour of water at the effluent mixing point. Water has got a distinct odour and sufficient foam, making its unfit for drinking purpose.

MATERIALS AND METHODS:**Sampling periodicity:**

The present study was carried out for the period of one year from March 2014 to February 2015. Monthly water samples were collected in clean polythene bottles. The clean containers were

rinsed several times with pond water before collecting the samples. The samples were taken to the laboratory within one hour for Hydrobiological analysis.

The water bodies in general appeared to be relatively similar for many biologists till recently. But with advent of limnology and environmental science, it is established that these water bodies manifest the most amazing physical, chemical and biological diversity. As proposed a survey of the local water bodies were conducted on a fixed duration of every month and different parameter were determined from 01.03.2014 to 28.02.2015. Periodic sampling was done at five sampling stations, naming 1.Nagchoon Talab 2.Doodh Talai 3.Singhad Talai 4.Padam Kund and 5.Rameshwar Kund. In general it was found in Algae, 130 species belonging to 92 genera. Identification was done with the help of standard books and monographs, Desikachary, 1959 and Prescott, 1938. The Algal materials preserved in the Department of Botany, S.N. Govt. P.G. College, Khandwa. Nygaard,(1949) proposed Myxophycean, Chlorophycean, Diatom, Euglenophycean and compound quotient indices to assess the water quality.

Nygaard`s trophic state of indices:

Nygaard (1949) proposed Myxophycean, Chlorophycean, Diatom, Euglenophycean and compound quotient indices to assess the water quality.

Nygaard`s Phytoplankton Quotients and Water Quality			
Index	Mode of Calculation	Oligotrophic	Eutrophic
Myxophycean	Myxophycean / Desmideae	0.0-0.4	0.1-3.0
Chlorophycean	Chlorococcales / Desmideae	0.0-0.7	0.2-9.0
Bacillariophycean	Centric Diatom / Pennate Diatom	0.0-0.3	0.0-1.75
Euglenophycean	Euglinophyceae/Myxophyceae+ Chlorococcales	0.0-0.2	0.0-1.0
Compound	Myxophycean+ Chlorococcales+ Centric Diatom+ Euglenophycean / Desmideae	0.0-0.1	1.2-2.5

The compound quotient modified by Nygaard (1976) given below :

$$\text{C.Q.} = \frac{\text{Myxophycean} + \text{Chlorococcales} + \text{Diatom} + \text{Euglenophycean}}{\text{Desmideae}}$$

Where : C.Q. = Compound Quotient

If the quotient value is less than :

- 2 = Oligotrophic
 2 - 6.1 = Weak Eutrophic
 Above 6 = Eutrophic

In the present study, the modified compound quotient is used to assess the water quality.

RESULTS AND DISCUSSION:

In the present investigation, characters accounting for the ponds diversity are studied, over a period of 12 months selecting five representative, permanent ponds and results are analyzed on the basis of earlier literature.

Morphometry: The obtained values for the volume of the ponds by morphometrical studies are given below:

1.	Nagchoon Talab	:	768900 m ³	75429090 liters
2.	Doodh Talai	:	452700 m ³	44409870 liters
3.	Singhad Talai	:	87140 m ³	8548434 liters
4.	Padam Kund	:	160 m ³	15696 liters
5.	Rameshwar Kund	:	3000 m ³	294300 liters

Showing Class Wise Composition of Phytoplankton Diversity from Five Ponds:

Sr. No.	Class	Genera	Species
1.	Cyanophyceae	28	44
2.	Bacillariophyceae	22	24
3.	Xanthophyceae	03	03
4.	Chlorophyceae	34	52
5.	Charophyceae	01	02
6.	Euglenophyceae	01	02
7.	Dinophyceae	03	03
Total	07	92	130

Nygaard's Phytoplankton Quotients and Water Quality of Five Ponds:

Sr.No.	Index	Mode of Calculation	Phytoplankton Quotient
1.	Myxophycean	<u>Mixophyceae</u> Desmideae	Nagchoon Talab - 1.13 Doodh Talai - 2.9 Singhad Talai - 2.26 Padam Kund - 1.73 Rameshwar Kund -1.46
2.	Chlorophycean	<u>Chlorococcales</u> Desmideae	Nagchoon Talab - 0.8 Doodh Talai -0.53 Singhad Talai - 0.4 Padam Kund - 0.4 Rameshwar Kund -0.34
3.	Diatom	<u>Centric diatoms</u> Pennate diatoms	Nagchoon Talab - 0.16 Doodh Talai - 0.1 Singhad Talai - 0.11 Padam Kund - 0.18 Rameshwar Kund -0.12
4.	Euglenophycean	<u>Euglenophyceae</u> <u>Myxophyceae + Chlorococcales</u>	Nagchoon Talab - 0.06 Doodh Talai - 0.03 Singhad Talai - 0.05 Padam Kund - 0.06 Rameshwar Kund -0.07
5.	Modified Compound Quotient	<u>Myxophyceae + Diatoms +</u> <u>Chlorococcales + Euglenophyceae</u> <u>Desmideae</u>	Nagchoon Talab - 2.46 Doodh Talai - 13.0 Singhad Talai - 6.5 Padam Kund - 5.11 Rameshwar Kund -5.44

- Thus the present study infers that Nygaard's indices may not be applicable universally for all aquatic bodies to assess the trophic status. It is to be determined by experimental studies on phytoplankton of different water bodies.

- 14 Cyanophyceean members were reported from Nagchoon Talab, 35 from Doodh Talai, 23 from Singhad Talai, 13 from Padam Kund and 12 from Rameshwar Kund. These members were reported throughout the year.
- A total of 6 Bacillariophyceean members were encountered in Nagchoon Talab, 24 species in Doodh Talai, 22 species in Singhad Talai, 12 species in Padam Kund and 20 species in Rameshwar kund. Summer months recorded more Bacillariophyceean members than winter months.
- 52 species of Chlorophyta were reported from Nagchoon Pond, 22 species from Doodh Talai, 29 species from Singhad Talai, 26 from Padam Kund and 25 species from Rameshwar Kund. Chlorophyceean pecks were recorded during summer and rainy months.
- 03 species of Xanthophyta 02 species of Euglenophyta and 03 species of Dinoflagellates were reported in all the sampling ponds during summer months.
- Regarding species abundance numerically the Cyanophyta in Doodh Talai Bacillariophyta in Doodh Talai and Singhad Talai and Chlorophyta in Nagchoon Talab, Singhad Talai and Padam Kund, formed most abundant groups. While Chlorophyta in Rameshwar Kund and Doodh Talai, Bacillariophyta in Rameshwar kund and Padam Kund ranked next. The Third position was occupied by Bacillariophyta in Nagchoon Talab and Cyanophyta in Padam Kund Rameshwar Kund and Nagchoon Talab respectively. Euglenophyceean members and Dinoflagellates were absent during several month.
- With reference to seasonal distribution the phytoplankton peaks ware reported during summer season and the total number decreased during February and March

REFERENCES:

1. Desikachary, T.V. (1959); Cyanophyta. Pub. Indian council of Agricultural Research, New Delhi.
2. Mahajan, S.K. and Mishra, Shakun (1988a); Algal flora of Barwani: A Preliminary study. 58th Annual Sess. Acad. Sci. India (Biol. Sect.)P. 32.
3. Forel, F.A. (1992); Leleman monographie Limnologique Lausanne.1904, 3 Vols.
4. Mahajan, S.K. and Mishra Shakun. (1988b); Comparative study of algal flora of Lentic and Lotic systems at Khargone, Madhya Pradesh. Ibid. P.87.
5. Mahajan, S.K. and Mishra, Shakun (1990a); Biomonitoring indicators of water quality at Khargone. Madhya Pradesh Proc. Natl. Symp. Velavar College for women. Erode. T.N. P.7.
6. Mahajan, S.K. and Mishra Shakun. (1990b); Occurrence of Spirulina at Khargone. Madhya Pradesh. Natl. Symp. On Spirulina – ETTA. Sponsored By Sci. and Tech. Res. Devt. Corpn. And supported through Deptt. of Biotechnology. New Delhi and organized by Shri AMM. MCRC. Tharamani. Madras.

7. Mahajan, S.K. and Mishra Shakun. (1990c); Cryptogamic flora of west Nimar district of Madhya Pradesh. Diamond Jubilee Sess. Nat. Acad. Sci. India. (Biol. Sect). P.11.
8. Mahajan, S.K. and Mishra Shakun. (1990d); Cyanobacteria of Khargone. Madhya Pradesh. Proc. Natl. Symp. on Cyanobacterial Nit. Fixation NFBGAC, IARI, New Delhi. P.539-540.
9. Mahajan, S.K. and Mishra Shakun. (1991a); A Contribution to our knowledge about pond and riverine algae of West Nimar. 2nd work shop on river Narmada. "Pollution and Environmental Problems associated with the river Narmada in Madhya Pradesh" in the light of Narmada valley Development (sponsored by MAPCOST) organized by Govt. Narmada Mahavidyalaya. Hoshangabad. Madhya Pradesh. P.22.
10. Mahajan, S.K. and Mishra Shakun. (1991b); Algal Flora of Choolgiri Hills. Madhya Pradesh *Phykos*. 30(1&2): P.87-89.
11. Mahajan, S.K. and Mishra Shakun. (1991c); Myxophyceae of West Nimar Madhya Pradesh Proc. 78th Ann. Sess. Ind. Sci. Cong. Part III. P.2.
12. Mahajan, S.K. and Mishra Shakun. (1993); on the occurrence of *Spirulina turpin em gardner* in Western Madhya Pradesh Professor M.N. Shah Birthday Centenary Sess. Nat. Acad. Sci. India. P.16.
13. Mahajan, S.K. and Mishra Shakun. (1994a); Chlorophyceae of Khargone. Madhya Pradesh Proc. 81st Ind. Sci. Cong. Part. III. P.5.
14. Mahajan, S.K. and Mishra Shakun. (1994b); Impact of Industrialization and Urbanisation on underground water pollution in West Nimar district of M.P. All India Res. Seminar on Industrialization, deforestation and their impact on the environment (with a special emphasis on the underground water pollution) organized by Dept. of Bot, Govt. P.G. Arts and Science College. Ratlam M.P. P.8.
15. Mahajan, S.K. and Mishra Shakun. (1994c); Study of green algae from West Nimar. Madhya Pradesh. Seaweed Res. and Utilisation Association. Silver Jubilee Celebration. Symp. on Algae and their utilization at Dept. of Bot. Presidency College Madras. P.4.
16. Nygaard, G. (1949). Hydrobiological studies on some Danish ponds and lakes. Part II. The quotient hypothesis and some new or little known phytoplankton organisms. Kongel. Danska Vidensk. Selskab. Biol. Skrift 7(1): P.293.
17. Prescott, G.W. (1968); *The Algae: A Review*. Houghton, Mifflin Co. 436 P.
18. Singh, H.R. (1989); *Advances in Limnology*, Narendra Publishing House Delhi– 110006 (India). 366P.
19. Welch, S.P. (1952); *Limnology*. Mc. Craw Hill Book Co., Inc. N. Y. p. IX + 538.

A SENSING BEHAVIOR SYNERGISTIC LIQUID-LIQUID EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION OF NICKEL (II) BY USING 1-(2',4'-DINITRO AMINOPHENYL)-4,4,6-TRIMETHYL-1,4-DIHYDROPYRIMIDINE-2-THIOL: ANALYSIS OF FOUNDRY AND NICKEL ELECTROPLATING WASTE WATER

Ganesh S. Kamble^{1,2*}, Sunil S. Joshi³, Mansing A. Anuse^{2*}

¹Department of Engineering Chemistry, Kolhapur Institute of Technology's, College of Engineering, Kolhapur, 416434, Maharashtra, India

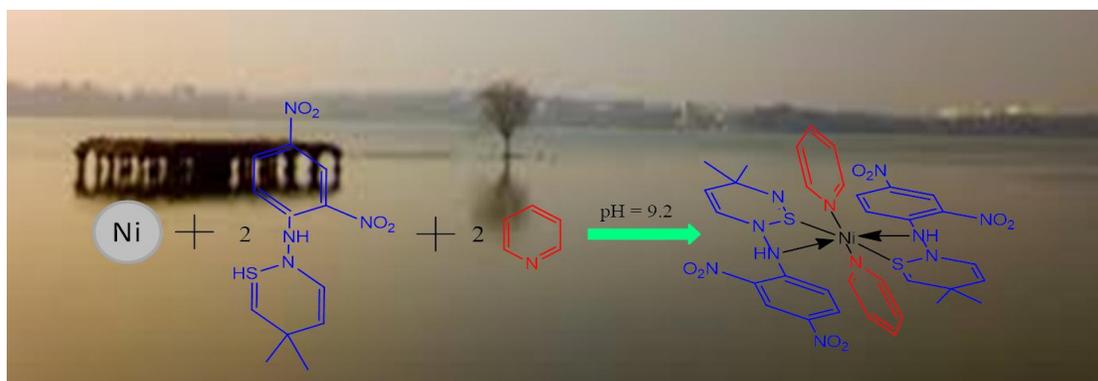
²Analytical Chemistry Laboratory, Department of Chemistry, Shivaji University, Kolhapur, 416004, Maharashtra, India

³Department of Humanities and Sciences, TKIET's College of Engineering, Warananagar, Kolhapur, Maharashtra, India

*Corresponding author E-mail: 1ganeshchemistry2010@gmail.com

2mansinganuse@yahoo.co.in

ABSTRACT:



We report the sensing behavior liquid-liquid extraction of nickel (II) which have been selectively determined from contaminated water samples by simple Uv-visible spectrophotometer. The method is based on synergistic extraction of nickel (II) by 1-(2',4'-dinitro aminophenyl)-4,4,6-trimethyl-1,4-dihydropyrimidine-2-thiol, [2',4'-dinitro APTPT] with pyridine. Nickel (II) reacts with 2',4'-dinitro APTPT and forms a green coloured complex at pH 9.2. Also, the Ni(II) ion were detected through naked-eye with the ligand. The absorbance of coloured complex was measured at 660 nm and coloured complex is stable for more than 48 h even in the presence of other competing ions. The system obeyed Beer's law in the concentration range of 5 to 50 $\mu\text{g mL}^{-1}$ of nickel (II) and optimum range evaluated by Ringbom's

plot method is 10 to 40 $\mu\text{g mL}^{-1}$ with an excellent linearity and a correlation coefficient of 0.999. The molar absorptivity and Sandell's sensitivity of the extractive species were found to be $1.64 \times 10^3 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ and $0.0585 \mu\text{g cm}^{-2}$ in presence of pyridine, and $7.4 \times 10^2 \text{ dm}^3 \text{ mol}^{-1} \text{ cm}^{-1}$ and $0.78 \mu\text{g cm}^{-2}$ in absence of pyridine, respectively. The composition of nickel (II)-2',4'-dinitro APTPT-pyridine was established by slope ratio method, mole ratio method and Job's method of continuous variation. It was found that Metal:Ligand:Synergent (M:L:Sy) ratio is 1:2:2. To assess precision and accuracy of the developed method, determinations were carried out at $n = 5$. The relative standard deviation of all measurements does not exceed 0.16 %. Excellent selectivity was found toward Ni(II) ion due to a specific complex formation between Ni(II) ion and organic ligand. In the extraction of Ni(II), several affecting factors, including the solution pH, ligand concentration, equilibrium time, initial Ni(II) ion concentration, foreign ions were investigated and applicability of the method checked by the analysis of synthetic mixtures and alloys. The developed method is successfully used for determination of nickel (II) from waste water effluents from foundry region and nickel plating industry (Kolhapur city). Results obtained by the developed method also confirmed by AAS. We claimed from this study that Ni(II) could be successfully determined by the spectrophotometric method developed in the current work. The present work is obviously much simpler than the conventional comprising multistep processes.

KEYWORDS: Nickel (II); Synergistic extraction; 2',4'-dinitro APTPT; Pyridine; Spectrophotometry

ABBREVIATIONS:

2',4'-dinitro APTPT	1-(2',4'-dinitro aminophenyl)-4,4,6-trimethyl-1,4-dihydropyrimidine-2-thiol
DMG	Dimethylglyoxime
PAR	4-(2-Pyridylazo) resorcinol
Py	Pyridine
Sy	Synergent

INTRODUCTION:

Nickel is moderately abundant (99 ppm) and it is used in large quantities in wide varieties of alloys both ferrous and nonferrous. Meteoritic iron-nickel was raw material for the swords of many ancient warriors [1]. Nickel is an important element for use in the food industry as a catalyst in hydrogenation of oils. Due to its high strength and resistance to corrosion in many media [2]. It is used in nickel plating and also in the manufacture of alloys along with iron, copper, aluminium, chromium,

zinc, and molybdenum. Very strong permanent magnets are made from 'Alnico' steel. Monel metal is very resistant to corrosion and is used in apparatus to handle F_2 and other corrosive fluorides. Nickel improves both the strength of steel and its highly resistance to corrosion. Because of its high melting point ($1453\text{ }^\circ\text{C}$) it is used in the manufacture of some food processing vessels and many other pieces of equipment. Nickel is an important element of the enzyme urease and as such is considered to be essential to plants and some domestic animals. The determination of trace amounts of nickel is important in biological sciences, environmental analytical chemistry, metallurgy and industry [3]. On the other hand, due to the industrial facilities, heavy metal contents in environmental samples increase unfavorably. US EPA has classified nickel as one of the 13 priority metal pollutants for its widespread use [4]. Compared with other transition metals, nickel is a moderately toxic element. However, it is known that inhalation of nickel and its compounds can lead to serious problems including cancer of the respiratory system [5]. Moreover, nickel toxicity can cause a skin disorder known as nickel-eczema [6], cancer of nasal cavity and lungs, dermatitis, asthma, acute pneumonitis and disorders of central nervous system.

Considering its toxicity and owing to its involvement in some essential metabolic processes [7], it has become necessary to develop the procedures with high selectivity for determination of nickel content from waste effluents. Among the various instrumental techniques available for the determination of nickel (II). Some of these methods comprise ion selective electrode [8,9], voltammetry [10,11], polarography [12], atomic fluorescence [13], X-ray fluorescence [14]. But spectrophotometry is preferred as a versatile technique due to its low cost and easy experimental procedures. The successful application of such procedures mainly relies on the stability of the coloured complex that usually formed between the analyte metal ions and organic complexing agent.

The aim of this work is to develop a very simple, selective and low cost procedure and is to study the synergistic effect of 1-(2',4'-dinitro aminophenyl)-4,4,6-trimethyl-1,4-dihydropyrimidine-2-thiol, [2',4'-dinitro APTPT] with pyridine on the extraction of nickel (II) into chloroform, and to apply this extraction system to the determination of the mentioned analytes, using spectrophotometer and reliability of the method is confirmed by AAS. The effects of 2',4'-dinitro APTPT and pyridine on the percent extraction of the metal complexes were studied and the optimum extraction conditions were investigated. Furthermore, this method has been applied successfully for the analysis of nickel (II) in synthetic mixtures and alloys. The proposed method, when compared with other spectrophotometric methods, was found to be satisfactorily selective (Table 1) [15-35]. The present results from spectrophotometry have been compared with those obtained through the AAS. It also offers advantages

like reliability and reproducibility in addition to its simplicity, instant colour development and less interferences.

EXPERIMENTAL:

Apparatus:

The absorbance measurements of the reagent and its nickel (II) complexes were measured with a UV-Vis digital spectrophotometer model Systronic 106 (300 -800 nm) using 1 cm quartz cell. For measurement of the pH values, Elico digital pH meter model LI-120 was used.

All glass vessels were cleaned by $K_2Cr_2O_7$ solution and followed by washing carried out with soap water and ringed with distilled water before to use.

Preparation of reagents and standard nickel (ii) solution:

A stock solution of nickel (1 mg mL^{-1}) was prepared $NiSO_4 \cdot 6H_2O$ (Merck, Darmstadt, Germany) and standardized by a known method [36]. More diluted standard solutions (10 to $100 \text{ } \mu\text{g mL}^{-1}$) were freshly prepared by appropriately diluting the stock nickel (II) solution with water immediately before use.

All other solvents and chemicals were of analytical reagent. Different interfering ions were prepared by dissolving weighed quantities of their salts in water or dilute HCl [37]. Synthetic mixtures containing nickel (II) were prepared by combining with commonly associated metal ions in definite composition [38]. Double distilled, de-ionized water was used throughout the experiments.

Synthesis of chromogenic ligand, 2',4'-dinitro APTPT:

1-(2',4'-Dinitro aminophenyl)-4,4,6-trimethyl-1,4-dihydropyrimidine-2-thiol, [2',4'-dinitro APTPT] was synthesized and recrystallized as reported by R. A. Mathes [39]. The synthesis was carried out in two steps. In the first step, 2-methyl-2-isothicyanato-4-pentanone was prepared by mixing of mesityl oxide with ammonium thiocyanate in presence of sulphuric acid in water for 15 min. While in the second step, the 2-methyl-2-isothicyanato-4-pentanone was condensed with 2,4-dinitro phenyl hydrazine in 50 mL ethanol. The mixture was refluxed for 50 min, and cooled. The crystalline product was precipitated. It was recrystallised from glacial acetic acid, washed with water and air dried and finally characterized. A 0.02 M stock solution of 2',4'-dinitro APTPT was prepared by dissolving 0.324 g in a 50 cm^3 of chloroform.

Recommended procedure:

An aliquot of the sample containing $300 \text{ } \mu\text{g}$ nickel (II) was transferred into a 125 mL separatory funnel before that pH was adjusted to 9.5 with dilute hydrochloric acid and sodium hydroxide and made

volume to 25 mL with water. The whole solution was thoroughly mixed with 5.0 mL of a 0.02 mol L⁻¹ 2',4'-dinitro APTPT and 5.0 mL of 0.5 mol L⁻¹ pyridine in chloroform and equilibrated for 10 min. The organic layer having green colour was allowed to separate and dried over anhydrous sodium sulphate. The green colour organic layer was transferred to a 10.0 mL of standard volumetric flask and made upto the mark with chloroform. The absorbance of the green coloured complex was measured at 660 nm against respective reagent blank prepared in similar manner. Percentage extraction (% E) and metal distribution ratio (D) were calculated according to Eqs. (1) and (2), respectively.

$$\%E = \frac{[\text{Ni}^{2+}]_{\text{org.}}}{[\text{Ni}^{2+}]_{\text{aq., init.}}} \times 100 \quad \dots\dots\dots (1)$$

$$D = \frac{[\text{Ni}^{2+}]_{\text{org.}}}{[\text{Ni}^{2+}]_{\text{aq.}}} \quad \dots\dots\dots (2)$$

where, $[\text{Ni}^{2+}]_{\text{aq., init.}}$ are represents the initial concentration of metal ion in the aqueous phase. $[\text{Ni}^{2+}]_{\text{aq.}}$ and $[\text{Ni}^{2+}]_{\text{org.}}$ the total concentrations of metal ion in the aqueous and organic phases after equilibrium, respectively.

RESULTS AND DISCUSSION:

Spectral characteristics:

Nickel (II) reacts with 2',4'-dinitro APTPT at pH 9.2 into chloroform and forms a green coloured ternary complex in presence of pyridine as an auxiliary ligand. The ratio of the ternary complex showed 1:2:2 (M:L:Sy). The maximum absorption of coloured complex was 660 nm in chloroform, and was stable for a more than 48 h. The optimum conditions for the effective extraction of nickel (II) were established by studying the effect of pH, ligand concentration, pyridine concentration, choice of solvent, equilibrium time and interference of various diverse ions. The optimized conditions and spectral characteristic properties are shown in Table 2.

Absorption spectra:

Preliminary studies of extraction of nickel (II) with 2',4'-dinitro APTPT in presence of pyridine have indicated that, the formation of green colored complex at room temperature. The absorption spectra of reagent and its nickel (II) complex were studied over the wavelength range 300-800 nm and shown in Fig. 1. The spectrum of reagent versus solvent as a blank and spectrum of nickel (II) complex against reagent blank showed at 660 nm and 415 nm, respectively. It was clearly seen that, on the subsequent work the developed spectrophotometric technique is sensitive for the determination of nickel (II).

Effect of pH:

The pH plays very important role in the spectrophotometric determination of nickel (II). Because in the optimized pH range hydroxo complex of metal species are stable and enhances the complex colour. Therefore we have studied the effect pH on the developed colour complex of nickel (II)-2',4'-dinitro APTPT-pyridine by varying the pH of nickel (II) solution in the range from 1 to 14. The results are shown in Fig. 2, where it was clearly found that, the optimal pH range for the reaction of nickel (II) with 2',4'-dinitro APTPT is 8.7-9.8 in the presence and absence of pyridine. However, in the presence of 5.0 mL of 0.5 mol L⁻¹ pyridine, there was enhancement of absorbance but in absence of pyridine absorbance was decreased in the same pH range. Thus, in the subsequent work, to ensure complete colour formation the aqueous solution was adjusted at pH 8.7-9.8. On the other hand, in the aqueous solution of pH ≤ 8.5, the absorbance of the coloured complex was found low and in the aqueous solution of pH ≥ 10.0, the absorbance of the produced coloured complex decreased drastically. Hence, for further studies, the central value of this range pH 9.2 was recommended.

Effect of solvent:

In the extraction of nickel (II), solvent plays as an very important role in solvation of nickel (II) species with ligand. For this purposes the influence of various organic solvents were examined for the effective extraction of nickel (II) with 2',4'-dinitro APTPT complex in presence of 5 cm³ of 0.5 mol L⁻¹ pyridine. The results are shown in Table 3. It was observed that, the percentage extraction (%E) values increased in the order of kerosene (6.14), < *n*-butanol (7.48) < amyl acetate (9.59) < amyl alcohol (22.07) < toluene (26.48) < xylene (58.15) < methyl-*iso*-butylketone (62.57) < 1, 2-dichloroethane (84.26) < carbon tetrachloride (93.28) < chloroform (99.99). In the light of these findings, chloroform was selected for further extraction studies.

Effect of a chromogenic ligand concentration (2',4'-dinitro APTPT):

The effect of ligand concentration on the formation of complex species of nickel (II) was studied at pH 9.2. Different molar concentrations (0.01 to 0.04 mol L⁻¹) of 2', 4'-dinitro APTPT in chloroform were added into a fixed nickel (II) ion concentration (30 µg mL⁻¹) and absorbances were measured according to the standard procedure. It was observed that, 3.5 mL of 0.02 mol L⁻¹ reagent was necessary for full and constant color development in the presence of 5.0 mL of 0.5 mol L⁻¹ pyridine. The absorbance of the organic phase was measured at 660 nm and against reagent blank. In absence of pyridine, absorbance was lowered. However, in order to ensure the complete complexation 5.0 mL of 0.02 mol L⁻¹ reagent

was recommended. A further excess of 2',4'-dinitro APTPT has no adverse effect on the sensitivity and absorbance of nickel (II)- 2',4'-dinitro APTPT-pyridine complex.

Effect of equilibrium time:

It is often necessitated to investigate the trace amounts of metal ions with high efficiency in a minimum time. The results indicated that, the optimum shaking time of 7 min was determined by varying the shaking time from 0.5 to 20 min in absence and presence of pyridine. It was found that, the color formation was instantaneous and absorbance remained constant for more than an hour. Prolonged shaking has no adverse effect on the extraction of nickel (II) in presence of pyridine. Hence, shaking time of 10 min was chosen for in all further studies.

Effect of pyridine concentration:

Synergistic effect also plays a very important role in the extraction of metal ions. Herewith, dilute pyridine is used as synergent for extraction of nickel (II). Pyridine shows the synergistic effects by the formation of an adduct with nickel (II) species. The effect of pyridine concentration was studied from 0 to 5.0 mL of 0.5 mol L⁻¹ to obtain the maximum and constant color development. It was observed that color of nickel (II) complex into chloroform increases with the pyridine concentration and remains constant from 3.0 mL of 0.5 mol L⁻¹ pyridine. Therefore 5.0 mL of 0.5 mol L⁻¹ pyridine was used for further extraction.

Effect of color stability of complex:

Synergistic effect of pyridine over the extraction of nickel (II) also helps to enhance the colour stability of complex. The color stability of nickel (II) with ligand was studied at room temp by measuring the absorbance at regular time intervals. The absorbance of the nickel (II)-2',4'-dinitro APTPT-pyridine complex in chloroform was stable for more than 20 h. But in absence of pyridine complex was stable for 10 h. Herewith, synergistic effect proved the colour stability of the complex.

Analytical performance: Validity of Beer's law and sensitivity:

At the optimized reaction conditions of the nickel (II) with 2',4'-dinitro APTPT in the pH 9.2. The developed method obeyed Beer's law over the concentration range of 5 to 50 µg mL⁻¹ of nickel (II) as evaluated by Ringbom's plot method [40] was 10 to 40 µg mL⁻¹. Molar absorptivity was 1.64 x 10³ dm³ mol⁻¹ cm⁻¹ in presence of pyridine and 7.4 x 10² in absence of pyridine were calculated by Beer's plot. The

sensitivity of the method defined by Sandell was $0.0585 \mu\text{g cm}^{-2}$ in presence of pyridine while $0.78 \mu\text{g cm}^{-2}$ in absence of pyridine. The standard deviation calculated from ten determinations on a solution containing $30 \mu\text{g mL}^{-1}$ of nickel (II) is 0.018 and relative standard deviation of the method is 0.16%. These results indicate that the method has good level of precision and hence was found suitable for the routine analysis of the nickel (II) in water samples. The precision and accuracy data of the method is shown in Table 2. The data given in Table 2 revealed that, the developed method is simple, reliable, less toxic and free from interference ions compared to the reported methods.

Stoichiometry of the complex:

The synergistic extraction of nickel (II) by mixtures of an acidic chelating extractant and synergent has been investigated. In order to apply this kind of extraction system for the separation of nickel (II) from environmental samples. The extraction properties of nickel (II) have been evaluated at pH 9.2.

The probable composition of extracted species was ascertained by plotting graphs of $\log D_{[\text{Ni(II)}]}$ against $\log C_{[2',4'\text{-dinitro APTPT}]}$ at fixed pyridine concentration (0.5 mol L^{-1}) (Fig. 3). The plots were linear having the slopes 1.9 and 2.0 at pH 8.0 and 10.2, respectively. Also plots of $\log D_{[\text{Ni(II)}]}$ against $\log C_{[\text{pyridine}]}$ at fixed 2',4'-dinitro APTPT concentration (0.02 mol L^{-1}) (Fig. 4) were linear with slopes of 1.7 and 1.8 at pH 8.0 and 10.2, respectively. The probable composition of extracted species was calculated to be 1:2:2 (Metal:Thiol:Pyridine). The composition was also verified by Mole ratio (Fig. 5) and Job's method of continuous variation (Fig. 6).

Nickel (II) reacts with 2',4'-dinitro APTPT in the presence of auxiliary ligand pyridine, giving an uncharged chelate which is distributed between two phases according to the following equations No. (3), (4) and (5). The probable partition equilibrium of the Ni(II)-2',4'-dinitro APTPT complex with and without the pyridine between water and chloroform may be expressed as follow.



and the equilibrium constant can be expressed as,

$$\beta_{1,2} = \frac{[\text{Ni}(\text{R-S})_2(\text{H}_2\text{O})_2]_{\text{org.}} [\text{H}_2\text{O}]_{\text{aq.}}^4}{[\text{Ni}(\text{H}_2\text{O})_6]^{2+}_{\text{aq.}} [\text{R-SH}]_{\text{org.}}^2}$$

The Ni(II)-2',4'-dinitro APTPT complex reacts with pyridine to give 1:2:2 (Nickel:Thiol:Pyridine) ternary complex.



which is defined by an equilibrium constant,

$$\beta_{1,2,3} = \frac{[\text{Ni}(\text{R-S})_2 (\text{Py})_2]_{\text{org.}} [\text{H}_2\text{O}]_{\text{aq.}}^2}{[\text{Ni}(\text{R-S})_2 (\text{H}_2\text{O})_2]_{\text{org.}} [\text{Py}]_{\text{org.}}}$$

Thus, overall extraction mechanism may be expressed as,



Therefore, extraction constant is given by,

$$K_{\text{ex}} = \frac{[\text{Ni}(\text{R-S})_2 (\text{Py})_2]_{\text{org.}} [\text{H}_2\text{O}]_{\text{aq.}}^6}{[\text{Ni}(\text{H}_2\text{O})_6]_{\text{aq.}}^{2+} [\text{R-SH}]_{\text{org.}}^2 [\text{Py}]_{\text{org.}}}$$

Then distribution ratio is given by,

$$\begin{aligned} D_{1,2,2} &= \frac{[\text{Ni}(\text{R-S})_2 (\text{H}_2\text{O})_2]_{\text{org.}} + [\text{Ni}(\text{R-S})_2 (\text{Py})_2]_{\text{org.}}}{[\text{Ni}(\text{H}_2\text{O})_6]_{\text{aq.}}^{2+}} \\ &= \beta_{1,2} [\text{R-SH}]_{\text{org.}}^2 [\text{H}_2\text{O}]_{\text{aq.}}^4 + \beta_{1,2,3} [\text{Py}]_{\text{org.}}^2 [\text{H}_2\text{O}]_{\text{aq.}}^2 \end{aligned}$$

Where, R-SH is 2',4'-dinitro APTPT and Py is pyridine.

On the basis of above reactions and data of composition of extracted species confirmed that, the coloured species is most likely fit with the valencies of nickel (II), ligand and synergent. Based on this investigation the structure is recommended for the complex is shown in Fig. 7.

Study of diverse ions:

The determination of nickel (II) ion at concentration $30 \mu\text{g mL}^{-1}$ in the presence relatively high excess of some diverse ions relevant to industrial effluent was critically investigated by the developed procedure. The effect of foreign ions on the determination of nickel (II) was investigated by adding the

known amount of diverse ion to a standard nickel (II) solution and by comparing the final absorbance with the standard. The results showed in Table 4. The results revealed that the presence of large amounts of foreign ions did not cause any significant change in the corrected absorbance of the nickel (II) complex. The tolerance level of the interfering ions and selectivity of this method was improved to acceptable limit $99\pm 2\%$ by using suitable masking agents.

APPLICATIONS:

Separation of nickel (II) from associated metals:

The developed method was used for separation and determination of nickel (II) from associated metal ions containing Au(III), Bi(II), Cu(II), Co(II), Sb(III), Ru(III), Ir(III), Ag(I), Hg(II), Zn(II), Cd(II), and Fe(III). At pH 9.2, nickel (II) separated from these metal ions by its extraction with 5 cm^3 of 0.02 mol L^{-1} 2',4'-dinitro APTPT and 5 cm^3 of 0.5 mol L^{-1} pyridine in chloroform. Under these conditions metal ions remain quantitatively found in the aqueous phase. Therefore, for determination of metal ions from the aqueous phase, it was evaporated to moist dryness by treating with 5 cm^3 conc. HNO_3 followed by HCl. Then the residue was dissolved in water and diluted to appropriate volume and determined by standard methods [39, 41-43]. The organic phase containing nickel (II)-2',4'-dinitro APTPT-pyridine complex was estimated spectrophotometrically at 660 nm against reagent blank. Some of the metal ions were strongly interfered with nickel (II) such as Cu(II), Hg(II), Co(II), and Cd(II)

Copper(II), Hg(II), Co(II), and Cd(II) were interferred with nickel (II) and co-extracted which affects on the colour stability of nickel (II) complex. Therefore, separation of these metal ions can be achieved by use of masking agent. Copper(II), Co(II) and Cd(II) masked by each of 1 mg of thiosulphate while Hg(II) was masked by 50 mg of sulphate, under these conditions the added metal ions remained in the aqueous phase quantitatively and were subsequently demasked by evaporation to moist dryness by treating with 2 cm^3 of conc. HClO_4 . The residue was dissolved in water, diluted to appropriate volume and metal ions were determined by standard methods (Table 5) [38, 39, 44, 45, 46]. The absorbance of nickel (II)-2',4'-dinitro APTPT-pyridine complex from organic phase was measured at 660 nm against reagent blank.

Determination of nickel (II) in a synthetic mixtures:

For validation of proposed analytical method, we have prepared the several synthetic mixtures containing $30\text{ }\mu\text{g mL}^{-1}$ of nickel (II) and known amount of different composition of metal ions were added followed by suitable masking agents. The recommended general spectrophotometric procedure

used for analysis of nickel (II). The results were obtained in good agreement with the amount added (Table 6).

Determination of nickel (II) from alloys:

Analytical applicability of proposed method was also confirmed by analysis of standard alloys such as Monel metal (Shubh Chemi Incorporate, Mumbai), Gun metal (Kamini Industries, India), Brass (Shubh Chemi Incorporate, Mumbai), Nickel-Silver (ITA Laboratory, Mumbai), Cast iron (33b) and Nickel-Base alloy (Nimonic 901). About 0.1 g of each alloy was dissolved in 5.0 mL of *aqua-regia* and were heated almost to dryness. The allowed residue was filtered to remove silica and metastannic acid if present. The filtrate was diluted with water to 100.0 mL in a standard volumetric flask. An aliquot of nickel (II) content solutions are taken and was determined by recommended general procedure. The results mentioned in Table 7 and revealed good and perfect agreement with AAS.

Analysis of nickel (II) from foundry waste effluents:

The developed method used for investigation of nickel (II) from foundry waste effluents from Kolhapur city. Toady, Kolhapur city (Maharashtra State, India) is new born city for various industries and now well known for foundry industries since last 20 years. Day by day, foundry industries are going to increases in Kolhapur region. Therefore, environmental have affected by the foundry industries because in such foudrys for removal of adhering sand, scale and decomposition products high pressure streams of water are used against the castings. During the washings of castings eliminates the black waters which are extremely diilicult to filter and clarify. Therefore such foundry effluents are directly discharges into the fresh water. An object of the present invention is to determine the trace nickel (II) from the foundry waste water in an efficient but simple manner.

The water samples were collected from various foundry region of Kolhapur city as mentioned in Table 8. Each sample (100.0 mL) was evaporated almost to dryness and treated with 5.0 mL concentrated nitric acid. The residue was boiled with 50.0 mL of water and filtered through Whatmann filter paper No. 1. The filtrate was diluted to required volume with water. An aliquot of nickel (II) solution was analyzed by the proposed method. The accuracy of the results obtained by proposed method were confirmed directly with AAS method.

Analysis of nickel (II) from electroless nickel plating waste water:

A wider variety of industrial parts were coated by electroless nickel (EN) plating techniques provides a large benefits towards the corrosion protection. The plating were carried out by chemical bath deposition techniques. Large amount of waste water discharges in to the environment fresh water. Therefore, the environment protection point of view, it is essential to develop an effective technique for determination of nickel (II) from electroless nickel plating (EN) waste water. In order to determine a nickel (II) from the electroless nickel plating waste water, the spectrophotometric method was carried out using a chromogenic reagent.

As mentioned in Table 9, the water samples were collected from various places of Gokul Shirgaon, MIDC, Kolhapur (Maharashtra State, India) and aliquot of nickel (II) solution was prepared and analyzed by same as above mentioned in topic 4.4.

CONCLUSION:

The method described the spectrophotometric determination of nickel (II) by using 2',4'-Dinitro APTPT as a metallochromic ligand. The developed method proved its sensitivity and selectivity towards the nickel (II). The developed method is simple, reproducible, rapid and reliable. Moreover, the method has advantages of less interference ions. Thus, it can acts as alternative approach to the widely used instrumental techniques for determination of nickel (II) from natural waters. Due to following important features of the proposed method, it had been used for ananalysis of nickel (II) from the industrial effluents as well as natural waters. (i) low ligand concentration; (ii) the recommended extraction procedure is a single stage; (iii) 2',4'-dinitro APTPT forms complex with nickel (II) in weak acidic medium; (iv) pyridine used as a synergent; (v) stoichiometry of extracted species is 1:2:2 (M:L:Py); (vi) the ternary complex is stable for more than 48 h.

REFERENCES:

1. De Bussy J. H., Materials and Technology, Vol. 3, Longman Group Ltd. London, 1970.
2. Sharma B. K., Environmental Chemistry, Meerut; Goel Publishing House 1997.
3. Greenwood N. N., Earnshaw A., Chemistry of Elements (1331), Pergamon Press, Oxford, 1984.
4. Patnaik P., Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil and Solid Wastes, CRC Press, Boca Raton, FL, 1997.
5. Templeton D., Biological Monitoring of Chemical Exposure in the Workplace, World Health Organization, Geneva, 1990.

6. Kristiansen J., Cristenesen J. M., Henriksen T., Nielsen N. H., Menne T. (2000), *Anal. Chim. Acta* 403, 265-272.
7. Judith T. Z., Peter T., Thomas T., *Immunotoxicology of Environment Occupational Metals*, School of Medicine, New York, 1998.
8. Gupta V. K., Prasad R., Kumar P., Mangla R. (2000), *Anal. Chim. Acta* 420, 19-27.
9. Abbaspour A., Izadyar A. (2001), *Microchemical J.* 69, 7-11.
10. Korolczuk M. (2000), *Talanta* 53, 679–686.
11. Vukomanovic D. V., Page J. A., VanLoon G. W. (1996), *Anal. Chem.* 68, 829-833.
12. Mark H. B., Koran Jr. D., Gierst L. (2001), *J. of Electroanal. Chem.* 498, 228–231.
13. Rigin V. (1993), *Anal. Chim. Acta* 283, 895-901.
14. Lau O. W., Ho S. Y. (1993), *Anal. Chim. Acta* 280, 269-277.
15. Fan X., Zhu C. (1998), *Microchem. J.* 59, 284-293.
16. Furukawa M., Shibata S. (1982), *Anal. Chim. Acta* 140, 301-307.
17. Hashem E. Y., Abu-Bakr M. S., Hussain S. M. (2003), *Spectrochim. Acta Part A* 59, 761-769.
18. Fu-Sheng W., Pei-Hua Q., Nai-Kui S., Fang Y. (1980), *Talanta* 28, 189-191.
19. Ishizuki T., Tsuzuki M., Yuchi A., Ozawa Y., Wada H. (1993), *Anal. Chim. Acta* 272, 161-167.
20. Ferreira S. L. C. (1988), *Talanta* 35 (6), 485-486.
21. Cacho J., Nerin C. (1981), *Anal. Chim. Acta*, 131, 277-280.
22. Niazi A., Yazdanipour A. (2008), *Chinese Chem. Lett.* 19, 860-864.
23. Zhao S. L., Xia X. Q., Ma H. R., Xi H. J. (1994), *Talanta* 41 (8), 1353-1356.
24. Zhao S., Xia X., Kong X., Liu T. (1997), *Talanta* 45, 13-17.
25. Ma Q., Ma H., Su M., Wang Z., Nie L., Liang S. (2001), *Anal. Chim. Acta* 439, 73–79.
26. Zhao S., Xia X., Hu Q. (1999), *Anal. Chim. Acta* 391, 365-371.
27. Safavi A., Ensafi A. A., Massoumi A. (1991), *Talanta* 38 (2), 229-231.
28. Uesugi K., Yamaguchi S. (1982), *Microchem. J.* 27 71-76.
29. Ramachandraiah C., Kumar J. R., Reddy K. J., Narayana S. L., Reddy A. V. (2008), *J. Environ. Manage.* 88, 729-736.
30. Reddy K. H., Prasad N. B. L., Reddy T. S. (2003), *Talanta* 59, 425-433.
31. Toribio F., Frenandez J. M. L., Bendito D. P., Valcarcel M. (1980), *Microchem. J.* 25, 338-347.
32. Odashima T., Ishii H. (1993), *Anal. Chim. Act.* 277, 79-88.
33. Zachariadis G. A., Themelis D. G., Kosseoglou D. J., Stratis J. A. (1998), *Talanta* 47, 161–167.
34. Ferreira S. L. C., Costa A. C. S., De Jesus D. S. (1996), *Talanta* 43, 1649-1656.

35. Costa A. C. S., Ferreira S. L. C., Andrade M. G. M., Lobo I. P. (1993), *Talanta*, 40 (8), 1267-1271.
36. Vogel A. I., *A Text Book of Quantitative Inorganic Analysis*, 3rd Ed. Longmans, London, 1975.
37. Flaschka H. A., Barnard Jr. A. J., *Chelates in Analytical Chemistry, A collection of monographs*, Vol. 4, Marcel Dekkar, Inc., New York 1972.
38. Marczenko Z., *Spectrophotometric Determination of Elements*, Ellis Horwood limited, Chichester, 1976.
39. Mathes R. (1953), *J. Am. Chem. Soc.* 75, 1747-1748.
40. Ringbom A. Z. (1939), *Z. Anal. Chem.* 115, 332.
41. Kamble G. S., Kolekar S. S., Han S. H., Anuse M. A. (2010), *Talanta* 81, 1088-1095.
42. Sandell E. B., *Colorimetric Determination of Traces Metals*, 3rd Ed., Interscience Publ. New York, 1965.
43. Anuse M. A., Chavan M. B. (1984), *Chem. Anal. (Warsaw)* 29, 409-420.
44. Kamble G. S., Kolekar S. S., Anuse M. A. (2011), *Spectrochim. Acta A* 78, 1455-1466.
45. Kamble G. S., Ghare A. A., Kolekar S. S., Han S. H., Anuse M. A. (2011), *Spectrochim. Acta A* 84, 117-124.
46. Kamble G. S., Gaikwad A. P., Kokare B. N., Kolekar S. S., Han S. H., Anuse M. A. (2011), *Ind. Eng. Chem. Res.*, 50, 11270-11279.

Table 1. Comparison of the present method with other spectrophotometric methods for the determination of nickel (II)

Reagent	λ_{\max} nm	Acidity/ pH	Beer's law validity range, ppm	Molar absorptivity Lit mol ⁻¹ cm ⁻¹ ϵ	M:L ^a	Remarks	Ref. No.
i) 2-[2-(6-Methyl benzothiazolyl)azo]-5-(N-methyl-N-sulphomethyl)amino-benzoic acid	642	pH 5.6	0-7	$\epsilon = 8.81 \times 10^4$ $s = 0.6 \times 10^{-3}$	1:2	• Most foreign ions do not interfere	15
ii) 2-[2-(6-Methyl benzothiazolyl)azo]-5-(N-ethyl-N-sulphomethyl) aminobenzoic acid	620		0-6	$\epsilon = 8.82 \times 10^4$ $s = 0.7 \times 10^{-3}$ $\epsilon = 1.03 \times 10^5$		• Good selectivity	
iii) 2-[2-(6-Methyl benzothiazolyl)azo]-5-(N-ethyl-N-carboxymethyl)aminobenzoic acid	625		0-12	$s = 0.5 \times 10^{-3}$		• Absorbance was measured after 5 min	
2-[2-(3,5-Dibromo-pyridyl)azo]-5-dimethylamino benzoic acid	618	pH 6.0	0.04-0.4	$\epsilon = 1.50 \times 10^5$	1:2	• Cu(II), Co(II), Fe(III), Pd(II), V(III) seriously interfered • Absorbance was stable for 24 h	16
4-(2-Benzo-thiazolylazo) salicylic acid	525	pH 7.0	0.59-7.08	$\epsilon = 0.6 \times 10^4$ $s = 2.824 \times 10^{-9}$	1:1	• Fe(III), F ⁻ , HPO ₄ ²⁻ interfered seriously	17
2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	520 and 560	pH 5.5	0-15	$\epsilon = 1.26 \times 10^5$	1:2	• Absorbance was measured after 30 min	18

							<ul style="list-style-type: none"> Absorbance was stable for 24 h 	
2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	547	pH 2.5	0.4-72	$\epsilon = 1.0 \times 10^5$	-		<ul style="list-style-type: none"> Equilibrium time 20 min Absorbance measured at 457 nm and 526 nm 	19
2-(2-Thiazolylazo)- <i>p</i> -cresol		pH 5.7	20-70	$\epsilon = 2.6 \times 10^4$	-		<ul style="list-style-type: none"> Equilibrium time 10 min Absorbance was stable for 24 h 	20
1-(1,2,4-Triazolyl-3-azo)-2 naphthol		pH 5.0	0.2-2.8	$\epsilon = 3.7 \times 10^4$	-		<ul style="list-style-type: none"> Cd(II), Co(II), Cu(II), Fe(III), Hg(II), La(III), V(IV) were interfered 	21
1-(2-Thiazolylazo) 2-naphthol		pH 8.0	0.05-1.05	$s = 0.012$	-		<ul style="list-style-type: none"> Simultaneously determined Co(II) and Cu(II) with nickel (II) 	22
<i>p</i> -Acetyl aresenazo		pH 6.0	0-0.8	$\epsilon = 6.5 \times 10^4$	1:2		<ul style="list-style-type: none"> Absorbance was stable for 48 h Maximum absorbance measured after 1 min 	23
Benzothiazolyldiazoaminoazobenzene		pH 550	0-0.7	$\epsilon = 1.96 \times 10^5$	-		<ul style="list-style-type: none"> <i>p</i>-Octyl 	24

		9.4						polyethylene glycol phenyl ether was used as a emulsifier	
								<ul style="list-style-type: none"> Equilibrium time 50 min 	
5,17-Bis(quinoyl-8-azo)-25,26,27,28-tetrahydroxycalix [4]arene	pH	580	1.7 x 10 ⁻⁷ – 5.1 x 10 ⁻⁶	$\epsilon = 1.28 \times 10^5$	1:1			<ul style="list-style-type: none"> Highly sensitive Absorbance was stable for 3 h 	25
5-(6-Methoxy-2-benzothiazole aminoquinolene	azo)-8-pH	623	0-0.32	$\epsilon = 1.28 \times 10^5$	1:3			<ul style="list-style-type: none"> CTAB was used as a surfactant Absorbance was measured after 20 min 	26
Ammonium dithiocarboate	2-amino-1-cyclohexene-1-pH	535	0-4.0	$\epsilon = 2.8 \times 10^4$	1:2			<ul style="list-style-type: none"> Higher pH range Low interference of ions 	27
2-Hydroxy-1-naphthaldoxime	pH	410	5-50	$\epsilon = 8.1 \times 10^3$	1:2			<ul style="list-style-type: none"> Equilibrium time 10 min 	28
N-ethyl-3-carbazolecarboxy-thiosemicarbazone	aldehyde-3-pH	400	1.2-5.6	$\epsilon = 1.114 \times 10^4$ $s = 5.29 \times 10^{-3}$	-			<ul style="list-style-type: none"> Absorbance was stable for 72 h Less interfered 	29
1-Phenyl-1,2-propanedione-2-oxime thiosemicarbazone	pH	395	0.42-3.76	$\epsilon = 1.01 \times 10^4$ $s = 5.0 \times 10^{-3}$	1:2			<ul style="list-style-type: none"> Absorbance was stable for 12 h 	30

2,2'-Dihydroxybenzophenone thiosemicarbazone	pH 7.8	385	5-40	$\epsilon = 15.4 \times 10^3$	-	<ul style="list-style-type: none"> Absorbance was stable for 24 h 	31
2-Pyridinecarbaldehyde 3,5-dinitro-2-pyridylhydrazone	pH 4.5	484	0-6	$\epsilon = 1.0 \times 10^5$	1:2	<ul style="list-style-type: none"> Equilibrium time 7 min 	32
2-Benzoyl pyridine-2-pyridyl hydrazone	pH 8.3	375, 385	0-1.5	$\epsilon = 5.04 \times 10^4$	-	<ul style="list-style-type: none"> Extraction method was free from interference ions Synergistic effect caused by thiocyanate ion 	33
2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	pH 5.25	530 and 562	10-200	$\epsilon = 1.10 \times 10^5$	1:2	<ul style="list-style-type: none"> Triton X-100 was used as a surfactant Absorbance was measured after 50 min Absorbance was stable for 24 h 	34
2-(5-Bromo-2-pyridylazo)-5-diethylaminophenol	pH 4.5	530 and 560	0-0.40	$\epsilon = 1.22 \times 10^4$ at 530 and $\epsilon = 8.20 \times 10^4$ at 560 nm	-	<ul style="list-style-type: none"> Tergitol NPX was used as a surfactant Absorbance was measured after 50 min Absorbance was stable for 6 h 	35

Table 2. Spectral characteristics and precision data of nickel (II)-2',4'-dinitro APTPT-pyridine complex

Optical characteristics and precision	Parameters
Solvent	Chloroform
λ_{\max} (nm)	660
pH range	8.7–9.7
2',4'-dinitro APTPT concentration	5 mL (0.02 mol L ⁻¹)
Pyridine concentration	5 mL (0.5 mol L ⁻¹)
Equilibrium time (min)	10
Stability (h)	> 48
Beer's law range ($\mu\text{g mL}^{-1}$)	5-50
Ringbom optimum conc. range ($\mu\text{g mL}^{-1}$)	10-40
With pyridine	
Molar absorptivity (lit mol ⁻¹ cm ⁻¹)	1.67×10^3
Sandell's sensitivity ($\mu\text{g cm}^{-2}$)	0.058
Without pyridine	
Molar absorptivity (lit mol ⁻¹ cm ⁻¹)	7.4×10^2
Sandell's sensitivity ($\mu\text{g cm}^{-2}$)	0.78
Relative standard deviation*, (%)	0.16
Range of error	± 0.2
Mean recovery	99.8 ± 0.06
Stoichiometry of the extracted complex	1:2:2

* Average of five determinations

Table 3. Effect of solvent on extractability of nickel (II)-2',4'-dinitro APTPT-pyridine complex

Solvent	Dielectric constant	λ_{\max} , nm	Absorbance	% Extraction
Kerosene	1.80	460	0.032	6.14
<i>n</i> -Butanol	11.20	465	0.039	7.48
Amyl acetate	17.10	460	0.050	9.59
Amyl alcohol	2.30	450	0.115	22.07
Toluene	2.38	415	0.138	26.48
Xylene	5.00	425	0.303	58.15
Methyl isobutylketone	13.11	445	0.326	62.57
1,2-Dichloroethane	2.24	425	0.439	84.26
Carbon tetrachloride	4.40	435	0.486	93.28
Chloroform	10.50	460	0.512	99.99

Table 4. Study of diverse ions for the determination of 30 $\mu\text{g mL}^{-1}$ nickel (II) with 2',4'-dinitro APTPT at 660 nm (relative error $\pm 2\%$)

Ions added as	Tolerance limit, mg
Fluoride, bromide, nitrate, nitrite, tartarate, malonate, oxalate,	100
Mg(II), Ca(II), Te(IV), sulphate, thiourea, salicylate	50
Ir(III), Tl(III), Se(IV), acetate, succinate	25
Mo(VI), Al(III), Zn(II), Ga(III), Sr(II), Nb(V)	15
Mn(II) ^c , Bi(III), W(VI), Sn(II), Cd(II) ^a , Hg(II) ^b , Pd(II), citrate	10
In(III), Cr(VI) ^d , Cr(III), Sn(IV), Co(II) ^a , Mn(VII) ^a , ascorbate	5
Y(III), Th(IV), Fe(II), Pb(II), Pt(IV), Ti(III), Gd(III), Cu(II) ^a	3
Sb(III), Au(III), Ag(I), Ru(III), Fe(III), thiocyanate, thiosulphate	1
U(VI), Zr(IV), Os(VIII), Rh(III)	0.500
Iodide, EDTA	None

^a = Masked by 1mg Thiosulphate^b = Masked by 50 mg Sulphate^c = Masked by 100 mg Fluoride^d = Masked by 10 mg Citrate

Table 5. Separation of nickel (II) from associated metal ions

Metal ion	Amount taken, μg	Average % Recovery*	R.S.D. %	Chromogenic ligand	Reference number
Ni(II)	300	99.8	0.15		
Hg(II) ^b	100	99.9	0.07	PAR	38
Ni(II)	300	99.5	0.49		
Zn(II)	100	98.4	1.11	PAR	38
Ni(II)	300	99.8	0.22		
Cd(II) ^a	100	99.5	1.23	PAR	38
Ni(II)	300	99.9	0.27		
Bi(III)	100	99.7	0.11	Ascorbic acid + KI	39
Ni(II)	300	99.8	0.20		
Sb(III)	250	98.8	1.32	Ascorbic acid + KI	39
Ni(II)	300	99.9	0.06		
Fe(III)	50	98.6	1.39	Thiocyanate	39
Ni(II)	300	99.7	0.23		
Ir(III)	150	99.6	0.41	HBr + SnCl ₂	39
Ni(II)	300	99.8	0.09		
Au(III)	1000	99.9	0.17	2',4'-Dinitro APTPT	41
Ni(II)	300	99.7	0.30		
Ru(III)	200	99.6	0.42	Thiourea	43
Ni(II)	300	99.9	0.10		
Cu(II) ^a	500	99.8	0.05	2',4'-Dinitro APTPT	44
Ni(II)	300	99.9	0.24		
Co(II) ^a	100	99.8	0.15	2',4'-Dinitro APTPT	45
Ni(II)	300	99.9	0.15		
Ag(I)	50	99.7	0.26	2',4'-Dinitro APTPT	46

* = Average of five determinations ^a = Masked by 1mg Thiosulphate ^a = Masked by 50mg Sulphate

Table 6. Determination of nickel (II) from ternary synthetic mixtures

Composition (μg)	Average Recovery [*] , %	R.S.D., %
Ni(II), 300; Cu(II) ^a , 300; Co(II) ^a , 100	99.9	0.09
Ni(II), 300; Fe(III), 50; Mn(II), 100	99.9	0.12
Ni(II), 300; Cu(II) ^a , 300; Zn(II), 100	99.8	0.09
Ni(II), 300; Ag(I), 50; Au(III), 100	99.7	0.18
Ni(II), 300; Pd(II), 100; Au(III), 100	99.8	0.13
Ni(II), 300; Pd(II), 100; Ir(III), 200	99.9	0.15
Ni(II), 300; Mn(II), 100; Mo(VI), 100	99.8	0.09
Ni(II), 300; Cd(II) ^a , 100; Pb(II), 100	99.8	0.09
Ni(II), 300; Hg(II) ^b , 100; Bi(III), 100	99.9	0.09
Ni(II), 300; Sn(II), 300; Pb(II), 100	99.9	0.17
Ni(II), 300; Ag(I), 100; Cd(II) ^a , 100	99.9	0.10
Ni(II), 300; Au(III), 100; Hg(II) ^b , 100	99.9	0.09

* Average of five determinations

^a = Masked by 1mg Thiosulphate

^b = Masked by 50 mg Sulphate

Table 7. Determination of nickel (II) from alloys

Composition of Alloy, %	Certified values of Ni(II), %	Amount of Ni(II) found*, %		Confidence limit $\alpha = 0.95$	R.S.D., %
		AAS method	Propose d method		
		Monel Metal (Shubh Chemi Incorporate, Mumbai) Cu ^a , 80.1; Mn ^b , 13.50; Fe, 0.68	4.65		
Gun Metal (Kamini Industries supplied standards, India) Cu ^a , 65; Fe, 0.5; Sn, 1; Pb, 20, Zn, 30	0.3	0.3	0.29	0.13	0.08
Brass (Shubh Chemi Incorporate, Mumbai) Zn, 41.90; Fe, 0.78; Mn ^b , 0.55; Al, 0.51	0.3	0.3	0.28	0.21	0.15
Nickel-Silver (ITA, Laboratory, India) Cu ^a , 54.6; Pb, 0.13; Sn, 0.05; Mn ^b , 0.21	17.4	17.2	17.2	0.08	0.03
Cast Iron alloy 33b Si, 2; Mn ^b , 0.5; Cr, 0.5; Mo, 0.5	2.0	2.0	1.92	0.06	0.15
Nickel-Base alloy 387 BCS (Nimonic 901) Cr ^c , 12.46; Co ^a , 21; Ti, 2.95; Al, 0.24; Mo, 5.83; Mn ^b , 0.08; Fe, 36; Cu, 0.032	41.9	41.8	41.76	0.11	0.09

* = Average of five determinations ^a = Masked by 1mg Thiosulphate

^b = Masked by 100 mg Fluoride ^c = Masked by 10 mg Citrate

Table 8. Analysis of nickel (II) from foundry waste water effluents

Foundry waste effluent water	Amount of Ni(II) found*		Confidence limit $\alpha = 0.95$	R.S.D., %
	mg L ⁻¹			
	Proposed method	AAS method		
Gokhale College, Kolhapur ^a	7.4	7.3	0.03	0.002
Udyamnagar, Kolhapur ^a	9.8	9.7	0.21	0.016
Near Panchanganga River ^a	12.5	12.4	0.11	0.004
Rankala Lake ^b	4.6	4.5	0.06	0.012
Rankala Lake ^b	4.4	4.4	0.08	0.031
MIDC-Kagal ^c	14.8	14.9	0.11	0.028

* Average of five determinations

^a Jayanti Nala (River), Kolhapur City, Maharashtra, India.

^b Rankala Lake, Kolhapur City, Maharashtra, India.

^c Waste effluent water from MIDC-Kagal, Kolhapur, Maharashtra, India.

Table 9. Analysis of nickel (II) from electroless nickel plating waste water

Electroless nickel plating waste water	Amount of Ni(II) found*		Confidence limit $\alpha = 0.95$	R.S.D., %
	mg L ⁻¹			
	Proposed method	AAS method		
Waste water Sample 1 ^a	4.1	4.3	0.02	0.014
Waste water sample 2 ^a	4.8	4.7	0.02	0.006
Waste water sample 3 ^b	5.9	5.8	0.13	0.011
Waste water sample 4 ^b	6.3	6.5	0.05	0.018

* Average of five determinations

^a Gokulshirgaon, MIDC, Kolhapur, Maharashtra, India.

^b Shirol MIDC, Kolhapur, Maharashtra, India.

Figures:

Fig. 1. (A) Absorption spectra of 2',4'-dinitro APTPT Vs. Chloroform blank

(B) Absorption spectra of Ni(II)-2',4'-dinitro APTPT-pyridine complex Vs. 2',4'-dinitro APTPT blank

Ni(II) = $30 \mu\text{g mL}^{-1}$, pH = 9.2, 2',4'-Dinitro APTPT = 5 cm^3 of 0.02 mol L^{-1} , Pyridine = 5 cm^3 of 0.5 mol L^{-1} , Solvent = Chloroform, Equilibrium Time = 10 min, Wavelength = 300 to 800 nm.

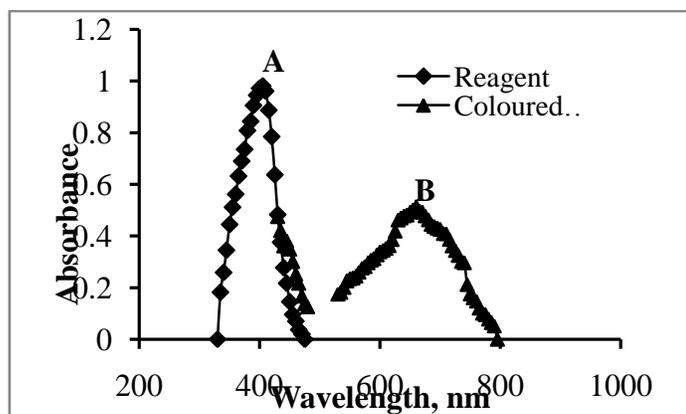


Fig. 2. Effect of pH on the extraction of

(A) Ni(II)-2',4'-dinitro APTPT-pyridine complex

(B) Ni(II)-2',4'-dinitro APTPT complex

Ni(II) = $30 \mu\text{g mL}^{-1}$, pH = 1-14, 2',4'-Dinitro APTPT = 5 cm^3 of 0.02 mol L^{-1} , Pyridine = 5 cm^3 of 0.5 mol L^{-1} , Solvent = Chloroform, Equilibrium Time = 10 min

$\lambda_{\text{max}} = 660 \text{ nm}$.

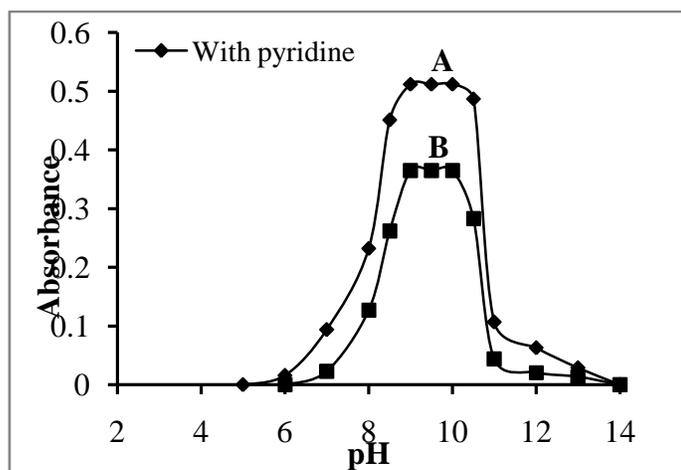


Fig. 3. Slope ratio method: With fixed pyridine concentration

Log D_[Ni(II)] – Log C_[2',4'-dinitro APTPT] plot for determination of composition of extracted species in chloroform

Ni(II) = 30 $\mu\text{g mL}^{-1}$, pH = 8.0 and 10.2, 2',4'-Dinitro APTPT = 0.1 to 3.5 cm^3 of 0.02 mol L^{-1} Pyridine = 5 cm^3 of 0.5 mol L^{-1} , Solvent = Chloroform, Equilibrium Time = 10 min, λ_{max} = 660 nm.

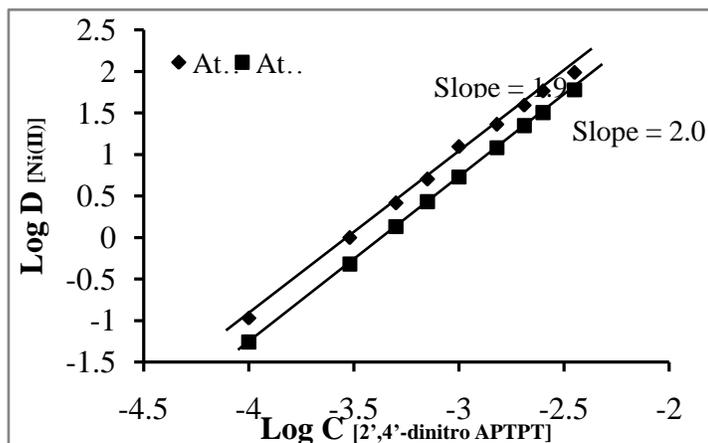


Fig. 4. Slope ratio method: With fixed 2',4'-dinitro APTPT concentration:

Log D_[Ni(II)] – Log C_[Pyridine] plot for determination of composition of extracted species in chloroform

Ni(II) = 30 $\mu\text{g mL}^{-1}$, pH = 8.0 and 10.2, 2',4'-Dinitro APTPT = 5 cm^3 of 0.02 mol L^{-1} Pyridine = 0.1 to 3.5 cm^3 of 0.5 mol L^{-1} , Solvent = Chloroform, Equilibrium Time = 10 min, λ_{max} = 660 nm.

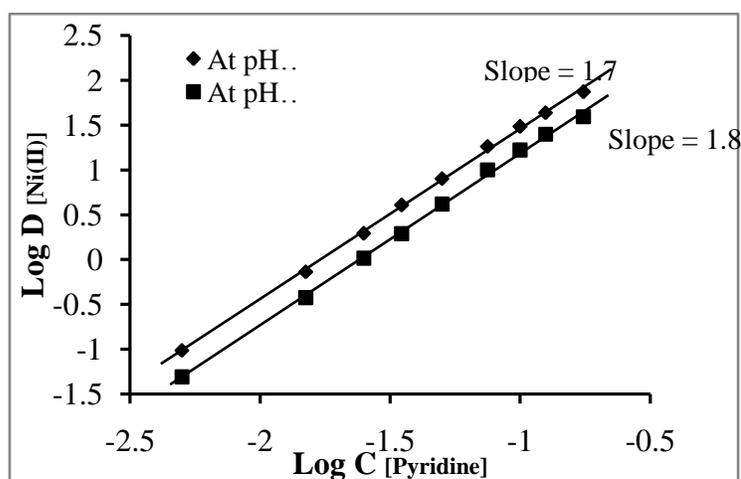


Fig. 5. Mole ratio method for determination of composition of complex Ni(II)-2',4'-dinitro APTPT-pyridine complex

Ni(II) = 0.2 to 1.8 cm³ of 50 μg mL⁻¹, pH = 9.2, 2',4'-Dinitro APTPT = 1.0 cm³ of 8.518 × 10⁻³ mol L⁻¹, Equilibrium Time = 10 min, Pyridine = 5.0 cm³ of 8.518 × 10⁻³ mol L⁻¹, Solvent = Chloroform, λ_{max} = 660 nm.

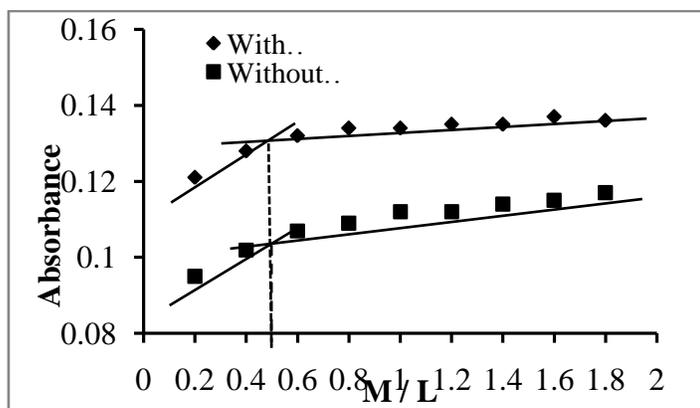


Fig. 6. Job's plot for continuous variation method for Ni(II)-2',4'-dinitro APTPT-pyridine complex

Ni(II) = 0.2 to 1.8 cm³ of 50 μg mL⁻¹, pH = 9.2, Pyridine = 5.0 cm³ of 8.518 × 10⁻³ mol L⁻¹, Equilibrium Time = 10 min, 2',4'-Dinitro APTPT = 0.2 to 1.8 cm³ of 8.518 × 10⁻³ mol L⁻¹, Solvent = Chloroform, λ_{max} = 660 nm.

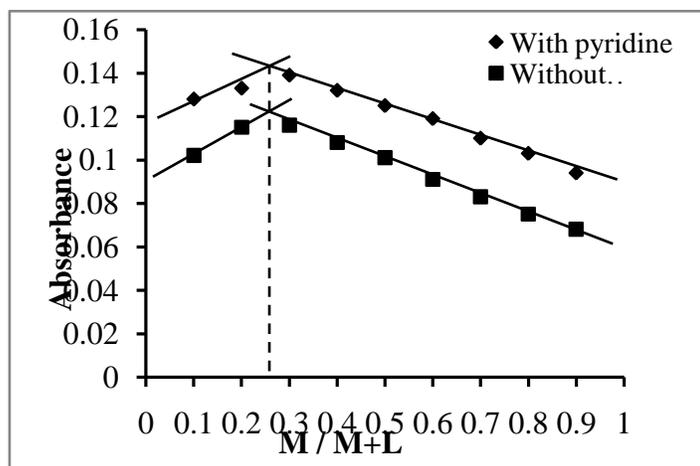
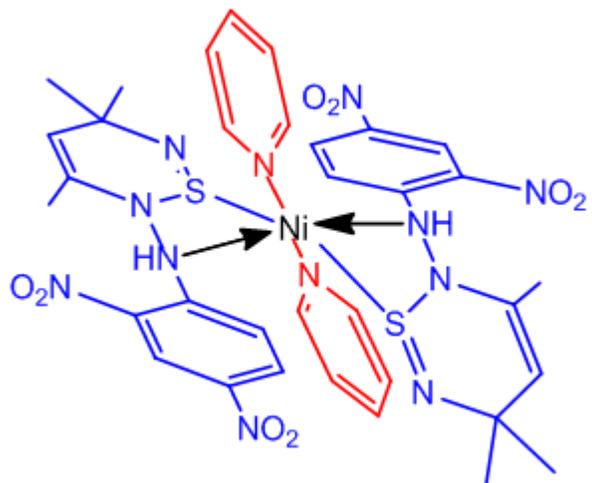


Fig. 7. Structure of Ni(II)- 2',4'-dinitro APTPT-pyridine complex



PLANKTON COLLECTION, PRESERVATION AND MOUNTING WITH CASE STUDY OF COASTAL WATERS OF DIGHA, BAY OF BENGAL

**Saumya Dash¹, Rajesh Kumar Behera², Anupama Pati¹, Pradipta Kumar Mohapatra²,
R. K. Sarangi³, Dipti Raut¹ and Lipika Patnaik*¹**

¹Environmental Science Laboratory, Department of Zoology, Ravenshaw University, Cuttack

²Department of Botany, Ravenshaw University, Cuttack 753 003 INDIA

³Indian Space Research Organization, Ahmadabad, Gujarat, INDIA

*Corresponding author E-mail: lipika_pat@yahoo.co.uk

INTRODUCTION:

Phytoplanktons are the primary producers in the sea and act as the base of marine food chain. These are the indicator of water quality. Zooplanktons are the drifting primary consumers that feed on the phytoplankton of the marine ecosystem. Sunlight and nutrients are the limiting factor for phytoplankton growth and reproduction. Nutrients are distributed throughout the water body, but sunlight is restricted only to the photic zone. Thus the planktons always try to float and stay near the surface layer of the water column. Planktons are classified in to the following types based on their size.

Femtoplankton – 0.02-0.2 μ m

Picoplankton – 0.2-2 μ m

Nanoplankton – 2-20 μ m

Microplankton – 20-200 μ m

mesoplankton – 0.2-20mm

Megaplankton – 20-200mm

Plankton- Collection, Slide Preparation, Counting, Identification:

The water samples should be collected using Niskin water sampler and about 8-10 litres of water should be filtered through the plankton net of varying mesh size based on requirement. The samples are preserved in 5% formaldehyde solution followed by the addition of 0.08ml of Lugol's iodine to 10ml of the sample. This can be preserved for several days. After at least 24hr of preservation the sample should be centrifuged at 1000rpm for 10minutes. Discard the supernatant and the pellet is to be collected in a watch glass for mounting. Take a drop of DPX on a clean and dry glass slide. Transfer one to two drops of processed sample over DPX and mount with a cover slip. The slide should be allowed to

dry completely. After 48hr of drying the slide can be observed under a microscope for identification of planktons.

Sample collection from Coastal waters of Digha, Bay of Bengal:

Water samples were collected from the coastal waters of digha, Bay of Bengal in the month of November 2015, January, 2016 and March, 2016. Sampling was done bimonthly using Trawlers hired from Shankarpur jetty which is 13 kms from Digha Sea Beach. Plankton samples from the surface water were collected by using Niskin water sampler and plastic bucket. Around 8-10 litres of water was filtered through the plankton net. After collection the sample was filtered through plankton net of 50 μ mesh size and immediately preserved in 5% formaldehyde solution. Then 0.08ml Lugol's iodine was added to 10ml of sample. This can be preserved for several days. After at least 24hr of preservation the sample was centrifuged at 1000rpm for 10minutes. The supernatant was taken out without disturbing the pellet. Then the pellet was collected in a watch glass for mounting. A drop of DPX mount was taken on a clean and dry glass slide. Over the DPX one to two drops of collected sample was placed and mounted with a cover slip. The slide was labelled properly and left for drying. After 48hr of drying the slide was observed under a microscope for identification of planktons.

Counting using Sedgwick - Rafter cell:

Sedgwick-Rafter cell is a rectangular cavity in the glass slide (50 x 20 x 1mm) having 1ml (1000mm³) capacity. The floor of the cavity is divided into 1 cubic mm square area. The concentrated sample was mixed properly and 1ml was transferred into the cell cavity. Cover slip was placed carefully avoiding air bubbles and allowed to settle for 15min. Planktons were counted under low magnification.

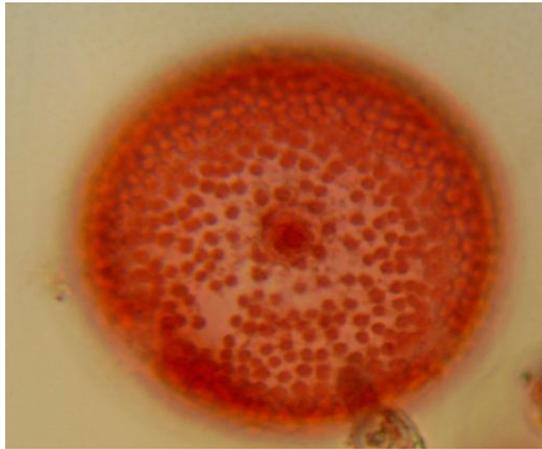
Identification:

Prepared slides were observed under compound microscope at magnification of 10x and 40x. Photographs of the observed planktons were taken with the help of a camera(Magnus Pro 3.7) which was connected to the microscope through an adapter and identified using various monographs, NIO Identification manual and from marinespecies.com web site.



Shankarpur Jetty, Digha

Recorded planktons from Digha coast:



Coscinodiscus sp. (Ehrenberg, 1839) Valve view

Systemic Position:		Salient features:	
Phylum	Ocrophyta	1.	Cells are circular with radiating or non radiating valves.
Class	<u>Bacillariophyceae</u>	2.	Valves are convex.
Sub class	Coscinodiscophycidae	3.	Outer layer is hard, porous and composed of silica.
Order	<u>Coscinodiscales</u>		
Family	<u>Coscinodiscaceae</u>		
Genus	Coscinodiscus		



***Dinophysis caudata* (Saville-Kent, 1881)**

Systemic Position:		Salient features:
Phylum	Myzozoa	1. Cells have small epitheca and large hypotheca.
Class	Dinophyceae	2. Body girdle is surrounded by wing like structures.
Order	Dinophysiales	3. Presence of Sulcus is a prominent feature of Dinophyceae.
Family	Dinophysiaceae	
Genus	Dinophysis	
Species	caudata	



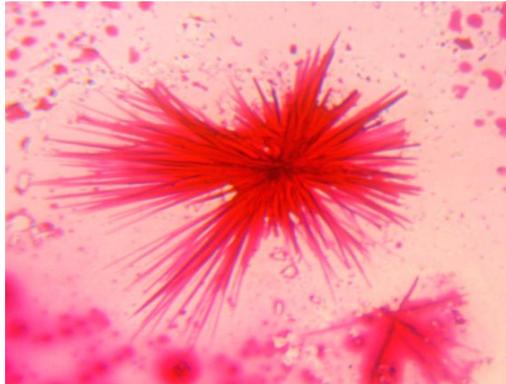
***Ceratium fusus* (Schrank, 1793,(Ehrenberg), Dujardin, 1841)**

Systemic Position:		Salient features:
Phylum	Pyrrophytophyta	1. Needle- shaped body.
Class	Dinophyceae	2. Epitheca long and tapers into slightly bent apical horn.
Order	Gonyaulacales	3. Hypotheca with left antapical horn usually longer than apical horn.
Family	Ceratiaceae	
Genus	Ceratium	



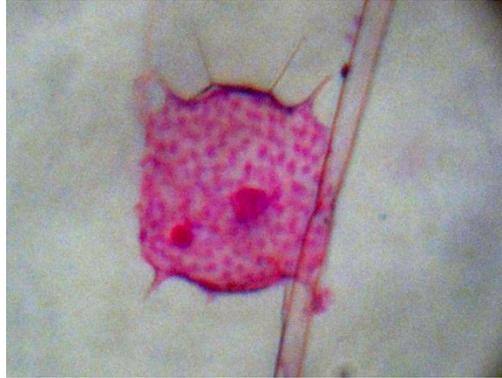
Pleurosigma sp. (W. Smith, 1852)

Systemic Position:		Salient features:
Phylum	Ochrophyta	1. Elongated cell with tapering ends.
Class	Bacillariophyceae	2. Central raphe is sigmoid.
Order	Naviculales	
Family	Pleurosigmataceae	
Genus	Pleurosigma	



Trichodesmium sp. (Ehrenberg ex, Gomont, 1892)

Systemic Position:		Salient features:
Phylum	Cyanobacteria	1. Forms blooms on the surface.
Class	Cyanophyceae	2. Presence of parallel trichomes.
Order	Oscillatoriales	
Family	Phormidiaceae	
Genus	Trichodesmium	



***Biddulphia mobiliensis* (With chromatophores) S.F Gray, 1821**

Systemic Position:		Salient features:
Phylum	Ochrophyta	1. Forms short chains.
Class	Bacillariophyceae	2. Surface of the valve has spines or ridges.
Order	Biddulphiales	
Family	Biddulphiaceae	
Genus	Biddulphia	



***Microsetella norvegica* (Boeck , 1865)**

Systemic Position:		Salient features:
Phylum	Arthropoda	1. Slender body laterally compressed.
Order	Harpacticoida	2. Urosome is as wide as prosome.
Family	Ectinosomatidae	3. Very long furcal setae.
Genus	Microsetella	
Species	norvegica	



Protoperidinium sp. (Bergh, 1882)

Systemic Position:		Salient features:
Phylum	Myzozoa	1. Body is spherical or turnip shaped.
Class	Dinophyceae	2. Presence of short longitudinal flagellum
Order	Peridinales	
Family	Protoperidiniaceae	
Genus	Protoperidinium	



Acrocalanus longicornis (Giesbrecht, 1888)

Systemic Position:		Salient features:
Phylum	Arthropoda	1. Cephalosome is rounded.
Class	Maxillopoda	2. Teeth on the proximal portion are more in numerous.
Order	Calanoida	3. Armature of the distal portion of the terminal segment of 4 th legs has few fine teeth.
Family	Paracalanidae	
Genus	Acrocalanus	
Species	longicornis	



Tintinnid sp. (Kofoid & Campbell, 1929)

Systemic Position:		Salient features:
Phylum	Ciliophora	1. Vase shaped body.
Class	Oligotrichea	2. Outermost layer is known as Lorica.
Order	Choreotrichida	
Genus	Tintinnid	

REFERENCES:

1. Bergh, (1881), Revista del Museo Argentino de Ciencias Naturales “ Bernardino Rivadavia” Instituto Nacional de Investigacion de la Cisncias Naturales, Hidrobiologia. 4(1), P 1-79.
2. Dujardin,F. (1841),Histoire naturelle des Zoophytes. Infusoires, comprenant la physiologie etla classification de ce animaux. Etlamaniere de les etudier a l’ aide du microscope. Ouvrage accompagne de planches. Libraire Encyclopedique de Robet: Paris, xii+ 684.
3. Ehrenberg,C.G.(1834), Dritter Beitrag Zure Erkenntniss grosser Organization in der Richtung des Kleinsten Raumes Abhandlungen der Koniglichen . Akademie der Wissenschaften in Berlin1833,P 145- 336.
4. Gomont, M.(1892),Monographie des oscillariees (Nostocacees Homocystees). Deu xieme partie.- Lyngbyeys. Annales des Sciences Naturelles,Botanique. 7(16),P 91-264.
5. Goswami, S.C. (2004), Zooplankton Methodology, Collection & Identification– a field Manual, National Institute of Oceanography, Goa, India
6. Gray, S.F. (1821), A natural arrangement of British plants, according to their relations to each other, as pointed out by Jussieu, De Candolle, Brown and C. Including those cultivated for use; with an introduction to Botany.1: [i] xxviii, [1]-824.
7. Harold, G. M. (1986), Identification Manual for Phytoplankton of the United States Atlantic Coast , EPA / 600 / 4-86 / 003

8. Hoppenrath, M. Elbrächter, Drebes, G. (2009), Marine Phytoplankton. Selected microphytoplankton from the North Sea around Helgoland and Sylt. Koeltz Scientific Books.
9. Kofoid and Campbell (1929), A conspectus of the marine and freshwater ciliate belonging to the suborder Tintinnoinea with description of new species principally from the Agassiz expedition to the Eastern Tropical Pacific (1904-1905).
10. Moreira, R.A., Rocha, O. Santos, R.M., Laudares-Silva, R., Dias, E.S. and Eskinazi-Sant Anna, E.M. (2015), First record of *Ceratium furcoides* (Dinophyta), an invasive species, in a temporary high-altitude lake in the Iron Quadrangle (MG, South east Brazil), *Brazil. J. Biol.*, 75, No.1, pp. 98-103.
11. Robert, P. (2003), A guide to the Marine Plankton of southern California 3rd Edition. UCLA Ocean GLOBE & Malibu High School, California.
12. Sahu, K.C., Baliarsingh, S.K., Srichandan, S., Aneesh A. Lotliker, Kumar, T.S. (2013), Monograph on Marine Plankton of East Coast of India-A Cruise Report, Indian National Centre for Ocean Information Services, Hyderabad, 146pp.
13. Saville-Kent. (1881), A manual of the Infusoria. D. Bogue, London.
14. Smith, W. (1852), Notes on the Diatomaceae with descriptions of British species included in the genus *Pleurosigma*. *Annals and Magazine of Natural History*. 29, P 1-12.
15. Telesh I, Postel L, Heerkloss R, Mironova E, Skarlato S (2009) Zooplankton of the open Baltic Sea: Extended atlas. BMB Publication
16. Todd, C.D., Laverack M.S. & Boxshall, G.A. (1991), Coastal marine zooplankton, A practical manual for students, Cambridge University press, New York, 5-103.pp.
17. Verleucar, X.N. & Somshekar Desai, (2004), Phytoplankton Identification Manual, National Institute of Oceanography, Goa, India.
18. World Register of Marine species- www.marinespecies.org
19. www.algaebase.org

SEA WATER NUTRIENT ANALYSIS METHODS

**Saumya Dash¹, Rajesh Kumar Behera², Anupama Pati¹, Pradipta Kumar Mohapatra²,
R. K. Sarangi³, Dipti Raut¹ and Lipika Patnaik*¹**

¹Environmental Science Laboratory, Department of Zoology, Ravenshaw University, Cuttack

²Department of Botany, Ravenshaw University, Cuttack 753 003 INDIA

³Indian Space Research Organization, Ahmadabad, Gujarat, INDIA

*Corresponding author E-mail: lipika_pat@yahoo.co.uk

INTRODUCTION:

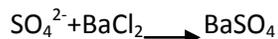
The quality of coastal water is dependent on its nutrient concentration and other indices. Coastal water receives waste from different sources and can result in harmful algal blooms. Anthropogenic stress inducers on fresh water bodies ultimately reach the marine environment and pollute the coastal waters. The primary nutrients which act as regulators of good health of coastal environment are Nitrate and Phosphate. These Nutrients in Sea water are highly unstable and in excess concentration they induce flourishing of harmful marine plants and animals. Due to their sensitivity, marine water samples for all nutrients should be maximally analysed within six hours after collection [2]. This chapter deals with basic Nutrient analysis methodology of marine samples. The methods discussed have been standardized in our laboratory.

The mode of preservation:

Phosphate	Refrigeration at -4°C
Sulphate	Refrigeration at -4°C
Silicate	Refrigeration at -4°C
Nitrate	Refrigeration at -4°C
Nitrite	Refrigeration at -4°C

I. DETERMINATION OF SULPHATE IN SEA WATER**PRINCIPLE:**

The turbidimetric method of measuring sulphate is based on the fact that sulphate is precipitated as barium sulphate by addition of barium chloride and this tendency is enhanced in presence of sodium chloride, hydrochloric acid and glycerol [4].



The absorbance of the barium sulphates formed is measured by a spectrophotometer at 420 nm and the sulphate ion concentration is determined by comparison of the reading with a standard curve.

MATERIALS REQUIRED:**APPARATUS REQUIRED:**

- UV- Visible Spectrophotometer
- Magnetic stirrer
- Volumetric flask
- Volumetric pipette
- Beaker
- Glass rod
- Measuring Cylinder
- Spatula
- Pipette
- Wash Bottle
- Tissue Paper

CHEMICALS REQUIRED:

- Isopropyl Alcohol
- Glycerol
- 35% Hydrochloric acid
- Sodium Chloride
- Barium Chloride
- Sodium Sulphate
- Distilled Water

PROCEDURE:**PREPARATION OF REAGENTS:****Conditioning reagent**

Take 250 ml volumetric flask and transfer 25ml of glycerol, followed by 15ml of 35% HCl. To the same flask add exactly 50ml of 95% Isopropyl alcohol and mix well. Accurately weigh 37.5g Sodium chloride and dissolve it in distilled water separately. Then mix all the contents and make up the final volume to 250ml.

Standard Sulphate solution

Dissolve 0.1479g of anhydrous Na_2SO_4 (Sodium sulphate) in distilled water and make up the final volume to 1000ml. The stock solution contains 100mg/l of SO_4^{2-} (Sulphate).

Preparation of Standard for Standard curve, Blank and sample analysis

Take 10ml, 20ml, 30ml, 40ml and 50ml of standard stock Sulphate solution in five different volumetric flasks. Then adjust the volume to 100ml by adding distilled water. These solutions contain 10mg/l, 20mg/l, 30mg/l, 40mg/l and 50mg/l of sulphate respectively. To each flask add 5ml of conditioning reagent and stir the sample with a magnetic stirrer. Add 2g of BaCl_2 during stirring and continue this for 1minute. Measure the absorbance at 420 nm.

For blank take 100ml of distilled water, add 5ml of conditioning reagent and 2g of BaCl_2 during stirring and continue this for 1minute. Measure the absorbance at 420 nm.

For sample analysis filter the sample through Whatman No. 1 filter paper. Take 20ml of the filtered sample in a volumetric flask and then make up the final volume to 100ml by adding distilled water. To this add 5ml of conditioning reagent and 2g of BaCl_2 as mentioned above. Then measure the absorbance at 420nm. Unknown concentration of Sulphate can be calculated from the Standard curve.

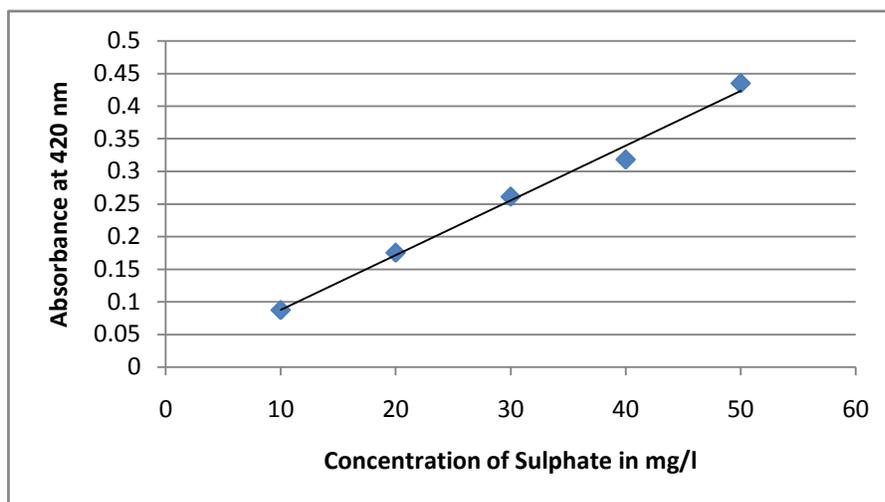


Figure 1. Standard curve of Sulphate

II. DETERMINATION OF SILICATE IN SEA WATER

PRINCIPLE:

Sea water reaction with molybdate results in the formation of silicomolybdate, phosphomolybdate and arsenomolybdate complex. Metol and oxalic acid are used as reducing solution capable of reducing the silicomolybdate complex to give a blue reduction compound. The reducing solution also decomposes any phosphomolybdate or arsenomolybdate to prevent interference from phosphate and arsenate [3].

MATERIALS REQUIRED:

APPARATUS REQUIRED:

- UV- Visible Spectrophotometer
- Volumetric flask
- Volumetric pipette
- Beaker
- Glass rod
- Measuring Cylinder
- Spatula
- Pipette
- Wash Bottle
- Tissue Paper

CHEMICALS REQUIRED:

- Ammonium molybdate
- 35% HCl
- Metol Sulphite
- Na_2SO_3
- Oxalic acid
- H_2SO_4
- Sodium silicofluoride (Na_2SiF_6)

PROCEDURE:

PREPARATION OF REAGENTS:

Ammonium molybdate

Dissolve 0.4g of ammonium molybdate in 30ml of distilled water and add 1.2ml of 35% HCl . Make up the final volume to 50ml and keep it in a polyethylene bottle.

Metol sulphite

Dissolve 0.48g of Na_2SO_3 in 40ml of distilled water, to this add 0.8g of metol. After dissolving, filter the solution through Whatman No-1 filter paper and store in clean glass stoppered bottle.

Oxalic acid

Dissolve 2g of oxalic acid in 20ml distilled water and store in a clean glass bottle.

50% H_2SO_4

Take 25ml of Conc. H_2SO_4 and add 25ml of distilled water slowly to make up the final volume to 50ml.

Reducing reagent

Mix 25ml of metol sulphite solution with 15ml of oxalic acid. Slowly add 15ml of 50% H_2SO_4 . Then make up the final volume of the mixture to 75ml with distilled water.

Standard Silicate solution

Take 0.960g of dried Na_2SiF_6 in distilled water and make up the volume to 1000ml in a volumetric flask. This solution contains $5000\mu\text{g/l}$ of silicate. Store this solution in a polyethylene bottle. This is solution 'A'.

Dilute 10ml of 'A' to 100ml with distilled water. This is solution 'B'.

Dilute 10ml of 'B' to 250ml with distilled water. This is stock solution 'C' containing $20\mu\text{g/l}$ silicate.

Preparation of Standard for Standard curve, Blank and sample analysis

From the stock solution 'C' pipette 10ml, 20ml, 40ml and 60ml solution in four different volumetric flask and make up the volume to 100ml with distilled water. This working solution contains $2\mu\text{g/l}$, $4\mu\text{g/l}$, $8\mu\text{g/l}$ and $12\mu\text{g/l}$ of silicate respectively. Take 4ml of ammonium molybdate in 8 different test tubes of 25 ml capacity. Pipette out 10ml of each concentration of silicate working solution in duplicate and add to the test tubes containing Ammonium molybdate. Add 6ml of reducing reagent each to the tubes containing 4 ml of ammonium molybdate and 10 ml of varying concentration of silicate working solution ($2\mu\text{g/l}$, $4\mu\text{g/l}$, $8\mu\text{g/l}$ and $12\mu\text{g/l}$). Mix the tubes and keep it at room temperature for 1 hour. Measure the absorbance at 810nm after one hour.

For blank take 10ml of distilled water and add to 4ml of ammonium molybdate along with 6ml of reducing reagent. Then take the absorbance after one hour incubation.

For sample analysis, filter the sample through Whatman filter paper No.1. Add 10ml of the filtered sample to 4ml ammonium molybdate solution. To this add 6ml reducing reagent and keep it at

room temperature for one hour. Measure the absorbance at 810nm. Calculate the concentration of silicate from the Standard curve.

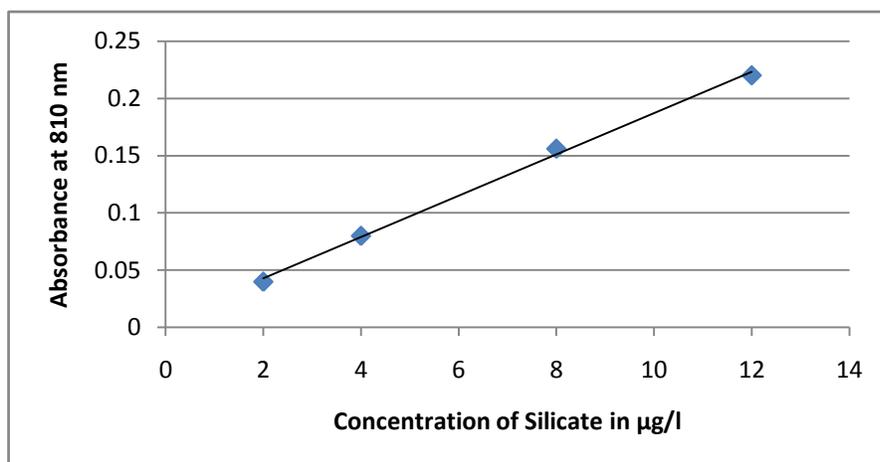


Figure 2. Standard curve of Silicate

III. DETERMINATION OF PHOSPHATE IN SEA WATER

A. DETERMINATION OF ORTHOPHOSPHATE

PRINCIPLE:

The Orthophosphate reacts with acidified ammonium molybdate solution and forms molybdophosphoric acid, which is then reduced to blue complex in the presence of stannous chloride[2],[3].

MATERIALS REQUIRED:

APPARATUS REQUIRED:

- UV- Visible Spectrophotometer
- Water bath
- Volumetric flask
- Beaker
- Glass rod
- Measuring Cylinder
- Spatula
- Pipette
- Wash Bottle
- Tissue Paper

CHEMICALS REQUIRED:

- Ammonium molybdate
- Con. H_2SO_4
- Stannous chloride
- Glycerol
- Potassium dihydrogen phosphate
- Distilled water

PROCEDURE:

PREPARATION OF REAGENTS:

Ammonium molybdate

- a) Dissolve 25g of ammonium molybdate in 75 ml of distilled water and make up the total volume to 175ml using distilled water (**Sol –A**).
- b) Take 280ml of Conc. H_2SO_4 and slowly add 400ml of distilled water. Allow it to cool down (**Sol-B**).

Mix the two solutions '**A**' and '**B**' and dilute to 1L in a volumetric flask.

Stannous chloride

Dissolve 2.5g of stannous chloride in 100ml glycerol by heating on a water bath for rapid dissolution.

Standard Phosphate solution

Dissolve 4.388g dried anhydrous potassium dihydrogen phosphate in distilled water and make up the volume to 1L. Dilute this solution hundred times. This is standard phosphate stock solution containing 10mg/l phosphate.

Preparation of Standard for Standard curve, Blank and sample analysis

From the stock solution pipette out 1ml, 2ml, 3ml, 4ml and 5ml solution in duplicates. Adjust the final volume to 50ml with distilled water. This working solution contains 0.2mg/l, 0.4mg/l, 0.6mg/l, 0.8mg/l and 1mg/l of phosphate. Add 2ml ammonium molybdate solution to each flask followed by addition of 5drops of stannous chloride solution. Measure the absorbance at 690nm after 10-15 minutes.

For blank analysis take 50ml of distilled water and add 2ml ammonium molybdate followed by 5 drops of stannous chloride. Then take the absorbance at 690 nm after 10-15 minutes.

For sample analysis filter the sample through Whatman No. 1 filter paper. Pipette out 50ml of filtered sample. To this add 2ml ammonium molybdate followed by 5 drops of stannous chloride. After 10-15 minutes of incubation take the absorbance reading at 690 nm and calculate the concentration of orthophosphate through standard curve.

B. DETERMINATION OF TOTAL PHOSPHATE**PRINCIPLE:**

All forms of phosphorous i.e. soluble reactive phosphate, polyphosphate, organic phosphate are converted to soluble inorganic orthophosphate by digestion with perchloric acid and oxidation with sodium hydroxide. The phosphate thus released, can be determined colorimetrically by following the Orthophosphate determination method[2],[3].

MATERIALS REQUIRED:**APPARATUS REQUIRED:**

- UV- Visible Spectrophotometer
- Water bath
- Hot plate
- Volumetric flask
- Beaker
- Glass rod
- Measuring Cylinder
- Spatula
- Pipette
- Wash Bottle
- Tissue Paper

CHEMICALS REQUIRED:

- Perchloric acid
- Phenolphthalein
- Ethanol
- NaOH
- Ammonium molybdate
- Con. H_2SO_4
- Stannous chloride
- Glycerol
- Potassium dihydrogen phosphate
- Distilled water

PROCEDURE:**PREPARATION OF REAGENTS:**

Perchloric acid about 60% - 70%

Phenolphthalein indicator

Dissolve 0.5g phenolphthalein in 150ml of 95% ethanol and 50ml of distilled water. To the same solution add 0.02N NaOH drop wise till the appearance of faint pink colour.

8% NaOH

Dissolve 8g NaOH in 100ml of distilled water.

Ammonium molybdate

- a) Dissolve 25g of ammonium molybdate in 75 ml of distilled water and make up the total volume to 175ml using distilled water (**Sol –A**).
- b) Take 280ml of Conc.H₂SO₄ and slowly add 400ml of distilled water. Allow it to cool down (**Sol- B**).

Mix the two solutions '**A**' and '**B**' and dilute to 1L in a volumetric flask.

Stannous chloride

Dissolve 2.5g of stannous chloride in 100ml glycerol by heating on a water bath for rapid dissolution.

Standard Phosphate solution

Dissolve 4.388g dried anhydrous potassium dihydrogen phosphate in distilled water and make up the final volume to 1000 ml. Dilute this solution hundred times. This is standard phosphate stock solution containing 10mg/l phosphate.

Preparation of Standard for Standard curve, Blank and sample analysis

Standard working solution preparation for standard curve is same as that of Orthophosphate.

For blank and sample analysis take 25ml of distilled water and 25ml of filtered sample respectively. Then evaporate it to complete dryness at 70°C. After cooling add 1ml perchloric acid and again evaporate. Allow the residue to cool and after cooling add 100ml of distilled water followed by 1 drop of phenolphthalein indicator. Then titrate the sample against 8% NaOH drop wise till the appearance of pink colour. From this solution pipette out 25ml sample and add 1ml ammonium molybdate followed by 3 drops of stannous chloride. Measure the absorbance at 690nm after 10-15 minutes and calculate the unknown concentration from standard curve.

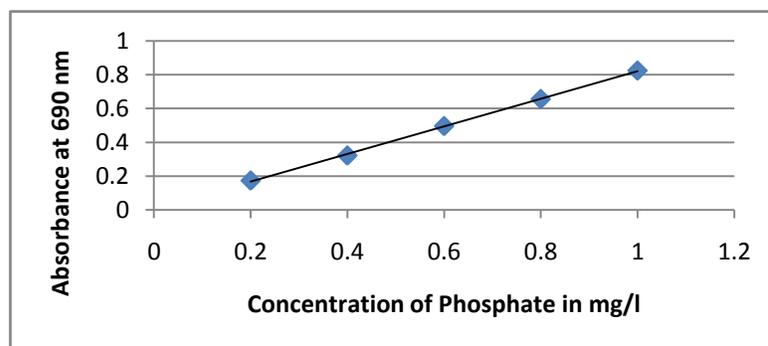


Figure 3. Standard curve of Phosphate (Orthophosphate and Total phosphate)

IV. DETERMINATION OF NITRITE IN SEA WATER

PRINCIPLE:

In acid solution, the nitrite yields nitrous acid, which diazotises the sulphanilamide. The diazonium salt when reacts with aromatic amine, N-1, naphthyl ethylenediamine dihydrochloride forms a red dye, which is measured spectrophotometrically[1],[2],[3].

MATERIALS REQUIRED:

APPARATUS REQUIRED:

- UV- Visible Spectrophotometer
- Volumetric flask
- Beaker
- Glass rod
- Measuring Cylinder
- Spatula
- Pipette
- Wash Bottle
- Tissue Paper

CHEMICALS REQUIRED:

- Sulphanilamide
- 35% HCl
- NEDA (N-1, naphthyl ethylenediamine dihydrochloride)
- Sodium nitrite
- Distilled water

PROCEDURE:

PREPARATION OF REAGENTS:

Sulphanilamide solution

Add 50ml of 35% Conc. HCl to 400ml of distilled water, to this add 5g of sulphanilamide reagent and make up the final volume to 500ml.

NEDA

Dissolve 0.5g of NEDA in 500ml of distilled water. Keep the reagent in a dark bottle.

Standard Nitrite solution

Dissolve 0.345g of sodium nitrite in 1000ml of distilled water. **This is primary standard 'A'.**

Dilute 10ml of 'A' to 1L with distilled water. This is **secondary standard 'B'**.

Dilute 10ml of 'B' to 100ml with distilled water. **This is the final stock solution containing .00500034 mM/l nitrite.**

Preparation of Standard for Standard curve, Blank and sample analysis

Take 2.5ml, 5ml, 10ml, 15ml, 25ml and 50ml of the stock solution in different volumetric flasks in duplicates. Then make up the volume to 100ml with distilled water. This working solution contains 0.000125mM/l, 0.00025mM/l, 0.0005mM/l, 0.00075mM/l, 0.00125mM/l and 0.0025mM/l nitrite respectively. To this add 1ml of sulphanilamide, 1ml of NEDA after 10 minutes. Incubate the solution for 10-15 minutes. Measure the absorbance at 543nm.

For blank and sample analysis, pipette out 25ml of distilled water and 25ml of filtered sample (Whatman No. 1 Filter paper) respectively. To this add 0.5ml sulphanilamide and wait for 10 minute. Then add 0.5ml NEDA and again wait for 10-15 minute. Measure the absorbance at 543 nm and calculate the unknown concentration of nitrite from the standard curve.

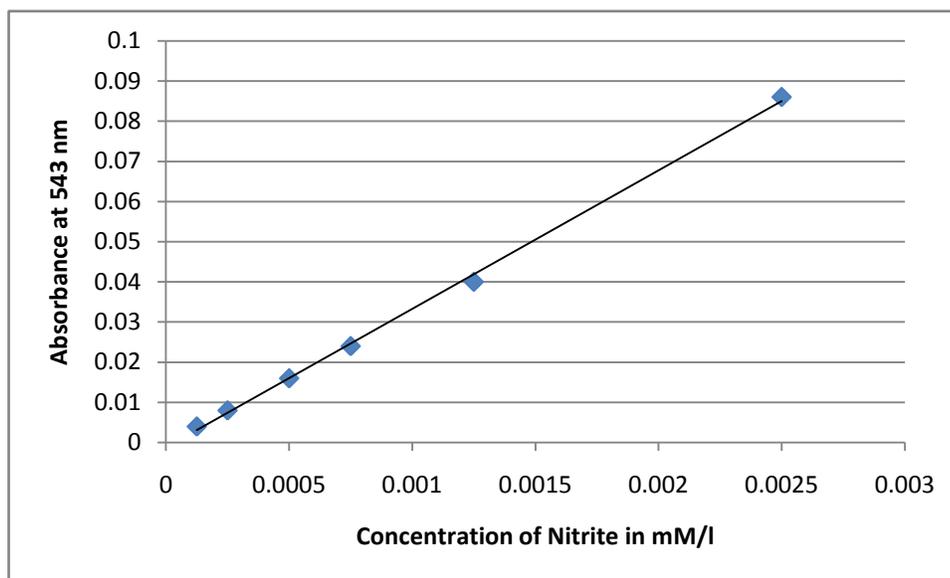


Figure 4. Standard curve of Nitrite

V. DETERMINATION OF NITRATE IN SEA WATER

PRINCIPLE:

Nitrate in sea water is reduced to nitrite by heterogenous reduction through cadmium granules. Nitrite is determined by diazotising with sulphanilamide and coupling with N-1, naphthyl ethylenediamine dihydrochloride. The coupling reaction using NEDA gives a coloured azo dye [1],[2],[3].

MATERIALS REQUIRED:

APPARATUS REQUIRED:

- UV- Visible Spectrophotometer
- Cadmium reduction column
- Volumetric flask
- Beaker
- Glass rod
- Measuring Cylinder
- Spatula
- Pipette
- Wash Bottle
- Tissue Paper

CHEMICALS REQUIRED:

- Sulphanilamide
- 35% HCl
- NEDA (N-1, naphthyl ethylenediamine dihydrochloride)
- Potassium nitrate
- Ammonium chloride
- Ammonia solution(32%)
- Copper sulphate
- Distilled water

PROCEDURE:

PREPARATION OF REAGENTS:

Ammonium chloride buffer

Dissolve 5g of ammonium chloride in distilled water and make up the final volume to 500ml. To this add 0.7ml of ammonia solution (32%) to adjust pH level.

2% copper sulphate solution

Dissolve 2g of copper sulphate in 100ml of distilled water. This is REQUIRED for washing of cadmium granule before packing the column.

Sulphanilamide solution

Add 50ml of 35% Conc. HCl to 400ml of distilled water. To this add 5g of sulphanilamide reagent and make up the final volume to 500ml.

NEDA

Dissolve 0.5g of NEDA in 500ml of distilled water. Keep the reagent in a dark bottle.

Standard Nitrate solution

Dissolve 0.1011g dry potassium nitrate in 100ml of distilled water. Pipette 1ml of Standard Nitrate solution and dilute it to 100 ml. This is **stock nitrate solution containing 100 μ M/l nitrate.**

Preparation of Standard for Standard curve, Blank and sample analysis

Take 2.5ml, 5ml, 7.5ml, 10ml and 12.5ml of stock solution in different volumetric flask. Then adjust the final volume to 50ml and divide the solution in to two sets of 25 ml each (25+25). This is the working solution contains 5 μ M/l, 10 μ M/l, 15 μ M/l, 20 μ M/l and 25 μ M/l nitrate respectively. To this add 0.5ml of sulphanilamide and after 10 minutes add 0.5ml of NEDA. Take the absorbance at 543nm after 10-15 minutes of incubation.

For blank and sample analysis take 50ml of distilled water and 50ml of filtered sample respectively (Whatman No. 1 filter paper). Release each 50ml of sample and 50ml of ammonium chloride buffer through the cadmium reduction column. Discard the first 25ml and collect the next 50ml as 25ml + 25ml in two different conical flasks. Add 0.5ml of sulphanilamide to this and wait for 10 minutes. Again add 0.5ml of NEDA and leave for 10-15 minute incubation. After incubation measure the absorbance at 543nm and calculate the unknown concentration of nitrate from the standard curve.

Column precaution

Cadmium column can effectively process 100 samples without change of cadmium granules. After processing 100 samples the granules should be replaced to minimize error. The upper layer of column should always be submerged with ammonium chloride solution. The column should have slow flow rate. Addition of ammonium chloride increases the life of the column.

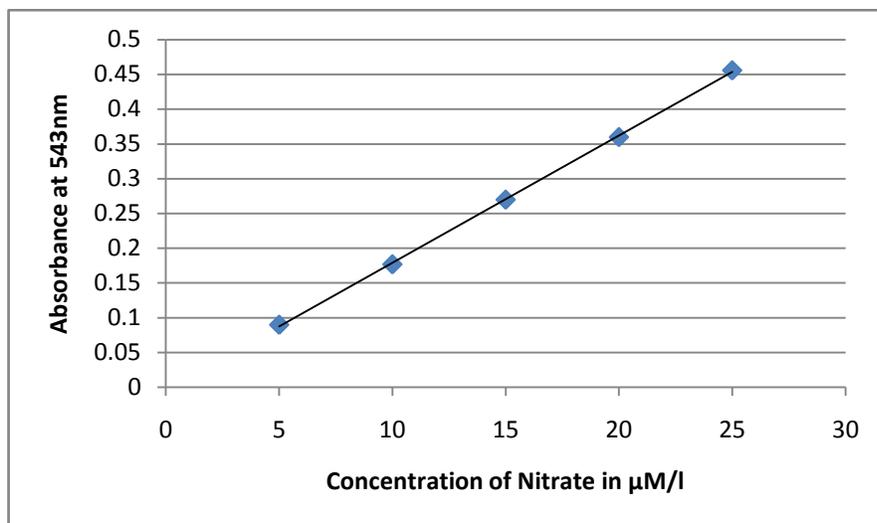


Figure 5. Standard curve of Nitrate

REFERENCES:

1. Bermuda Biological Station For Research, Inc. Bermuda Atlantic Time-series Study.
2. Grasshoff, K., Ehrhardt, M., Kremling, K., 1999. Methods of Sea water analysis, 3rd edition, Verlag Chemie, Weinheim, Germany.
3. Strickland, J.D. and Parsons, T.R., 1972. A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada.167.
4. Trivedy, R.K. and Goel, P.K., Chemical and Biological Methods For Water Pollution Studies.

**PHYSICO-CHEMICAL PARAMETERS OF RIVER SIANG IN ARUNACHAL
PRADESH, INDIA**

Biplab Kumar Das

Department of Zoology,

Silapathar Science College, Silapathar, Dhemaji, Assam-787057

Corresponding author E-mail: biplabkumar1987@gmail.com

ABSTRACT:

Water is one of the nature's most important gifts to mankind. River Siang is the main river of East Siang district and also it is one of the most important influent tributary of the mighty River Brahmaputra drainage system. River Siang plays an important role in lives of the surrounding inhabitants viz. fishing, bathing, washing, disposal, industrial wastes, and other human activities. Analysis of physico-chemical parameters were carried out during 2012-2014 in the four different seasons at different study sites of River Siang. The major and important water quality parameters were measured in all collected samples, including Water Colour, Air Temperature, Water Temperature, pH, DO, FCO₂, Conductivity, Total alkalinity, Turbidity, Total Hardness, TSS, TDS.

KEY WORDS: Physico-Chemical Parameters, WHO, East Siang, Arunachal Pradesh

INTRODUCTION:

Among all the natural resources on planet, water is most vital resource. Rivers are vital systems and are essential for the sustenance of all life. The Arunachal Pradesh's territory is a complex hill system with varying elevation, and number of rivers and rivulets [1]. The unique drainage system of the state falls under upper Brahmaputra basins. For domestic, industrial and agricultural purposes rivers provides main water resources [2]. The main sources of pollution of river water are modern civilization, urbanization and prolonged discharge of industrial effluents, domestic sewage and solid waste dump [3]. Wild and domestic animals using same drinking water can also contaminate the water through direct defecation and urination [4]. The environment and the ecosystem were badly affected by social, agricultural and industrial activities of human population. River water and ground water were polluted by the growing use of chemicals in the form of fertilizers and pesticides. The ecosystem could be destabilized and could cause ill effects on the health of the human beings as well as all other living organisms [5], [6]. The physical and chemical characteristics of any riverine water, sediments play an

important role of ecological significance especially in river ecosystem. It reflects the history of the pollution.

STUDY SITE:

The River Siang, is largest river of Brahmaputra river system, originates from Chema Yungdung Glacier near Kubi at 5150 m in Tibet. In Tibet it flows in West–East direction. After 1625 km traverse in Tibet it takes a turn in south direction, enters the territory of India near Tuting in the Upper Siang district of Arunachal Pradesh. Then it flows through North–South direction in East Siang district towards Assam. Finally it merges with Lohit and Dibang in Assam and it becomes the mighty River Brahmaputra [7], [8].

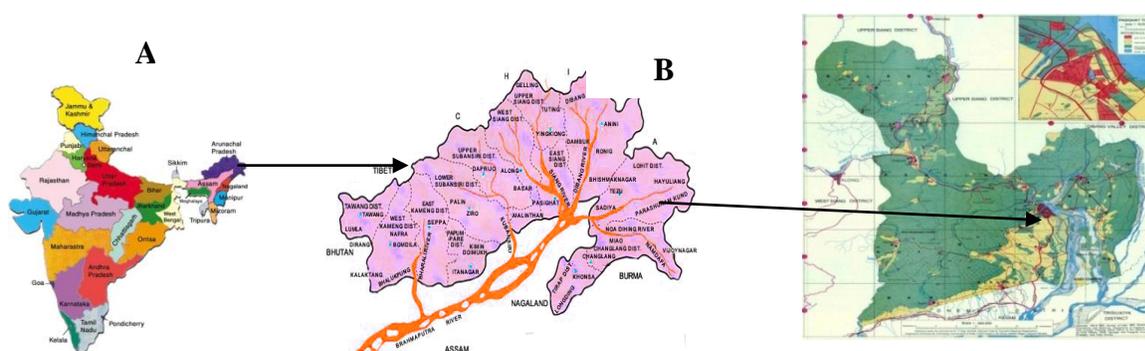


Fig 1: Map of (A) India indicating Arunachal Pradesh, (B) Arunachal Pradesh indicating to East Siang District, (C) In East Siang district highlighting River Siang (Study Area) of Arunachal Pradesh

MATERIALS AND METHODS:

Water was collected and stored in clean polyethylene bottles that have been pre washed with de-ionized water. Air temperature, water temperature and pH were determined in the field because of their unstable nature. Water temperature and air temperature were measured with the help of mercury thermometer and pH was measured with pen type pH meter in the field and other parameters was analyzed in the laboratory using standard procedure of APHA [9] and using Perkin Elmer Atomic Absorption Spectrophotometer (AAS) [10].

RESULTS:

The present study of physico-chemical parameters of the River Siang revealed the below mentioned parameters and the parameters are discussed in the below:

1. **Water Colour:** The colour of water colour was clear in most of the seasons at the different study sites but sometimes the colour is pale-green in the mid-stream of the river.

Table 1: Physico-Chemical Parameters (Mean and S.D) of River Siang:

Sr. No.	Parameters	Winter	Pre-Monsoon	Monsoon	Post-Monsoon
1	Air Temp. C ⁰	16.17 ± 1.47	27.17 ± 1.94	36.67 ± 9.87	27.50 ± 1.64
2	Water Temp. C ⁰	13.50 ± 3.08	24.00 ± 4.05	27.17 ± 1.72	25.33 ± 3.93
3	pH	6.60 ± 0.30	6.83 ± 0.44	6.91 ± 0.19	7.16 ± 0.42
4	DO (mg/l)	5.30 ± 1.15	7.67 ± 0.77	7.97 ± 0.95	6.62 ± 0.27
5	FCO ₂ (mg/l)	8.47 ± 1.20	4.87 ± 0.86	7.23 ± 1.38	7.92 ± 1.50
6	Conductivity (ppm)	13.83 ± 2.23	13.17 ± 2.04	8.00 ± 2.10	9.33 ± 2.07
7	Total Alkalinity (mg/l)	68.54 ± 5.75	84.47 ± 9.50	69.53 ± 13.83	80.27 ± 9.08
8	Turbidity (NTU)	93.08 ± 6.83	87.79 ± 9.24	82.60 ± 8	89.43 ± 9.86
9	Total Hardness (mg/l)	72.08 ± 3.33	77.13 ± 8.04	96.98 ± 24.57	69.67 ± 3.69
10	TSS (mg/l)	117.48 ± 9.33	120.08 ± 15.72	256.93 ± 3.38	120.87 ± 6.87
11	TDS (ppm)	6.17 ± 1.17	5.17 ± 1.60	5.75 ± 1.89	7.67 ± 2.07

Values Mean ± SD

2. **Air Temperature (AT):** AT (°C) ranges between 22.50 ± 1.38 to 30.17 ± 5, minimum being in winter season and maximum in monsoon season. Test of variance (t-test) for AT (°C) revealed that, the values obtained from t-test ranging from 20.064849 to 30.685151, had been found to be statistically significant (P<0.001, 95% CI) (Table 1 and Figure 3).
3. **Water Temperature (WT):** WT (°C) value ranged between 13.50 ± 3.08 to 27.17 ± 1.72, minimum in winter season and maximum in monsoon season. Test of variance (t-test) for WT (°C) revealed that, the values obtained from t-test ranging from 12.731758 to 32.268242, had been found to be statistically significant (P<0.005, 95% CI) (Table 1 and Figure 3).
4. **pH:** The pH value ranged between 6.60 ± 0.30 to 7.16 ± 0.42, minimum in winter season and maximum in post-monsoon season. Test of variance (t-test) for pH revealed that, the values

obtained from t-test ranging from 6.509343 to 7.238990, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).

5. **Dissolved Oxygen (DO):** The DO (mg/l) value ranged between 5.30 ± 1.15 to 7.97 ± 0.95 , minimum in winter season and maximum in monsoon season. Test of variance (t-test) for DO (mg/l) revealed that, the values obtained from t-test ranging from 4.968067 to 8.806933, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).
6. **Free Carbon-di-oxide (FCO₂):** The FCO₂ (mg/l) value ranged between 4.87 ± 0.86 to 8.47 ± 1.20 , minimum in pre-monsoon season and maximum in winter season. Test of variance (t-test) for FCO₂ (mg/l) revealed that, the values obtained from t-test ranging from 4.598432 to 9.643234, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).
7. **Conductivity:** The conductivity ($\mu\text{mho/cm}$) value ranged between 127.67 ± 5.10 to 156.78 ± 7.07 minimum in winter season and maximum in post-monsoon season. Test of variance (t-test) for conductivity ($\mu\text{mho/cm}$) revealed that, the values obtained from t-test ranging from 123.538613 to 151.628054, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).
8. **Total Alkalinity (TA):** The TA (mg/l) value ranged between 68.54 ± 5.75 to 84.47 ± 9.50 , minimum in winter season and maximum in post-monsoon season. Test of variance (t-test) for TA (mg/l) revealed that, the values obtained from t-test ranging from 63.139870 to 88.264297, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).
9. **Turbidity:** The turbidity (NTU) value ranged between 82.60 ± 8 to 93.08 ± 6.83 , minimum in winter season and maximum in monsoon season. Test of variance (t-test) for turbidity (NTU) revealed that, the values obtained from t-test ranging from 81.296169 to 95.155498, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).
10. **Total Hardness (TH):** The TH (mg/l) value ranged between 69.67 ± 3.69 to 96.98 ± 24.57 , minimum in post-monsoon season and maximum in monsoon season. Test of variance (t-test) for TH (mg/l) revealed that, the values obtained from t-test ranging from 59.223704 to 98.709629, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).
11. **Total Suspended Solids (TSS):** The TSS (mg/l) value ranged between 117.48 ± 9.33 to 256.93 ± 3.38 , minimum in winter season and maximum in monsoon season. Test of variance (t-test) for TSS (mg/l) revealed that, the values obtained from t-test ranging from 144.456347 to 263.223653, had been found to be statistically not significant ($P > 0.005$, 95% CI) (Table 1 and Figure 3).
12. **Total Dissolved Solids (TDS):** The TDS (ppm) value ranged between 5.17 ± 1.60 to 7.67 ± 2.07 , minimum in pre-monsoon season and maximum in post-monsoon season. Test of variance (t-test)

for TDS (ppm) revealed that, the values obtained from t-test ranging from 4.488073 to 7.886927, had been found to be statistically significant ($P < 0.001$, 95% CI) (Table 1 and Figure 3).

Correlation matrix analysis of physico-chemical parameters of water

The statistical analysis had been carried out by Pearson's correlation coefficient between physico-chemical parameters of water of River Siang. A linear association implies that as one variable increases, the other increases or decreases linearly. Values of the correlation coefficient close to 1 (positive correlation) imply that as one variable increases, the other increases nearly linearly. However, a correlation coefficient close to -1 implies that as one variable increases, the other decreases nearly linearly. Values close to 0 imply little linear correlation between the variables or no correlation.

In River Siang, Pearson's correlation of water revealed strong positive and negative correlations among the physico-chemical parameters as showed in Table 2. The strong positive correlation of WT with AT ($r = 0.981$, significant at 0.05) was due to the relationship of air temperature and water temperature. The strong positive correlation of WT with pH ($r = 0.957$, significant at 0.05) due to the hydrolysis of ion on surface of water in River Siang. DO showed positive correlation with AT ($r = 0.970$, significant at 0.05). Hardness showed negative correlations with water temperature ($r = -0.967$, significant at 0.05) and with pH also ($r = -0.998$, significant at 0.01). TDS showed positive correlations with turbidity ($r = 0.969$, significant at 0.05). Conductivity showed positive correlations with TSS ($r = 0.993$, significant at 0.01).

The positive and negative correlation among all the physico-chemical parameters was the represented the major sources of seasonal changes in water quality of River Siang (Table 2).

Principal Component Analysis (PCA) of Physico-Chemical Parameters :

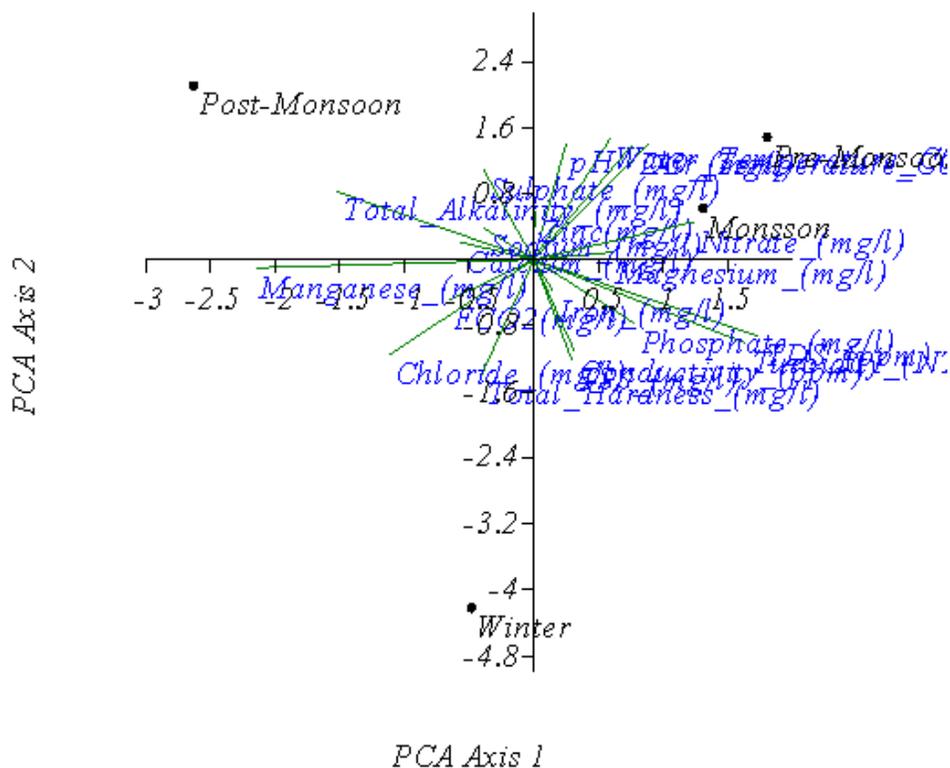
The results obtained from the Principal component analysis (PCA) based on data of different seasons revealed that the variables, notably, temperature, total alkalinity, total hardness, DO and FCO_2 were associated with higher values of communalities during all the seasons. However, other physico-chemical variables such as pH, conductivity, iron, nitrate, phosphate and zinc had less contribution to the communalities. The two-dimensional PCA ordination with various rotations basically showed a continuous pattern of samples. It was evident from the PCA as represented in Figure 2, that relative distance between the four survey seasons indicates the similarity between them and respective coordinates. The analysis of PCA revealed that, at the level of significance $\text{Alpha} = 0.50$, the decision was

to reject the null hypothesis of absence of significant correlation. In other words, the correlation between variables was significant.

Table 2: Pearson's Correlation for different Physico-Chemical parameters of River Siang during different seasons

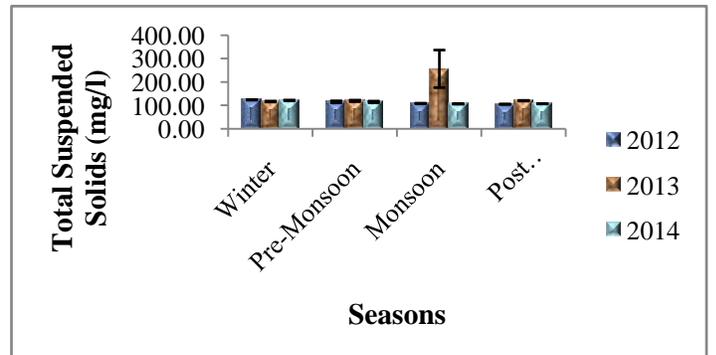
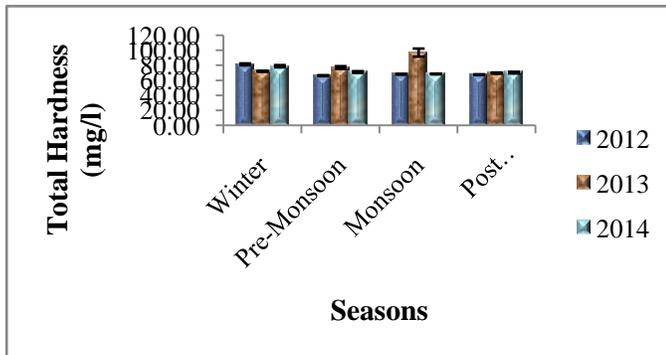
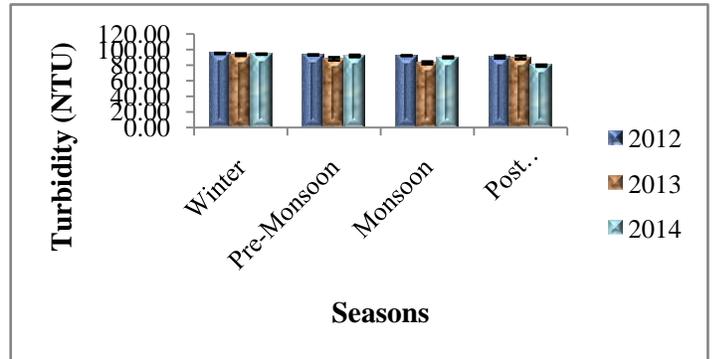
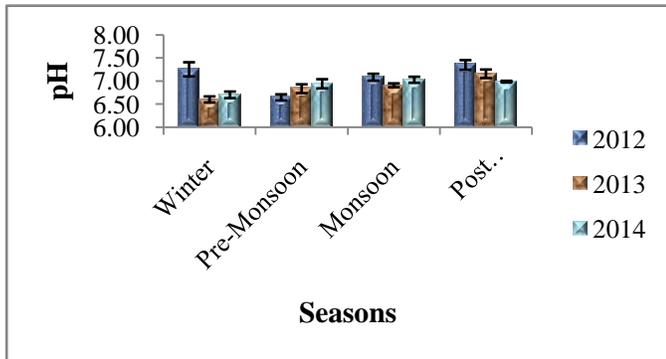
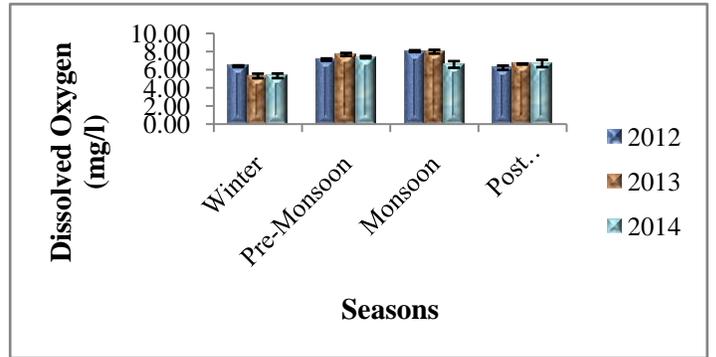
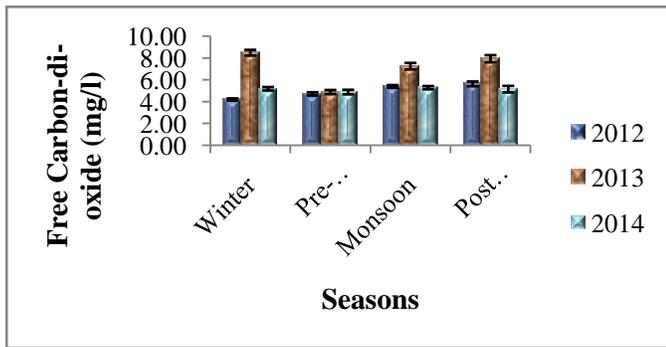
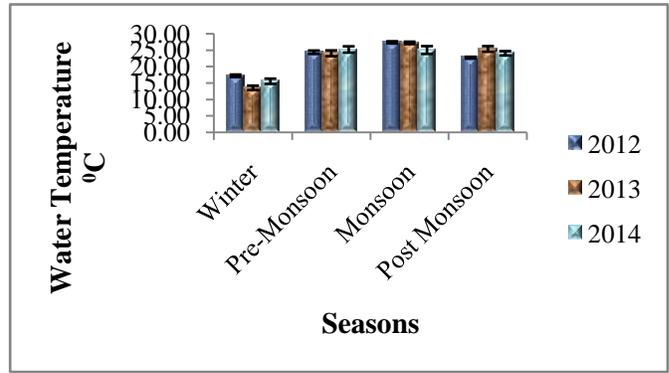
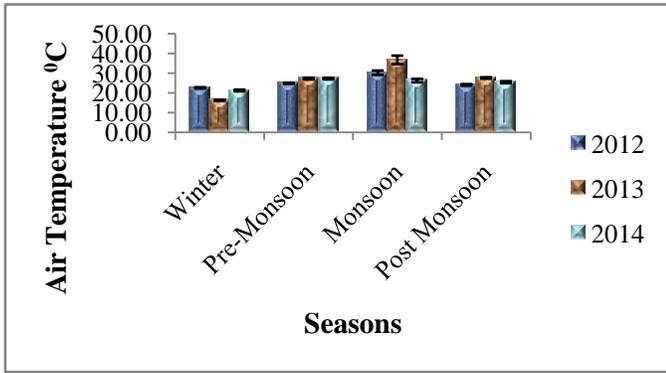
	AT	WT	Turbidity	TSS	pH	DO	FCO ₂	TA	TH	TDS	Conductivity
AT	1										
WT	0.981*	1									
Turbidity	-0.301	-0.444	1								
TSS	-0.672	-0.800	0.696	1							
pH	0.886	0.957*	-0.566	-0.938	1						
DO	0.970*	0.927	-0.309	-0.532	0.782	1					
FCO ₂	-0.413	-0.266	-0.122	-0.319	0.013	-0.608	1				
TA	0.212	0.262	-0.807	-0.233	0.231	0.362	-0.401	1			
TH	-0.907	- 0.967*	0.508	0.918	- 0.998**	-0.802	0.013	-0.183	1		
TDS	-0.234	-0.350	0.969*	0.519	-0.422	-0.302	0.062	-0.925	0.364	1	
Conductivity	-0.597	-0.735	0.661	0.993* *	-0.900	-0.437	-0.428	-0.153	0.879	0.467	1

Figure 2: Bi-plot of PCA analysis derived from the four studied seasons on the physico-chemical parameters of River Siang



DISCUSSION:

Physico-chemical characteristics of water varied according to seasons. Most of the water parameters vary seasonally. The air temperature in river water was largely regulated by solar radiation and topography. Temperature, in turn, regulates the dissolved oxygen concentration of water and primary productivity, causes a great variability in plant and animal distribution. Water temperature showed a definite seasonal trend of increased during monsoon season and decreased during the winter seasons. The degree and annual variation in water temperature of a water body had been a great bearing upon its productivity. There was no significance change in the pH value during the whole observation periods. The pH values of the River Siang were under the permissible limit of the WHO for drinking purposes. The maximum DO value in monsoon season, it was because of the bright sunlight as it influences the percentage of soluble gases. The long day period of high intensity of sunlight accelerated photosynthesis which resulted to increase DO in monsoon season. During the present study it was observed that the FCO_2 showed an inverse relationship with DO. The conductivity of River Siang was also affected by the rain water,



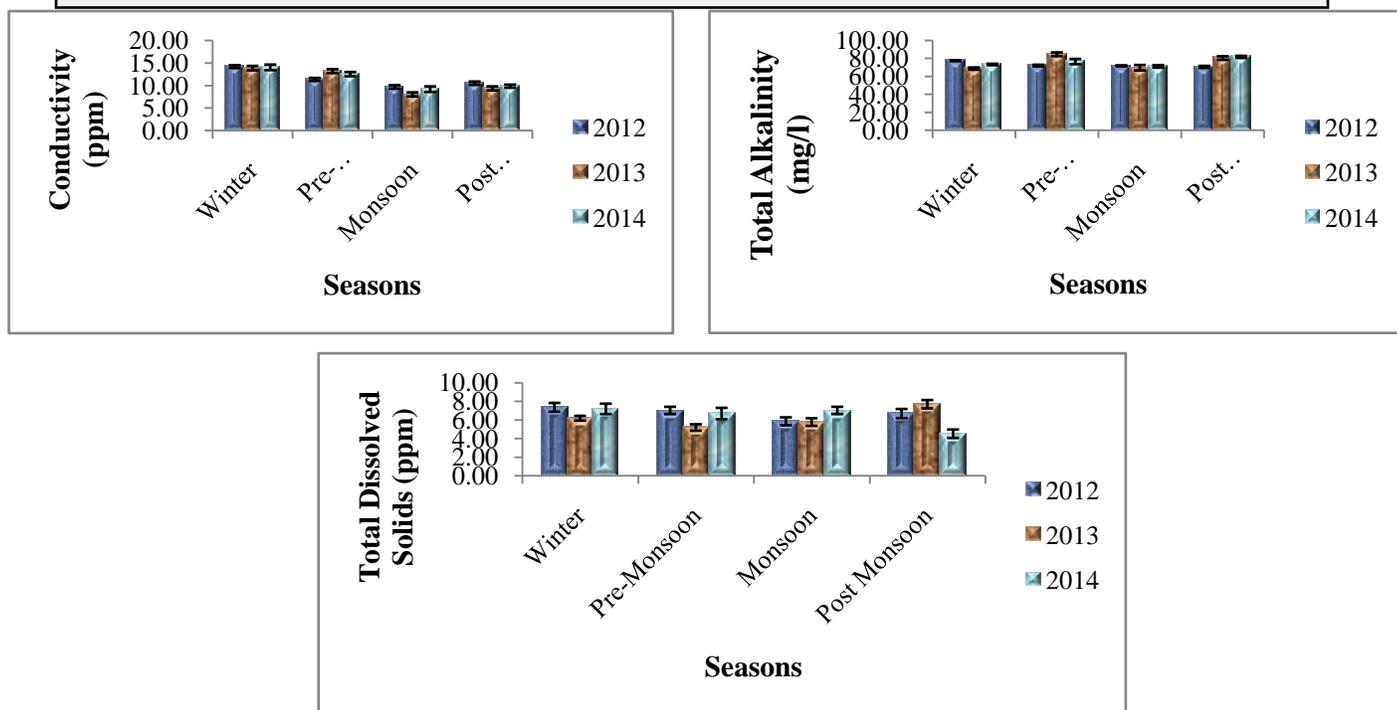


Fig 3: Physico-Chemical Parameters of River Siang in Different Seasons and Year

rain water lowers the conductivity of River Siang, because rainwater had low conductivity and the increase in water levels dilutes mineral concentrations. The value of total alkalinity of River Siang was under the permissible limit of the WHO standards. Turbidity of the river loses its ability to support aquatic life. Sediments can clog fish gills, reduce growth rate, decrease resistance to disease and prevent egg and larvae development. As particles settle they can smother the eggs of fish and insects. TSS can also destroy fish habitat because suspended solids settle to the bottom and can eventually blanket the river bed. Suspended solids can smother the eggs of fish and aquatic insects, and can suffocate newly-hatched insect larvae. TDS were recorded maximum in winter season. Seasonally, the values were highest in winter and lowest in monsoon season, the intermediate values were recorded in both pre-monsoon and post-monsoon seasons. The maximum and minimum value of TDS was found to be below the desirable WHO standards limits in River Siang. All the physico-chemical parameters are below the permissible limits of WHO [11] standards.

ACKNOWLEDGEMENTS:

The authors are thankful to Assam University, Silchar and to the UGC, New Delhi for granting UGC-Fellowship to the first author. The author grateful to Analytical Chemistry Division of CSIR- North-East Institute of Science and Technology, Jorhat, Assam for providing laboratory facilities and help in chemical analysis of water samples.

REFERENCES:

1. Das, B. K. and Kar, D. (2011). Habitat Mapping, Spatial Analysis of Fish Diversity of River Subansiri during winter season in Assam and Arunachal Pradesh (India). *Environment and Ecology*. 29 (4A): P. 1948-1951.
2. Gawas, A. D., Lokhande, P. B. and Meijawas, H. A. (2006). Study of Physico-Chemical Parameters of Surface Water in the Mahad Industrial area, *Poll Res.*, 25 (1): P. 109-114.
3. Khatoon, N., Rehman, M. and Khan A. F. (2013). Study of Seasonal Variation in the water quality among different Ghats of River Ganga, Kanpur, India, *Journal of Environmental Research and Development*, 8 (1): P. 1-10.
4. Jain, A. K. (2009). *River Pollution*, First Edition, APH Publishing, New Delhi, India. P. 330.
5. Kaplan, H., Hill, K., Lancaster, J. and Magdalena H. A. (2000). A theory of human life history evolution: diet, intelligence, and longevity. *Evolutionary Anthropology*. P. 156-185.
6. Palavai, V. (2009). *Diversity and distribution of freshwater fishes of the Andaman Islands*. Pondicherry University, Puducherry, India. Ph. D. Thesis.
7. Das, B. K., Boruah, P. and Kar, D. (2014a). Study of Seasonal Variation of Water Quality of River Siang in Arunachal Pradesh, India. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*. 8 (2IV): P. 11-20.
8. Das, B. K. and Kar, D. (2015). "Physico-Chemical Parameters and Drainage types of River Siang in Arunachal Pradesh, India". In: Mishra, G. C. (Eds.): *Conceptual Framework and Innovations in Agroecology and Food Sciences*. Krishi Sanskriti Publications, New Delhi, India: P. 53-56.
9. APHA. (2010). *American Public Health Association Standard Methods for the Examination of Water and Wastewater*, Sixteen Edition, Washington, USA. P. 1-10.
10. Abolude, D. S.; Davies, O. A. and Chia, A. M. (2009). Distribution and concentration of trace elements in Kubanni reservoir in northern Nigeria. *Research Journal of Environmental and Earth Sciences* 1: P. 39-44.
11. WHO. (2010). *World Health Organization, Guideline for Drinking Water Quality*, Geneva.

METHODS AND REASONS OF ADOPTIONS FOR VEGETABLE INNOVATION BY THE TRIBAL FARMERS OF KEONJHAR DISTRICT OF ODISHA

Bibhu Santosh Behera^{1*}, Anama Charan Behera² and Rudra Ashish Behera³

¹ Research Scholar, OUAT, Bhubaneswar, Odisha, INDIA

¹Senior Research Fellow, ICAR - National Rice Research Institute, Cuttack

²Principal, D. B. (Junior) College, Turumunga, Keonjhar, Odisha, INDIA

³ MBA scholar, TTS, Bhubaneswar, Odisha, INDIA

*Corresponding Author E-mail:- bibhusantosh143@gmail.com

ABSTRACT:

The adoption is the inertia of innovation strategies for development of the society in terms of various technology. As this era is the era of technology and we have basket full of technology, we have to transfer those technologies and empty that basket it is the right time. The above study was conducted in Keonjhar Dist. Of Odisha in the year 2011-2013 for getting the details about innovations adopted by tribal vegetable farmers who are the really the brilliant Commandos of the forest land having interest to cultivate vegetables in the barren forest land to harvest green vegetables. In this research paper the researcher emphasize various part of innovations to become the torch bearer of society hence be justified with suitable reasons.

KEYWORDS: Vegetable Adoption; Innovation; Tribal farmers.

INTRODUCTION:

An innovation diffuses within a social system through its adoption by individuals and groups. The decision to adopt an innovation, however, “is not normally a single, instantaneous act”, it involves a process. The “adoption process” is a decision-making process goes through a number of mental stages before making a final decision to adopt an innovation. This final stage in the process is characterized by large scale, continued use of the idea, and most of all, by satisfaction with the idea. Trial may be considered as the practical evaluation of an innovation. It provides evidence of advantages of the innovation. Being satisfied with the trial and considering the pros and cons of the situation, the individual takes final decision and applies the innovation in a scale appropriate to own situation on a

continued basis.

Vegetable cultivation is a part of Horticultural science. In scientific word it is termed as "Olericulture". In global context "India" placed 2nd position after china in vegetable cultivation. (Both in area and production). But we are proud to know that our country placed 1st position in cauliflower, 2nd in onion, 3rd in cabbage and 4th in potato respectively in the world. As per the recommendation made by Indian Council for Medical Research (ICMR), the use of vegetables per day is 280 gm. But now days we avail less than equal to 100 gm due to poor production and adoption pattern of vegetable production in India

RESEARCH METHODOLOGY:

The research methodology followed here is stratified random sampling for selection of samples. 145 No of farmers were taken for study. The statistical methods here obeyed is frequency, percentage, ranking and gap percentage for studying gap and draw backs of technology.

REVIEW OF LITERATURE:

Adoption level of growers in vegetable cultivation:

A study conducted on AKDA tribal block of Maharashtra established that tribal farmers are generally conservative and therefore less likely to adopt new innovations. (Bajaj & Kambley (1982). Dighe and Pawar (1992) reported that the association between caste and adoption was statistically non-significant. Apparo, Radhakrishnan, Menon (1992) established an association between cosmopolitaness and level of adoption of improved agricultural practices through National Demonstration.

Bavalatti et al. (1993) revealed that participation will help to acquire more knowledge about improved agricultural technology and also provide opportunity for contrived experience and interaction leading to the increased knowledge which in turn helps for higher adoption practices. Innovation adopted by tribal farmers. The tribal farmers had adopted seed and varietal innovations more followed by seed treatment and plant protection measures. Where as adoption in improved agricultural implements, post harvest and storage care were found to be very less.

RESULT AND DISCUSSION:

Adoption of vegetable enterprise:

The sample area is a vegetable pocket of the Keonjhar district. The farmers are doing vegetable cultivation since long. The researcher was to identify the experience of sample tribal farmers in vegetable cultivation.

Table1. Vegetable Farming Practices (In years) N=145

Duration in years	Frequency	Percentage
Up to 2 years	12	8.27
2 to 5 years	28	19.31
5 to 10 years	50	34.48
More than 10 years	55	37.93

The table 1 data depicted that 34.48 percent farmers were practising vegetable cultivation within 5 to 10 years, which was very important for determining adoption as per our objective. Another 37.93 percent farmers were doing vegetable cultivation since more than 10 years which depicted the expertise of them in field of olericulture. Here we may determine adoption, rejection, discontinuance level as well as time line of vegetable cultivation in their locality. A total of 27.58 percent of the respondents had started the enterprise since less than 5 years. Hence the data revealed that the result of research was based on the opinion of experienced tribal vegetable farmers.

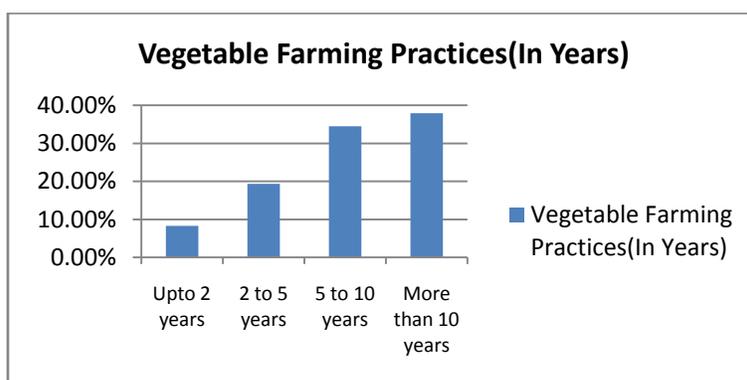


Fig. 1 Distribution of Respondents according to Vegetables Practices

Types of vegetable adoption:

As man has more choice. Always man needs more interventions. So for, more profit tribal vegetable farmers adopt various type of vegetables.

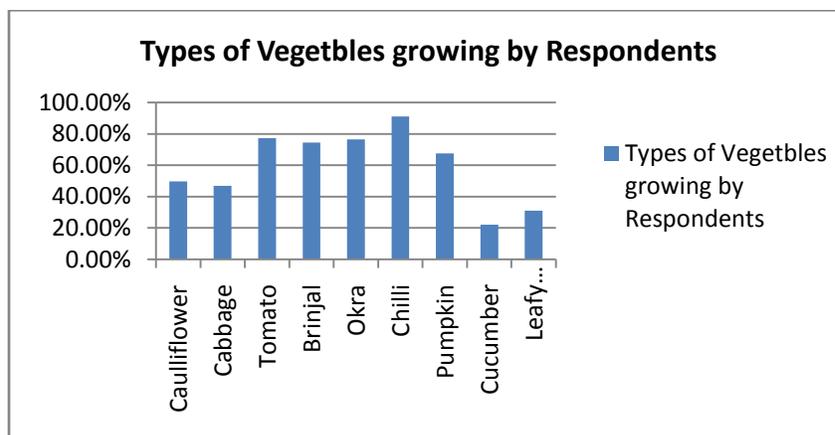
The data from table 2 depicted that the sample farmers had adopted a total of nine types of vegetables. It was further observed that chilli was cultivated by maximum number of farmers

(91.03percent) followed by tomato(77.24 percent) and okra(76.55 percent).The more adoption of chillies in the sample area was due to the adoption of Pusa Jwala variety by them and good climate fit for chilly as well as capsicum cultivation in their locality.

Table 2: Types of Vegetable adoption by the farmers (Production) N=145)

Sl.No.	Types of the Vegetables	Frequency	Percentage	Ranking
1.	Cauliflower	72	49.65	VI
2.	Cabbage	68	46.89	VII
3.	Tomato	112	77.24	II
4.	Brinjal	108	74.48	IV
5.	Okra	111	76.55	III
6.	Chillies	132	91.03	I
7.	Pumpkin	98	67.58	V
8.	Cucumber	32	22.06	IX
9.	Leafy Vegetables	45	31.03	VIII

Fig .2 Distributions of Respondents according to types of vegetables growing by respondents



Purpose of vegetable adoption:

A farmer adopts a crop with multiple purposes. But there must be a prime one for adoption of the enterprise. The following table gave the most preferred reason of vegetable adoption by the farmer respondents. Man is always purposive in the attitude. Each and every activity he pursues is definitely goal oriented. Any activity taken up without a pre mind set up finally ends in a fiasco. Hence setting a goal initially is a must. Likewise vegetable growers cultivated vegetable throughout the year to meet

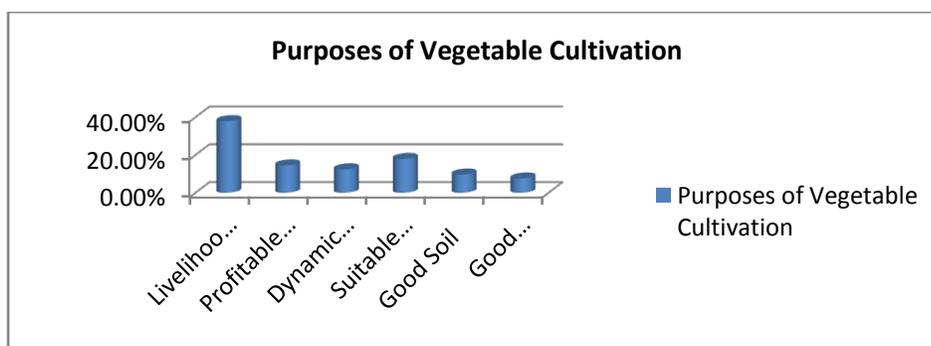
their different requirements and due to certain advantageous condition. Different purpose were listed out and asked to the individual interviewee. The results are analyzed in the three point scale and depicted in the table 3

Data from the Table 3 revealed that 37.93 percent farmers were taking vegetable farming as maintenance of livelihood followed by 17.93 percent farmers adopted it due to suitable climate, 14.48 percent as profitable business and 12.41 percent as dynamic enterprise. Only 9.65 percent respondents agreed that they adopted it due to good soil, so soil reclaim nation should be done to increase the productivity of vegetable. A total of 7.58 percent sample showed their interest in this sector due to good marketing facilities, which was very poor figure and need based marketing support should be there for the vegetable farmers.

Table 3: Purpose of Vegetable Farming N=145

Purposes	Frequency	Percentage	Rank Order
Livelihood Maintenance	55	37.93	I
Profitable Business	21	14.48	III
Dynamic Enterprise	18	12.41	IV
Suitable Climate	26	17.93	II
Good Soil	14	9.65	V
Good marketing facilities	11	7.58	VI

Fig.3 Distribution of Respondents according to Purposes of Vegetable Cultivation



Adoption of field preparation innovations:

Table 4: Field Preparation Innovation N=145

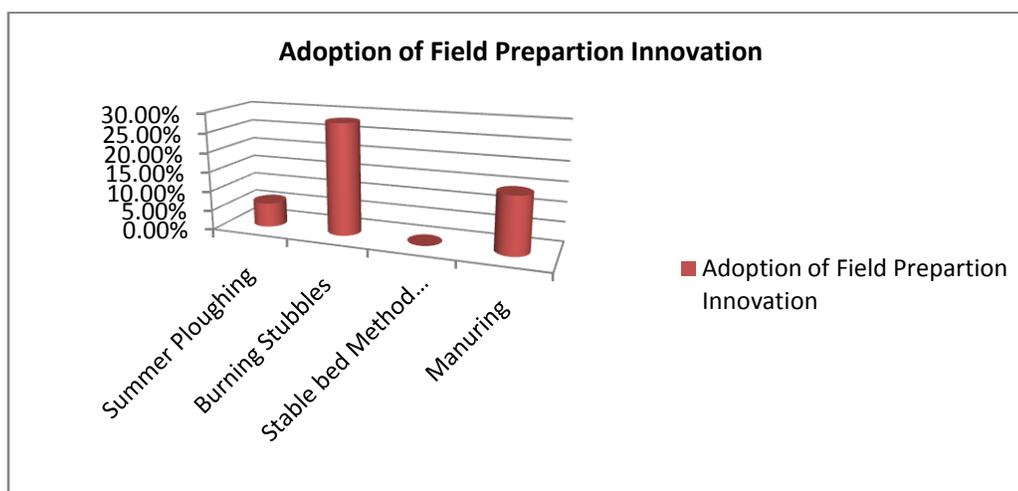
Innovations	Frequency	Percentage	Gap Percentage
Summer Ploughing	9	6.21	93.79

Burning of stubbles	41	28.27	71.72
Stale bed Method Practices	0	0	0
Manuring	21	14.48	85.51

This Table 4 depicted that burning of stubbles was somewhat adopted by 28.27 percent of the respondents. A small proportion of 14.48 percent of the respondents gave some cowdung manure to their field before cultivation. The summer ploughing though a good innovation was not practised even to a modest degree. The field preparation technologies were not popular among the tribal vegetable farmers except the burning of stubbles to certain extent.

Here , we found that gap percentage was more in Summer ploughing(93.79 percent) and though a good innovation but still now it was not diffused among all farmers.So, action should be taken up by Extensionists and Dist. Level official to popularize this method.Similarly manuring method had a wide gap in adoption process by the respondents(85.51 percent) as because of illiteracy and they may not able to see the good impact of manuring process in a short period.My suggestion on behalf of them to the Scientists to orient the farmers about the advantages of manuring so as the gap might be minimized.

Fig.4 Distribution of Respondents according to Adoption of Field Preparation Innovation



Adoption of varietal innovation

Table 5: Varietal Innovations N=145

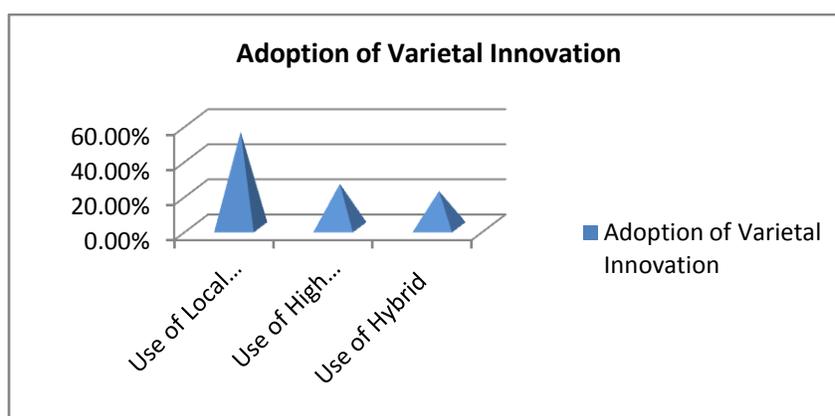
Innovations	Frequency	Percentage	Gap Percentage
Use of Local/Indigenous Variety	79	54.48	45.51

Use of HYV	36	24.82	75.17
Use of Hybrid	30	20.68	79.31

Table 5 depicted that more popularity of using local varieties by tribal farmers due to taste, culture etc. and 54.48 in percentage. They had less priority on adoption of HYV and hybrid varieties, 24.82 percent and 20.68 percent respectively after taking new initiative by NGOs, Seed companies & Govt. in seed village scheme.

The gap percentage was highest in case of Hybrid variety (79.31 percent) and high yielding variety (75.17 percent) adoption so, it had direct impact on Production and productivity. As some local varieties were still unknown to them still there was some gap in this. (45.51 percent)

Fig.5 Distribution of Respondents according to Adoption of Varietal Innovation



Adoption of Seed Treatment Innovations

Table 6: Seed/Seedling Treatment Innovations N=145

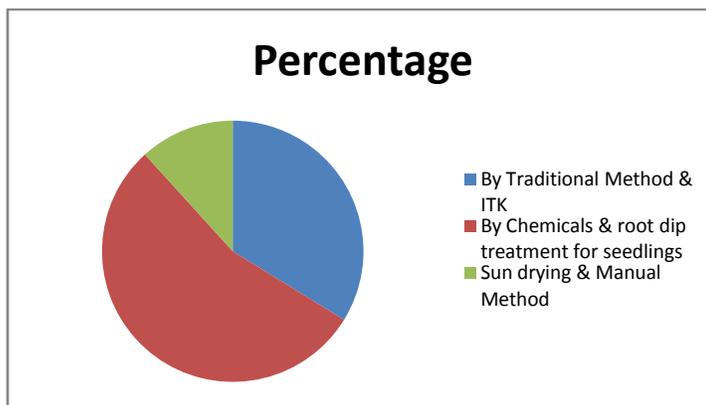
Innovations	Frequency	Percentage	Gap percentage
1.By Traditional Method & ITK	49	33.79	66.20
2.By Chemicals & root dip treatment for seedlings	79	54.48	45.51
3.Sun drying & Manual Method	17	11.724	88.27

It was seen from the above Table 6 that Majority (54.48 percent) of the respondents were adopting Chemicals and root dip treatment due to the cause of easily availability of chemicals and awareness via seed treatment campaigns by govt. and NGOs in their locality. Another result showed that root dip treatment by chemicals was more effective, so they would like it into practice. From the sample 33.79 percent respondents were still practising traditional method of seed treatment due to traditional

in nature and cultural trait. Only 11.724 percent farmers were fond of sun drying methods as they had believed to their ancestors and to nature.

Here gap percentage was highest in Sun drying & manual method(88.27) followed by Traditional method and ITK use(66.20).It symbolized that due to advent of Chemical methods,being popularized by Govt. and leading NGOs via campaign. So Seedling Treatment by using chemicals had comparatively low gap than the above Indigenous methods.

Fig.6 Distribution of Respondents according to Adoption of Seed Treatment Innovations



Seed Sowing & Nursery Management Innovations N=145

Table 7. Seed Sowing Innovations

Innovations	Frequency	Percentage	Gap Percentage
1.Line Sowing/Transplanting	67	46.20	53.79
2.Broadcasting	78	53.80	46.20

The data presented in the Table-6.2.7 revealed that Majority of people were following Broadcasting methods because they were still in dark in the Current era of Hi-tech agriculture. It was due to unaware about the benefit of line sowing. Due to advent of some Schemes and campaigns through line departments via demonstration 46.20 percent farmers were able to adopt the technique of line sowing/Trans planting and got the positive results from this.

Line Sowing/Transplanting Method had a wide gap (53.79 percent) because of lack of awareness among respondents and another reason might be improper information flow among them. But, broadcasting method had comparatively lower gap, as tribal farmers loved to adopt broadcasting method because of easy process. So, Block level officials should demonstrate on field demonstration on “Line sowing/Transplanting” with some incentives for which more adoption might be occurred.

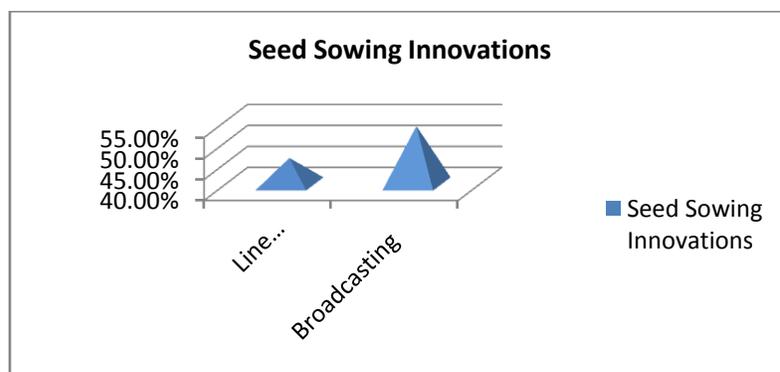


Fig. 7 Distribution of Respondents according to Adoption of seed sowing Innovations

Adoption of Nursery Management Innovations

Production of quality seedling is proportionately related to the less attack of pests and diseases as well as to better fruiting. Nursery raising requires more management, because seedlings are very much sensitive and needs much care. Different measures are to be taken for getting disease free, strong, vigour and good seedlings. The study therefore attempted to assess the extents of knowledge in nursery raising and gap exists with the growers. Vegetable cultivation requires specific operations like drainage, raised bed, spacing, seedling treatments, watering etc. The study therefore attempted to assess the knowledge of various practices in planting seedlings in the main field. The information collected in the same scale points are analyzed and presented below.

Table 8: Nursery Management Innovations

Innovations	Frequency	Percentage	Gap Percentage
1.Nursery bed preparation	35	24.13	75.86
2.Growing of small vegetable plants for transplanting	39	26.89	73.10
3.Hot bed treatment	28	19.31	80.68
4.Earthing up	25	17.24	82.75
5.Drainage Facility	18	12.41	87.58

The above Table 8 indicated that 26.89 percent respondents were practising growing of small vegetable plants for transplanting purpose in nursery management innovation because disease free plants yielded more production and good true to type plants. From the sample 24.13 percent respondents were adopting nursery bed preparation for hardening of plants and proper nourishment to the saplings. Only 19.31 percent farmers were adopting hot bed treatment followed by 17.24 percent in

earthing up and 12.41 percent for drainage facility because land management was important in vegetable cultivation.

The gap percentage was chronologically more incase of the drainage facility (87.58 percent), Earthing up (82.75 percent), and hot bed treatment (80.68) because of drudgery and labour intensive work. Comparatively lower gap found in Nursery bed Preparation (75.86 percent) and growing of small vegetable plants for transplanting (73.10 percent). My suggestion to the Govt. Officials to orient about nursery management practices with some demonstration so that tribal vegetable farmers would able to adopt it more.

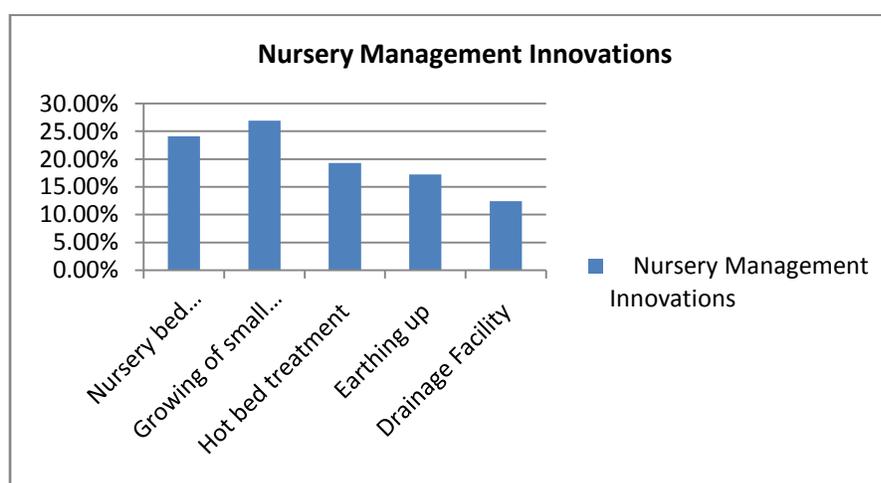


Fig. 8 Distribution of Respondents according to Adoption of Nursery Management Innovation

Adoption of Seed Rate/ Plant population innovations

Table 9: Seed Rate/ Plant population innovations N=145

Innovations	Frequency	Percentage	Gap Percentage
Use of Agronomist/Seed certification officers/SMS's recommendation in maintaining appropriate seed rate for better crop yield	54	37.24	62.75
Use of various planting methods and Canopy management in maintaining plant populations	23	15.86	84.13
Following their own way by neglecting above two as they have confidence in their own method	68	46.89	53.10

It can be concluded from the above Table 9 that majority of the respondents (46.89 percent) were following their own way as traditional in nature and believed in superstition. But due to advent of

seed village scheme and positive effect from NHM and OTELP scheme some farmers were using Agronomist’s recommendation for their betterment in cultivation were 37.24 percent. Only 15.86 percent respondents were adopting the use of various planting methods and canopy management in maintaining plant population.

From this table, Gap percentage revealed that as most of the respondents were illiterate and due to ignorance of Govt. Officials regarding information flow wider gap(84.13 percent) found in use of various planting methods and Canopy management in maintaining plant populations followed by use of Agronomist’s recommendation(62.75 percent) and following their own way(53.10 percent).In the era of “Evergreen revolution” farmers must exposed to scientific use of seed application in their field and government should give more emphasis on this matter.

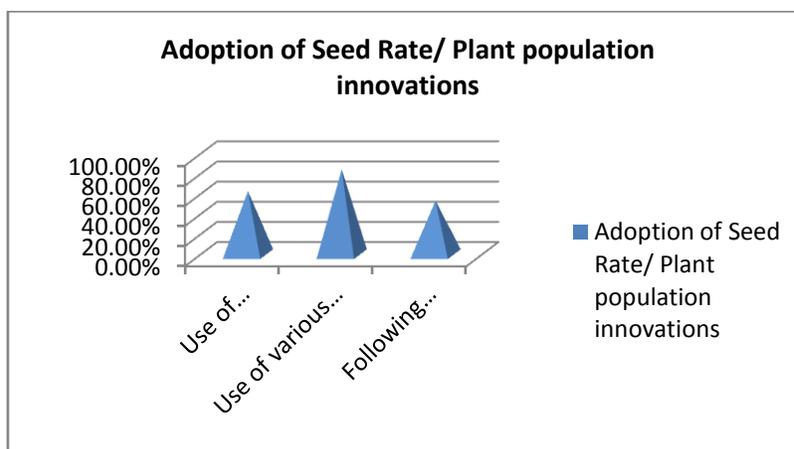


Fig. 9 Distribution of Respondents according to Adoption of Seed Rate/Plant Population Innovation

Adoption of Spacing related Innovations

Table 10: Spacing related Innovations N=145

Innovations	Frequency	Percentage	Gap Percentage
1.Row to Row	61	42.06	57.93
2.Plant to Plant	70	48.27	51.72
3.Canopy Management	24	16.55	83.44

It was clear from the Table 10 that majority of the respondents (42.06 percent) were having more emphasis on row to row spacing because it provoked hygienic and soothing growth of plants. Apart from these 48.27 percent respondents were also following the plant to plant, and 16.55 percent

maintaining canopy management for betterment in cultivation process.

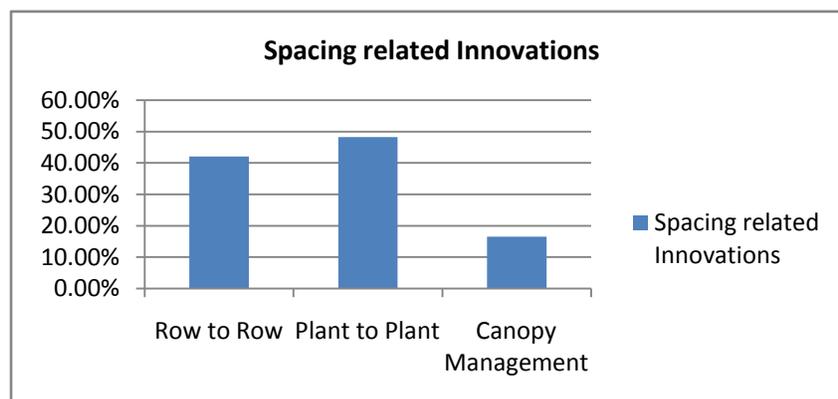


Fig. 10 Distribution of Respondents according to Adoption of Spacing related Innovations

In canopy management gap percentage was highest(83.44 percent) followed by Row to Row planting method(57.93 percent) and Plant to Plant method(51.72). Actually these were happening due to low intervention of scientific planting methods. So the Subject Matter specialist should draw more attention on it by motivating farmers towards this way, so gap must to e filled up.

Adoption of Manure/Fertilizer/Micronutrient Innovation

Vegetable plant require essential a nutrients from various sources like fertilizers micro nutrients, manures, bio fertilizers vermicompost etc. to enhance flowering and fruiting. The adoption levels of respondents were analyzed.

Table 11: Manure/Fertilizer/Micronutrient Innovation N=145

Innovations	Frequency	Percentage	Gap Percentage
1.Use of Green Manure	81	55.89	44.13
2.Use of FYM	64	44.11	55.86

It would be clear from the above Table 11 that the use of green manure was highest (55.89 percent) by tribal vegetable farmers as they were residing inside the forest. So, they easily got plant residues and used them as green manure with luxury, less labour and less cost. From the sample 44.11 percent respondents liked to use FYM due to their cattle wealth, they had having. But not all respondents used green manure or FYM as per their availability and choice of use.

Gap percentage was highest in adoption of FYM (55.86 percent) because of less cattle wealth followed by 44.13 percent in Green Manuring adoption. So; the Agricultural Experts should motivate the respondents via result and method demonstration for effective adoption.

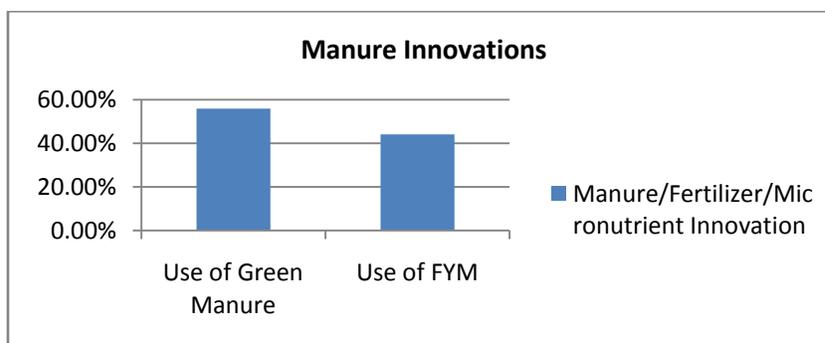


Fig. 11: Distribution of Respondents according to Adoption of Manure Innovation

Table 12: Fertilizer Innovations N=145

Fertilizers are the essential inputs in vegetable cultivation. It regulates the growth; reduction of pests and diseases attack and increase the yield.

Innovations(Chemical Fertilizer)	Frequency	Percentage	Gap Percentage
1.Nitrogen Application(Urea/Gromer)	58	40	60
2.Phosphorus(SSP/DAP)	54	37.24	62.75
3.Potash (MOP)	33	22.75	77.24

The above Table 12 predicted about the Extent of Use of Chemical Fertilizers in terms of N-P-K ratio. So, we found that Nitrogen Consumption was high amongst all fertilizers by the respondents i.e. 40 percent as opined by them. As from the Soil Testing Analysis it was seen that Nitrogen was essential for vegetable crops. As the tribals were living in Forest and hilly areas leaching was more. So in order to fill the deficiency they adopted Nitrogen. The use of Phosphorous was second highest because it had more demand in cole crops during bud formation, flowering and in reproductive stage and 37.24 percent as per the respondents use. Potash was using very less i.e. 22.75 percent because the forest soil is enriched with Potash, hence justified.

If we consider the Table 12 gap percentage was highest (77.24 percent) in Potash consumption followed by Phosphorous (62.75 percent) and Nitrogen fertilizer (60 percent). As most of the Tribal farmers were poor, they may not be able to meet all needs still now. Another reason might be inputs available in improper time and due to malpractice by vendors. So my suggestion to the Soil Chemist to orient the farmers regarding testing of soil samples and as per report they must recommend proper dosages of fertilizer in order to avoid injudicious application of fertilizer.

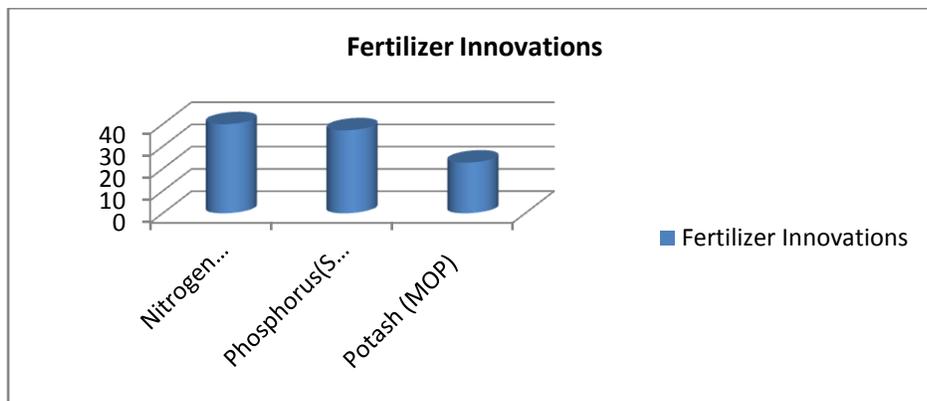


Fig.12 Distribution of Respondents according to Adoption of Fertilizer Innovation

Table 13 Method of Fertilizer Application

Methods Followed	Frequency	Percentage	Gap Percentage
1.Basal	34	23.44	76.56
2.Split	29	20	80
3.Top dressing	23	15.86	84.13
4.In broad casting & Blind dosages	59	40.68	59.31

The Above Table 13 proved about the methods adopted for chemical fertilizers by the farmers and found to be 40.68 percent still using broad casting methods due to unawareness, so Fertilizer Consumption Index per field was more due to irreparable and injudicious application of fertilizer in the crop and fertilizer loss due to evaporation and leaching. But 23.44 percent respondents were applying fertilizer in Basal dose followed by 20 percent in Split. A few of respondents (15.86 percent) were obeying the ethics of using top dressing method.

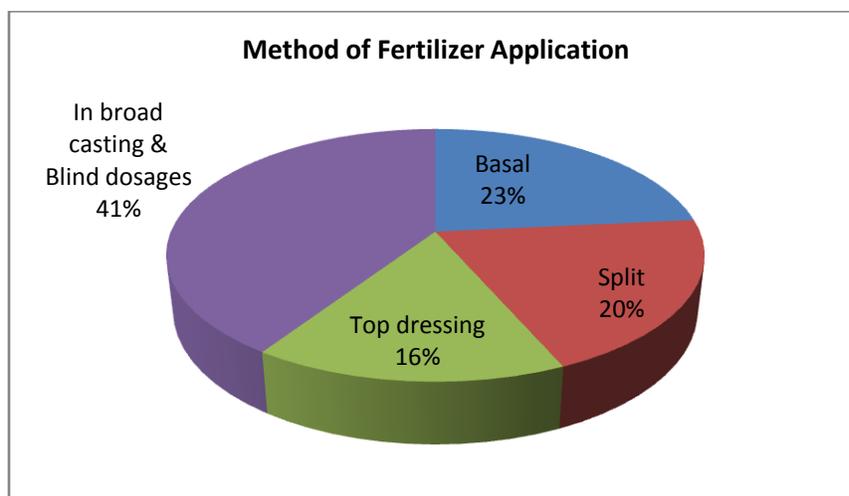


Fig. 13 Distribution of Respondents according to Method of Fertilizer Application

Gap percentage was found more in top dressing method (84.13 percent) and Split application (80 percent) because respondents were not acquainted and exposed to scientific application of fertilizers. Gap was also existing incase of basal(76.56 percent) and broadcasting method (59.31 percent). So fertilizer companies should orient the farmer before using it by supplying important information by organizing awareness camps and government functionaries should co-operate them by on field demonstration.

Adoption of Water Management Innovations

Table 14: Water Management Innovations N=145

Innovations	Frequency	Percentage	Gap Percentage
1.Own Arrangement/Source	79	54.48	45.51
2.Irrigation Facility in that cropped area	11	7.58	92.41
3.Drainage facility	19	13.10	86.89
4.Watershed/ catchment/command area facility	21	14.48	85.51
5.Drip Irrigation	15	10.344	89.56

The water management innovations of the respondents were presented in the Table-14. Out of 5 various categories of innovations own source of arrangement was the highest (54.48 percent) among all due to their own initiatives and grant-in-aid from Million-Well Scheme. Though DPAP programme was operating with IWMP(Integrated watershed management Project), it had not such remarkable effect for

management of water and in water use efficiency was 14.48 percent opined by respondents. Similarly Irrigation facility in that cropped area, drip irrigation and drainage facility followed in water management were 7.58 percent, 10.34 percent & 13.10 percent respectively.

From the Research it was found that, gap percentage become more wide incase of "Irrigation facility in that cropped area" (92.41 percent), "Drip irrigation" (89.56 percent), "Drainage facility" (86.89) and "Watershed Area facility" (85.51 percent). It implies that involvement of Water resource department in that area was very poor. So more problematic, hazards in that area by severe drought, crop failure & stress.

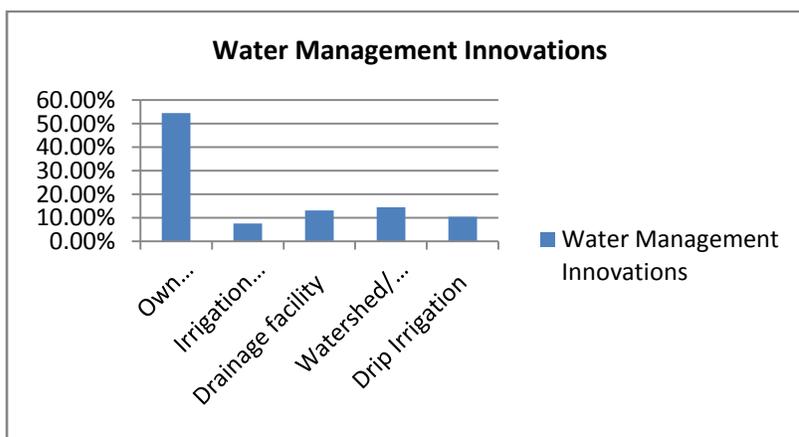


Fig. 14 Distribution of Respondents according to Water Management Innovation

Table 15: Agricultural Equipments/Implements Innovations N=145

Table-(A) Hand Operated (Manual)

Innovations	Frequency	Percentage	Gap Percentage
1.Sprayer	32	22.06	77.93
2.Water Cane/Rose Cane	79	54.48	45.51
3.Weeder	34	23.44	76.56

The Table 15 depicted about the distinguish between hand operated agriculture equipments versus machine operated equipments and finally made a conclusion that respondents mostly prefer to use water cane as it was cheap and lighter in weight having less drudgery i.e. 54.48 percent, followed by using hand operated weeder i.e. 23.44 percent opined by respondents and these weeder had more drudgery and more problematic to operate in their field from many observations. Similarly hand operated sprayer were having least preference from respondents side was 22.06 percent only.

Gap percentage was more increase of adoption of hand operated sprayer (77.93 percent) and weeder(76.56 percent).It was due to more drudgery, and time taking process.So Agriculture Engineers should invent drudgery free and farmers friendly equipments.

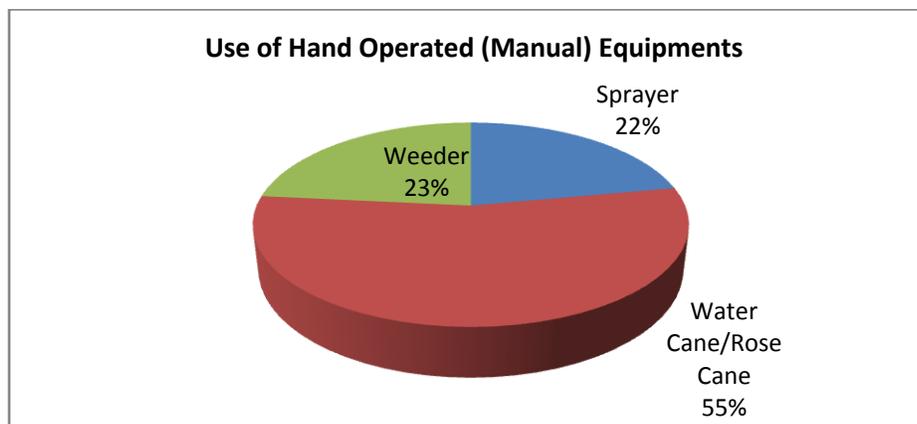


Fig. 15: Distribution of Respondents according to Use of Hand Operated Equipments

Table-(B) Machine Operated

Innovations	Frequency	Percentage	Gap Percentage
1.Sprayer	98	67.58	32.41
2.Weeder	10	6.89	93.10

It was clear from the above Table that respondents having more interest to use Sprayer which was machine operated and easy to use. It was used mostly because as per the joint initiative taken by Government Agriculture Department & NABARD, Sprayer was available to all with 50 percent subsidized cost in RKVY and NFSM scheme so more popularized i.e. 67.58 percent.. A few respondents (6.89) percent had shown a least interest in machine operated weeder because high rate, they may not able to afford it and more machinery problems along with more maintenance cost, hence be justified. Machine operated weeder (93.10 percent) has more gap percentage than Sprayer(32.41percent) due to more maintenance, costly and critical in operation. For the context of farm mechanization common equipment centres should be established in each village via farmers club.

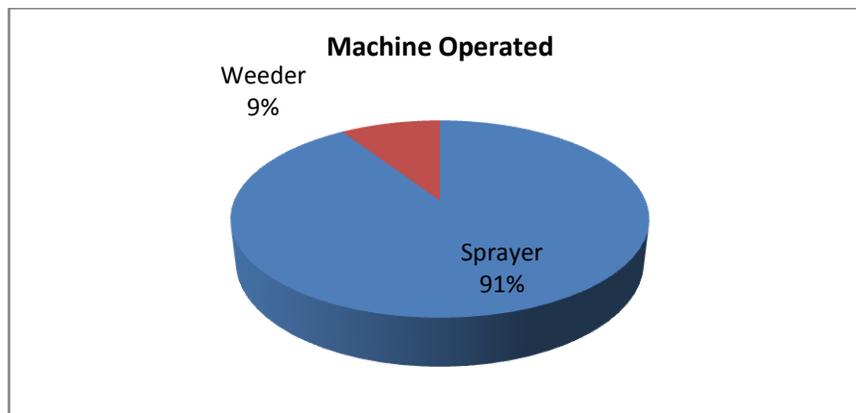


Fig. 16: Distribution of Respondents according to Machine Operated Equipments

Adoption of Intercultural Innovation

These are specified operation carried once or twice in a crop growth generally 20-25 days and 45 days after transplanting. Weeding, hoeing, earthing up operations are advantages for crop in the following reason.

Less crop weed completion, Crop gets nutrient, sun light and shelter in a better way, Hoeing and earthing up operation causes accretion, Fertilizers and manures can get easily mixed with soil, Plant root get available form of nutrients, The study therefore attempted to assess the adoption level various intercultural operation. The information collected in the same points are analyzed and presented in table 16.

Table 16: Intercultural Innovation N=145

Innovations	Frequency	Percentage	Gap Percentage
1.Hand Hoeing	36	24.82	75.17
2.Weeding	42	28.96	71.03
3.Uprooting ,discarding & burning of disease plants Manually	67	46.20	53.79

This Table 16 showed the level of intercultural operations by respondents and was found as follows. Majority (46.20 percent) of People had more emphasis to do it by own hand in uprooting, burning. Weeding operation was next to uprooting operation and 28.96 percent respondents practising it in vegetable crop. Similarly 24.82 percent respondents were practising hand hoeing in vegetable crop.

As hand hoeing work had more drudgery so people were denied to do this. So gap was more in this case followed by weeding and manual intercultural operation due to labour-intensive and cost

effective method. So machinery equipments must be used to minimize their drudgery and to some extent chemicals may be used.

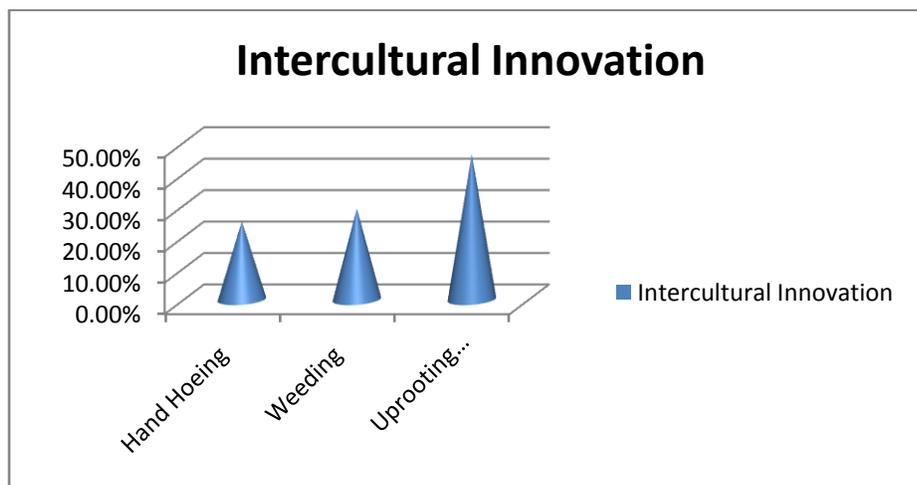


Fig.37 Distribution of Respondents according to Intercultural Innovation

Adoption of Post Harvest Innovations

Harvesting is not much important as the vegetable growers are much experimented in harvesting the produce, still then timely harvest enhances fruiting, market demand. Grading, packaging and other harvesting operations are important to attract the traders and consumers for getting good prices.

Table 17: Post Harvest Innovations N=145

Innovations	Frequency	Percentage	Gap Percentage
1.Grading	45	31.034	68.96
2.Sorting	31	21.37	78.62
3.Packaging & wrapping	27	18.62	81.37
4.Storage by using ITKs	34	23.44	76.56
5.Storage by using Chemicals	8	5.51	94.48

On the basis of Post Harvest innovation procedure, it was found from the above Table 17 that most of the respondents(31.034) adopt grading procedure because it was very easy and adds value in market due to uniform size. Tribal peoples were usually like to store their vegetables by following ITK and their own method and 23.44 percent respondents practising this.(The ITKs were using Neem, Karanj and Mahua leaves and oil, Tobacco leaves, using Bhadi(Upper rake) and straw with green leaves for proper storage of vegetables). From the sample, 21.37 percent tribal farmers were following sorting

procedure for various charges claim from customers. Due to the impact of Industrialization and commencement of MNCs, Companies by collaboration with KVIC and MSME, they had ample knowledge regarding wrapping and packaging before sending the vegetables to market without any damage and packing attracted more to the customer and 18.62 percent respondents followed it as per data base. Due to interference of BILATI, Odisha and Department Of Horticulture, Government Of Odisha now people of tribal community learn about preservation of Vegetables with help of chemicals are 5.51 percent opined by tribal farmers.

From the Post Harvest Innovation, research found that More gap was existing in case of "Storage by using Chemicals (94.48)". It was due to lack of knowledge regarding Proper Package of practices in Post Harvest Technology. So, Horticulture Professionals should take this matter serious to fill the gap via providing proper training to the farmers.

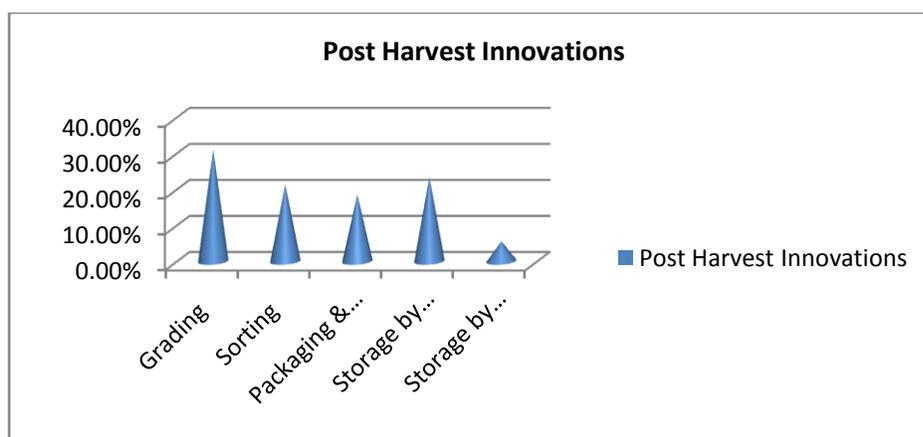


Fig.17 Distribution of Respondents according to Post Harvest Innovations

Plant Protection Related Innovations

The data in the Table 18 explained that majority (28.96 percent) of the respondents were followed the procedure of using Botanicals for plant protection purpose as the forest by-products easily available with them and less hazard with cheap rate might be the main reason thereof. Second majority of respondents (20 percent) were followed of using entomophagic parasites due to influence from Krishi Vigyan Kendra after training and exposure to it by the host farmers. From the sample, 17.24 percent respondents were using weedicides, as weed was a major problem in vegetables. They were using it after latest trial by weeder in major infestation case. Due to infestation of Root Knot nematodes in Vegetable crops 14.48 percent farmers were using nematicide. Use of Herbicide & Fungicide was very

low (11.034 percent and 8.27 percent respectively) as opined by the respondents due to un awareness about this.

Table 18: Plant Protection Related Innovations N=145

Related Innovations	Reasons for Adoption	Frequency	Percentage	Gap Percentage
1.Using of Weedicides	Minimization of weed infestation and less crop weed competition	25	17.24	82.75
2.Using of Acaricides/Fungicides	Minimization of fungal disease	12	8.27	91.72
3.Using of Nematicides	Controlling of Nematodes and Nematode related disease	21	14.48	85.51
4.Using of Herbicides	Controlling unwanted plants in field	16	11.034	88.96
5.Using of Plant Botanicals & Extracts(Neem cake,Karanj Oil,NSKE)	Controlling of diseases and pests in a holistic and natural way.	42	28.96	71.03
6.Using of Entomophagic Parasites/Parasitoids	Controlling of Insects & pests and using parasitism as natural enemy for that	29	20	80

As the Tribal vegetable farmers had low literacy rate, due to lack of trust worthy information, and ignorance by Government Officials, so there was more gap in adoption of plant protection innovations .Due to less exposure, the farmers were still in dark and this gap act as barrier for Transfer of any new technology.My suggestion to Plant Protection Officer to improve the competency of farmers with a regular visit and free service during their crop cultivation.

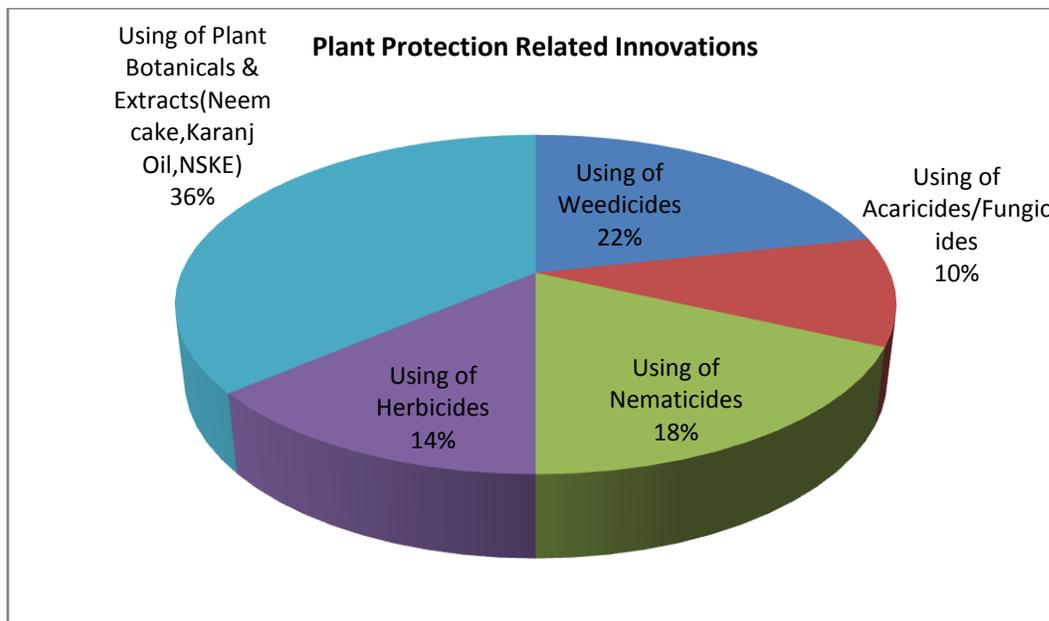


Fig. 18 Distribution of Respondents according to Plant Protection Related Innovations

Disease & Pest Management Related Innovations

A various number of diseases and pest attack to vegetable crops. Disease may occur due to fungal, bacterial and viral infection. So the yield also reduces drastically in some cases minor disease and pest cause maximum damage due to adverse climatic condition. The vegetable cultivators must have idea about different diseases and pest like, special feature symptoms nature of damage, control nature and integrated pest management etc. So accordingly they follow Various Measures for preventive measures as cited in the following Table 19

Table 19: Disease & Pest Management Related Innovations N=145

Related Innovations	Reasons for Adoption	Frequency	Percentage	Gap Percentage
1.Using IPM & IDM Techniques being recommended by Govt./NGO trainers	Using as holistic, sustainable way of package approach for effective insect-pest and disease management.	48	33.10	66.89
2.Using Various	Traps act as the warriors for	27	18.62	81.37

traps & cards for controlling Insects(Pheromone trap, light trap,Tricho card etc)	killing and trapping enemy by protecting crop in natural way.			
3.Using Agronomic Measures for less diseases(Crop rotation, Cropping pattern)	It creates eradication of disease in crop geometry by cropping pattern change and rotation and also creates resistant against diseases.	32	22.06	77.93
5.Using good disease & Pest resistant Varieties of seeds/Seedlings(BT variety & others)	Disease resistant variety creates avoidance by secretion of foul order/ bitter taste for the insect pests. So less expensive in disease pest management.	29	20	80
6.Use of guard crop/Cover crop/trap crop for minimization of pest attack	Act as security agent or boundary for protecting crops from any loss	9	6.20	93.79

From this Table 19 we may study the reality of the Plant Disease and Pest management properly. From the data we might concluded that 33.10 percent respondents follow the principle as well as concept of IPM and IDM due to training and campaign programme by NGOs and line departments in this locality and yielded a remarkable result among all measures. From the samples 22.06 percent farmers were using agronomic measures followed by 20 percent respondents using good resistant varieties for betterment in crop production by suppressing the negative factor of crop failiure.Using of various Traps were having positive response from farmers were 18.62 percent. This was because of on field demonstration by ATMA Extension reforms Scheme. Only 6.20 percent respondents were opined

about use of cover/guard crop. It was gradually increasing, as less costly and positive effect on crop field.

The Table Symbolized poor intervention of Agriculture Department in the line of Proper disease and pest Management. Plant Protection Authorities were rarely visiting the field as per their wish. But whenever severe condition occurs we may find their face. As a result of which wider gap occurs by hindering more outbreak of disease pest in that area with low production in crop. This gap may be filled up, if they set up knowledge management portals, agriclinics in that area.

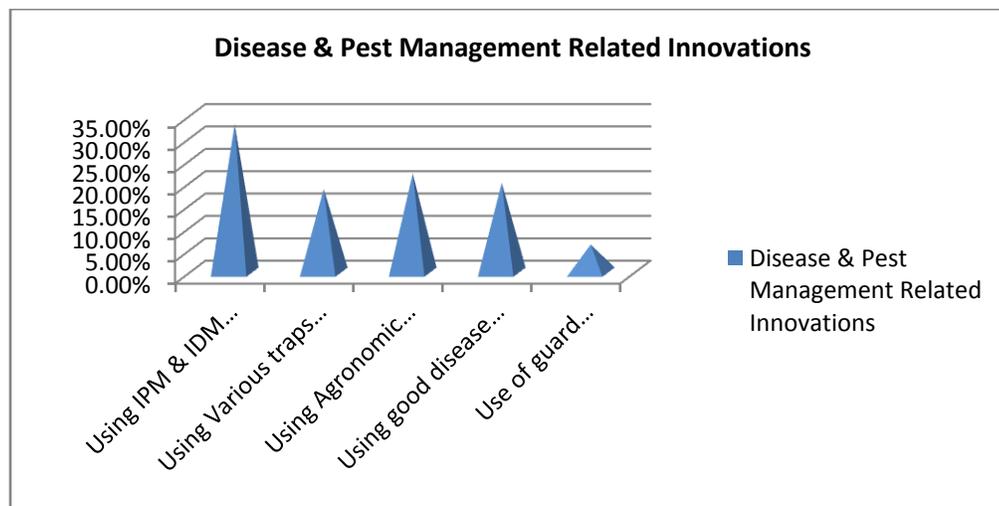


Fig. 19 Distribution of Respondents according to disease & Pest Management Related Innovations

Source of Guidance for Adoption of these Innovations

Table 20 Source of Guidance for Adoption of these Innovations N=145

Sources	Frequency	Percentage	Gap Percentage
1.Family Member	30	20.68	79.31
2.Friend Farmer	27	18.62	81.37
3.Opinion Leader	8	5.51	94.48
4.Input dealer	12	8.27	91.72
5.Govt.Extension Agents	14	9.65	90.34
6.NGO	49	33.79	66.20

It was clear from the above Table that NGO was the first and foremost social institution in society was 33.49 percent rating from respondents for source of guidance for adoption followed by 20.08 percent from Family members and 18.62 percent from friend farmers being operationally defined from sociogram.Goverment Extension Agents were acting as very poor (9.65 percent) due to less

involvement followed by 8.27 percent from input dealer and 5.51 percent from opinion leaders from other community.

Gap percentage was found more in the indulgence of Opinion leader, Input dealer, and Government Extension Agent and Friend farmer. So information gap also occurs in Technology adoption and Dissemination. This gap may be fulfilled if all had a positive indulgence with dedicated work by following the Principle of Education “Knowledge by sharing” and “Sa vidya ja vimuktaye”.

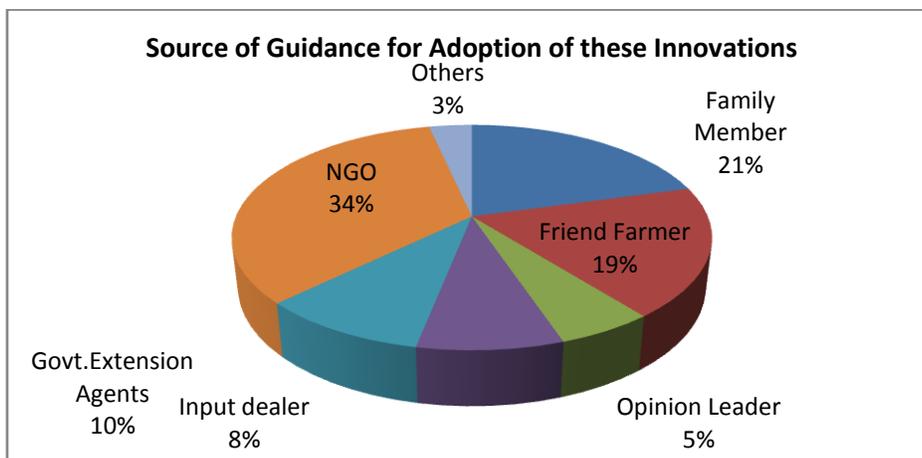


Fig. 20: Distribution of Respondents according to Source of guidance For Adoption

Adoption of Source of New Ideas & Practice

Table 21: Source of New Ideas & Practice N=145

Sources	Frequency	Percentage	Gap Percentage
1.Group Meeting	19	13.10	86.89
2.Demonstration	16	11.03	88.96
3.Exhibition	17	11.72	88.27
4.Farmer Fair	36	24.82	75.17
5.TV	14	9.655	90.35
6.Radio	36	24.82	75.17
7.News Paper	5	3.44	96.56

The data from the above Table 21 revealed that Majority of the respondents were getting new ideas and made it practice from Farmers fair i.e. 24.82 percent in the concept of “seeing is believing”, followed by group meeting (13.10 percent), Exhibition (11.72 percent) and from demonstration (11.03 percent) in the concept of “learning by doing & seeing is believing.” Radio was acting as the key element

to disseminate and transcript information to illeterates in tribal pockets was 24.82 percent as per respondents opinion followed by 9.65 percent in TV .Here Audio aid had more emphasis and vital role than Audio-visual aids. Only 3.44 percent people had eager for news paper due to their illiteracy.

Gap percentage was more in case of use of News paper, TV, Exhibition, Group meeting, Demonstration. As Visual communication in Extension Education says that 90 percent thing were retaining by seeing.So, We must emphasized on more demonstration, group meeting.For demonstration we must follow the principle "Learning by doing".As people were illiterate and unable to read news paper government should supply TV to each "farmers club" with a news paper being read by any literate person daily basis.So we should follow the principle of "Seeing is believing & learning by seeing". Radio had comparatively good impact so, every farmer should be supplied a Radio with subsidized rate by any donor agency or government. Alternate of TV may be developed by Extension worker by projectors,slides,Flip chart,Posters and implementing all audiovisual aids available in that area.In this way gap may be filled up, it had no doubt.

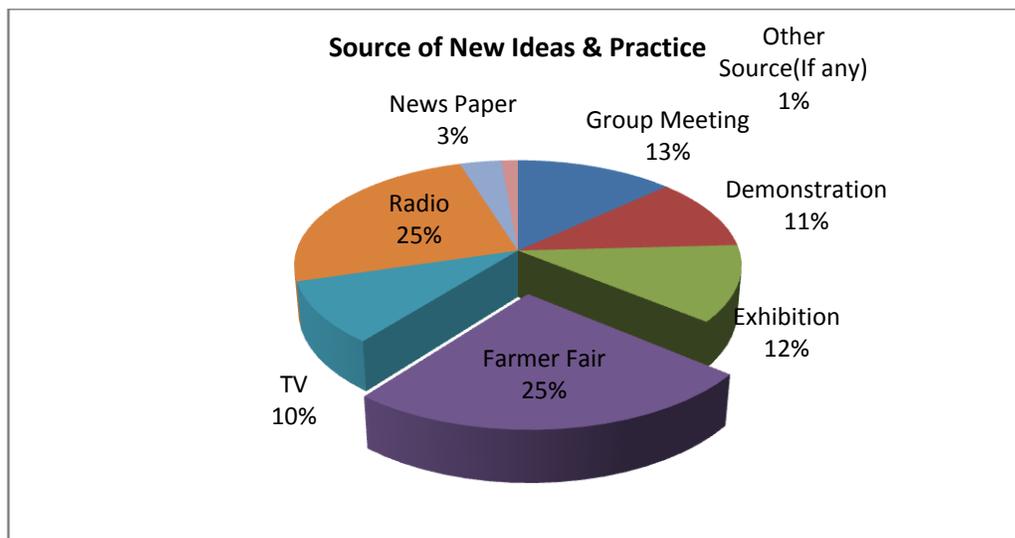


Fig.21: Distribution of Respondents according to Source of New Ideas & Practice

Adoption of Hi-tech Agricultural Practices

Table 22: Expose to Hi-tech Agricultural Practices N=145

Innovations	Frequency	Percentage	Gap Percentage
Vermicompost,Vermiculture & Vermiwash	27	18.62	81.37
Phospho Compost	13	8.96	91.03
NADEP Compost	4	2.75	97.24
Magic Compost	8	5.51	94.48
EM Tonic	6	4.13	95.86
Micronutrients	10	6.89	93.10
Bio Fertilizers	5	3.44	96.56
Hormones	3	2.06	97.93

According to the above result from table 6.2.22, It was depicted that the respondents had good adoption on fertilizers but they had comparatively less adoption on micro nutrients, bio- fertilizers, vermicompost, Magic compost, NADEP, Phospho compost, EM Tonic & Hormones. Application of nutrients was very much essential in vegetables to enhance flowering, fruiting and quality fruits.

Our soil was deficient in Boron, Zinc, Molybdenum etc, so the respondents should adopt micro nutrients, bio fertilizers, Vermicompost in large scale; as these were essential nutrients for vegetable crops, which should have taken care by the extension functionaries working in the concern area.

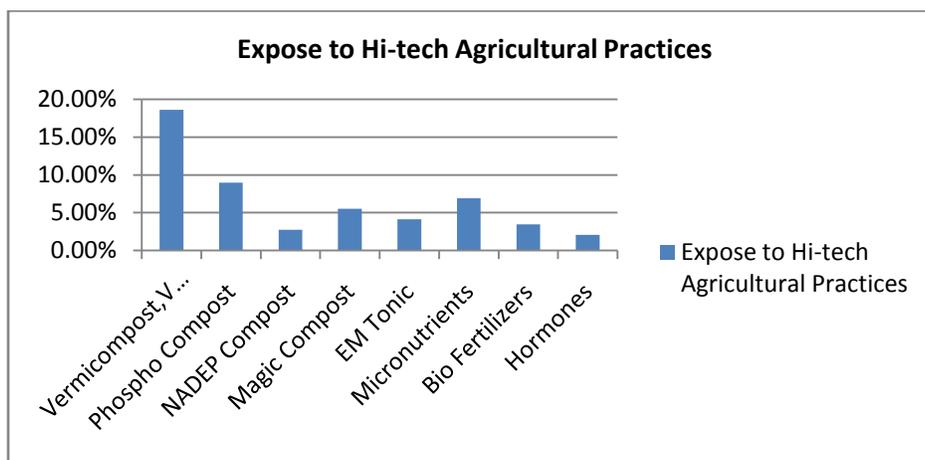


Fig. 22: Distribution of Respondents according to Expose to Hi-tech Agricultural practices

Adoption of Organic Farming Practices

Table 23: Extent of Use of Organic Farming Practices N=145

Innovations	Frequency	Percentage	Gap Percentage
Jivaras	8	5.51	94.48
Amrit Pani	28	19.31	80.68
Panchagabya	7	4.82	95.17

From the Table 23 the data revealed that the respondents had a less affinity for organic farming practices due to costly, time taking and cumbersome job. Apart from these it was effective after a long duration and still not popularized means in baby stage of Progress now. My suggestion for this for making Evergreen Revolution and giving a big hand for Vision-2050 ,organic farming practices should be uplifted by Change Agents.

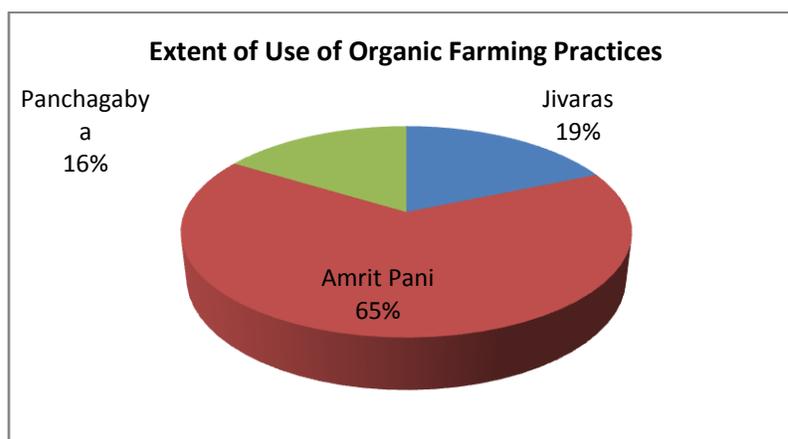


Fig. 23: Distribution of Respondents according to Organic Farming Practices

CONCLUSION:

As adoption is the final process and innovation to invention is a decision making process so by considering all above hi-tech adoption methods every farmer can get their sustainable livelihood and meaningful life by feeding themselves and feeding to others. Here the researcher want to show his brief intention on sociocultural innovation which are being economically viable, socially acceptable and technically feasible.

REFERENCES:

1. Abdul, R.Q, Ashfaq, H.M and Sultan, A.C (1993): Farmers characteristics affecting adoption of agricultural innovations. *Journal of Rural Development and Administration*. Vol. xxv, (3): 111 – 113.
2. Agronomic research centre, Viswabharati (1990): A study of the working of the HVVP in the district of Birabhami, W.B (Kharif Paddy 67-68) mimeographed, Shantiniketan.
3. Ahemed, Md.S (1992) knowledge and adoption behavior of farmers towards the recommended agricultural practices of NWDPR in Chuddapali of A.P (up Pub.) M.sc (Ag) thesis, OUAT, BBSR.
4. Ahemd .J and Elias, S.M (1991).marketing of potato traders level in some selected areas of Bangladesh. *Economic affairs Kolkata* 333(3): (183-188).
5. Ajore, R. 1998 .Constraint in adoption of improved variety of wheat by hill farmers of Uttar Pradesh. *Indian J.Ext.Edn* XXLI (1 and 2) :75-78.
6. Ali M 2000, Dynamics of vegetables in Asia. A synthesis in dynamic of vegetable distribution and consumption in Asia Mubaria Ali (Ed). Asian vegetable research and development centre, Shanchua, Tiwan PP.1-19.
7. Alexander Corinne, Jorge Fernandez-Cornejo, and Rachael E. Goodhue (2002) Determinants of GMO Use : A survey of Iowa Corn- soybean Farmers' Acreage Allocation. In V Santaniello.
8. Antwal, P.H and Bharaswadkar, R.B (1990), Constrains in the utilization at new technology by rural women, *Maharashtra journal of extension* –IX 264 -247.
9. Anonymous. 2011. ICAR-Vision 2030 of Indian Council of Agricultural Research. Directorate of Knowledge Management in Agriculture. New Delhi. pp 1-24.
10. AppaRao, G. Radhakrishna and Menon .K (1998). Farmers' characteristics in relation to adoption of agricultural practices through national Demonstration. *Madras Agril. J* 62(10-12); PP 860-861
11. Arene, C.J (1994) Discriminant analysis of small holder farmer adoption potential and the prediction of extension cost in Nigeria: a comparative enterprise perspective *Journal of Extension System* 10 (1) : 46–58.
12. Arora, VPS 1998, Managing vegetable marketing in hill region of UP, PanthNagar.Dept. of Agriculture ,Economics,GB Pant university of Agricultural and technology ,269 P
13. Arya, S.R.S and S.L (1994). New technology of rain fed agriculture and identification of constraints its adoption on mid hills UP, *Agril situation in India*. 39(7): 487-496.
14. Attavar, M (1991). Hybrid seed catching up the Hindu, *Survey of Indian Agriculture*.147-149.

15. Babu, B.K, Prabhakar, K and Reddy. Gr (2007) knowledge of vegetable growers on vegetable marketing. *Journal of research, ANGRAU* 35(2):97-98.
16. Bandiera, O. and I. Rasul (2006) 'Social Networks and Technology Adoption in Northern Mozambique', *The Economic Journal* 116(514): 869-902.
17. Barsan, G.S and Copener, H.R (1968). Factors related to the acceptance of Agricultural Administration and Extension Vol 29 (2) : 149 – 156.
18. Barsan, G.S and Copener, H.R (1998). Factors related to the acceptance of new ideas and techniques in farming, Punjab, India *IJEE*, 4(1.2):29-30.
19. Bajaj & Kambly(1982).," A study on the adoption of Improved Agricultural Practices by tribal farmers of Maharastra."
20. BallavShri and Prasda Guru (1995). Lack of technical Knowledge attributed to gap in technology. *ofExt.system1(1):78-80.*
21. Basantia,D(2011)"Impact of NGO on socio-economic development of tribal farmers in Koraput District".
22. Bishop R and Coughenour C.M (1994) Discontinuance of Farm Innovations. Mimeo Billetin AE 361 Department of Agricultural Economics and Rural Sociology, Ohio State University, Columbus.
23. Chadha, K.L. 2009. Horticulture: The Next in Agriculture Agriculture Year Book 2009. Agriculture Today. pp: 24-29.
24. Choudhury,S.N.(1993).,"Adoption behavior of tribal farmers in Phulbani district towards improved agricultural practices"
25. Das, J. (2002); Keynote address: Socio- Economic perspectives of Detribalisation in North Orissa, conducted by Department of Tribal Studies, North Orissa University, Baripada.
26. Darr David A and Wen S. Chern (2002) Analysis of Genetically Modified Organism Adoption by Ohio grain Farmers. Proceedings of the 6th International Conference on Agricultural biotechnology: New Avenues for production, Consumption and Technology Transfer. Ravello Italy July 11-14 2002.

**AN ENVIRONMENT FRIENDLY GREEN PROTOCOL FOR THE SYNTHESIS OF
NOVEL COMPOUNDS IN AQUEOUS MEDIA WITH THEIR BIOLOGICAL
EVALUATION**

M. S. Kadam

P. G. Research Centre, Department of Zoology,
Yeshwant Mahavidyalaya, Nanded, M.S., INDIA

Corresponding author E-mail: mskadam2006@rediffmail.com

ABSTRACT:

A clean, simple, green, environmental friendly and waste minimizing synthesis of 6-amino-4-aryl-3-methyl-1-phenyl-1,4-dihydropyrano [2,3-c] pyrazole-5-carbonitriles was accomplished in good to excellent yields *via* the one-pot three component condensation of 3-methyl-1-phenyl-2-pyrazolin-5-one, aromatic aldehyde, and malononitrile in aqueous medium. The reaction has the advantages of good yield, less pollution; ease of separation, and of being environment friendly.

KEYWORDS: Green synthesis; Aqueous medium; Aromatic aldehyde; Malononitrile.

INTRODUCTION:

Increasing urbanization and industrialization have resulted in a dramatic increase in the volume of wastes generated worldwide, particularly of sewage sludge or biosolids generated as a byproduct from waste water treatment. Waste management has become a major environmental challenge, and land application of biosolids is generally considered the best option of disposal because it offers the possibility of recycling plant nutrients, provides organic material, improves a soil's chemical and physical properties, and enhances crop yields. However, the benefits from biosolids application have to be weighed against potential deleterious effects such as risks of excessive leaching of nitrate, contamination of soils and crops with human pathogens and heavy metals, nutritional disorders in crops, increase of soil salinity, contamination of groundwater with pesticides, hormones, and pharmaceuticals, and decreased stability of native soil organic matter. For these reasons, this special issue focuses on the agronomic and environmental implications of soil application of biosolids and presents the most recent scientific information on the subject.

Papers in special issue cover various aspects of the release of nutrients from biosolids and their effect on the growth of cereal and fruit crops, pasture, and trees on a range of soils in diverse locations. Papers also report on the residual nutrient effects of biosolids, their release of potentially damaging heavy metals, and effects on soil organisms, thus providing a broad view of the soil-agronomic advantages and environmental implications of recycling organic matter and nutrients from sewage treatment systems into soils. Green chemistry is about the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. Environmental chemistry is the chemistry of the natural environment, and of pollutant chemicals in nature. Green synthesis seeks to reduce and prevent pollution.

Water is perhaps one of the greener solvents, one can imagine in terms of costs, availability, safety and environmental impact. But because of the low solubility of most organic compounds in it and its great reactivity towards some organic compounds (e.g. organometallics), the use of water as solvent was limited to hydrolysis reactions until the pioneering works of (Breslow and Grieco) in the early 1980s. Since then, many striking examples have appeared in the literature showing that water has unique properties as a solvent that can sometimes lead to surprising results

Pyrano pyrazole is a fused heterocycle comprised of pyrazole and pyran rings which are known as the sub-structural units of several biologically active compounds.^{1,2} Polyfunctionalised benzopyrans have been widely used as medicinal intermediates due to their biological and pharmacological properties such as antibacterial, molluscicidal, anthelmintic, hypnotic and insecticidal activity.³⁻⁹ Some 2-amino-4*H*-pyrans can be used as photoactive materials.¹⁰ The 4*H*-pyran ring is also a structural unit of a number of natural products.¹¹⁻¹³ 1,4-Dihydropyrano[2,3-*c*]pyrazoles are generally prepared by one-pot three component condensations of malononitrile, aldehyde and 3-methyl-1-phenyl-2-pyrazolin-5-one using $\text{KF}/\text{Al}_2\text{O}_3$ in DMF at room temperature.¹⁴ The utilisation of water as reaction medium for the synthesis of 1,4-dihydropyrano[2,3-*c*]pyrazoles is demonstrated by using various phase transfer catalysts such as triethylbenzylammonium chloride (TEBA)¹⁵ and hexadecyltrimethylammonium bromide (HTMAB).¹⁶ Similarly, the use of the neutral organo-catalyst DL-proline using the grinding technique¹⁷ and a surfactant such as *p*dodecylbenzenesulfonic acid¹⁸ (DBSA) has recently been demonstrated.

Solvent-free reaction conditions along with microwave irradiation technique using piperidine as the base have also been introduced for the synthesis of 1,4-dihydropyrano[2,3-*c*]pyrazoles.¹⁹ In recent years, the catalytic activity of sulfamic acid has emerged as a useful acid imparting high regio- and chemoselectivity in various chemical transformations.²⁰⁻²³ The versatility of sulfamic acid because of its low cost, eco-friendly nature and ready availability as a common organic chemical encouraged us to

explore it in various multi-component reactions under benign reaction conditions. Here we report another remarkable catalytic activity of cesium chloride in water for the one-pot three-component condensation of malononitrile, an aromatic aldehyde and 3-methyl-1-phenyl-2-pyrazolin-5-one, to form a variety of 6-amino-4-aryl-3-methyl-1-phenyl-1,4-dihydropyrano[2,3-c]pyrazole-5-carbonitriles.

MATERIALS AND METHODS:

Melting points are uncorrected. IR spectra were recorded on a Shimadzu FTIR-1710 spectrophotometer. ^1H NMR spectra were recorded at 400 MHz in CDCl_3 using TMS as internal standard.

Experimental:

Typical experimental procedure:

A mixture of aromatic aldehyde (3 mmol), malononitrile (3 mmol), 3-ethyl-1-phenyl-2-pyrazolin-5-one and Cesium chloride in water (20 ml) was refluxed for the time period as mentioned in Table 1. After the completion of reaction, it was cooled at room temperature and poured into crushed ice to get solid product which was filtered off. The crude products were recrystallised from ethanol to give pure 1,4-dihydropyrano[2,3-c] pyrazole in good to excellent yields.

The physical details and spectral analysis for the new product are given below:

6-Amino-4-(3,4-dimethoxyphenyl)-3-methyl-1-phenyl-1,4-dihydropyrano[2,3-c]pyrazole-5-carbonitrile (4d): Yellow crystalline solid,

m.p. 191–193°C. IR (KBr): τ_{max} 3490, 3330, 3017, 2937, 2896, 2198, 1666, 1589, 1381, 1242, 1122, 882 cm^{-1} . NMR (CDCl_3): δ 1.92 (s, 3H, CH_3), δ 3.81 (s, 3H, OCH_3), δ 3.83 (s, 3H, OCH_3), δ 4.67 (s, 1H, ArCH), δ 6.33 (s, 2H, br., NH_2), 6.88 (s, 1H, ArH), 6.72 (d, $J = 8.28$ Hz, 1H,

ArH), 6.79 (d, $J = 8.28$ Hz, 1H, ArH), 7.29–7.37 (m, 5H, ArH). Anal. Calcd for $\text{C}_{21}\text{H}_{18}\text{N}_4\text{O}_3$: C, 67.37; H, 4.85; N, 14.96; found: C, 67.29; H, 4.83; N, 14.99%.

RESULTS AND DISCUSSION:

Initially, we examined the reaction of benzaldehyde (3 mmol), malononitrile (3 mmol) and 3-methyl-1-phenyl-2-pyrazolin-5-one (3 mmol) in water (20 ml) using cesium chloride as the catalyst. The room-temperature stirring of the reaction mixture for 3–5 h did not result in the formation of the expected product. Therefore we carried out the reaction by heating under reflux for 7–13 h, using TLC to monitor progress. When the reaction was complete, the mixture was cooled to room temperature and a solid product was precipitated. The entire reaction mixture was poured onto crushed ice and the solid was filtered off. The crude product was recrystallised from ethanol to afford analytically pure product in

82% yield. The scope of this three-component condensation was then extended using a range of aromatic aldehydes, and the results are summarised in Table 1.

Thus the methoxy substituted aromatic aldehydes (Table 1, entries) underwent a clean three component condensation to form the corresponding 1,4-dihydropyrano[2,3-*c*]pyrazoles in excellent yields. Other aromatic aldehydes produced 1,4-dihydropyrano[2,3-*c*] pyrazole in good yields. However, *p*-dimethylamino benzaldehyde (Table 1, entry 10) failed to produce any 1,4-dihydropyrano[2,3-*c*] pyrazole. A similar failure was reported earlier.¹⁸ The isolated pyrano[3,2-*c*] pyrazole derivatives were completely characterised by IR and ⁵H NMR, and the melting points of known compounds were consistent with those of the references reported. For example, the IR spectra for **4a** exhibited sharp bands at 3471, 3257 cm⁻¹ due to NH₂ and 2198 cm⁻¹ due to CN. The ¹H NMR spectrum of **4a** exhibited a characteristic peak at $\delta = 4.62$ ppm for H-4 and a broad singlet peak at $\delta = 6.71$ ppm due to the NH₂ group.

Table 1. Details of Ar, reaction time and percent yield of compounds:

Entry	Ar	Reaction time/h	Product	Yield /%	Melting-point/°C Found
1	C ₆ H ₅	6	White	70%	167-168
2	4CH ₃ C ₆ H ₅	8	White	80%	168-170
3	4ClOC ₆ H ₅	5	Yellow	80%	175-177
4	4OHC ₆ H ₅	5	White	80%	208-209
5	4NO ₂ OC ₆ H ₅	5	Cream	60%	185-187
6	2ClOC ₆ H ₅	4	Green	70%	178-180
7	3,4(CH ₃ O) ₂ C ₆ H ₅	3	White	70%	191-193
8	4CH ₃ OC ₆ H ₅	4	White	80%	167-170
9	2OHOC ₆ H ₅	9	White	60%	168-171
10	OSC ₅ H ₄	9	White	64%	220-223

The synthesis of 1,4-dihydropyrano[2,3-*c*]pyrazole-5-carbonitriles by one-pot three component condensation of aromatic aldehydes, malononitrile and 3- methyl-1-phenyl-2-pyrazolin-5-one in the presence of catalytic quantity of cesium chloride in water is reported. This one-pot synthesis is characterised by mild reaction conditions, broad scope, high yields, and preparative simplicity.

BIOLOGICAL ACTIVITY:**Antimicrobial activity:**

The synthesized compounds were evaluated for their antibacterial activity against gram positive species *S. aureus* and *B.subtilis* and gram negative species *E.coli* and *S.typhi* by paper diffusion method. All the synthesized compounds were dissolved in dimethyl sulphoxide (DMSO).

Table 2: Antimicrobial activity of compound (4a-4j):

Entry	Compounds	Zone of Inhibition in mm			
		<i>S.aureus</i>	<i>B.subtilis</i>	<i>E.coli</i>	<i>S.typhi</i>
1	4a	06	12	10	10
2	4b	18	20	16	12
3	4c	10	10	12	14
4	4d	14	12	18	12
5	4e	16	18	20	14
6	4f	07	12	10	10
7	4g	08	10	14	12
8	4h	10	10	12	14
9	4i	14	12	17	12
10	4j	10	18	18	14
11	Norfloxacine	14	24	20	16
12	Streptomycin	16	18	20	18

The synthesized compounds exhibited zone of inhibition at **06-20mm** in diameter where as standard **Norfloxacine** exhibited zone of inhibition at 14 and 24 in diameter against *S. aureus* and

B.subtilis and 20 and 16mm in diameter against *E.coli* and *B.subtilis* and 20 and 18mm in diameter against *S. aureus* and *B.subtilis* respectively. Amongst the synthesized compounds (**4b, 4e,4g,4j**) shows higher zone of inhibition against *S. aureus*. Compounds (**4b, 4d, 4e,4g,4i,4j**) shows higher zone of inhibition against *E.coli*, compounds (**4b, 4e,4j**) shows higher zone of inhibition against *B.subtilis* and *S. aureus* shows higher zone of inhibition against *S.typhi* as compared to other compounds.

CONCLUSION:

In conclusion, we have synthesized an environmental friendly efficient and facile method for the synthesis of novel compounds. The product formed can be easily isolated by simple workup technique, requires ambient reaction condition, short time, less expensive and give good yield. These synthesized compounds show biological activity.

REFERENCES:

1. M.H. Elnagdi, M.R.H. Elmoghayar and G.E.H. Elgemeie, Adv.Heterocyclic Chem., (1987), 41, 319.
2. M.H. Elnagdi, M.R.H. Elmoghayar and K.U. Sadek, Adv. HeterocyclicChem., (1990), 48, 223.
3. S. G. Kuo, L. J. Huang and H. Nakamura, J. Med. Chem. (1984), 27, 539.
4. L. L. Adreani and E. Lapi, Boll. Chim. Farm. 1960, 99, 583; Chem. Abstr.(1961), 55, 2668d.
5. Y. L. Zhang, B. Z. Chen, K. Q. Zheng, M. L. Xu and X. H. Lei, ActaPharm. Sinica, (1982), 17, 17; Chem. Abstr. (1982), 96, 135 383e.
6. L. Bonsignore, G. Loy, D. Secci and A. Calignano, Eur. J. Med. Chem.(1993), 28, 517.
7. E.C. Witte, P. Neubert and A. Roesch, Ger. Offen. DE 1986, 3 427 985;Chem. Abstr. (1986), 104, 224 915f.
8. J.L. Wang, D. Liu, Z.J. Zhang, S. Shan, X. Han, S.M. Srinivasula,C.M. Croce, E.S. Alnemri and Z. Huang, Proc. Natl. Acad. Sci. U.S.A.,(2000), 97, 7124.
9. Y.A. Mohamed, M.A. Zahran, M.M. Ali, A.M. El-Agrody and U.H. El-Said, J. Chem. Res. (S), (1995), 322.
10. D. Armesto, W.M. Horspool, N. Martin, A. Ramos and C. Seoane, J. Org.Chem. (1989), 54, 3069.
11. S. Hatakeyama, N. Ochi, H. Numata and S. Takano, J. Chem. Soc., Chem.Comm. (1988), 1202.
12. R. Gonzalez, N. Martin, C. Seoane and J. Soto, J. Chem. Soc., PerkinTrans. 1, (1985), 202.
13. Kamaljit Singh, Jasbir Singh and Harjit Singh, Tetrahedron, (1996), 52,14273.
14. X.S. Wang, D.Q. Shi, L.C. Rong, C.S. Yao and G.Y. Dai, Jieguo Huaxue,(2003), 22, 331.
15. D.Q. Shi, S. Zhang, Q.Y. Zhuang, S.J. Tu and H.W. Hu, Chin. J. Org.Chem., (2003), 23, 1314.

16. T.S. Jin, A.Q. Wang, Z.L. Cheng, J.S. Zhang and T.S. Li, *Synth. Commun.*,(2005), 35, 137.
17. S.B. Guo, S.X Wang and J.T. Li, *Synth. Commun.*,(2007), 37, 2111.
18. T.S. Jin, R.Q. Zhao and T.S. Li, *Arkivoc*, (2006), xi, 176.
19. J.F. Zhou, S.J. Tu, Y. Gao and M. Ji, *Chinese J. Org. Chem.*, (2001),21,742.
20. T.S. Jin, G. Sun, Y.W. Li and T.S. Li, *Green Chem.*, (2002), 4, 255.
21. W. Bo, Y.L. Ming and S.J. Shuan, *Tetrahedron Lett.*, (2003), 44, 5037.
22. B. Wang, Y.L. Gu, C. Luo, T. Yang, L.M. Yang and J.S. Suo, *Tetrahedron Lett.*, (2004), 45, 3369.
23. P.R. Singh, D.U. Singh and S.D. Samant, *Synlett*, (2004), 11, 1909.

PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER SAMPLES OF JHARIA COAL MINING REGION, DHANBAD, INDIA

B. P. Panigrahy* and Prasoon Kumar Singh

Department of Environmental Science and Engineering,
Indian School of Mines, Dhanbad-826004, Jharkhand, India

*Corresponding author E-mail: binaypanigrahy@gmail.com

ABSTRACT:

The study was carried out to assess the impacts of industrial and mining activities on the groundwater quality in Jharia coal mining region of Jharkhand State. Groundwater samples Twenty Nine (29 Nos.) were collected from various locations of the study area. The water quality parameters considered in the present study were pH, Temperature, Electrical Conductivity, Total Dissolved Solids, Alkalinity, Chloride, Nitrate, Sulphate, Bicarbonate, Total Hardness, Calcium, Magnesium, Sodium and Potassium. The pH of the analyzed groundwater samples varied from 6.2 to 7.6, indicating mildly acidic to alkaline in nature. Concentration of TDS varied from 301 to 923 mg/L and spatial differences in TDS values reflect the variation in lithology, surface activities and hydrological regime prevailing in the region. The quality assessment shows that in general, the water is suitable for drinking with some exceptions. However, EC, TDS, Cl, TH, Mg, Ca and SO_4 values are exceeding the desirable limits at some site, making it unsafe for drinking.

KEYWORDS: Jharia coalfield; Water quality; Groundwater Level.

INTRODUCTION:

Groundwater is the most important water resource on earth. It comprises of the major and the preferred source of drinking water in rural as well as urban areas and caters to 80% of the total drinking water requirement and 50% of the agricultural requirement in rural India (Meenakshi et al. 2006). To prepare a sustainable management strategy for ground water development, it is important to understand the fluctuation of ground water levels with reference to natural or artificial recharge in space and time domain (Mushini V.S.R et al. 2012). Groundwater is believed to be comparatively much clean and free from pollution than surface water. However, indiscriminate discharge of industrial effluents, domestic sewage and solid waste dump cause groundwater to become polluted and creates

health problems (Patilet al.2010) The groundwater is a dynamic and replenish able natural resource, but in hard rock terrains its availability is of limited extent and is essentially confined to the fractured and weathered horizons, which points towards efficient management of groundwater in these areas(Saraf A.K.et al.1998). Due to the ever-increasing demand for potable and irrigation water and the inadequacy of available surface water, the importance of groundwater is increasing exponentially (Nagarajan et al. 2010). Hence, to utilize and protect valuable water sources effectively and predict the change in groundwater environments, it is necessary to understand the hydrochemical parameters of groundwater such as pH, electrical conductivity (EC), total dissolved solids (TDS),sodium absorption ratio (SAR), total hardness (HT), major anion (CO_2 , HCO_3^- , Cl^- , and SO_4^{2-}) concentrations, and major cation (Ca_2 , Mg_2 , Na, and K) concentrations (Prasanna et al. 2010; Guendouz et al. 2003; Edmundset al. 2006).

The quality of the ground water depends on a series of geological, hydrological and mining conditions, which vary significantly from mine to mine (Younger et al. 2002). The ground water resource may act as potential water source in the water scare mining areas and by adopting a suitable water management strategy and treatment process, the mine water generated during mining operations may be harnessed and utilized to meet the regional water demand for domestic, industrial and irrigation uses (Singh,1994). The Gondwana sequence in the Jharia basin begins withTalchir Formation which is followed stratigraphically upwards by Barakar Formation, Barren Measures and Raniganj Formation. The oldest rocks are exposed along the northern margin and youngest formations are outcropped towards south in the western part of the basin(Sharma et al.1966; Chandra,1992).The effects of climate change on ground water will depend onthe ground water system, its geographical location, and changes in the hydrological variables (Alley,2001; Sophocleous, 2004).

Ground water is affected by climate change through various hydrological processes, and trends in climate variables will be reflectedin ground water trends. The response of ground water levels to key climate variables has been studied with both statistical models (Viswanathan, 1984; Bierkens et al.,) The quality of groundwater is the resultant of all the processes and reaction that act on the water from the moment it condenses in the atmosphere to the time it is discharged by a well..Ground water is affected by climate change through various hydrological processes, and trends in climate variables will be reflected in ground water trends. The response of ground water levelsto key climate variables has been studied with both statistical models (Viswanathan, 1984; Bierkens et al., 2001; KnottersandBierkens, 2001; Chen et al., 2002) Over burden of the population pressure, unplanned urbanization, unrestricted exploration and dumping of the polluted water at inappropriate place enhance the infiltration of harmful compounds to the ground water (Pandeyet al., 2009). The coal field has the vast number of

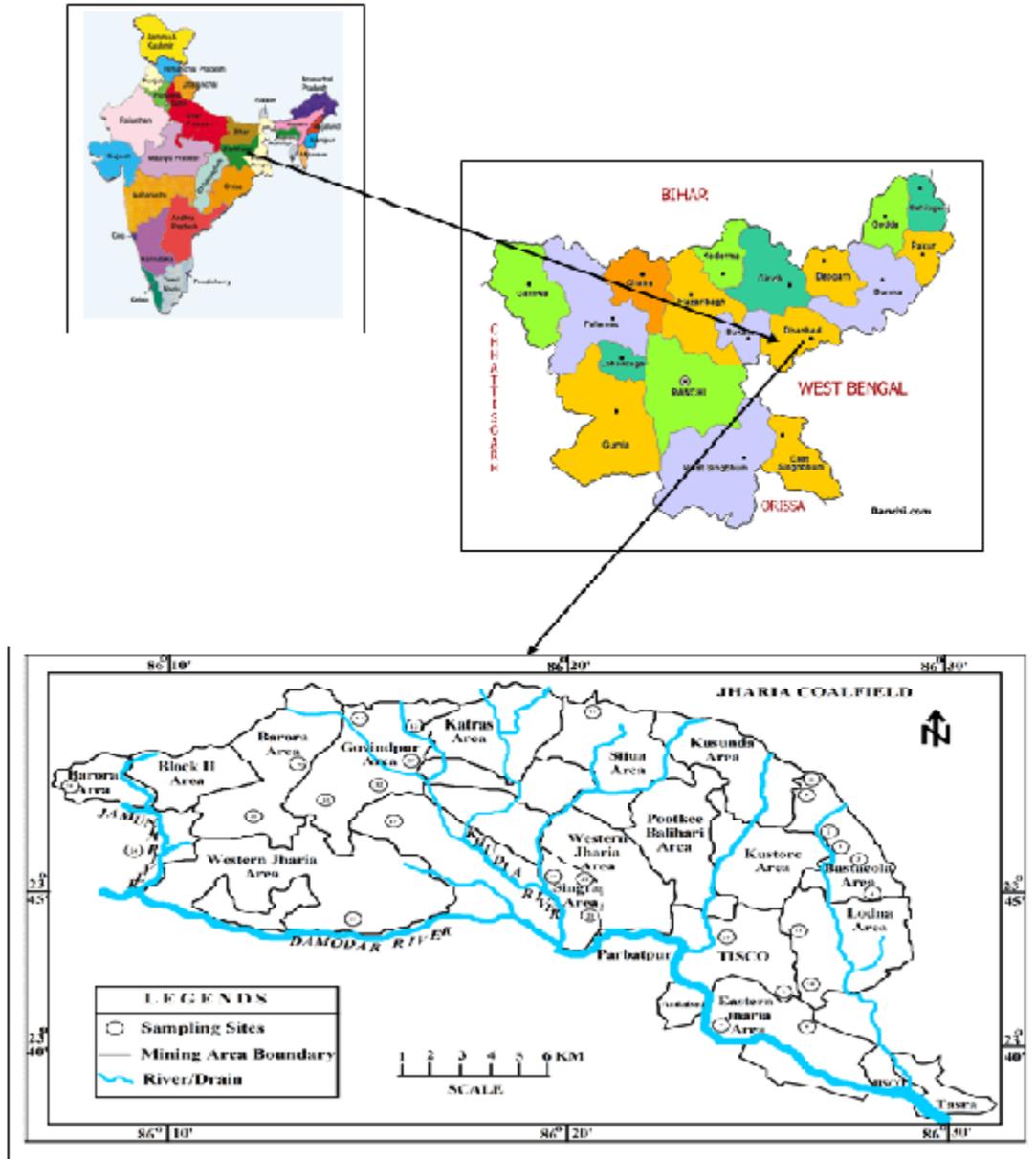
streams and Damodar River of the area. the Damodar gets heavily polluted with coal effluent of coal based industries on rout in Dhanbad- Bokaro region (Tiwarayet al. 1994)Groundwater quality, i.e., of dissolved ion content, is mostly affected either by natural geochemical characteristics, including climate, lithology,mineral weathering, nature of geochemical reactions, solubility of salts, dissolution/precipitation reactions, ion exchange, wet and dry deposition of atmospheric salt, and evapotranspiration, or by various anthropogenic activities, such as agriculture, sewage disposal, mining and industrial wastes(Singh and Chandel, 2006; Nisi et al. 2008; Jiangand Yan, 2010).

The groundwater quality determination in recent times has gained importance owing to the reason of being affected by various contaminants. In order to obtain an adequate assessment of the groundwater quality of an area, distribution of various chemical constituents and the types of groundwater present are the prerequisites. In Jharia Coal mining area, it has been stated by (Ghosh et al. 1991) that over the years, water resource conditions had been affected due to unplanned mining history prior to 1970 and urban sprawl resulting in severe damage to the quality and water table. This has necessitated the need to develop an adequate groundwater resource management plan of the area with specific reference to identification of the processes responsible and their evaluation. The hydro geochemical conditions that is responsible for causing significant variations in groundwater quality.

MATERIALS AND METHODS:

Description of the Study area:

Jharia Coal mining area is one of the most important Coal mining areas in India. It is roughly elliptical or sickles shaped, located in Dhanbad district of Jharkhand lies between latitude $23^{\circ}39'$ N and $23^{\circ}48'$ N and longitudes $86^{\circ}11'$ E and $86^{\circ}27'$ E. It stretches from Chandanpura on the west to Sindri on the east. The grand chord Railway line passes along north of this Coal mining area. It is bounded in the North by Eastern Railway and in the south by Damodar River. The main component of the natural drainage in JCF is the Damodar River, a fourth order stream that flows approximately west to east and captures all the surface drainage from the JCF, the drainage pattern of the drainage system in the area is dendritic. There are eight major streams, a few perennials and the rest intermittent, which drains the JCF from north to south to join the Damodar River. They are Tisra, Chatkari, Katri, Khudia, Jamuniya, Kumari and Bansjora etc.



The climate in the Jharia Coal mining area is very pleasant during cold weather months starting from November to February. The occasional rain during the hot weather from March to June makes the climate, a little more comfortable for a time during rains. But from June to October the conditions are not on the whole very unpleasant during October to November. The days are warm and the nights are cool. There is relatively higher average rainfall along the northern margin of the field than in the Damodar valley. The general climate may broadly be described as the of the tropical monsoon belt. The temperature range in Jharia Coal mining area varies between 5°C and 48°C.

Table 1 Descriptions of Groundwater Sampling of Jharia Coal Mining Region

Sr No	Sampling Location	Type	Latitude (N)	Longitude (E)	Elevation (Ft)
1	Near Victory	D/W	23°45'50.0"	86°24'43.9"	690
2	Bengali Koti	D/W	23°45'38.1"	86°25'14.9"	645
3	Ghanoodih	D/W	23°44'47.4"	86°26'14.2"	667
4	Goluckhdih	D/W	23°44'80.0"	86°26'33.0"	637
5	Dobari	D/W	23°45'20.2"	86°25'56.6"	638
6	Bera	D/W	23°46'01.6"	86°25'53.1"	656
7	Bhowrah South	D/W	23°40'41.3"	86°24'26.1"	526
8	Patherdih	T/W	23°40'36.8"	86°25'48.0"	652
9	Digwadih Campus	T/W	23°41'46.2"	86°25'19.3"	552
10	Bararee	T/W	23°43'25.9"	86°24'34.2"	623
11	Bhagamore	T/W	23°47'36.5"	86°18'06.6"	599
12	Lagarkha	D/W	23°48'9.00"	86°16'48.8"	671
13	AkashKinari	D/W	23°47'48.4"	86°16'11.2"	640
14	Govindpur	D/W	23°47'28.4"	86°15'54.5"	632
15	Sonardih	D/W	23°46'36.8"	86°14'20.6"	794
16	Tetulmari	D/W	23°48'05.8"	86°20'07.0"	675
17	MoonidihBazar	D/W	23°44'24.0"	86°20'49.2"	695
18	Baludih	D/W	23°44'04.1"	86°20'33.0"	671
19	Burdudih	D/W	23°43'57.5"	86°20'22.5"	626
20	manjhladih	D/W	23°43'59.0"	86°20'16.5"	653
21	Jatudih	D/W	23°44'52.0"	86°20'56.7"	646
22	Amdih	D/W	23°44'37.0"	86°19'45.0"	608
23	Sineedih	D/W	23°46'57.9"	86°15'06.9"	648
24	Damuda	D/W	23°46'07.5"	86°10'22.4"	693
25	Kharkharee	D/W	23°46'36.8"	86°14'20.6"	794
26	Phulawartar	D/W	23°46'35.6"	86°14'12.2"	690
27	Kesalpur	D/W	23°43'49.3"	86°18'42.9"	557
28	Barora	D/W	23°48'48.1"	86°14'17.1"	694
29	Mooraidih	D/W	23°48'15.6"	86°13'59.0"	330

(Note: D/W: Dug Well, T/W: Tube Well)

In the month of May and June, weather becomes very sultry due to high temperature and increasing humidity. The relative humidity is highest during the month of July to September. The annual rainfall in Jharia and adjacent region varies from 1197 mm to 1382 mm. This is the most exploited Coal mining area because of available metallurgical grade coal reserves. Mining in this Coal mining area was initially in the hands of private entrepreneurs, who had limited resources and lack of desire for scientific mining. The mining method comprised of both opencast as well as underground. The opencast mining areas were not backfilled, so large void is present in the form of abandoned mining. Extraction of thick seam by caving in past at shallow depth has damaged the ground surface in the form of subsidence and formation of pot holes or cracks reaching upto surface, enhancing the chances of Spontaneous heating of coal seams and mine fire. This Coal mining area is engulfed with about 70 mine fires, spread over an area of 17.32 sq. km., blocking 636 million tonnes of coking coal and 1238 million tonnes of non-coking coal. Around 34.97 sq. km. area of the JCF is under subsidence. It is mentioned in JCF reconstruction program that 70% of the underground production of coal would come by caving and balance 30% by stowing and thus about 101 sq. km. underground mining area would be affected by subsidence. The other factor, which damages the land in JCF, is opencast mining and overburden dumps.

Physioraphy, Drainage and Climate:

The area has a flat to gently undulating topography with a general southerly slope towards Damodar River, which flows west to east beyond the southern boundary of the block. The highest ground elevation is about 149 m and the lowest elevation has been observed to be about 126 m. The drainage pattern in the present study area is dendritic in nature. The main drainage of the area is controlled by the Damodar River. . Apart from these a number of small ponds are found throughout the block. Most of the small ponds are formed due to illegal mine pits in the study area.

The area lies in the tropical region with fairly wide temperature variations between winter and summer. The climate of Jharia Coalfield is tropical monsoon type with maximum precipitation occurring in the months of June to September. The maximum temperature of the coalfield raises upto 44°C in May while it dips to 5° to 7°C in December/January. The annual rainfall in Jharia Coalfield and adjacent regions varies from 1197 to 1380 mm.

Based on porosity and hydraulic conductivity parameters, the rock formation of the area may be classified as hard and soft rocks. Hard rock mainly crystalline and consolidated sedimentary is characterised by very little porosity. Ground water in such rocks circulated to a limited extent through the secondary openings represented by joints, cracks, fissures and such other planes of discontinuity.

Soft rocks represented by sandstone, pebbles and loose sand, possess higher degree of primary porosity and as such characterized by higher water storage capacity. As greater part of the study area is underlain by Precambrian crystalline rocks. The weathered residual of the hard rocks as well as the fractures, joints, fissures, faults and other zones of discontinuity are the principle repositories of ground water in the area.

Sample collection and preservation

A systematic sampling was carried for the assessment of ground water quality of Jharia Coal mining area. Representative 29 groundwater samples were collected from different mines of Lodna, Bastacolla, Sijua, Western Jharia, Block-II, Barora, mining area of the study area. The groundwater samples were collected in one litre narrow-mouth pre-washed polyethylene bottles. Prior to each field work polyethylene bottles were washed in the laboratory with dilute hydrochloric acid and then rinsed twice with double distilled water. At the sampling sites, before collecting the samples bottles were also washed with the mine water. Suspended sediments were separated from the water samples in the laboratory by using 0.45 μm Millipore membrane filters.

RESULTS AND DISCUSSION:

Physico-chemical analysis of groundwater:

The collected groundwater samples were analyzed for different physico-chemical parameters such as pH, Electrical conductivity, Turbidity, TDS, Total hardness, Ca, Mg, Cl, etc. The results were compared with the Indian Standards (IS: 10500) for drinking purposes.

Hydrogen ion concentration (pH):

pH is a measure of the hydrogen ion concentration in water and indicates whether the water is acidic or alkaline. The measurement of alkalinity and acidity of pH is required to determine the corrosiveness of the water. The pH of the ground water samples were found to be ranging from 6.9 to 7.6 (Fig. 2). The water samples are slightly acidic to alkaline in nature. According to World Health Organization (W.H.O) low pH is likely to give rise to off taste and to promote corrosion. Limit is 6.5 to 8.5 (W.H.O). Electrical conductivity is a measurement of water's capacity for conveying electric current and is directly related to the concentration of ionized substance in the water.

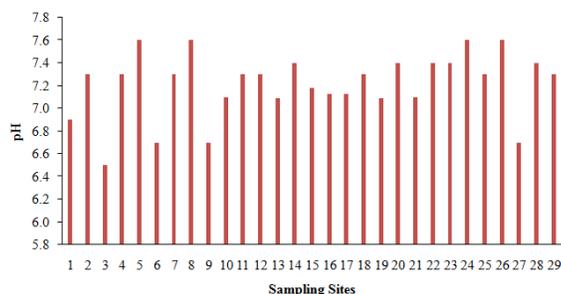


Figure 2: Variation of pH Values in Study Area

Table2: Physicochemical parameters of Groundwater of Jharia Coal mining Region

S No.	pH	EC	TDS	Turb.	TA	TH	Cl ⁻	HCO ₃ ⁻	SO ₄ ²⁻	NO ₃ ⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
1	6.90	1130	790	1.5	120	91	52	182.8	46.0	13.9	17.7	11.5	26.1	6.0
2	7.30	810	560	1.4	80	203	70	154.0	156.8	8.5	47.0	20.8	32.8	4.5
3	6.50	1300	918	1.3	60	239	58	146.9	50.9	13.9	66.6	17.7	34.8	3.7
4	7.30	530	375	0.5	100	290	46	189.9	42.2	4.2	79.1	22.5	26.8	8.9
5	7.60	835	589	0.9	68	278	40	168.4	140.6	2.3	50.9	36.6	31.8	3.2
6	6.70	780	552	1.4	60	146	48	197.0	42.5	2.3	37.7	12.6	54.8	6.0
7	7.30	530	375	0.5	100	265	46	189.9	42.5	4.2	69.1	22.5	36.8	8.9
8	7.60	835	589	0.9	68	303	40	168.4	168.7	2.3	60.9	36.6	31.8	1.2
9	6.70	780	552	1.4	60	221	48	197.0	167.4	2.3	67.7	12.6	54.8	6.0
10	7.10	630	447	0.2	76	277	60	144.2	154.4	5.7	65.8	27.3	99.2	4.8
11	7.30	1300	923	0.1	44	297	30	140.9	188.5	6.0	72.6	28.0	33.0	3.2
12	7.30	1300	923	0.1	44	309	30	140.9	256.9	6.0	62.6	37.0	36.0	6.2
13	7.09	854	606	0.8	56	355	80	155.0	125.9	28.9	64.8	47.0	46.6	4.6
14	7.40	466	331	0.5	104	325	50	129.5	46.2	15.0	58.0	43.7	68.8	11.4
15	7.18	480	341	0.4	156	251	32	132.1	58.5	3.8	42.2	35.3	34.8	4.3
16	7.13	630	447	0.2	76	419	60	144.2	168.5	5.7	75.0	56.3	49.2	7.8
17	7.13	630	447	0.2	76	491	76	144.2	167.5	5.7	85.8	67.3	39.2	8.8
18	7.30	1300	923	0.1	44	335	37	140.9	57.5	6.0	9.6	75.7	11.1	6.2
19	7.09	854	606	0.8	56	354	58	155.0	144.5	28.9	66.8	45.4	16.2	11.6

20	7.40	466	331	0.5	104	375	50	129.5	154.4	15.0	78.0	43.7	48.8	1.4
21	7.10	480	341	0.4	156	276	23	132.1	42.0	3.8	52.2	35.3	44.8	1.3
22	7.40	723	513	5.3	44	230	34	115.6	256.4	9.6	45.1	28.6	58.6	6.7
23	7.40	723	513	5.3	44	232	34	115.6	142.4	9.6	45.8	28.6	48.6	5.7
24	7.60	835	589	0.9	68	476	40	168.4	256.2	2.3	80.9	66.6	41.8	6.2
25	7.30	530	375	0.5	100	290	46	189.9	64.2	4.2	79.1	22.5	36.8	8.9
26	7.60	835	589	0.9	68	262	40	168.4	43.4	2.3	60.9	26.6	41.8	6.2
27	6.70	780	552	1.4	60	121	48	197.0	198.5	2.3	27.7	12.6	64.8	6.0
28	7.40	723	513	5.3	44	255	40	115.6	68.4	9.6	55.1	28.6	68.6	5.7
29	7.30	530	375	0.5	100	290	46	189.9	68.9	4.2	79.1	22.5	36.8	8.9
Min	6.5	466	301	0.1	44	91.4	23	115.6	42.0	2.3	9.6	11.5	11.1	1.2
Max	7.6	1300	923	5.3	156	491.0	80	197.0	256.9	28.9	85.8	75.7	99.2	11.6
Average	7.2	779.3	551	1.2	77	284.6	47	156.7	121.4	7.9	58.8	33.5	43.3	6.0
Stdev	0.3	262.7	185.6	1.5	31	89.7	13.6	26.5	71.5	7.1	19.0	16.9	17.6	2.7

Electrical Conductivity and Total dissolved solids (TDS):

Conductivity is ability of water to carry an electrical current. This ability mainly depends on presence of anion and cations in water and also depends on mobility, valence of ions and temperature. It is the measure of the mineralization and indicative of the salinity of ground water. The electric conductivity with 400 micro-mhos/cm at 25°C is considered suitable for human consumption. The overall conductivity ranges from 466 $\mu\text{S/cm}$ to 1300 $\mu\text{S/cm}$ groundwater of study area.

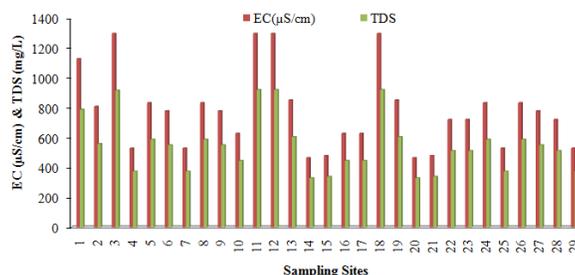


Figure 3: Variation of EC and TDS

The total dissolved solid consists of inorganic substances. The principal constituents of total dissolved solids are calcium, magnesium sodium, bicarbonates, chlorides and sulphates. The palatability of water with a TDS level less than 600 mg/L is generally considered to be good whereas at TDS level greater than 1200 mg/L in drinking water becomes increasingly unpalatable (WHO, 1984).the TDS were varied from 301 mg/L to 923 mg/L (Fig 3).

Temperature:

Temperature is one of the most important ecological and physical factors which have profound influence on the biotic and biotic components of the environment. Temperature helps in controlling the solubility of gases. The water temperature of all the samples analysed did not have much variations and was between 25⁰-28⁰C.

Alkalinity and Total hardness:

Alkalinity desirable limit is given 16.0 mg/L to 188.0 mg/L under WHO guidelines and it varies between 44 mg/L to 156mg/L in the study area. The total hardness (TH) of the analyzed water samples of the study area varies between 44 mg/L to 562 mg/L and (Avg. 233 mg/L) respectively indicating hard to very hard types of water (Table 4). Hardness of the water is property attributable to the presence of alkaline earths i.e. Ca and Mg. The data indicate that 10 groundwater samples have TH values higher than 300 mg/L, which is the potable limit (BIS 1991).Hardness has no known adverse effect on health but it can prevent water from the formation of lather with the soap and increases the boiling point of the water. The high TH may cause the encrustation on water supply distribution systems. (Fig 4)

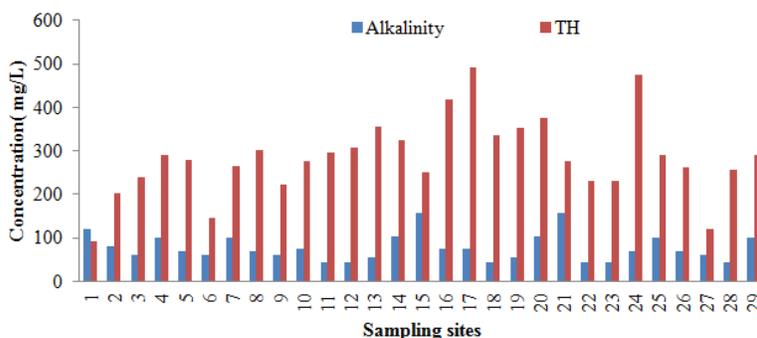


Figure 4: Variation of Total Hardness and Alkalinity Concentrations

Table 3: Range of chemical parameters in study area and WHO and Indian Standard (IS: 10500) for drinking waters

Parameters	Water Samples Range	WHO (1997)		IS:10500 (BIS 1991)	
		Highest Permissible	Max. Desirable	Highest Permissible	Max. Desirable
pH	6.5 -7.6	6.5-9.2	7.0-8.5	8.5-9.2	6.5-8.5
EC	466-1300	1,500	750	-	-
Turbidity	0.1-5.3				
HCO ₃ ⁻	115-197	600	200	600	200
TA	44-156				
Cl ⁻	23-80	600	250	1,000	250
NO ₃ ⁻	2.3-28.9	50	-	100	45
SO ₄ ²⁻	42-256	600	200	400	200
Na	11.1-99.2	200	50	-	-
Ca	9.6-85.2	200	75	200	75
Mg	11.5-75.7	150	30	100	30
K	1.2-11.6	200	100	-	-
TDS	301-923	1,500	500	2,000	500
TH	44-562	500	100	600	300

Table 4: Hardness Classification of water

Hardness(mg/L)	Water Class	No. of samples
0-75	Soft	8
75-150	Moderately hard	5
150-300	Hard	6
>300	Very hard	10

Chloride:

Chloride a major anion in potable and industrial water has no adverse effect on health, but imparts bad taste to drinking water. A high concentration of chlorides affects growth of vegetation and imparts an increase in corrosiveness of metals. Chloride in excess of 100mg per litre imparts a salty taste and may cause physiological damages. Water with high chloride content us. The chloride content in the study area varies from 23 mg/L to 60in the groundwater. Usually has an unpleasant taste and may be objectionable for some agricultural purposes. (Fig 5).

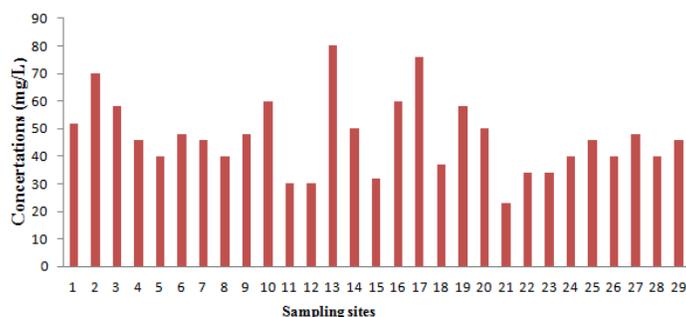


Figure 5: Variation of Chloride Concentrations in Study Area

Calcium and Magnesium:

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) ions are both common in natural waters and both are essential elements for all organisms. Calcium and magnesium, when combined with bicarbonate, carbonate, sulphate and other species, contribute to the hardness of natural waters. The effect of this hardness can be seen as deposited scale when such waters are heated. Normally hardness due to calcium predominates although in certain regions, magnesium hardness can be high. In some river catchments, hardness can vary seasonally reaching peak values during low flow conditions. Calcium is one of the principle cation in groundwater .the calcium is most abundant element in human body, which required 0.7 to 2.0 gm/day., It also helps in the formation of bones and teeth. The Highest desirable level of calcium in drinking water is 75 ppm and maximum permissible level is 200 ppm (WHO, 1984).The range of calcium ions was 9.60 mg/L to 85.62 mg/L. The maximum Calcium was found to be 85.62 mg/L in groundwater of Moonidih of Jharia coal mining area which was beyond the desirable limit.

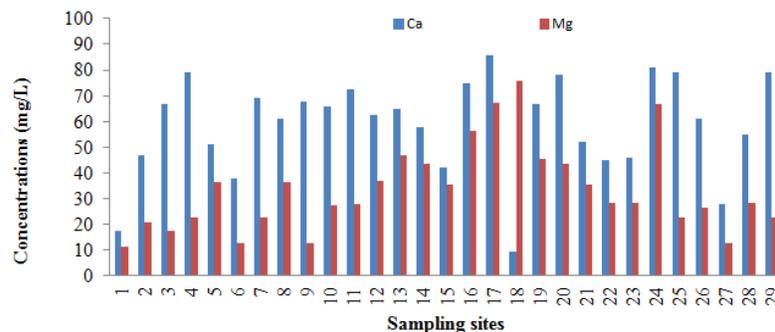


Figure 6: Variation of Calcium and Magnesium Concentrations in Study Area

Magnesium is the most important alkaline earth metal present in ground water. It is one of the most important contributors to the hardness of water. The lower concentration of magnesium is not harmful but higher concentration is laxative. According to (WHO, 1984) and the maximum acceptable limit of magnesium in drinking water is 30 mg/L. The magnesium ranged from 11.45 mg/L to 75.69 mg/L in the water samples of the study area. (Fig 6)

Sulphate and Bicarbonate:

High concentration of sulphate in association with Sodium or magnesium in the drinking water might give rise to gastrointestinal irritation. According to the IS:10500 the desirable limit is 200 mg/L. The sulphate in the water samples ranged from 41.3 mg/L to 256 mg/L. According to the WHO limit is 400 mg/L. Low concentration is physiologically harmless. The overall concentration of sulphate in the study area is within the safe limit.

The bicarbonate concentration of the study area was 115.6 mg/L - 197 mg/L. The maximum bicarbonate concentration was found in block II area. The ground water containing 600 mg/L of bicarbonate is considered fairly safe and good for domestic purpose. (Fig 7)

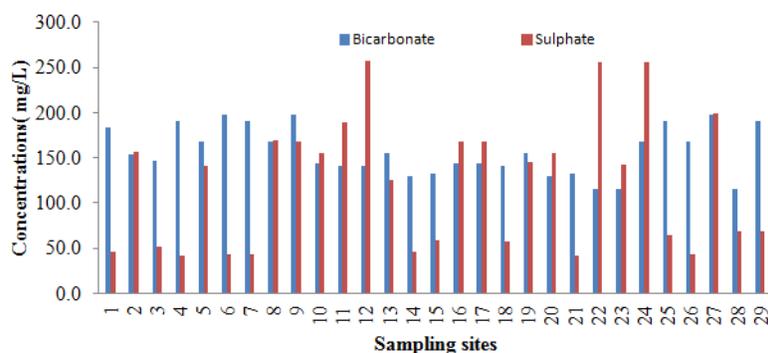


Figure 7: Variation of Bicarbonate and Sulphate Concentrations in Study Area

Sodium and Potassium:

The sodium concentration in the water samples was found between 11.45 mg/L to 99.2 mg/L. The desirable limit for sodium is given as 200 mg/L according to WHO (1984) guidelines.(Fig 8)

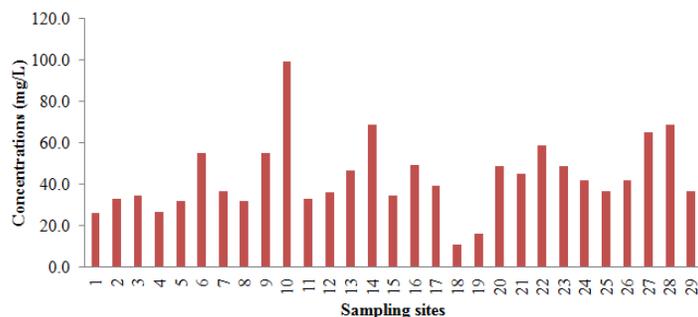


Figure 8: Variation of Sodium Concentrations in Study Area

Potassium is less common cation in the groundwater. in the water samples was 1.2mg/L to 11.60 mg/L .(Fig 9)

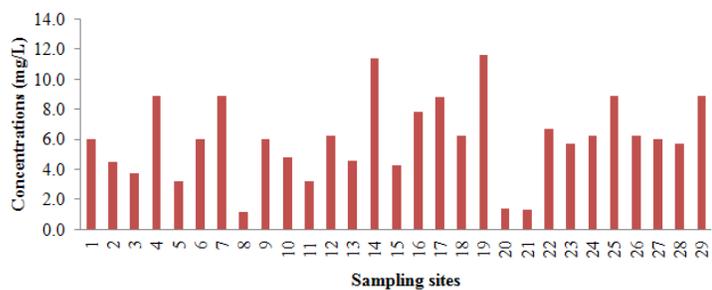


Figure 9: Variation of Potassium Concentrations in Study Area

Nitrate:

Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural water. Nitrate poisoning in infant animals including human, can cause serious problems and even death. Nitrate poisoning has been referred to as the 'blue baby' syndrome, although the correct term is 'Methenoglobinemia'. The Nitrate content in the Mine water samples varied from 2.3 mg/L to 28.94mg/L .The Highest desirable level of Nitrate in drinking water is 45 mg/L as per IS:10500. The high value of Nitrate is due to the use of Explosives of ammonium Nitrate base and use of Fertilizer in agriculture. (Fig 10)

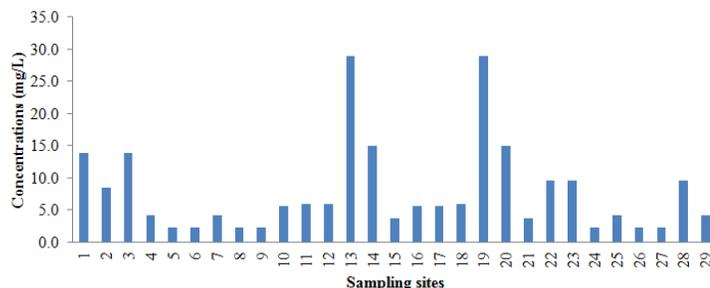


Figure 10: Variation of Nitrate Concentrations in Study Area

CONCLUSION:

For drinking water quality assessment of the groundwater evaluated in terms of physicochemical analysis. Also the groundwater quality data were compared with the prescribed limits of WHO (1997) and Indian Standard for drinking water (IS-10500). The pH values indicating slightly acidic to alkaline in nature. The quality assessment shows that in general, the water is suitable for drinking with some exceptions. However, EC, TDS, Cl, TH, Mg, Ca and SO_4 values are exceeding the desirable limits at some site, making it unsafe for drinking.

ACKNOWLEDGEMENTS:

The authors are thankful to Director, ISM for his permission to publish this paper.

REFERENCES:

1. Alley W. M. (2001): Ground water and climate. *Ground Water* 39 (2), 161.
2. Meenakshi and Maheshwari R. C. (2006): Fluoride in drinking water and its removal, *J. Of Hazardous Materials*, 137(1), 456-463.
3. Mushini V.S.R., Vaddi D.R. and Bethapudi S.A. A. (2012): Assessment of Quality of Drinking Water at Srikurmamin Srikakulam District, Andhra Pradesh, India, *I. Res. J.Environment Sci.*, 1(2), 13-20.
4. Nagarajan R, Rajmohan N, Mahendran U, and Senthamilkumar S. (2010): Evaluation of groundwater quality and its suitability for drinking and agricultural use in Thanjavur city, Tamil Nadu. *India Environ Monit Assess* 171:289–308.
5. Ghosh M. K. (1998): Water Resources and Water Demand in Future in Coal mining area Areas, *J. Indian Mining and Engg.* 37(6):31-34.

6. Ghose, M. K. (1993): Water Resources and Water Quality Criteria for Public Water supply in Mining Areas., J. of the Institution of Public Health Engineers,1,pp.44-51
7. Pandey, Sandeep K and Tiwari, S. (2009): Physico-chemical analysis of ground water of selected area of Ghazipur city-A case study. Nature and Science 7(1).
8. Patil V.T. and Patil P. R. (2010): Physicochemical Analysis of Selected Groundwater Samples of Amalner Town in Jalgaon District, Maharashtra, India. E-J. Chem., 7(1): 111-116.
9. Prasanna M.V. Chidambaram S, Senthil Kumar G, RamanathanA. L. and Nainwal, H. C. (2010): Hydrogeochemical assessment of groundwater in Neyveli Basin, Cuddalore District, South India. Arab JGeosci 4:319–330.
10. Sharma N. L.and Ram K. S. V. (1966): Introduction to the geology of coal and Indian coalfields. Orient Publishers, Jaipur.
11. Singh G. (1994): Augmentation of underground pumped out water for potable purpose from coal mines of Jharia coalfield. Proceedings in 5th international mine water congress, vol 2, Nottingham.
12. Singh V. and Chandel C. P. S. (2006): Analysis of wastewater of Jaipur cityfor agricultural use. Res J Chem Environ 10(1):30–33.
13. Tiwary, R. K. and B. B. Dhar (1994): Effect of coal mining and coal based industrial activites on the water quality of the river Damodar with special reference to heavy .metals.IntJ.J.Surface mining, Reclamation Env.,8:111-115.
14. Viswanathan and M.N. (1984): Recharge characteristics of an unconfined aquifer fromthe rainfall–water table relationship. Journal of Hydrology 70 (1–4), 233–2509.
15. WHO (1997): Guidelines for drinking-water quality. vol.1, Recommendations, World Health Organisation, Geneva, WHO. pp1-4.
16. Younger, Pand, Banwart S. A, Hedin R. S. (2002): Mine water—hydrology, pollution, and remediation. Kluwer Academic Publishers, Dordrecht.

WATER (H₂O) AT GLANCE**Rajaram Gundu Chougale**

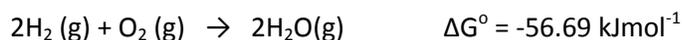
Department of Chemistry,

Br. Balasaheb Khardekar College, Vengurla, Dist – Sindhudurg, M.S., INDIA

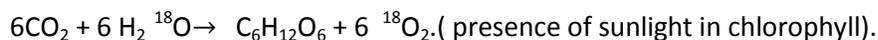
Corresponding author E-mail: adiomvandanarajaram@gmail.com

On earth planet surface 70% water, out of which 3% water useful for drinking and other purposes. 1% water is easily available.

The Water is formed from two hydrogen atoms and one oxygen atom.

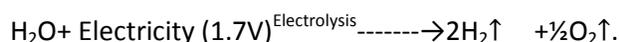


Water is more valuable than platinum and gold metals. Human being and living organisms not survive and sustain their life without water. Ordinary water used as coolants in nuclear power reactor. The mechanism of photosynthesis has been studied using ¹⁸O isotope in water. Using ¹⁸O it has been shown that the oxygen released in photosynthesis is not from CO₂ but from water.



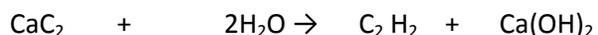
The potential energy of water is converted into electricity at hydropower station. Steam produced from water by atomic energy. Pressurized steam sent to turbine and generator generates electricity. Steam is produced from water at geothermal stations also for electricity.

In future Hydrogen is fuel. The Hydrogen is clean, non polluted energy source, obtained from electrolysis of water.



During electrolysis process the hydrogen is evolved at cathode and oxygen at anode.

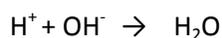
Water will be produces **combustible gases** with some chemicals e.g. Acetylene gas is obtained from CaC₂.



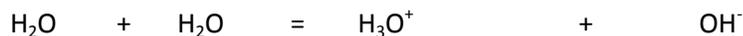
Calcium carbide water Acetylene Calcium hydroxide

Combustion of acetylene produces 310.4 calories of energy.

Neutralization, in general, is the combination of H⁺ ions of an acid with OH⁻ ions of a base to form the practically unionized water.



Acid-base neutralization reactions taking place in water.(water system concept)



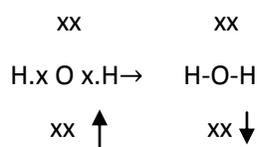
Acid1 Base2 Acid 2(conjugate acid to base2) Base 1(Conjugate base to acid 1)

Hydration energy released when one mole of gaseous cation is plunged into water. Hydration of positively charged cation is an electrostatic phenomenon, both the charge on the cation (Z) and radius of cation (r) contribute to the value of hydration energy. ΔH_{hyd} for Cs^+ is -263 kJ mol^{-1} , for Fe^{3+} is $-4376 \text{ kJ mol}^{-1}$, for Na^+ is -405 kJ mol^{-1} . ΔH_{hyd} decreases, pKa values increase. Higher the ΔH_{hyd} , lower is the pKa and higher is the acidity. pKa value of Na^+ is 14.5, of Fe^{3+} is 2.2, of Ti^{+4} is -4.0.

In H_2O molecule two hydrogen atoms are covalently bonded to the highly electronegative Oxygen atom. Here each H atom can hydrogen bond to the Oxygen atom of another molecule, thus forming large chains or cluster of water molecules. Each Oxygen atom has unshared electron pair which leads to hydrogen bonding with other water molecule. Thus liquid water is made of cluster of a large number of molecules. Oxygen atom (2,6) has six valence electrons and can achieve the stable octet by sharing two electrons, one with each H atom.

Thus Lewis Structure of water can be written as

Unshared electron pair



Sharing electrons

Water is one component system. Three phase equilibria exist, Solid Ice = Liquid Water, Liquid Water = Water Vapour, Solid Ice = Water Vapour. The phase coexists at triple point.

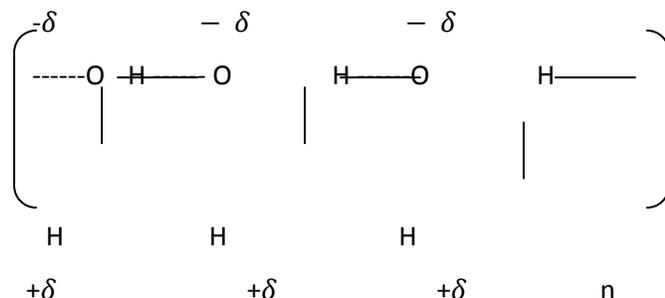
At temperature higher than critical point, liquid – Vapour equilibria do not occur, only vapour phase exists. Critical Point Temperature 374°C (647K) Pressure 223 bar OR 218 atm, Triple Point Temp: 0.0098°C (273.0098K) [273.0075K : F.P + 273.0023K : M.P]. Boiling Point temperature 100°C at Pressure 1.013 bar OR 1 atm.

Tritium isotope occurs in very small quantities in nature. Out of 10^{10} parts in ordinary water only 7 parts are tritium. It is also found in heavy water (D_2O). When the volume of 75 tons of water after being electrolyzed reduces to mere 0.5 cm^3 . It is shown by mass spectrograph that in 10^4 parts of it only 1 part of tritium is present.

Table 1: General information about the water molecule

1.	Molecular formula	:	H ₂ O
2.	Molecular shape	:	Angular
3.	Mole. Wt.	:	18
4.	Boiling point	:	100 ⁰ C.
5.	Melting Point	:	0 ⁰ C
6.	Ice point	:	273.15 K
7.	Density Maximum Density	:	0.997073gm cm ³ at 25 ⁰ C 1 at 4 ⁰ C
8.	Refractive index	:	1.33254
9.	Surface tension	:	71.97 dyne cm ⁻¹
10.	Viscosity	:	0.8937 centipoise
11.	Dissociation Temperature	:	2000 ⁰ C
12.	Vapour Pressure	:	23.756 mm of Hg
13.	Equilibrium Constant	:	1.04 x10 ⁻¹⁴
14.	Dielectric Constant	:	78.4 to 81.1
15.	ΔH Formation	:	-285.8 kJ mol ⁻¹ at 298K or -242 kJ mol ⁻¹
16.	enthalpy charge ΔH°	:	-229.9kJ mol ⁻¹ (H ⁺ =0.0 , OH ⁻ =-229.9)
17.	ΔS (entropy change)	:	69.9 Joule mol ⁻¹ K ⁻¹
18.	ΔG (Free energy change)	:	-237.2 KJ mol ⁻¹ at25 ⁰ C and 1atm
19.	ΔG°	:	-56.69 KJ mol ⁻¹
20.	Dipole moment (μ_{obs})	:	1.82 Debye or 1.84 D or 1.85 Debye
21.	μ_{OH}	:	1.52Debyes
22.	H-O-H angle	:	105 ⁰ or 104.5 ⁰ or 104 ⁰ .5' or 104 ⁰ .28'
23.	O-H bondlength	:	0.96 ⁰ A or 0.96x10 ⁻¹⁰ m
24.	Bond energy H-O-H	:	118 kcal mol ⁻¹ or 29.29 kJ mol ⁻¹
25.	Hydrogen bond, bond energy Strength of hydrogen bond	:	2 to 10 kcal mol ⁻¹ About 20 kJ mol ⁻¹
26.	Symmetry	:	C ₂ V
27.	Mobility H ⁺ Mobility OH ⁻	:	36.25x10 ⁻⁸ m ² v ⁻¹ s ⁻¹ 20.64x10 ⁻⁸ m ² v ⁻¹ s ⁻¹
28.	Magnetic Susceptibility	:	- 89x10 ⁻⁶
29.	Molar Magnetic Susceptibility	:	-1.60 x 10 ⁻³ ml

Water is hydride group 16 elements, Oxygen. Oxygen is highly electronegative element. Due to large difference in electronegativity between the two atoms (Hydrogen and Oxygen) water behaves as dipoles i.e. $\text{H}\delta^+ - \text{O}\delta^-$. $\text{H}\delta^- - \text{O}\delta^+$ bonds become highly polar. Polar molecules interact strongly with other dipoles. When these two dipoles are brought closer (dipole-dipole attraction), they will be linked together by a special type of bond called **hydrogen bond**. Hydrogen atom acts as a bridge between the two strongly electronegative atoms, holding one by a covalent bond and the other by purely electrostatic forces.



Hydrogen bond is stronger than van der Waals forces of attraction but weaker than covalent bonding. H_2O molecules get associated due to intermolecular hydrogen bonding. They form associated molecules or Clusters $(\text{H}_2\text{O})_n$. Water exists as a liquid $(\text{H}_2\text{O})_n$. Liquids whose molecules are held together by hydrogen bonds are called associated liquids. Polywater has a freezing point -40°C and a very high density of 1.4 gm cm^{-3} , enthalpy of formation -120 kJ mol^{-1} . In ice, each water molecule is tetrahedrally associated with four water molecules due to Hydrogen bonding. Association is responsible for the abnormally high B.P. & M.P. of water. Greater the dielectric constant of solvent, greater is its dissociating power, water has greater dielectric constant Value 78.4 then it behaves good ionizing solvent.

In general like dissolves like, e.g. ionic salts or ionic solute (polar solute) dissolve more readily in polar solvent like water than non-polar solvent like alcohol, benzene & carbon tetrachloride. Energy required to separate inorganic compounds/solids (Lattice energy) is obtained from polar solvents having high dielectric constant, most of the ionic compounds dissolve in water. The cations and anions get hydrated (solvated) and then dissolve.

The oppositely charged particles can coexist in water; therefore it is a good ionizing medium. This increases the chemical reactions.

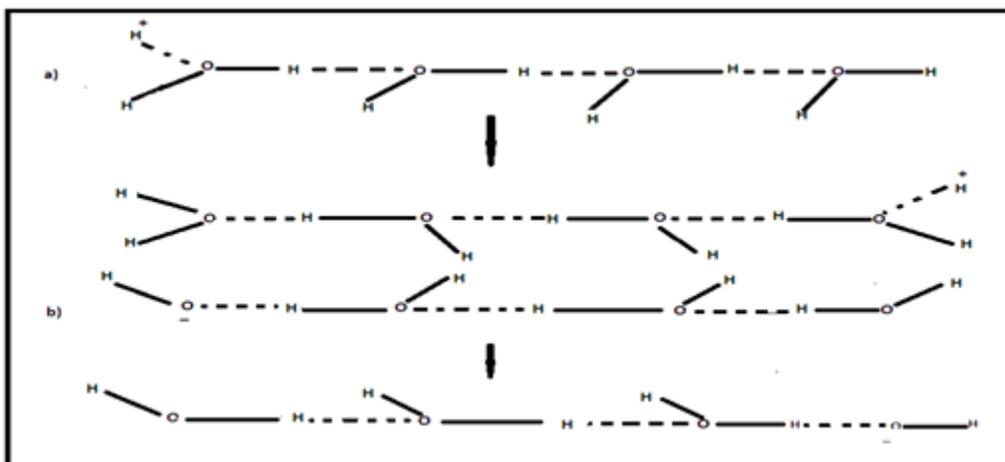


The relative orientation of water molecules is more favorable in ice because of the ordered hydrogen-bonded networks. Electrical conduction studies show that mobility of the H^+ ion is nearly 50 times higher in ice than in liquid water. Both H^+ and OH^- ions have significantly greater mobility than the other ions. If H^+ and OH^- ions moved as clusters, their mobility would be less than those of the other ions.

The high mobility observed is attributed to the chain mechanism. The ability of H^+ and OH^- ions to move along water molecules joined through hydrogen bonds. Since the rigid hydrogen bonded structure of the ice should facilitate efficient Proton transfer.

It has been suggested that tunneling also plays a role in proton transfer reaction. Wavelike behavior allows particle to pass through potential barriers, the effect of tunneling is equivalent to reducing the activation energy and thus increasing the rate.

A Chain mechanism for the transfer of (a) H^+ and (b) OH^- across water molecules.



Water is strong dipole. It can polarize of noble gas atoms and due to attraction between dipole water and induced dipole-noble gas atom, hydrates are obtained. The gases Ar, Kr and Xe forms gas hydrates $Ar \cdot 5 H_2O$, $Kr \cdot 5 H_2O$, $Xe \cdot 6 H_2O$, $Kr \cdot 5 D_2O$, $Xe \cdot 6 D_2O$. Solids that consist of molecules of a compound together with water molecules are called hydrates eg. $ScCl_3 \cdot 6 H_2O$. The gases Ar, Kr and Xe may be trapped in cavities of water when water solidifies. The compounds inert gas hydrates have formulae approximately to $6 H_2O:1$ gas atom. The hydrates of noble gases prepared by bringing vapours of water and noble gas together under Pressure at low temperature. They are crystalline compounds.

Liquid hydrates:

Chloroform and ethyl chloride has unitcell containing 136 water molecules with 8 large cages and 16 smaller ones. The anesthetic effect of substance such as chloroform may be due to the formation of liquid hydrate crystals in brain tissue.

Salt hydrate:

It is formed when tetraalkylammonium or sulfonium salts crystalline from aqueous solution with high water content eg. $[(C_4H_9)_4N]C_6H_5CO_2 \cdot 39.5 H_2O$ OR $[(C_4H_9)_3S]F \cdot 20H_2O$

Water exchange in Aqua Ions $[M(H_2O)_n]^{m+}$

Water exchange reactions in which five typically inert aqua ions $M = Cr^{3+}, Co^{3+}, Rh^{3+}, Ir^{3+}$ and Pt^{2+} . Have exchange rate constant in the range $10^{-3}-10^{-6} s^{-1}$. Water exchange is characteristically slow.

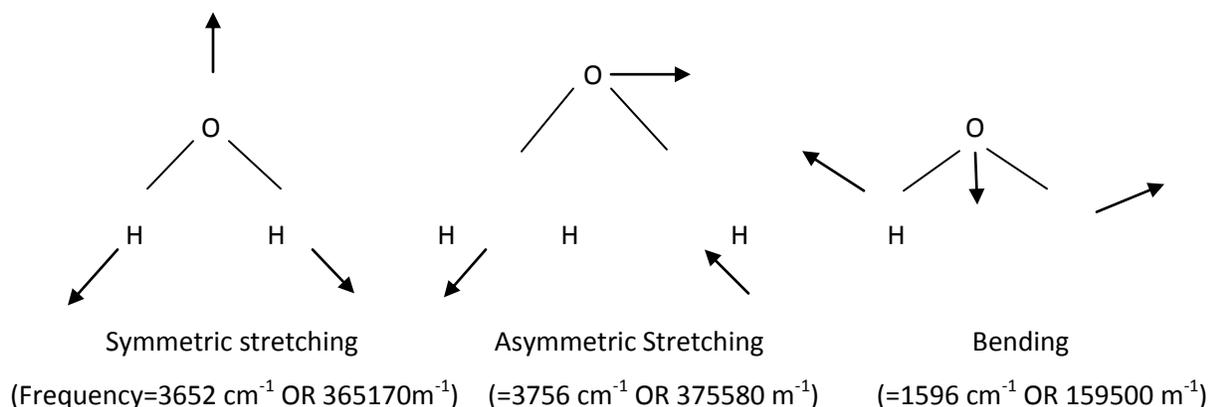
Structure of Water molecule:

Water molecule is a non-linear (Geometry), triatomic molecule with a bent structure and it possesses permanent dipole moment.

In a vibration of spectrum of a molecule we are concerned with the number of fundamental vibrational modes of a molecule. Each fundamental mode corresponds to a band in spectrum and each vibrational degree of freedom corresponds to the fundamental mode of vibration. Total degrees of freedom for a molecule with 'n' atoms are $3n$ ($3 \times 3 = 9$). $3n$ degrees of freedom = Rotational + Translational + Vibrational. $Vibrational = 3n \text{ degrees of freedom} - (Rotational + Translational)$

For non-linear molecule having 'n' number of atoms, show three translational & three rotational degrees of freedom. Therefore, the expression for vibrational degrees of freedom will be given by $3n - (3 + 3) = 3n - 6$.

Degree of vibrational freedom = $3 \times 3 - 6 = 9 - 6 = 3$, Where $n = 3$, three atoms in water. Water molecule shows three modes of vibration two are stretching vibration & one bending vibration. All these vibrations involve change in dipole moment ($\mu \neq 0$) Hence all the three modes will be IR active.



Then normal modes of vibration of water molecule:

For water molecule that does not possess center of symmetry and has permanent dipole moment. All the vibrational modes of water molecule are Raman as well as IR active.

Vibrational modes of water

Mode of Vibration	Symmetric stretching	Asymmetric stretching	Bending
IR	Active	Active	Active
Raman	Active	Active	Active

Spectrum for H₂O Molecule:

- Symmetric stretching: Dipole moment changes, IR active. Polarizability changes, Raman active; produce intense Raman lines.
- Asymmetric stretching: Dipole moment changes, IR active. Polarizability changes, Raman active. However the change in polarization is very small and Raman lines are very weak.
- Symmetric bending: Dipole moment changes to some extent hence IR active. Change in Polarizability is very small hence Raman absorption is unobservable, gives unobservable lines.

The Symmetries of the molecular orbitals of the H₂O molecule derived from the 2s and 2p orbitals of the O atom and the 1s orbitals of the two H atoms.

In case H₂O molecule, there are two vertical planes of symmetry one is given the label σ_v and the other σ'_v . Water molecule has a twofold axis of rotation denoted by C₂. The H₂O molecule has the symmetry elements E, C₂, σ_v and σ'_v (Set of symmetry operations together – Point groups).

Why drink water?

Water helps to lose weight, maintains healthy heart & healthy skin, fights infections, get rid of body toxins, prevent joint pains and arthritis, Boost eyes, Prevent constipation, Reduce risk of Cancer. Improves Productivity etc. According to age everyday 1.5 to 5 liter pure drinking water (Oxygenated water: 14 ppm) essential for human body. Water is elixir of life. Water is the large constituent of the body. The average body water is 60 to 70 percent of the total body weight. Females contain a little less amount of water than males. Water has the highest latent heat evaporation than any other liquid. A Certain amount of water can cause maximum cooling by evaporation; so that the body temperature does not rise. Water can form true solutions as well as colloidal solutions. Even the water insoluble

substances are made water soluble by the hydrotropic action. Therefore it is most suitable solvent for cellular components; water thus brings various substances in contact for chemical reactions to proceed. A large number of chemical reactions in the body are accelerated by water (catalytic action) due to its ionizing power. All chemical reactions in the body proceed in presence of water only. Water acts as a lubricant in the body to prevent friction in joints, pleura, conjunctiva and peritoneum.

Control Pollution, Save Water and Save Planet.

REFERENCES:

1. K. B. Baliga, S.A. Zaveri, Dr. S.S. Mangaonkar, Dr. Arti Sawant, Deepak Teckhandani, Dr. A. Y. Desai, Asha Mathew, College Physical Chemistry, Himalaya Publishing House Mumbai.
2. K. Raghuraman, D. V. Prabhu, P.A. Sathe, S.H.S. Bohra, Sugandha Shetye, Basic Principles in Physical Chemistry, Sheth Publishers Pvt. Ltd. Mumbai.
3. S. S. Kelkar, D. A. Shanbhag, S. A. Mahimkar. Pathways of Physical Chemistry, Saujanya Prakashan Mumbai.
4. S. M. Malushte, V. N. Kulkarni, D. N. Vora, K. R. Sharma, N. B. Laxmeshwar, Concept in Physical Chemistry, Chetana Publications educational publishers Mumbai.
A. C. Deb, Fundamentals of Biochemistry. New Central Book Agency Calcutta.
5. Gordon M. Barrow, Physical Chemistry Tata McGraw Hill Publishing Company limited Fifth edition New Delhi.
6. Arun Bahl, B.S. Bahl, G.D. Tuli essentials of Physical Chemistry S. Chand and Company LTD, New Delhi.
7. F. Albert Cotton, Geoffrey Wilkinson Paul Gaus, Basic Inorganic Chemistry, Third edition Wiley India.
8. J.D. Lee, Concise inorganic Chemistry fifth edition Wiley India.
9. G.K. Vemulapalli, Physical Chemistry Prentice Hall of India New Delhi 110001, 1997.
10. A. Satya Prakash, G. D. Tuli, S.K. Basu, R.D. Madan, Advanced Inorganic Chemistry, S Chand and Company Ltd. Ramnagar New Delhi 110055.
11. A.G. Kulkarni, S.P. Sathe, J.K. Verma, Sudheer Lingayat, Inorganic Chemistry, Sheth Publishers Pvt Ltd. Mumbai.
12. K. V. S. Laxmi Devi, S. P. Turakhia, Chhaya Dixit, Rajeshwari A. Mirji, Beena Arora, College Inorganic Chemistry, Himalaya Publishing House Mumbai.

ASPECTS OF WATER POLLUTION: DATA ANALYSIS

Pratibha Sadashiv Desai

Acharaya Jawadekar College of Education, Gargoti
Tal - Bhudargad, Dist - Kolhapur, Maharashtra, India 416 209

Corresponding author E-mail: pnimbalkar67@gmail.com

ABSTRACT:

From last few decades world is shouting against the pollution and its harmful effect. Pollution became a hot issue all over the world. All the countries have taken a serious action to control the pollution. Each and every nation has been engaged in preparation of National Environmental Policy for sustainable development and conservation of natural resources. Now a days pollution is a global issue. Earth summit held on Environment and Development at Rio-de-Janerio in 1992 concluded that the continuous degradation of environment will never achieve sustainable development. Water is the most essential component for human existence. Mankind has definitely polluted the water resources of the world. This is so because we have not limited our use of water. We have over used water to make it a scarce element and our continuous usage has made it become polluted and contaminated over the course of time. It is the need of time to aware about water pollution. So purpose of this paper is to create awareness about causes effects and prevention of water pollution among each and every person.

KEYWORDS: Water pollution; aspects

INTRODUCTION:

Water is the most essential component for human existence. The Earth is called as 'Blue Planet' because of water. Water covers almost three fourth of earth's surface. Water is not only essential for survival of all living things but is also the source of economic wealth and the creator of beautiful environment. Water is needed for agricultural production, industrial production and to meet various other needs for human survival. Now a day, this precious resource is facing the two serious problems pollution and acute shortage. Fresh water and marine water, both are facing the problem of deterioration of water due to anthropogenic activities like industrialization urbanization and population explosion. So it is very essential to know our responsibility to save water and also to prevent water pollution.

OBJECTIVES OF THE RESEARCH WORK:

- i. To study the concept and causes of water pollution.
- ii. To study the effect, prevention and control of water pollution.

SCOPE AND IMPORTANCE OF THE RESEARCH WORK:

- i. Present paper is important for all student and teacher of environmental science faculty.
- ii. Present paper is important for all human being who can understand the issues of water.

RESEARCH METHODOLOGY:

For present research researcher used document analysis method.

DATA ANALYSIS AND INTERPRETATION:

Today everyone is discussing about the pollution. Pollution is defined as, undesirable change in the physical chemical or biological characteristics of natural water, air, or soil, which can adversely affect on the life or can create a potential health hazards to any living organisms or can cause damage to non-living things material or property.

WATER POLLUTION:

The negative change in physical, chemical and biological properties of natural water due to addition of pollutants causing adverse effects on aquatic life and other living being including man is called water pollution.

The classification of water pollution can be done on the basis of

- i. Origin of pollution
- ii. Source of pollutants
- iii. Nature of pollutants
- iv. Habitat and storage site.

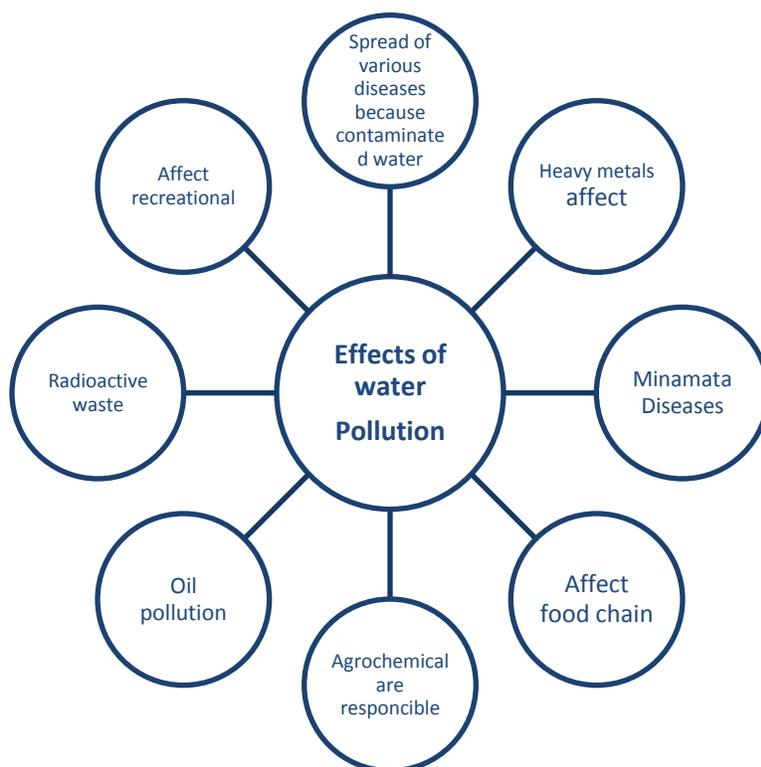
The water pollution can be studied on the basis of nature of pollutants like physical pollution, chemical pollution and biological pollution, etc. The water pollution can be studied on the basis of habitat and storage site in which the water resource is divided into surface water pollution and ground water pollution. The surface water pollution involves the river water pollution, lake water pollution,

estuarine water pollution, sea water pollution, etc. The ground water pollution involves change in quality of hand pumps, bore wells, open wells, etc.

HOW CAN WE CHECK THE PURITY OF THE WATER?

To check the pollution load and water safety for different uses, regular monitoring is required. Water quality is determined by different parameters like PH, turbidity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, nitrates, phosphate sulphate, chlorides, etc. The biological parameters involves most probable number (MPN) and standard plate count (SPC), detection of pathogens, also some phytoplankton and zooplankton are used as pollution indicator species.

EFFECTS OF WATER POLLUTION:

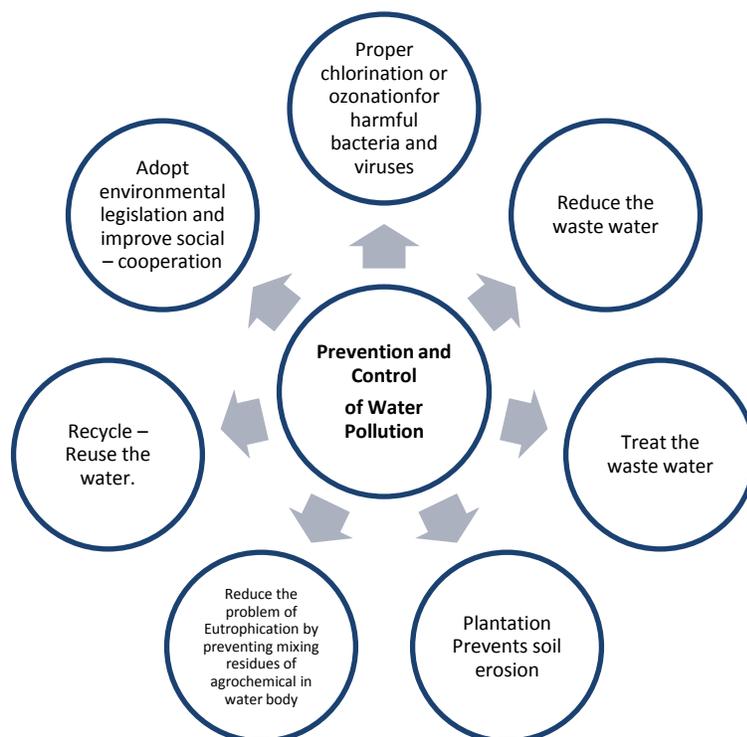


EFFECTS OF WATER POLLUTION:

- i. Diseases like cholera, typhoid, dysentery, poliomyelitis etc. spread by contaminated water.
- ii. Many organic and inorganic compounds are harmful to living system, toxic compounds like heavy metals, pesticides, cyanides are also harmful.

- iii. Mercury and cadmium cause diseases like 'Minamata' and 'Itai-Itai' respectively.
- iv. Chemical pesticides undergo biotransformation through food chain.
- v. Because of agrochemicals like nitrates and phosphates coming from field runoff causes nutrient enrichment of water body. It favours luxuriant and rapid growth of aquatic weeds. This process is known as 'Eutrophication'. Here the dissolved oxygen gets depleted and leads to suffocation of aquatic life. Higher levels of nitrates are responsible for 'Methaemoglobinemia'
- vi. Oil pollution in water forms a distinct layer on upper surface which inhibits the mixing of dissolved oxygen. The aquatic animals get killed as the oil coats the body surface and prevents the gas exchange.
- vii. Radioactive waste in aquatic bodies leads to genetic damages, mutation and mortality.
- viii. Polluted water affects the recreational value as well as the aesthetic beauty of any water body.

PREVENTION AND CONTROL OF WATER POLLUTION:



INTERPRETATION:

Saving of water is important and people must learn to conserve it. We are already short of fresh water, which is the basic to our living. If we can't save the water, then the next wars in the world will be fought over water. So saving of water is important and people must learn to conserve it.

CONCLUSIONS:

- i. The negative change in physical chemical and biological properties of natural water due to addition of pollutants causing adverse effects on aquatic life and other living beings including man.
- ii. Effects of polluted water are –heavy metals affect, agrochemicals are responsible, oil pollution affect, radioactive waste, Affect recreational it spreads various diseases.
- iii. We can prevent and control water pollution by – Recycling water, Reducing over use of water, preventing mixing of agrochemical, by doing plantation, proper chlorination, ozonation for disinfection of harmful bacteria and viruses.

REFERENCES:

1. Best, J. W. (2009) Research in Education Englewood Cliffs N. J. Prentice Hall.
2. Kothari, C. R. (2005) Research Methodology New age. International (P) Limited, Publisher Ansari Road, Daryaganj, New Delhi.
3. Raut, P.D. (2009) Environmental studies: Shivaji University, Kolhapur.
4. <http://www.tropical-rainforedt-animals.com/how-to-reduce-pollution.html> Retrieved on 29 March 2016.
5. www.indiaexpress.com 22 March 2016 Retrieved on 25 March 2016.

SEASONAL VARIATIONS IN PHYSICO- CHEMICAL CHARACTERISTICS OF MUDAL VILLAGE POND FROM BHUDARGAD TAHSIL, KOLHAPUR, (M.S.) INDIA

S. A. Vhanalakar

Department of Zoology, Karmaveer Hire Arts, Science, Commerce and Education College,
Gargoti, Tal – Bhudargad, Dist – Kolhapur, 416209 M.S., INDIA

Correspondence author E-mail: sagarayan36@gmail.com

ABSTRACT:

The present study was undertaken to know the variation in different seasons in response to physicochemical properties of rural pond situated at Mudal village of Bhudargad Tahsil (Dist - Kolhapur) in Maharashtra. The study was carried out over a period of one year. By observing the result it can be concluded that the parameters which were taken to study the water quality are below the pollution level which satisfies the requirement for the use of various purposes like domestic, agricultural, industrial etc. It is found that the water from selected pond is non-potable for human being due to high concentration of one or the other parameter. The usefulness of these parameters in predicting pond water quality characteristics were discussed.

KEYWORDS: Water Quality; Physicochemical Parameters; Village Pond.

INTRODUCTION:

The water is one of the most important compounds of the ecosystem. Living things exist on the earth because of this is only planet that has the existence of water. It is necessary for the survival of all living things be it plant or animal life. It is the most abundant commodities in nature but also the most misused one.

Fresh water has become a scarce commodity due to over exploitation and its necessities have led to the deterioration of surface and subsurface water. The causative factors for the pollution of water are industries, agriculture and domestic activities (Prabhakaran et al., 2011). Due to over expanding population and industrial settlements, the demand for fresh water is increasing day by day. In today's scenario, unplanned urbanization, rapid industrialization and indiscriminate use of artificial chemicals cause heavy and varied pollution in aquatic environments leading to deterioration of water quality and depletion of aquatic fauna. Physico-chemical parameters play a vital role in determining the

distributional pattern and quantitative abundance of organisms inhabiting a particular aquatic ecosystem (Singh *et al.*, 2009).

The maintenance of water quality standards in lakes and reservoirs is necessary so that they do not become a nuisance to both aquatic life and man. The physical and chemical features of reservoirs are governed by existing hydrological and geomorphic processes. Reservoir water fluctuates in response to surface water runoff, direct precipitation, ground water discharge, rate of evaporation and most importantly human interference. These affect the physicochemical condition of a reservoir and in turn affect the fauna and flora by imposing physiological and behavioural adaptations. Their physiological parameters also act interdependently so as to greatly influence water quality criteria (Kemdirim, 2005).

Physicochemical studies on freshwater bodies are important as basis for any ecological work and also in the establishment of water quality standards. In this regard the present work has been carried out to study the physico-chemical parameters of Mudal village pond to determine the monthly variations in water quality.

MATERIAL AND METHODS:

The present study was carried out in a Mudal village pond in Kolhapur district, Maharashtra. The water is used for domestic, irrigation and fisheries purpose. The physico-chemical parameters of water were analyzed to know the status of the tank in a period of June, 2014 to May, 2015. Water samples were collected from four different sites of the tank in the morning between 9 to 10 am, in polythene bottle. The temperature and pH were recorded at the time of sample collection, by using thermometer and pocket digital pH meter. Transparency was measured with the help of Secchi disc. For analysis of chemical parameters water was fixed in the field and brought to the laboratory. The estimation of chemical parameters such as dissolved oxygen, total solids, free carbon dioxide, hardness, chlorides, alkalinity, phosphate and nitrate was carried out as per the standard methods described by APHA (1985) and Trivedy & Goel (1987).

RESULTS AND DISCUSSION:

Physical parameters of Mudal village pond:

The monthly variations in physical parameters of Mudal village pond was shown in table 1.

Water temperature:

The water temperature is one of the most important physical characteristics of aquatic ecosystem, as it affects the organisms. It affects a number of water quality parameters that is one of the

concerns for domestic, environmental, industrial and agricultural applications. In the present study, the water temperature ranges from 19.8°C to 23.3°C during the study period. The maximum (23.3°C) temperature was recorded in the month of May and minimum (19.8°C) in the month of December. It showed that, higher temperature in summer and relatively lowers in winter. This investigation is also in close conformity with the finding of Sharma and Capoor (2010), and Arya et al (2011).

Table 1: Physical parameters of Mudal village pond, Kolhapur district, Maharashtra

Months	Temperature °C	Transparency cm	Turbidity NTU	TDS gm/lit	pH
Jun	20.6	12.02	9.28	1.00	7.69
Jul	20.6	56.52	0.91	4.14	7.59
Aug	21.5	47.17	2.00	0.27	7.87
Sept	22.0	53.40	2.91	0.46	8.42
Oct	22.0	61.59	0.91	0.20	7.50
Nov	21.5	71.65	0.91	1.55	7.50
Dec	19.8	67.20	2.28	0.27	7.69
Jan	21.1	35.60	0.36	0.11	7.69
Feb	22.4	35.60	0.36	0.10	7.59
Mar	22.8	30.26	0.36	0.11	7.59
Apr	20.6	28.93	9.10	0.09	7.41
May	23.3	20.03	10.19	0.18	7.41

Water transparency:

The transparency of water fluctuates from 12.02 cm to 71.65 cm. The maximum (71.65 cm) was recorded in the month of November and minimum (12.02 cm) in the month of June. Higher transparency occurred during winter and summer is due to absence of rain, runoff and flood water as well as gradual settling of suspended particles (Khan & Chowdhury, 1994; Kadam, *et al.*, (2007).

Turbidity:

The turbidity of water fluctuates from 0.36 NTU to 10.19 NTU. The maximum value was recorded in the month of May and minimum value in the month of January, February and March. It might be due to human activities. The high turbidity during summer season might be responsible for the

higher water temperature because suspended particles absorb heat from the sun light making the water warm (Tiwari, 2005)

Total dissolved solids (TDS):

The total dissolved solids fluctuate from 0.09g/l to 4.14g/l. The maximum value was recorded in the month of July and minimum value in the month of April. Sakhare & Joshi (2001) and Korai *et al.*, (2008) reported that the TDS values were higher during monsoon months due to rain and runoff.

pH:

pH is one of the most important factors that serve as an index for the pollution. The pH values range from 7.41 to 8.42. The maximum pH value was recorded in the month of September and minimum in the month of April. The same results were recorded by Choudhary *et al.*, (1979) in Hirakud Dam and Rajshekar *et al.*, (2007) from a minor reservoir of Nadargul.

Chemical parameters of Mudal village pond:

The monthly variation in chemical parameters of Mudal village pond was shown in table 2.

Dissolved oxygen (DO):

The values of DO fluctuate from 6.40 mg/l to 11.83 mg/l. The maximum values (11.83 mg/l) was recorded in the month of February and minimum values (6.40 mg/l) in the month of May. The values obtained for investigated water body recorded higher amount of dissolved oxygen during winter and low values during summer months, thus clearly reflecting an inverse relation of dissolved oxygen with the temperature. Dissolved oxygen level during winter can also be attributed to low biological activity (Qadri *et al.*, 1981).

Free Carbon dioxide:

The value of free CO₂ ranges from 0.0 mg/l to 16.19 mg/l. The maximum value (16.19 mg/l) was recorded in the month of April and minimum value (0.0mg/l) in the month of August, September and October. The value of CO₂ was high in summer. This could be related to the high rate of decomposition in the warmer months and to increased photosynthetic activity during the growing season. Arvind Kumar (1995) and Islam & Pramanik (2009) also reported that high free CO₂ content during summer months were possibly due to the high temperature and heavy rain fall with heavy drainage, which speed up the decomposition of organic matter and low photosynthetic activity.

Hardness:

The values of hardness fluctuate from 37 mg/l to 129.50 mg/l. The maximum value (129.50 mg/l) was recorded in the month of March and May and minimum value (37 mg/l) in the month of September. Hujare (2008) reported total hardness was high during summer than winter and monsoon.

High value of hardness during summer can be attributed to decrease in water volume and increase of rate of evaporation of water. Similar results were obtained in the present study.

Table 2: Chemical parameters of Mudal village pond, Kolhapur district, Maharashtra

Months	DO	Free CO ₂	Hardness	Chloride	Alkalinity	Phosphate	Nitrate
Jun	9.42	3.68	101.75	54.06	142.50	1.77	0.78
Jul	8.10	8.10	69.38	51.38	156.75	1.18	1.01
Aug	10.06	0.00	46.25	46.05	142.50	0.87	1.01
Sept	10.06	0.00	37.00	46.72	99.75	0.76	0.65
Oct	10.18	0.00	58.28	36.04	142.50	0.29	0.17
Nov	8.24	4.88	60.13	33.39	142.50	1.02	0.20
Dec	9.48	12.88	74.00	38.18	152.00	0.93	0.44
Jan	6.74	4.05	93.43	36.87	121.13	0.35	0.49
Feb	11.83	4.05	92.50	38.21	133.00	0.35	0.47
Mar	8.73	4.05	129.50	42.77	156.75	0.43	0.08
Apr	8.28	16.19	76.31	48.97	209.00	1.02	0.19
May	6.40	8.10	129.50	60.29	213.75	1.00	0.23

Value expressed in mg/lit

Chlorides:

The values of chlorides range from 33.39 mg/l to 60.29 mg/l. The maximum value was recorded in the month of May and minimum value in the month of November. In the present study maximum value of chloride reaches in summer and minimum in the winter. Similar results were reported by Tiwari (2005).

Alkalinity:

Total alkalinity ranges from 99.75 mg/l to 213.75 mg/l. the maximum value was recorded in the month of May and minimum value in the month of September. The maximum alkalinity in the summer month may be due to increase in bicarbonates in the water. Hujare (2008) also reported similar results that alkalinity was maximum in summer and minimum in winter due to high photosynthetic rate.

Phosphate:

The nitrate and phosphate are two important constituents that immensely help in the growth of the plants where they present. If they are present in lake and ponds they excessively promote the growth of aquatic weeds and polluting our aquatic resources.

The maximum value (1.77 mg/l) was recorded in the month of June and minimum value in the month of October (0.29 mg/l). The high values of phosphate in July and August months are mainly due to rain, surface runoff, agriculture runoff; washer man activity could have also contributed to the inorganic phosphate content. Similar results were reported by Arvind Kumar (1995).

Nitrates:

The values of nitrate ranges from 0.08 mg/l to 1.01 mg/l. the maximum value (56.62g/l) was observed in the month of July and minimum in the month of January. The study also supports the findings of Mishra et al (2008). They reported nitrates are in low concentration in winter and high during monsoon which might be due to surface run off, due to rain.

ACKNOWLEDGEMENT:

The author is thankful to University Grants Commission (UGC), WRO office, Pune, India for the financial support under Minor Research Project (File No. 47 – 688/13, WRO) and The Principal, Karmaveer Hire College, Gargoti, Dist – Kolhapur for providing necessary research facilities.

REFERENCES:

1. APHA (1985) Standard Methods for Examination of Water and Wastewater, 20th edition, American Public health Association, Washington D. C.
2. Arvindkumar (1995) Some limnological aspects of the fresh water tropical wetland of Santhal.Pargana (Bihar). *Ind. J. Envi. Poll.*, 2(3):137-141.
3. Arya, S, Kumar, V, Raikwar, M, Dhaka, A and Minakshi (2011) Physico-chemical Analysis of Selected Surface Water Samples of Laxmi Tal (Pond) in Jhansi City, UP, Bundelkhand Region, Central India Journal of Experimental Sciences 2(8): 01-06.
4. Choudhary, N. K., Pradhan, P. K. and Dash, M. C. (1979) Certain physico-chemical factors and phytoplankton of Hirakud Dam. *Geobios*, 6: 104-106.
5. Hujare, M. S. (2008) Seasonal variation of physico-chemical parameters in the perennial tank of Talsande, Maharashtra. *J. Ecotoxicol. Environ. Monit.*, 18(3): 233-242.
6. Islam, M. N and Pramanik, M. S. (2009) Relationship between physico-chemical and meteorological conditions of a fish pond at Rajshahi, Bangladesh. *Res. J. Bio. Sci.*, 4(3): 357-359.

7. Kadam, M. S., Pampatwar, D. V. and Mali, R. P. (2007) Seasonal variations in different physico-chemical characteristics in Masoli reservoir of Parbhani district, Maharashtra. *J. Aqua. Biol.*, 22(1): 110-112.
8. Kemdirim, E. C. (2005) Studies on the hydrochemistry of Kangimi reservoir, Kaduna State, Nigeria. *Afr. J. Ecol.*, 43: 7-13
9. Khan, M. A. G and Choudhary, S. H. (1994) Physical and chemical limnology of lake Kaptai, Bangladesh. *Trop. Eco.*, 35(1): 35-51.
10. Korai, A. L., Sahato, G. A., Lashari, K. H. and Arbani, S. N. (2008) Biodiversity in relation to physico-chemical properties of Keenjhar Lake, Thatta district, Sindh, Pakistan. *Turk. J. Fish. Aquat. Sci.*, 8: 259-268.
11. Mishra R. R., Rath B., Thatoi H. (2008). Water Quality Assessment of Aquaculture Ponds Located in Bhitarkanika Mangrove Ecosystem, Orissa, India. *Turkish Journal of Fisheries and Aquatic Sciences* 8: 71-77.
12. Prabhakaran, N., Mahendran, N., Radha, S., Gurugnanam, B. and Mahendran, S. (2011). Water quality studies through GIS at Bhavani Taulk Erode District, Tamilnadu, India. *Eco. Env. & Cons.* 17(2): 291-295.
13. Qadri, M. Y., Naqash, S. A., Shah, G. M. and Yousuf, A. R. (1981) Limnology of two streams of Kashmir. *J. Indian Inst. Sci.*, 63: 137-141.
14. Rajshekar, A. V., Lingaiah, M. S., Rao, S. and Piska, R. S. (2007) The study on water quality parameters of a minor Nadergul, Rangareddy district, Andhra, Pradesh. *J. Aqua. Biol.*, 22(1): 118-122.
15. Sakhare, V. B. and Joshi, P. K. (2003) Study on some aspect of fisheries management pf Yeldari reservoir. *Ph. D. thesis*, S.R.T.M University, Nanded.
16. Santhokumar Singh, A. Dakua, D. and Biswas, S. P. (2009). Physico-chemical parameters and fish enumeration of Maijan Beel (Wetland) of Upper Assam, *Geobios*, 36: 184-188.
17. Sharma R and Capoor A (2010) Seasonal Variations in Physical, Chemical and Biological Parameters of Lake Water of Patna Bird Sanctuary in Relation to Fish Productivity *World Applied Sciences Journal* 8 (1): 129-132.
18. Tiwari, M., (2005). Assessment of physico-chemical status of Khanpura Lake, Ajmer in relation to its impact on public health. *Eco. Env. And Cons.*, 11(3-4): 491-493.
19. Trivedy, R. K. and Goel, P. K. (1986) Chemical and biological methods for water pollution studies. *Environmental Publication*, Karad, Maharashtra.

STUDY ON HYDROBIOLOGICAL PARAMETERS OF GODAVARI RIVER AT PAITHAN

D. R. Deshmukh

Department of Zoology, Pratishthan Mahavidyalaya, Paithan, Dist - Aurangabad, M.S. 431 007

Corresponding author E-mail: deshmukhdnyan@gmail.com

ABSTARCT:

The present study deals with the seasonal variation in hydrobiological parameters of godavari river water. the hydrobiological parameters such as Temperature, Dissolved oxygen PH, Alkalinity, Hardness, TDS and BOD of water playing an important role in the distribution of planktonic flora and fauna. The present work on hydrobiological parameters provides information on quality of water of Godavari River near Paithan. . Additions of sewage, domestic and agricultural waste, use of organic and inorganic fertilizers may responsible for eutrophication.

KEYWORDS: Hydrobiological parameters; Godavari river; Paithan.

INTRODUCTION:

Godavari river originates at Trimbakeshwar near Nashik in Maharashtra (India) and after travelling about 1500 km merges in the bay of bengal . It has total catchment area of 312,812sq km of which 63.3% lies in maharashtra (Rajput, 1990). Its main tributaries are Pravara, Purna, Penganga, Wainganga and Shivani in Maharashtra. Godavari discharges 93 km³ of water annually into Bay of Bengal, which is 1/4th of ganga's discharge. Godavari, the second largest basin of the country covers an area of the Deccan peninsula equivalent to 10 % of the country; hence Godavari river is considered to be the 'Ganges of Deccan'. Many researchers have investigated the limno-chemistry and characteristics of Indian river (Manikya Reddy, 1984; Mahajan, 1988; Adawant,1989; Deshmukh and Ambhore, 2006; Deshmukh and Sonawane, 2008; ,Bhadane 2016; Deshmukh and Sathe, 2014). The present work on hydrobiological parameters provides information on quality of water of Godavari river near Paithan. . As the river flows through rural and urban area, it receives various domestic, agricultural and industrial effluents; hence, water is assessed for its water quality and the impact of various human and cultural activities on physico-chemical and biological characteristics.

MATERIALS AND METHODS:

Figure showing Maps of Godavari River

Water samples were collected from sampling station and they were brought to the laboratory. The temperature of water was measured by thermometer at the spot, the dissolved oxygen was calculated in the laboratory by using the Winkler's method. pH of river water was calculated by using digital pen pH meter, the alkalinity was calculated by using the phenolphthalein and methyl orange indicator and the samples were titrated against the NH_2SO_4 solution. Hardness of water was calculated by using erichrome black't' indicator. TDS and BOD are calculated by APHA (1985).

RESULTS AND DISCUSSION:**Temperature:**

Temperature ranges between 16 to 27.5°C. The minimum temperature 16°C was recorded in January (winter season) whereas hottest during the May (summer) i.e. 27.5°C (Table 1) seasonal variations were observed in water temperature which also exhibited a correlation with atmospheric temperature by Zingade (1981), Welch (1952) has observed that shallow water reacts more quickly to change in atmospheric temperature. Muley and Patil (2006) recorded that maximum temperature was recorded during pre monsoon and lowest during winter. Fluctuations have been observed in the monthly values of dissolved oxygen (DO) which ranges between 1.7 to 3.4mg/lit. (Table 1).

Dissolved Oxygen:

The dissolved oxygen in the month of march is minimum (1.7) where as maximum in the month of October (Masood Ahmed and Krishnamurthy, 1990) showed a positive correlation between temperature and duration of sunlight. Soluble gases like dissolved oxygen in water at given temperature depends like factors like temperature of water ,partial pressure of the gas in contact with water, the concentration of dissolved salts, biology activity . Mathew et al., (1992) have shown that high dissolved oxygen levels are associated with higher ph of water. Deshmukh (1964) ,Goldman and Horne (1983) and Prakash (1982) reported that the concentration of do is inversly proportional to the concentration of CO₂ . Dhere and Gaikwad (2006) observed that dissolved oxygen is minimum in May and maximum in February month.

pH:

The PH parameter is one of the most important hydrobiological parameters that serves as an index for pollution. The pH is the value expressed as the negative lograthim of the hydrogen ion concentration. Moore (1950), Ganpati (1960), Singh (1995), Verma (1978) and Vyas et al (1968) showed that the pH of the Indian river ranges between 7.3 to 9.saxena (1978) reported that many factors affect the pH value .these factors are photosynthesis, exposure to air, disposal of industrial waste and domestic sewage. In the present investigation the pH value of the water ranges 7.3 -8.8 during the year 2002 (Table -1). Chandrashekar (1997) noted alkaline PH over 2 year study period in urban centers, pH of water is also highly influenced by nature of pollution in the form of sewage and industrial efflunts Kodarkar (1995). Muley and Patil (2006) recorded that there is a slight alkaline nature of Pauna river.

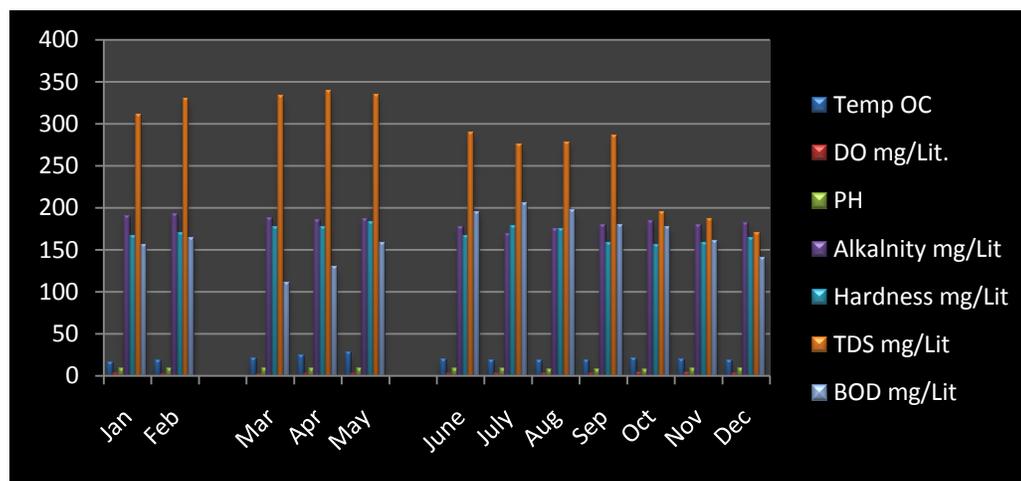
Alkalinity:

The alkalinity of river water ranges from 174 to 192 mg/lit. Carbonates and bicarbonates are responsible for the alkalinity of water. The alkalinity of river water is low during August month and is high during february month. From the above observations we conclude that the alkalinity is high during winter and summer whereas low during monsoon season. Bishop (1973), Adebisi (1981) showed that alkalinity was inversely related to the water level. Nalina and Puttaiah (2006) recorded that alkalinity is maximum in summer season and minimum in rainy season due to dilution of ground water with percolated rainwater.

Table 1. Seasonal variation in Hydrobiological parameters of Godavari river near paithan (2010)

Months	Temp °C	DO mg/lit.	pH	Alkalinity mg/lit	Hardness mg/lit	TDS mg/lit	BOD mg/lit
Jan	16	2.8	8.3	190	166	310	155
Feb	18	1.9	8.4	192	170	330	164
Mar	21	1.7	8.7	188	176	333	110
Apr	24.5	2.1	8.5	184	177	339	129
May	27.5	2.2	8.6	187	182	334	158
June	20	2.3	8.0	177	166	289	195
July	19	2.8	7.8	168	178	275	205
Aug	18	2.8	7.5	174	174	278	197
Sep	19	2.7	7.6	179	158	285	179
Oct	21	3.4	7.3	183	155	195	176
Nov	20	3.3	8.1	179	158	187	160
Dec	18	3.0	8.8	181	164	170	140

Figure 1. Seasonal variation in Hydrobiological parameters of Godavari river near Paithan

**Hardness:**

Hardness of water ranges from 155 to 182 mg/lit.(Table1) hardness of water is mainly due to the presence of carbonate (Ca^{++} and Mg^{++}) and expressed as an equivalent amount of $CaCO_3$. The high

concentration of hardness ranging between 150-300ppm and above may cause heart diseases and kidney problem in fish. The maximum value of water hardness in river kali was reported to be 488g/lit by George et al (1966). While in river Ganga at kanpur hardness fluctated between 112to250 mg/lit by Saxena et al (1866) hardness is found to be low (155mg/lit) during October where as high (182 mg/l) during may month. Muley and Patil (2006) observed that hardness is higher in February and lower during July.

Total Dissolved Solids (TDS):

The total dissolved ranges from 170 to 339 mg/Lit.TDS is lower in December where as higher in April month. The amount of dissolved solid is increases due to release of decaying matter from aquatic vegetation. The minimum dissolved solids are observed in winter where as maximum are observed in summer was noted by Jayaraman et al . (2003). Increase in TDS, increases hardness of water was recorded by Shastri et al. (2004) and Deshmukh and Sathe (2014).

Biochemical Oxygen Demand (BOD):

It is indicator parameters to know the presence of biodegradable matter in waste and express degree of contamination. Biochemical oxygen demand ranges from 140 to 205 mg/Lit.BOD level is more in monsoon season then winter and summer due to less quantity of solid and microbial population reported by Singhai et.al (1990).

ACKNOWLEDGEMENT:

The authors are thankful to the UGC, WRO Pune for providing financial assistance and also thankful to the Principal Pratishthan Mahavidyalaya, Paithan for Providing the necessary facilities required for this work.

REFERENCES:

1. Adebsi ,B. A. (1961) ,Hydrobial . 79 pp157-165.
2. Adwant, M .P.(1989) ,Ph .D thesis , Dr. Babasaheb Ambedkar marathwada university ,Aurangabad (MS) india.
3. APHA (1985) 16th edition , APHA washington ,dc indian council of medical research (icmr) 1975 drinking water standards icmr ,new Delhi .
4. Bishop J.E. (1973) , sungai gomback dr .w.junk publishier the hague pp.485

5. Chandrashekar S.V.A. (1977) ph .d. Thesis Osmania university Hyderabad (AP) india.
6. Deshmukh, B.S. and Sathe, S.D(2014), Journal of Aquatic Biology and Fisheries. 2 ,pp101 -105
7. D. R. Deshmukh and S.R. Sonawane(2008),J. exp. Zool. Vol. 11(1)pp 143-145.
8. Deshmukh J.U and Ambore N.E (2006) ,J aqua biol 21,pp 93-96.
9. Deshmukh S.B. (1964) ,Indian J. Environ.hlth6, pp166-188.
10. Dhare R.M. and Gaikwad J.M.(2006),J.Aqua biol 21,pp86-88
11. Ganapati S.V(1960).,proc. Symp .algology.icar new Delhi,pp204-218.
12. George I.P,venugopal S. and venkateshwer K (1986) ,Indian j. Environ hlth 28,pp303-313.
13. Jayaraman, P.R., Ganga Devi, T. and Vasudevan Nayar, T.(2003)., *Poll. Res.*, 22(1): 89-100.
14. Goldman C.R and Horne A.J (1983) Limnology.int ste. Ed miii book co london
15. Kodarkar M.S (1995) Conversation of lakes indian association of aquatic biologists(iaab) Hyderabad pub ,3 ,1-82
16. Mahajan K.K (1988),Ecology and pollution at indian river 1:1PP38.
17. Manikya Reddy (1984) P.hd. Thesis Osmania university ,Hyderabad.
18. Masood ahmed and krishnamurthy R (1990) J environ. Biol, 11,PP,335-343.
19. Mathew verghese ,Anil chauhan and I.P Naik (1992) Poll Res
20. Muley D.V and Patil I.M. (2006) J. Aqua biol. 21,PP, 68-75.
21. Nalina E and E.T puttaiaha (2006) J.Aqua.biol.21PP,105-110.
22. Moore W.G (1950). Lake providence.ecology 31PP, 113-118.
23. Prakash C(1982) water quality of keetham lake(soor sarovar) J. Emt.
24. Prakash R.A (1999). PhD . Thesis . Dr. Babasaheb ambed kar marathwada university, aurangabad (m s) india.
25. Singhai S., Ramani G.M. and Gupta U.S. (1990) Limnological (Barlin)21(1) PP,293-301.
26. Saxena K.I ,Chakraborty R.N , Khan A.K,Chattopadhy S.N and Chandrah (1966) Environ . Health PP 270-285.
27. Saxena M.M (1987) Environmental analysis of water, air and soil agro. Botanical .publ india.
28. Shastri,Y.C,Sonawane, Y.D.and Pingale,S.D (2004) *J. Ecotoxicol. Environ. Monit.*, 14(2)PP 137-141.
29. Singh M (1965) phytoplankton periodicity in a small lake near Delhi.
30. Verma S.R ,Tyagi A.K and Dalela R.C (1978). Proc .India.Acad. Sci. B.87,PP123-131.
31. Vyas I.N and Kumar H.D (1968) Hydrobiologia 31PP,421-434.
32. Welch P.S (1952) Limnlogy 2nd Edition Mc craw hill book co. N. Y. 536
33. Zingade M.D (1981) indian J. Mar. Sci 10,101.

WATER QUALITY ASSESSMENT AND MONITORING

Ch Vivek* and M Bhaskar

Division of Animal Biotechnology,

Dept. of Zoology, Sri Venkateswara University, Tirupati-517 502, A.P., India

Department of Zoology, Dravidian University, Kuppam-517 425, A.P., India

Correspondence author E-mail: hasujatha@gmail.com, vivek.chintada@gmail.com

INTRODUCTION:

The primary goal of the approach for Drinking-water Quality is that the protection of public upbeat. Water is important to sustain life, and adequate provide should be on the market to any or all. Humanizing access to safe drinking-water may result in concrete advantages to health. Water is employed for varied functions for way of life, agriculture, industry, fishery, etc. Water is provided from the ocean to the atmosphere through evaporation and comes back to the bottom surface as rain. It supports varied human activities and natural ecosystems. As water flows over and the bottom surface and becomes on the market as a water resource in rivers, lakes, underground water, and coastal water, it captures inorganic substances from the soil, and organic material and microorganisms generated by human activities and natural ecosystems.

Access to safe drinking-water is key to health, a basic right and a module of effective strategy for health safeguard. The consequence of water, sanitation and hygieniene for health and development has been mirrored within the outcomes of a series of international policy forms (WHO, 2004). Most recent, the world organisation (UN) General Assembly confirmed the amount from 2005 to 2015 because the International Decade for Action, "Water forever." Access to safe drinking- water is critical as a health and development issue at a national, regional and native level. In 1983-1984 and in 1993-1997 the World Health Organization (WHO) on the market the primary and second editions of the strategy for Drinking-water Quality in 3 volumes as successors to earlier WHO International Standards.

Water quality is that the summary of all physical, chemical, biological, and aesthetic characteristics of water that influence its useful use (Boyd and Tucker, 2012). The standard of water, whether or not it's used for utilization, irrigation or recreational functions, is noteworthy for health in each developing and developed countries worldwide (WHO, 2001). Water quality standards signify the amount that don't cause a risk to the soma and don't limit uses of water. Every normal varies looking on

the natural, public, cultural and economic scenario in every region. an affordable normal reflects the foremost trendy scientific data, and it ought to be evaluated sporadically and revised once necessary.

The basic and essential demand to confirm the protection of drinking-water area unit a “framework” for safe drinking-water, comprising health-based targets established by a talented health authority; adequate and properly managed systems within the vein of adequate infrastructure, correct observation and effective coming up with and management; and a system of freelance police investigation. Multi-dimensional advance to water quality assessment embrace become a predictable certainty. Relating to 100 years ago the standard of the aquatic setting be outlined by many analyses of water, however this definition has currently reached tier of complexity that necessitate synchronal contemplation of many aspects.

On a worldwide extent, moribific contagion of water poses the foremost vital health risk to humans, and there are inestimable facts of unwellness outbreaks and poisonings throughout history ensuing from exposure to untreated or inadequately treated water. However, vital risks to human health might also result from exposure to nonpathogenic, pestilent contaminants that are usually worldwide present in waters from that water comes. The big majority of marked water-related health troubles are the results of microorganism, be keen on medical specialty, viral, protozoan or further biological contamination. However, a considerable range of significant health issues might occur as a result of the chemical contamination of drinking-water. With this latter points in intellect, the target of this commission chapter is to debate the first sources of unhealthful contaminants in surface waters and groundwater, the pathways through that they shift in aquatic environments, factors that influence their concentration and structure on the numerous move flow ways, and therefore the virtual risks that these contaminants create to human and environmental health. Within the risk measuring progression, understanding the sources and pathways for contaminants within the setting could be an essential step in addressing (and reducing) uncertainty related to estimating the chance of exposure to contaminants in water. Additional significantly, thoughtful the sources and pathways of contaminants strengthen our ability to enumerate effects through brilliant measuring and testing, or to predict the chance of effects supported empirical models. Understanding the sources, outcome, and concentration of chemicals in water, in conjunction with assessment of effects, not solely forms the inspiration of risk characterization, however conjointly provides essential data needed to create conclusion concerning restrictive initiatives, redress, monitoring, and management.

MODERN ENDEAVOR ON WATER QUALITY ASSESSMENT AND MONITORING:

Water quality assessment is important to exuberantly assess and monitor drink quality to confirm a secure and clean drink provide (Yan and Tibeto-Burman, 2016). The hazard assessment approach for screening water quality knowledge will facilitate center of attention higher stage risk assessment work, as well as laboratory, field, and knowledge analysis studies, on contaminants with larger close at hand for adverse natural effects (Carriger et al., 2016). Durrieu et al., (2016) recognized that water superiority will be evaluated by suggests that of biomarkers like tissular catalyst activities of endemic species. Bhaskar et al., (1983) perform pragmatic study on nature of acidity and pH and their influence on aquatic animals. The best risk in fresh is frequently as of acute contamination throughout early wet-season 'pre-flush' stream into lentic waters, or constant input of contaminants over long periods of base flow. As a result of variations within the nature of hazard periods, water-quality intimidation and pollutant-delivery mechanisms, the advantages of various management choices to boost water quality may also diverge amongst fresh habitats and between fresh and marine environments (Davis et al., 2016). Early studies counsel each fresh invertebrates and fish ingest micro plastics, with uptake resulting in substantial effects that embrace physiological stress responses and even cipher of neoplasm formation (Imhof et al., 2013; Oliveira et al., 2013). Measure of molluscs bivalves action at elevated frequency (e.g., valvometry) throughout a protracted time stage is in a different way to record the animate thing behavior and to guage perturbations of the water quality in real time. As a result of the waste matter affects the activity of oysters, we have a tendency to contemplate the valves gap and shutting pace to observe the water quality assessment. Intensification of agriculture and extension of cultivation is increasing the pressure on the conventional resources by begin fertilizers and pesticides into the system (Nguyen et al., 2016). Hamid et al., (2016) incontestible that the importance of environmetric techniques for reliable characterization and analysis of exterior water quality, in more than a brief amount for fortunate management.

TOXIN SOURCE AND PATHWAYS:

In general, pollutants are often discharged into the atmosphere as gases, dissolved substances or within the particulate kind. Ultimately pollutants reach the aquatic atmosphere through a spread of pathways, together with the atmosphere and also the soil. Figure.1 illustrates, in schematic kind, the principal pathways of pollutants that influence fresh quality. Pollution could result from purpose sources or diffuse sources (non-point sources). There's no clear-cut distinction between the two, as a result of a diffuse supply on a regional native scale may result from an oversized range of individual purpose

sources, like automobile exhausts. A very important distinction between some extent and a diffuse supply is that some extent supply is also collected, treated or controlled (diffuse sources consisting of the many purpose sources might also be controlled provided all purpose sources are often identified). The main purpose sources of pollution to freshwaters originate from the gathering and discharge of domestic wastewaters, industrial wastes or bound agricultural activities, like farming. Most alternative agricultural activities, like chemical spraying or chemical application, square measure thought-about as diffuse sources. Rivers play a significant role in assimilative or carrying industrial and municipal waste, manure discharges and runoff from agricultural fields, roadways and streets, that square measure answerable for stream pollution (Stroomberg et al., 1995; Ward and Elliot, 1995). Bhaskar (2013) demeanored in vitro studies on the impact of 8-(-4-chlorophenylthio) cAMP on chosen organic chemistry parameters in Sertoli cells. The part fall-out of pollutants conjointly ends up in diffuse pollution of the aquatic atmosphere. The atmosphere is proving to be one in every of the foremost pervasive sources of pollutants to the world atmosphere. Vital concentrations of bound contaminants square measure even being determined in Arctic and Antarctic snow and ice, with high levels of bioaccumulation exaggerated through the organic phenomenon to mammals and native human populations. By definition some extent supply may be a pollution input which will be associated with one outlet. Untreated, or inadequately treated, disposal is perhaps still the main rootage of pollution to the world's waters. alternative necessary purpose sources embrace mines and industrial effluents. As purpose sources square measure localized, abstraction profiles of the standard of the aquatic atmosphere is also wont to find them. Some purpose sources square measure characterised by a comparatively constant discharge of the polluting substances over time, like domestic sewers, whereas others square measure occasional or unsteady discharges, like leaks and accidental spillages. A waste matter treatment plant serving a hard and fast population delivers a nonstop load of nutrients to a receiving water body.

NON-ATMOSPHERIC DIFFUSE SOURCES:

- Agricultural run-off, as well as wearing from surface and sub-soil evacuation. These processes transfer organic and inorganic soil particles, nutrients, pesticides and herbicides to adjacent water bodies.
- Urban run-off from town streets and encompassing areas. Possible contaminants embrace derivatives of fuel combustion, bacteria, metals and industrial organic pollutants, notably PCBs.

- Pesticides and herbicides may additionally be derived from urban horticulture, landscaping, farming and their regular use on railways, airfields and roadsides.
- In the worst circumstances pollutants from a spread of diffuse sources is also entertained into combined storm/sewer systems throughout storm-induced, high evacuation flow conditions, wherever they then contribute to major purpose sources.

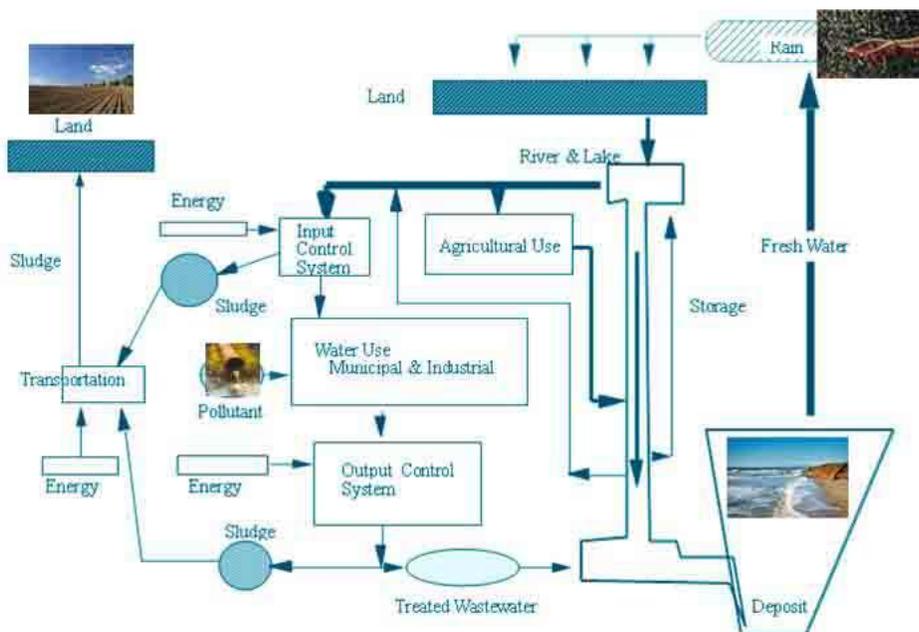


Fig 1. Water cycle and water uses

TRANSPORT PATHWAYS IN THE ENVIRONMENT:

Substances discharged from combustion sources are ultimately distributed among, and may sometimes accumulate in, varied environmental compartments (e.g., soils, vegetation, indoor dusts, animals, and humans). Some contaminants that are discharged from combustion facilities are possible to contribute primarily to environmental compartments on an area scale (within ten km). However, others that are additional persistent within the surroundings, are often distributed over abundant bigger distances even up to a regional scale over many kilometers. Most of the substances discharged from combustion facilities to air don't stay in air however are deposited to soil, vegetation, or surface water and may inherit contact with humans through a series of advanced environmental pathways that embrace transport through many environmental media.

WATER QUALITY ASSESSMENT METHODS FOR THE CHARACTERIZATION AND MANAGEMENT:

Surface water quality impairment continues to extend as a heavy concern throughout the planet. Water quality deterioration is primarily as a result of growing population and town increasing and is threatening human and ecological health, water accessibility, and further economic development (Houser and Richardson, 2010; Morse and Wollheim, 2014). Surface waters square measure particularly susceptible to pollution attributable to their straightforward accessibility for discarding of wastewaters (Singh et al., 2004). Water excellence destruction results from each phylogenesis inputs (e.g., public and industrial waste material discharges, agricultural runoff) and natural processes (e.g., chemical weathering and soil corrosion) (Holloway et al., 1998; Singh et al., 2011; Shin et al., 2013). Sensible and reliable assessment of water quality is needed for property water resource use with relevance system health and social devel-opment that, a lot of significantly, arranged a foundation for the interference and management of surface pollution (Simeonov et al., 2003; Shrestha and Kazama, 2007). Bhaskar et al., (1983) exemplify that the internal organ tissue ammonia metabolism of freshwater fish, *Sarotherodon mossambicus* (L) (Trewavas) acclimated to altered hydrogen ion concentration media. The paper-disc technique wasn't solely a easy assay for screening soil toxicity, however additionally effective attributable to its association with indirect soil quality indicators.

During the past decade, abundant analysis has investigated water quality impairment mistreatment completely different assessment strategies. For instance, Huang et al. (2010) used a fuzzy comprehensive assessment and multivari-ate data point technique for example that the water quality of the most stream channel was higher than the tributaries within the Qiantang stream (China). Veeraiah et al., (2014) instituted changed RP-HPLC technique for the analysis of Imidacloprid seventeen.8% Shining Path (Commercial grade). Similarly, Massoud (2012) evaluated the pollution levels of Damour stream (southern Lebanon) by applying a water quality index technique. The results indicated that the water quality of Damour stream was plagued by the phylogenesis activ-ities going down on the stream. Likewise, Xu (2005) gave a comprehensive water quality identification index (CWQII) that could be a new implement for wide-ranging water quality assessment of surface waters. Fu et al. (2014) used CWQII technique to judge the water quality of Taizi stream (China), and therefore the results unconcealed that water quality was inferior to category V from the years 2009 to 2012. Ban et al. (2014) additionally determined the CWQII values of Honghu Lake (China), and located CWQII enlarged from the years 2001 to 2005 and unbroken a balance from 2006 to 2011, that steered that the water quality had step by step improved since 2006 attributable to water protection measurements taken by native govern-ment since 2004.

NITROGEN SOURCES AND PATHWAYS:

More than seventieth of the nitrate is coming back from cropland, the remainder from regulated sources like waste treatment plants, septic and concrete runoff, forest, and also the atmosphere. Nitrate natural process into groundwater below cropped fields and moving underground till it reaches streams, contributes a calculable half-hour of nitrate to surface waters.

Importance of Nitrate Assessment:

- Elevated nitrate levels might damage fish and aquatic life.
- Because nitrate moves primarily via groundwater (not surface runoff), it will bemire beverage wells.

Strategy for reducing cropland nitrate going into surface waters constitute three categories:

- Manage in-field nutrients (i.e., optimize chemical rates, apply chemical nearer to temporal order of crop use)
- Manage and treat tile evacuation water (i.e., set up tile spacing and depth; management drainage; construct and restore wetlands for treatment purposes; and bioreactors)
- Diversify plant life (i.e., plant cowl crops; plant additional perennials on marginal cropland).

PESTICIDE RESIDUES:

India is one amongst the biggest chemical customers within the world. Due to the potential risks associated with pesticide use, water has to be monitored. The Bureau of Indian Standards (BIS) sets regulative limits for residual pesticides at trace levels (sub ppb) in drinkable (IS 10500) (BIS, 2012), prepacked drinkable (IS 14543) (BIS, 2004) and natural drinking water (IS 13428) (BIS, 2005). Pesticides enter surface and water primarily as runoff from crops and area unit most prevailing in agricultural areas. Pesticides are used on wooded areas, on roadsides, and in residential district and concrete landscape areas. Since warfare II chemical associated pesticide application to crops has big to a calculable 660 million pounds of active ingredient in 1993. While not correct safeguards pesticides have the potential to noticeably threaten several groundwater provides within the U. S. Close to five hundredth of the population obtains its drinkable from groundwater suppls and the maximum amount as ninety fifth of the population in agricultural areas uses groundwater as its source of drinkable. The term "pesticide" may be a composite term that features all chemicals that area unit accustomed kill or management pests. In agriculture, this includes herbicides (weeds), pesticides (insects), fungicides (fungi), nematocides (nematodes), and rodenticides (vertebrate poisons). The pesticides most acutely dangerous to man area unit pesticides and rodenticides, though pound for pound, herbicides area unit

the foremost wide used variety of chemical. Not each chemical is acutely harmful to humans or different non-target species.

Agricultural use of pesticides may be a set of the larger spectrum of business chemicals utilized in fashionable society. The American Chemical Society information indicates that there have been some thirteen million chemicals known in 1993 with some 500 000 new compounds being additional annually. Within the Great Lakes of North America, as an example, the International Joint Commission has calculable that there are a unit over two hundred chemicals of concern in water and sediments of the nice Lakes system. As a result of the environmental burden of harmful chemicals includes each agriculture and non-agricultural compounds, it's tough to separate the ecological and human health effects of pesticides from those of business compounds that area unit by choice or accidentally discharged into the setting. However, there's overwhelming proof that agricultural use of pesticides contains a major impact on water quality and results in serious environmental consequences.

The five selected pesticides area unit herbicides that area unit accustomed management deciduous weeds and grasses. The independent agency estimates between two hundred and 250 million pounds of those herbicides area unit applied annually within the U.S. Atrazine, simazine, and cyanazine area unit applied to agricultural land before and when planting. Alachlor and metolachlor area unit applied to soil before plant growth (pre-emergent).

The impact on water quality by pesticides is related to the subsequent factors:

- Active ingredient within the chemical formulation.
- Contaminants that exist as impurities within the active ingredient.
- Additives that area unit mixed with the active ingredient (wetting agents, diluents or solvents, extenders, adhesives, buffers, preservatives and emulsifiers).
- Degradate that's shaped throughout chemical, microbic or chemistry degradation of the active ingredient.

There are a unit many factors that influence a pesticides' potential to contaminate water:

- The ability of the chemical to dissolve in water (solubility).
- Environmental factors, such as, soil, weather, season, and distance to water sources
- Application ways and different practices related to the chemical use.

Groundwater contamination is higher once there's no crop or a young crop. An outsized actively growing crop has the power to cut back chemical concentration through a range of mechanisms:

- Larger plants consume a lot of water from the soil and thus cut back the power of a chemical to migrate through the soil and enter streams or groundwater.

- Larger plants will collect precipitation that prevents pooling of water and run-off from the world
- Root zones enrich the microbic community of the soil that then enhances the biodegradation of the chemical by microorganism.

The Safe drinkable Act sets standards for drinkable and mandates the Environmental Protection Agency set most Contamination Levels (MCLs) for variety of pesticides publically water provides. Non-public water provides aren't monitored or regulated by this Act. Since pesticides area unit most prevailing in agricultural areas wherever most residents acquire their drinkable from non-public sources, it's up to the patron or well owner to watch material levels. Testing and treatment choices area unit on the market to the general public.

Drinking water standards have faith in a range of criteria, that area unit tough to grasp - even for experts. Once the standards area unit perceived as a differentiation between safe and unsafe, a drinkable level extraordinary the quality level is of nice concern to the general public. Regulative limits for chemical residues in waters ought to have the subsequent characteristics: definition of the sort of water, definition of the residue, an acceptable analytical technique for the residues, and a proof of the premise for every limit. Limits is also derived by applying a security issue to a no-effect-level, or from levels occurring once sensible practices area unit followed, or from the detection limit of associate analytical technique, or directly by legislative call. Limits are most ordinarily developed for drinkable; however values have conjointly been planned for environmental waters, effluent waters, irrigation waters, and farm animal drinking waters. The contamination of water is of concern as a result of it should be used as drinkable and will act as a supply of contamination for surface waters. Most ordinarily, drinkable standards are applied to ground water.

The world Health Organization's guideline standards for drinkable for those pesticides exhibiting threshold toxicity effects area unit derived from the tolerable daily intake (TDI) or acceptable daily intake (ADI) by assumptive daily consumption of two liters of water by a 60-kg adult. For pesticides that area unit extremely persistent, have a high bioaccumulation potential, and area unit usually found in food, just one maximize the TDI is allotted to drinkable. In different cases, a default prices of ten the troubles TDI is allotted to drinkable. National governments usually follow constant procedure in essence, however the small print area unit completely different. Residues of a general chemical in irrigation water may be preoccupied to provide a residue level within the crop extraordinary the most residue limit (MRL). The most guideline limit would be set so residues within the crop wouldn't exceed the MRL.

PESTICIDES EXPERIMENTAL GUIDELINES:

The North American nation Food and Drug Administration publishes their chemical Analytical Manual (PAM) on the Web¹ and numerous strategies are created offered by the North American nation EPA² and therefore the U.S. Department of Labor activity Safety & Health Administration³. The Codex Alimentarius Commission has printed a paper on suggested strategies (Codex customary 229)⁴, that relates to printed info. Some chemical strategies offered to the Codex Commission on chemical Residues are offered on the Internet⁵. Steering documents are offered covering "Residues knowledge from supervised Trials" from FAO⁶ and therefore the European Commission⁷, "Residue Analytical Methods" from the eu Commission⁸ and "Submission and analysis of chemical Residues knowledge for the Estimation of most Residue Levels in Food and Feed" from FAO⁹.

ECOLOGICAL EFFECTS OF PESTICIDES:

Pesticides square measure enclosed in a very broad vary of organic small pollutants that have ecological impacts. Totally different classes of pesticides have contradictory kinds of effects on living organisms, so generalization is troublesome. Though terrestrial impacts by pesticides do occur, the principal pathway that causes ecological impacts is that of water contaminated by chemical runoff. The two principal mechanisms square measure bioconcentration and biomagnification.

Bioconcentration:

This is the movement of a chemical from the encompassing medium into associate degree organism. The first "sink" for a few pesticides is fat ("lipids"). Some pesticides, like pollutant, square measure "lipophilic", which means that they're soluble in, and accumulate in, fat like edible fish tissue and human fat. Alternative pesticides like glyphosate square measure metabolized and excreted.

Biomagnification:

This term describes the increasing concentration of a chemical as food energy is reworked at intervals the organic phenomenon. As smaller organism's square measure eaten up by larger organisms, the concentration of pesticides and different chemicals square measure progressively exaggerated in tissue and different organs. Terribly high concentrations may be discovered in high predators, as well as man.

The ecological effects of pesticides (and different organic contaminants) square measure varied and square measure usually inter-related. Effects at the organism or ecological level square measure typically thought of to be associate early warning indicator of potential human health impacts. The most important styles of effects square measure listed below and can vary looking on the organism beneath

investigation and therefore the kind of chemical. Completely different pesticides have markedly different effects on aquatic life that makes generalization terribly troublesome. The vital purpose is that a lot of those effects square measure chronic (not lethal), square measure usually not detected by casual observers, nevertheless have consequences for the whole organic phenomenon.

- Death of the organism.
- Cancers, tumors and lesions on fish and animals.
- Generative inhibition or failure.
- Suppression of system.
- Disruption of endocrine (hormonal) system.
- Cellular and deoxyribonucleic acid injury.
- Agent effects (physical deformities like hooked beaks on birds).
- Dolt health marked by low red to white vegetative cell quantitative relation, excessive slime on fish scales and gills, etc.
- Intergenerational effects (effects don't seem to be apparent till ulterior generations of the organism).
- Different physiological effects like egg shell cutting.

These effects don't seem to be essentially caused exclusively by exposure to pesticides or different organic contaminants, however could also be related to a mix of environmental stresses like eutrophication and pathogens. These associated stresses needn't be massive to possess a synergistic result with organic small pollutants. Ecological effects of pesticides extend on the far side individual organisms and may reach ecosystems. Swedish work indicates that application of pesticides is believed to be one in all the foremost important factors poignant diversity. Jonson et al., (1990) report that the continued decline of the Swedish partridge population is connected to changes in land use and therefore the use of chemical weed management. Vivek et al., (2016) accomplished that the acute toxicity and residue analysis of cartap complex pesticide: pharmacology implications on the fingerlings of freshwater fish *Labeo rohita*. V.G.N.V.Prasad et al., (2013 and 2016) over that the turpentine oil induced inflammation decreases absorption and will increase distribution of pain pill while not sterilization its elimination method in rats. Tata Rao et al., (2014) examined Organochlorine chemical residues within the water of paddy fields of Prakasam District of province, India. Veeraiah et al., (2013) examined changes in secretion activities of the fish *Channa punctatus* (bloch) beneath exposure to dicofol eighteen.5 % (E.C) Sub-lethal concentration. Chemical weed management has the result of reducing environment, decreasing the quantity of weed species, and of shifting the balance of species

within the plant community. Swedish studies additionally show the impact of pesticides on soil fertility, as well as inhibition of nitrification with concomitant reduced uptake of element by plants (Torstensson, 1990). These studies additionally recommend that insecticides adversely have an effect on soil microorganisms that square measure to blame for microorganism degradation of plant matter (and of some pesticides), and for soil structure. Box half-dozen presents some regional samples of ecological effects of pesticides.

Pesticide Residue Analysis Methods:

A multi-residue methodology supported LC-MS/MS has been delineated for three hundred pesticides in drinking water¹⁰. A comparatively new multi-residue methodology has been promptly accepted by several chemical residue analysts, the thus referred to as QuEChERS method¹¹ (Quick, Easy, Cheap, Effective, Rugged, Safe). This methodology, that covers a large chemical vary (polar, pH-dependent compounds), claims to be speedy (8 samples in but thirty min), easy (no punishing steps) and low-cost. The solvent consumption is low (10 milliliter acetonitrile; GC- and LC-amenable) and much no tableware is needed¹².

There square measure four strategies as well as liquid–liquid extraction (LLE), direct liquid injection (DAI), purge and entice (PAT) and head house (HS) were out there for determination of volatile organic compounds (VOCs) as well as trihalomethanes (THMs) in drink (Golfinopoulos et al., 2001).

INDUSTRIAL POLLUTION:

Industry plays a crucial role within the method of economic development within the world. It enhances the economic welfare of the people and provides the fabric merchandise they consume. The approach that society can develop within the future is basically addicted to however the expansion which trade generates is distributed. Trade is additionally a significant client of natural resources and a significant contributor to the general pollution load. Supported OECD (Organization for Economic Cooperation and Development) estimates, it accounts for regarding tierce of worldwide energy consumption of their member states, and for regarding ten percent of the overall water withdrawal. The relative contribution to the overall pollution load is clearly higher for industry-related pollutants. The economic sector generates each ancient pollutants (e.g., organic substances, gas, particulates and nutrients) and newly-recognized pollutants (e.g., specific venomous substances). Bhaskar and Govindappa (1986) ascertained the results of environmental acidity and pH scale on the physiology of fish genus *mossambica* throughout acclimatization. The economic sector includes variety of various

activities. As a result, there's a large vary of various resource and environmental impacts created by trade.

In recent years, the property development conception has been well known, that has promoted the implementation of integrated management of commercial production. The event of "industrial ecology" aims to provides theories and strategies to harmonize the economic sectors with the part which will bring solutions of property development to the trade and society. Counting on the fuel, the SO₂ content of flue gases is one to four g/m³; a mean size coal dismissed power station, with an output of 700MW, produces 2.5 million money supply of flue gases per hour, emitting regarding about 2.5 tons of sulfur per hour. The main pollutants from industrial emission embrace foamy emissions (SO₂, NO_x etc.) and particulate emissions. The foremost necessary styles of pollution from combustion processes area unit pollutant (NO) and dioxide (NO₂).

HEAVY METALS:

Heavy metals are non-degradable within the setting, a number of which might be nephrotoxic even at low intake levels, whereas others are essential to serve specific biological functions, however they'll still be harmful to human health if at high level (Rivai 2001; Afridi et al. 2012; Baig et al. 2011). Serious metals discharged into aquatic or soil environments will accumulate within the organic phenomenon and ultimately have an effect on human health by biomagnifications (Xin et al., 2015; Yeganeh et al. 2012). Therefore, to assess the potential risk of serious metals contamination in varied ecological systems is of nice significance.

Anthropogenic activities, like industrial production and unsafe disposal of commercial wastes agricultural wastes and domestic waste, unleash serious metals into the setting (Sirajudeen et al., 2012). The percolating waste product picks up an oversized variety of serious metals and reaches the formation system and contaminates water. These serious metal-bearing wastewaters are of goodly concern as a result of their extremely nephrotoxic, non-biodegradable and possibly malignant neoplastic disease in nature (Dermentzis et al., 2011). Metals are the foremost persistent contaminants within the aquatic setting (Chai et al., 2010; Li et al., 2014). Though the commercial sector accounts for under three per cent of the annual water with-drawals in Asian country, its contribution to pollution, particularly in urban areas, is goodly.

While some metals, such as Fe, Cr and Cu, act as micronutrients to take care of human and animal biological health, they will become nephrotoxic when prodigious accept-able levels. High concentration exposure isn't necessary to provide a state of toxicity within the body, as serious metal

accumulation happens in body tissues step by step, and over time, it will reach nephrotoxic concentration levels, abundant on the far side acceptable limits. Human health risk assessment through drinkable consumption has so become the prime focus of environmental researchers globally (Khan et al. 2014). Mining and process activities, production of alloys and chemicals, waste effluents, urban run-off, and agricultural run-off are major phylogeny contributors of Co to the aquatic setting. Oral exposure to Co in humans ends up in adverse effects on metastasis, cardio-vascular, gi, medicine, hepatic, renal, endocrine, dermal, ocular, physiological state, and weight (ATSDR 2004). Metallic element and its salts are employed in the animal skin tanning industry; the manufacture of catalysts, pigments and paints; fungicides; the ceramic and glass industry; photography; for chrome alloy and metal production; chrome plating; and corrosion management. As a result, metallic element has become a significant plant run-off waste product that's commencing to become a world trend (Hu 2002). variety of epidemiological studies of staff in metallic element-production facilities have incontestable associate association between inhalation of Cr (VI) and higher metastasis irritation and atrophy, lower metastasis effects, and excretory organ effects (USEPA 1998).

The toxicity of metallic element stems from its tendency to be corrosive and to cause sensitivity (Howard 2002). Inhalation and retention of materials containing metallic element (VI) will cause perforation of the septum, asthma, bronchitis, rubor, inflammation of the vocal organ and liver, and multiplied occurrence of bronchogenic cancer. Skin contact of metallic element (VI) compounds will induce skin allergies, dermatitis, dermal death and dermal corrosion (Bielicka et al., 2005). In general, the Cr content of surface waters reflects the extent of commercial activity (WHO 2003a). Ni, a hard, silvery-white metal, which mixes with alternative metals to create alloys, is employed principally within the production of unblemished steels, non-ferrous alloys and super alloys. Alternative uses of atomic number 28 and atomic number 28 salts are in electroplating, as catalysts, in Ni–Cadmium batteries, in coins, in fastening product, and in sure pigments and electronic product (IARC 1990). Allergic dermatitis is that the rifest impact of atomic number 28 within the general population (WHO 2007). Metal that is that the second-most exuberant metal within the earth's crust could be a com-mon constituent in soil and water. Iron oxides are used as pigments in paints and plastics, and as coagulants in water treatment. Anaerobic groundwater's could contain iron (II) at concentrations up to many milligrams per metric capacity unit while not discoloration or turbidness within the water once directly pumped up from a well. Style isn't typically notice-able at iron concentrations below 0.3 mg/L, though tur-bidity and color could develop in piped systems at levels on top of 0.05–0.1 mg/L. No health-based guideline price for iron is planned (WHO 2003a, b, c).

The primary anthropogenic sources of metal within the setting are from metal smelters and mining activities. The assembly and use of metal in brass, bronze, die castings metal, alloys, rubbers, and paints may cause its release to the setting through varied waste streams (EPA 2005). Waste streams from Zn- and alternative metal-manufacturing industries, domestic waste product and run-off will discharge Zn into waterways (ATSDR 2005). Bhaskar et al., (2001) ascertained that the influence of metal on internal organ and blood serum organic chemistry parameters in Rabbit. Oral exposure to high levels of Zn in humans may result in many general effects, the foremost sensitive of that are associated with diminished copper standing. Acute toxicity arises from the uptake of excessive amounts of Zn salts, either accidentally or deliberately as associated curative or dietary supplement. Unconditioned reflex typically happens when the consumption of over five hundred metric capacity unit of white vitriol (WHO 2003c). Nickel could also be found in some ground-waters as a consequence of dissolution from nickel ore-bearing rocks. Nickel is employed principally within the production of unblemished steels, non-ferrous alloys, and super alloys. Alternative uses of nickel and nickel salts are in electroplating, as catalysts, in nickel-cadmium batteries, in coins, in fastening product, and in some pigments and electronic product. Subramanyam and Bhaskar (1991) check out the role of chemical element, metal in induction of coronary artery disease. Veeraiyah et al., (2013) examined metal chloride induced changes in macromolecule molecules and organic chemistry changes (veeraiyah et al., 2013) of the seafood *Cirrhinus mrigala* (Hamilton). Allergic dermatitis is that the most rife impact of atomic number 28 within the general population. With relation to carcinogenicity, it absolutely was over that activity exposure to Sulfide and Oxide Nickel at high concentrations causes respiratory organ and nasal cancer (WHO 2007; Sharma et al., 2011).

WATER QUALITY MANAGEMENT ROLE IN AQUACULTURE:

The economical and profitable production of fish, crustaceans, and different aquatic organisms in cultivation depends on an appropriate setting within which they'll reproduce and grow. As a result of those organisms board water, the key environmental concern among the culture system is water quality. Water provides for cultivation systems might naturally be of caliber or contaminated by human action, however in most instances, the first reason for water quality impairment is that the culture activity itself.

Manures, fertilizers, and feeds applied to ponds to reinforce production solely are often part regenerate to animal biomass. Thus, at moderate and high production levels, the inputs of nutrients and organic come to culture units might exceed the assimilating capability of the ecosystems. The results is

deteriorating water quality that stresses the culture species, and stress ends up in poor growth, bigger incidence of diseases, magnified mortality, and low production (Bhaskar, 1994). Effluents from cultivation systems will cause pollution of receiving waters, and pollution getting into ponds in supply water or chemicals supplementary to ponds for management purpose will contaminate cultivation product. Thus, water quality in cultivation extends into the arenas of environmental protection and food quality and safety.

Information of water quality principles can facilitate aquaculturists verify the potential of a body of water to provide cultivation species, to keep up or fish stress and fish health, to provide higher-quality hydroponic product, to cut back environmental impacts of effluents, and to understand additional economical production and bigger profits. Bhaskar and Govindappa (1990) discovered changes in supermolecule metabolism of water fish *Tilapia mossambica* (peters) acclimated to altered pH scale media. Moveable meters are often wont to live dissolved gas, pH, salinity, and temperature; nutrients, noxious metabolites, alkalinity, and hardness are also determined with water quality check kits. However, so as to properly sample, analyze, and interpret pond-water analyses, aquaculturists got to have a general plan of water quality dynamics in ponds.

PHYTOPLANKTON COMMUNITIES:

Phytoplankton is that the predominant form of plant found in most cultivation ponds. Primary production by plant life is that the base of the organic phenomenon in lake cultures that rely on natural foods to support fish for crustacean production. plant life communities are thought of helpful as a result of they're a part of the lake microbic community that acts to keep up adequate environmental conditions for culture, as an example, plant life communities at moderate standing crops offer dissolved chemical element and assimilate ammonia. On the opposite hand, most water quality issues in cultivation ponds are the results of unmanaged growth of plant life communities. As an example, excessive abundance of plant life will result in imbalances in lake dissolved chemical element budgets, resulting in periods of low dissolved chemical element concentrations that may stress the animal below culture (Boyd and Tucker, 2012). Bhaskar and Govindappa (1992) matter-of-fact acid stress influence on fish muscle. Some techniques, like remote sensing and chemotaxonomic analysis, are planned to be used as supplements in plant life observation programs (Domingues et al., 2008).

Contemporary government policy is targeted around promotion and funding of higher construction management practices to reduce the loss of construction nutrients and also the maintenance of a Reef wide water quality and scheme monitor program. The monitor program is meant

to assess trends in uptake of management follow enhancements and their associated impacts on water quality and scheme standing over ensuing ten years (Brodie et al., 2011). Excessive salinity in water will cause physiological upset or death of placental. The results of salinity are typically as a result of upsets in water balance instead of associated with any specific particle. A guide to be used of saline water for placental and poultry is bestowed in Table twelve (National Academy of Sciences, 1972).

DATA QUALITY CONTROL:

Data internal control could be an advanced and long activity that should be undertaken unceasingly to confirm significant water quality assessments. This is often significantly crucial for a few of the chemical analyses dispensed on water samples, like dissolved trace parts, pesticides or perhaps ammonia and phosphates.

WORLD HEALTH ORGANIZATION BEVERAGE QUALITY POINTERS:

Regulatory standards ought to embody obligatory observation to verify whether or not the water quality meets the quality. If it doesn't meet the quality, some reasonably countermeasures should be taken so the quality will be achieved. On the opposite hand, in contrast to these regulative standards, there's a suggestion that serves even as a reference once the goal or the quality for the required water quality is provided. The World Health Organization beverage Quality pointers (DWQG) could be a typical example of such a suggestion. The World Health Organization DWQG is employed as a reference in development of national beverage quality standards in several countries. The method of developing the DWQG provides one among the foremost acceptable examples as an example the event of rational standards.

WATER QUALITY ACTS AND LAWS:

The Clean Water Act (CWA) establishes the essential structure for control discharges of pollutants into the waters of the U. S and control quality standards for surface waters. The idea of the CWA was enacted in 1948 and was referred to as the Federal pollution management Act; however the Act was considerably organized and enlarged in 1972. "Clean Water Act" became the Act's common name with amendments in 1972. underneath the CWA, EPA has enforced pollution management programs like setting waste matter standards for trade. We've got conjointly set water quality standards for all contaminants in surface waters. The Safe beverage Act (SDWA) is that the main federal law that ensures the standard of Americans' beverage. Under SDWA, EPA sets standards for beverage quality and

oversees the states, localities, and water suppliers World Health Organization implement those standards.

Water Act's:

1882: The Easement Act: allow non-public human rights to use a resource that's, groundwater, by performance it as a vicinity to the land. It additionally state of affairs that every one facade water belongs to the state and may be a state property.

1897: The Indian Fisheries Act: Ascertain two sets of penal offences whereby the govt will bring a claim somebody United Nations agency uses dynamite or alternative explosive substance in any manner with intent to catch or destroy any fish or toxic fish so as to kill.

1956: The watercourse Boards Act: Facilitate the states to register the central government in fixing associate informative watercourse Board to resolve problems in inter-state collaboration.

1970: The bourgeois Shipping Act: Shall modify waste arising from ships on the coastal areas encircled by a mere radius.

1974: The Water (Prevention associated management of Pollution) Act: Begin an institutional constitution for preventing and decreasing pollution. It establishes principles for water quality and waste material. Polluting industries should look for permission to discharge waste into effluentbodies.

1977: The Water preclusion and Control of effluence Cess Act: Grant for the charge and collection of cess or price on water consuming industries and confined authorities.

1978: The Water (Prevention and organize of Pollution) Cess Rules: Hold the standard definitions and point out the kind of and spot of meters that every consumer of water is requisite to affix.

1991: The Coastal Guideline Zone Notification: Situate regulations on different activities, including manufacture, are regulated. It provide some protection to the backwaters and estuaries.

General Act's

1986: The setting (Protection) Act authorizes the central government to safeguard and improve environmental quality, management and cut back pollution from all sources, and require or limit the setting and /or operation of any industrial facility on environmental grounds.

1986: The setting (Protection) Rules lay down procedures for setting standards of emission or discharge of environmental pollutants.

1989: The target of dangerous Waste (Management and Handling) Rules is to regulate the generation, collection, treatment, import, storage, and handling of dangerous waste.

1989: The Manufacture, Storage, and Import of dangerous Rules outline the terms employed in this context, associate degree sets up an authority to examine, once a year, the commercial activity connected with dangerous chemicals and isolated storage facilities.

1989: The Manufacture, utilize, introduce, Export, and Storage of dangerous Micro-organisms/genetically built Organisms or Cells Rules were introduced with a read to safeguard the setting, nature, and health, in reference to the applying of cistron technology and microorganisms.

1991: The general public insurance Act and Rules and modification, 1992 was entailed to supply for public insurance for the aim of providing immediate relief to the persons laid low with accident whereas handling any dangerous substance.

1995: The National Environmental judicature Act has been created to award compensation for damages to persons, property, and also the setting arising from any activity involving dangerous substances.

1997: The National setting proceedings Authority Act has been created to listen to appeals with reference to restrictions of areas during which categories of industries etc. square measure dispensed or prescribed subject to bound safeguards underneath the EPA.

1998: The medical specialty waste (Management and Handling) Rules may be a legal binding on the health care establishments to contour the method of correct handling of hospital waste like segregation, disposal, collection, and treatment.

1999: The setting (Siting for Industrial Projects) Rules, 1999 lay down careful provisions concerning areas to be avoided for siting of industries, preventative measures to be taken for website choosing as additionally the aspects of environmental protection that ought to be incorporated throughout the implementation of the commercial development comes.

2000: The Municipal Solid Wastes (Management and Handling) Rules, 2000 apply to each municipal authority answerable for the gathering, segregation, storage, transportation, processing, and disposal of municipal solid wastes.

2000: The gas Depleting Substances (Regulation and Control) Rules are set down for the regulation of production and consumption of gas depleting substances.

2001: The Batteries (Management and Handling) Rules, 2001 rules shall apply to each producer, importer, re-conditioner, assembler, merchant, auctioneer, user, and bulk shopper concerned within the manufacture, processing, sale, purchase, and use of batteries or elements thus on regulate and make sure the environmentally safe disposal of used batteries.

2002: The sound pollution (Regulation and Control) (Amendment) Rules lay down such terms and conditions as square measure necessary to scale back sound pollution, allow use of loud

speakers or public deal with systems throughout night hours on or throughout any cultural or spiritual merry occasion.

2002: The Biological Diversity Act is associate degree act to supply for the conservation of biological diversity, property use of its elements, and honest and equitable sharing of the advantages arising out of the utilization of biological resources and data related to it.

In addition to the antecedently mentioned pollution sources, the pollution of underground water provides from wastes carried in diffuse sources, like downward percolating (below-crop) drain waters from agriculture, is additionally of sizeable concern and is being studied on attainable means that for management. At present, however, there appears to be no sensible thanks to need routine observance of pollutants that will be acquiring soil water below crops. We believe, however, that the simplest sensible management of those diffuse sources of pollutants lies in improved and a lot of economical water management to scale back percolation losses to an inexpensive minimum during which use is predicated on crop demand for water, the leach demand for salinity management and also the potency realizable with the system of irrigation and distribution system used. An implication for the role of those water quality parameters provides the property life. In final concussion, chance to reduce reproductive, neurological, cancers, acute and chronic toxicity issues that helps to enhance socio-economic conditions. It's time taking however effort pays off.

REFERENCES:

1. Anastassiades¹², E. Scherbaum and D. Bertsch (2003), Chemisches und Veterinäruntersuchungsamt Stuttgart; Validation of a Simple and Rapid Multiresidue Method (QuEChERS) and its Implementation in Routine Pesticide Analysis, MGPR Symposium, Aix en Provence, France <http://www.quechers.com/default.htm>
2. ATSDR (2004), Toxicological profile for Cobalt. U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry
3. ATSDR (2005), Toxicological review for Zinc. U.S. Department of Health and Human Services Public Health Service Agency for Toxic Substances and Disease Registry, June 2005
4. Ban, X., Wu, Q. Z., Pan, B. Z., et al. (2014), Application of composite water quality identification index on the water quality evaluation in spatial and temporal variations: a case
5. study in Honghu Lake, China. Environmental Monitoring and Assessment, 186, 4237–4247.

6. Bielicka A, Bojanowska I, Wisniewski A (2005), Two faces of chromium—pollutant and bioelement. *Pol J Environ Stud* 14(1):5–10.
7. Bhaskar M. and Govindappa, S. (1986), Effects of environmental acidity and alkalinity on the physiology of *Tilapia mossambica* during acclimation. *Biochem. System. Ecol.* 14: 439 – 443. (IF: 2.0).
8. Bhaskar M. and Govindappa, S. (1992), Acid stress influence on fish muscle. *Environ. Ecol.* 10(1): 74-76.
9. Bhaskar M., (1994), Changes in the liver protein fractions of *Tilapia mossambica* (peters) on acclimation to altered pH media. *Fish Res.*19: 179-196. (IF: 1.6).
10. Bhaskar M., and Govindappa, S. (1990), Changes in protein metabolism of fresh water fish *Tilapia mossambica* (peters) acclimated to altered pH media. *Proc. Second. Ind. Fish. Forum, Mangalore.* pp 65-67.
11. Bhaskar M., Krishna Murthy, V., Reddanna, P. and Govindappa, S. (1983), Nature of acidity and alkalinity and their influence on aquatic animals. *Telugu.* 12(1): 51-56.
12. Bhaskar M., Madhuri, E., Latheef, S.A. and Subramanyam, G., (2001), Influence of Zinc on cardiac and serum biochemical parameters in Rabbit. *J. Exp. Biol.*, 39: 1170-1172. (IF: 1.195).
13. Bhaskar M., Sobhani, P., Krishna Murthy, V. and Govindappa, S. (1983), Hepatic tissue ammonia metabolism of fresh water fish, *Sarotherodon mossambicus* (L) (Trewavas) acclimated to altered pH media. *J. Aqua. Biol.* 1(1): 23- 28.
14. Brodie, J. E., Devlin, M., Haynes, D., & Waterhouse, J. (2011), Assessment of the eutrophication status of the Great Barrier Reef lagoon (Australia). *Biogeochemistry*, 106(2), 281-302.
15. Boyd, C. E., & Tucker, C. S. (2012), *Pond aquaculture water quality management*. Springer Science & Business Media.
16. Bureau of Indian Standards⁵, IS 10500 (2012), *Drinking Water [FAD 25: Drinking Water]*, with latest amendments.
17. Bureau of Indian Standards⁶, IS 14543 (2004), *Packaged Drinking Water (Other than Packaged Natural Mineral Water) [FAD 14: Drinks and Carbonated Beverages]*, with latest amendments.
18. Bureau of Indian Standards⁷, IS 13428 (2005), *Packaged Natural Mineral Water [FAD 14: Drinks and Carbonated Beverages]*, with latest amendments.
19. Chai LY, Wang ZY, Wang YY et al (2010), Ingestion risks of metals in groundwater based on TIN model and dose-response assessment a case study in the Xiangjiang watershed, central-south China. *Sci Total Environ* 408:3118–3124

21. Carriger, J. F., Castro, J., & Rand, G. M. (2016), Screening Historical Water Quality Monitoring Data for Chemicals of Potential Ecological Concern: Hazard Assessment for Selected Inflow and Outflow Monitoring Stations at the Water Conservation Areas, South Florida. *Water, Air, & Soil Pollution*, 227(1), 1-18.
22. Codex Alimentarius⁴, Current Official Standards,
23. http://www.codexalimentarius.net/web/standard_list.do?lang=eng
24. Davis, A. M., Pearson, R. G., Brodie, J. E., & Butler, B. (2016), Review and conceptual models of agricultural impacts and water quality in waterways of the Great Barrier Reef catchment area. *Marine and Freshwater Research*.
25. Domingues, R. B., Barbosa, A., & Galvão, H. (2008), Constraints on the use of phytoplankton as a biological quality element within the Water Framework Directive in Portuguese waters. *Marine Pollution Bulletin*, 56(8), 1389-1395.
26. Durrieu, G., Pham, Q. K., Foltête, A. S., Maxime, V., Grama, I., Le Tilly, V., ... & Sire, O. (2016), Dynamic extreme values modeling and monitoring by means of sea shores water quality biomarkers and valvometry. *Environmental Monitoring and Assessment*, 188(7), 1-8.
27. Dermentzis K, Christoforidis A, Valsamidou E (2011), Removal of nickel, copper, zinc and chromium from synthetic and industrial wastewater by electrocoagulation. *Int J Environ Sci* 1(5):2011 EPA 2005.
28. Europa, European Commission (2008)⁷, DG Health and Consumers, Guidelines on Comparability, Extrapolation, Group Tolerances and Data Requirements for Setting MRLs, SANCO 7525/VI/95 - rev.8.
29. <http://ec.europa.eu/food/plant/protection/resources/app-d.pdf>
30. Europa, European Commission⁸, DG Health and Consumers, Guidance Document on Residue Analytical Methods, SANCO/825/00 rev.7, March 2004
31. http://ec.europa.eu/food/plant/protection/resources/guide_doc_825-00_rev7_en.pdf
32. Food and Agriculture Organisation¹⁰ (FAO, 2002), Submission and evaluation of pesticide residues data for the estimation of maximum residue levels in food and feed, Rome.
33. Fu, T. Y., Zou, Z. H., & Wang, X. J. (2014), Water quality assessment for Taizi River watershed in Liaoyang section based on multivariate statistical analysis and water quality identification index. *Acta Scientiae Circumstantiae*, 34(2), 473–480 (in Chinese).
34. Food and Agriculture Organisation⁶ (1990), Guidelines on Producing Pesticide Residues Data from Supervised Trials, Rome.

35. <http://www.fao.org/AG/aGP/AGPP/Pesticid/Code/Download/pesticidas.pdf>
36. Golfinopoulos, S. K., Lekkas, T. D., & Nikolaou, A. D. (2001), Comparison of methods for determination of volatile organic compounds in drinking water. *Chemosphere*, 45(3), 275-284.
37. Greulich⁹ and L. Alder, BfR (2006), German Federal Institute for Risk Assessment, Fast multi residue screening of 300 pesticides in drinking water, Report BfR-IX-2005.
38. <http://www.bfr.bund.de/cd/5832>
39. Howard H (2002), Human health and heavy metals exposure. In: McCally M (ed) Life support: the environment and human health. MIT Press, Cambridge Hu 2002
40. Houser, J. N., & Richardson, W. B. (2010), Nitrogen and phosphorous in the UpperMississippi River: transport, processing, and effects on the river ecosystem. *Hydrobiologia*, 640, 71–88.
41. Holloway, J. M., Dahlgren, R. A., Hansen, B., et al. (1998), Contribution of bedrock nitrogen to high nitrate concentrations in stream water. *Nature*, 395, 785–788.
42. Huang, F., Wang, X. Q., Lou, L. P., et al. (2010), Spatial variation and source apportionment of water pollution in Qiantang River (China) using statistical techniques. *Water Research*, 44, 1562–1572.
43. Hamid, A., Bhat, S. A., Bhat, S. U., & Jehangir, A. (2016), Environmetric techniques in water quality assessment and monitoring: a case study. *Environmental Earth Sciences*, 75(4), 1-13.
44. Imhof, H.K., Schmid, J., Niessner, R., Ivleva, N.P., Laforsch, C., (2012), A novel, highly efficient method for the separation and quantification of plastic particles in sediments of aquatic environments. *Limnology and Oceanography: Methods* 10, 524–537.
45. IARC (1990), Nickel and nickel compounds. In: Chromium, nickel and welding. IARC monographs on the evaluation of carcinogenic risks to humans, vol. 49. International Agency for Research on Cancer, Lyon, pp 257–445 Khan et al. 2014
46. Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture⁵, Proposed Draft Revision of the List of Methods for Pesticide Residue Analysis Including Methods of Determination for Dithiocarbamates,
47. <http://www-naweb.iaea.org/nafa/fep/Methods-Main.pdf>
48. Li J, Li FD, Liu Q et al (2014), Impacts of Yellow River irrigation practice on trace metals in surface water: a case study of the Henan-Liaocheng Irrigation Area, China. *Hum Ecol Risk Assess* 20:1042–1057

49. Massoud, M. A. (2012), Assessment of water quality along a recreational section of the Damour River in Lebanon using the water quality index. *Environmental Monitoring and Assessment*, 184, 4151–4160.
50. Morse, N. B., & Wollheim, W. M. (2014), Climate variability masks the impacts of land use change on nutrient export in a suburbanizing watershed. *Biogeochemistry*, 121, 45–59.
51. Nguyen, N. T. T., & De Vries, M. B. (2016), Predicting trends in water quality in the coastal zone of TT-HUE, Vietnam-An assessment of impacts of rice culture and aquaculture.
52. Oliveira, M., Ribeiro, A., Hylland, K., Guilhermino, L., (2013), Single and combined effects of microplastics and pyrene on juveniles (0+ group) of the common goby *Pomatoschistus microps* (Teleostei, Gobiidae). *Ecological Indicators* 34, 641–647.
53. Prasad, V. G. N. V., Vivek Ch., Rao, M. A., & Rao, G. S (2016), “Curcumin Pretreatment Decreases Absorption of Phenacetin (Cytochrome P450 1A2 Substrate), Without Altering its Disposition Kinetics in Rats”. *Proceedings of the National Academy of Sciences, Springer, India Section B: Biological Sciences*, 1-5. Journl launched in the year 1930.
54. QuEChERS.com¹¹
55. <http://www.quechers.com/default.htm>
56. Sharma V, Verma SM, Sakhuja N, Arora D (2011), Impact of heavy metals (Chromium and Nickel) on the health of residents of Jagadhri city due to intake of contaminated underground water. *Arch Appl Sci Res* 3(5):207–212
57. Shrestha, S., & Kazama, F. (2007), Assessment of surface water quality using multivariate statistical techniques: a case study of the Fuji River basin, Japan. *Environmental Modeling and Software*, 22, 464–475
58. Simeonov, V., Stratis, J. A., Samara, C., et al. (2003), Assessment of the surface water quality in northern Greece. *Water Research*, 37, 4119–4124.
59. Singh, K. P., Basant, N., & Gupta, S. (2011), Support vector machines in water quality management. *Analytical Chimca Acta*, 703, 152–162.
60. Sirajudeen J, Manikandan SA, Naveen J (2012), Seasonal variation of heavy metal contamination of ground water in and around Uyyakondan channel Tiruchirappalli district, Tamil Nadu. *Der Chemica Sinica* 3(5):1113–1119
61. Singh, K. P., Malik, A., Mohan, D., et al. (2004), Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India)—a case study. *Water Research*, 38, 3980–3992.
- 62.

63. Shin, J. Y., Artigas, F., Hobble, C., et al. (2013), Assessment of anthropogenic influences on surface water quality in urban estuary, northern New Jersey: multivariate approach. *Environmental Monitoring and Assessment*, 185, 2777–2794.
64. Stroomberg, G. J., Freiriks, I. L., Smedes, F., & Cofino, W. P. (1995), Quality assurance and quality control of surface water sampling. *Quality assurance in environmental monitoring. Sampling and sample pretreatment*, 51.
65. Subramanyam, G. and Bhaskar M. (1991), The role of trace elements (Cadmium) in induction of atherosclerosis. *Proc. of the National Seminar on “The role of trace elements in the prevention of coronary atherosclerotic heart disease”*. Tirupati. pp 4-7.
66. Tata Rao S., Vivek Ch., Anthony Reddy P., Veeraiah K and P Padmavathi (2014), Determination of Organochlorine pesticide residues in the water of paddy fields of Prakasam District, Andhra Pradesh, India.
67. USEPA (1998), Toxicological review of Hexavalent chromium. In: Support of summary information on the integrated risk information system (IRIS). United States Environmental Protection Agency August 1998. CAS No. 18540-29-9.
68. US Food and Drug Administration¹, Pesticide Analytical Manual (PAM) <http://www.fda.gov/Food/ScienceResearch/LaboratoryMethods/PesticideAnalysisManualPAM/default.htm>
69. US Environmental Protection Agency², Pesticides, Index of Residue Analytical Methods (RAM), <http://www.epa.gov/oppbead1/methods/ram12b.htm>
70. US Department of Labor³, Occupational Safety & Health Administration (OSHA), Sampling and Analytical Methods, <http://www.osha.gov/dts/sltc/methods/index.html>
71. V.G.N.V.Prasad., Ch Vivek., P Anand Kumar., P Ravi Kumar and G S Rao (2013), Turpentine oil induced inflammation decreases absorption and increases distribution of phenacetin without altering its elimination process in rats. *European Journal of Drug Metabolism Pharmacokinetics.*, Springer, Volume 40, Issue: 1, pp 23-28, DOI 10.1007/s13318-013-0172-7.
72. Veeraiah K, Jaya Raju K, Padmavathi P, Samyuktha Rani A and Vivek Ch. November (2013), Cadmium chloride induced changes in protein molecules of the freshwater fish *Cirrhinus mrigala* (Hamilton). *International Innovare Journal of Life Science*. ISSN:2321-550X., 1(3), 18-23.
73. Veeraiah K, Vivek Ch and K Padmaja (2014), “Modified RP-HPLC method developed for the analysis of Imidacloprid 17.8% SL (Commercial grade)”. *Proceedings of the National Conference on Modern Trends in Zoological Research*, ISBN No. 978-81-909551-8-8.

74. Veeraiah K., Dhilleswa Rao H., Hyma Ranjani G., Venkatrao G and Vivek Ch., October (2013), Changes in hormonal activities of the fish *Channa punctatus* (bloch) under exposure to dicofol 18.5 % (E.C) Sub-lethal concentration. *International Journal of Recent Scientific Research*, ISSN:0976-3031,4(10),1631-1637.
75. Veeraiah. K, Venkatrao G, Vivek Ch and Hymaranjani G, April (2013), Heavy metal, cadmium chloride induced biochemical changes in the indian major carp *cirrhinus mrigala* (hamilton). *International Journal of Bioassays*, ISSN: 2278-778X, 2 (07), 1028-1033.
76. Vivek Ch, K Veeraiah, P Padmavathi, H Dhilleswara Rao, Bramhachari P.V (2016), "Acute toxicity and residue analysis of cartap hydrochloride pesticide: Toxicological implications on the fingerlings of fresh water fish *Labeo rohita*". *Biocatalysis and Agricultural Biotechnolog*, Elsevier, M.No: BAB_2016_40, ISSN: 1878-8181.
77. World Health Organization. (2001), *Water quality: Guidelines, standards, and health: Assessment of risk and risk management for water-related infectious disease*. L. Fewtrell, & J. Bartram (Eds.). IWA publishing.
78. Ward A. D. and Elliot W. J. (1995), In *Environmental Hydrology*, ed. A. D. Ward and W. J. Elliot, pp. 1. CRC Press, Boca Raton.
79. World Health Organization. (2004), *Guidelines for drinking-water quality: recommendations* (Vol. 1). World Health Organization.
80. WHO (2003a), Chromium in drinking water, background document for development of WHO guidelines for drinking-water quality. World Health Organization. WHO/SDE/WSH/03.04/04
81. WHO (2003b), Iron in drinking-water. Background document for development of WHO guidelines for drinking-water quality. World Health Organization. WHO/SDE/WSH/03.04/08
82. WHO (2003c), Zinc in drinking water, background document for development of WHO guidelines for drinking-water quality. World Health Organization. WHO/SDE/WSH/07.08/55
83. WHO (2007), Nickel in drinking water. Background document for development of WHO guidelines for drinking-water quality. World Health Organization. WHO/SDE/WSH/07.08/55
84. Yan, W., Li, J., & Bai, X. (2016), Comprehensive assessment and visualized monitoring of urban drinking water quality. *Chemometrics and Intelligent Laboratory Systems*, 155, 26-35.

ORGANIC FARMING AND CONSERVATION OF RESERVOIRS IN M.P. STATE

Leena Murlidharan and Sanjay Wagode

V. K. K. Menon College, Bhandup (E) Mumbai 42, M.S., INDIA

Corresponding author E-mail: leena.doctor@gmail.com

INTRODUCTION:

RESERVOIRS:

India has a total of 19,370 reservoirs units covering an area of 31,53,366 hectares. Nearly 70% of the 0.71 million active fishermen in India are employed in the inland fisheries sector. Since the reservoir fishery is a labour intensive activity, development of this sector will lead to the provision of gainful employment to this weaker section. For export demand there is urgent need to expand our production base. In addition it is always stressed that there is a need to utilize our natural resources productivity to ensure the much needed food security. Fisheries should be an avocation for better livelihood for improving the economic standards of rural poor.

Madhya Pradesh state has the largest water spread area under the reservoirs among the Indian states. Madhya Pradesh offers immense potential for fisheries development. By virtue of its land locked geographical position the states fisheries sector is entirely of "Inland category".

In Madhya Pradesh state total available water spread area is 3.245 lakh Ha till date, 3.15 lakh Ha of water spread area has been brought in inland fish farming. 96.90 Ha area has been developed by the private fish farmers through construction of new ponds. The Government of India with the support of Union Government is attempting to improve the economic condition of fish farmers, especially the unemployed youths by self employment opportunities through centrally sponsored Scheme for the development of Aquaculture in the state.

Situated in the centre of India, the State of Madhya Pradesh is one of the largest geographic units in the country. Except for the valleys of Narmada and Tapti river systems, Madhya Pradesh is mainly a plateau with mean elevation of 488m above MSL. The Vindhya and Satpura ranges of mountains crisscross the State and it has an average annual rainfall ranging 760-1500 mm. Four great rivers viz. Narmada, Tapti, Mahanandi and Mahi originate in this state. The rivers, tributaries, rivulets and streams in the state have a combined length of 20,661 km. Madhya Pradesh has an approximate number of 3,700 reservoirs when all the categories are taken together. It has a total water spread area

of 4.6 lakh ha. Under man made impoundments, which is the maximum among all the states in India. The Total available area under fish culture comes to about 2.71 lakh ha which is 58.9% of the total water spread area. Fish production from this area contributes to about 84.6% of the total fish production of the state.

A reservoir may be defined as a man-made impoundment with a large body of standing water. They are generally created by impoundment of a river or stream for irrigation, power generation, flood control or water supply as primary objective. The first man-made reservoir is believed to have come into existence about 6,000 years ago (Fernando, 1980). The productive level of Indian reservoirs is generally low.

PRESENT STATUS AND FUTURE POTENTIALS

Organic Farming:

Organic Farming defined as per National Programme on Organic Farming (NPOP) is ' Holistic System of Farm design and Management that seeks to create a healthy ecosystem which can achieve sustainable productivity without the use of artificial inputs such as chemical fertilizers and pesticides'.

Advantages of Organic Farming:

- i) To use on farm resources as far as possible
- ii) To preserve and enhance traditional and indigenous knowledge in farming, seeds and varieties.
- iii) To consider social and ecological impact of farming system
- iv) To produce healthy, nutritious and quality food.
- v) To minimize all form of pollution that may result from agricultural practices.
- vi) To maintain and enhance long term fertility of soils.
- vii) To help in water and soil conservation.

Indian Scenario of Organic Farming

- i) Organic Farming since Vedic Age and Sir Albert Howard (A British Agronomist) in 1900.
- ii) Farmers practicing Organic Farming either by default or due to lack of resources.
- iii) Only 0.05% area in India is under Organic Agriculture.
- iv) Large export oriented Industry
- v) APEDA Nodal Agency.

- vi) Capital Investment Subsidy Scheme (CISS) on Organic Farming started during Feb. 2005.

Scenario of Organic Farming in Madhya Pradesh

- i) Organic Farming being promoted as Bio-farming.
- ii) More than 3000 Bio Villages in M.P.
- iii) Ten Villages from each Block selected for Organic Farming.
- iv) On farm:- FYM, Vermicompost, NADEP, Biogas slurry, Green Manure and cow dung manure.
- v) Off- farm:- Bone meal, Poultry Manure, Neem cake, Karanj cake and Bio-fertilisers.
- vi) Fifty percent area in State Govt. farms put under organic farming.
- vii) Focus of the State Govt. to make it as Jaivik Madhya Pradesh.
- viii) Focus on Floriculture Mission of Organic Farming.
- ix) Certification:- MP Rajya Jaivik Pramanikaran Sanstha setup by MP Rajya Seed Corporation Ltd.

TAWA RESERVIOR:

The Tawa reservoir is a man made reservoir situated on the river Tawa in the Hoshangabad District of Madhya Pradesh. The river Tawa is a tributary of Narmada River. River Denva joins with Tawa River 823m upstream of Tawa dam site. The reservoir is also fed by a number of seasonal streams. It is located near Ranipur village, 35 km away from Itarsi Railway junction. The Dam is positioned at a Latitude of 22^o 30' 40" N and a Longitude of 77^o 58'30" E. The catchment area of the project is 5982.90 km². Construction of Tawa reservoir project was completed in 1974. The total area submerged due to the project comes to about 20,055 Ha of which 15056Ha. Was forest area, 1081Ha was farm land 3453Ha was grass and small forest and 151Ha was inhabited area. George Ninan et. al (2002)

HALALI RESERVIOR:

Halali reservoir is situated in the Raisen District of Madhya Pradesh at an altitude of 458m MSL. It is about 40km from Bhopal on Bhopal-Vidisha route. It is constructed on the Halali river system and serves as an irrigation dam. The dam is positioned at Latitude 23^o 30' N and Longitude of 77^o 30' E. The average water area of the reservoir is 4795Ha. The dam was commissioned in the year 1973 and named as Ashok Sagar Project. George Ninan et. al (2002).

REFERENCES:

1. A.O.A.C (1975): Official methods for examination of water and waste water 14 ed. Washington D.C.
2. Anon (1992): Review of Socio-Economic Research in the Fishery Sector of the Phillippines: A Country Paper ICLARM. Newsletter 15:11
3. Anon (1976): Report of the National Commission on Agriculture-Part VIII Fisheries. Government of India, Ministry of Agriculture, New Delhi pp 207
4. Anon (1998): Annual Report 1997-98.Tawa Federation of Fisheries Co operatives, Kesla pp24.
5. APHA (1975): Standard method for examination of water and waste water 14 ed.Washington D.C.
6. Aristotle (384-322 BC) Wide Global resources, perspective and alternatives ed. By Clair N. MCRO Site (1980) Univ. Park Press Baltimore 50 pp.
7. Bapat S.S. and V.R. Madalpore 1971. Observations on the hydrology of the river Khan. Marathwada Univ. J Sci. Sec. 11(4): pp.353-355.
8. Beak T.W. (1964): Biological measurements of water pollution.Chem.Eng.Papers 60:pp.33-45.
9. Berg, K. (1943): Physiographical studies on the river Sussa. Folia Limnol.Scand.1:pp.1-174.
10. Bhasakaran T. R. (1959): Industrial waste survey and river pollution studies in Bihar and U.P. States Bull.CPHERI 1:PP.55-62.
11. Buckley, J. A. (1983): Water Res,17(12)1929.
12. Butcher, R. W. (1932): Studies on ecology of river-II. The micro flora of rivers with special reference to the algae of the river Beg. Ann.Bot.46:pp.813-861.
13. Course Manual (1979): Water and Waste Water Analysis,NEERI, Nagpur,p.134.
14. Dakshini, K.M.M. and J. K. Soni (1979): Water quality of sewage drains entering Yamuna in Delhi. Indian J.Environ.Hlth.21(4):pp.354-360.
15. Desai V.R. (2007): Tawa Reservoir Ecology and Fisheries. CIFRI, Barrackpore .Bul. No. 100
16. Directorate of Fisheries, M.P. (2007): Annual Report. Department of Fisheries, M.P. Bhopal
17. Ellis M. M. (1937): Detection and measurements of Stream.Bull U.S. Bar.Fish, Washington 48(22):pp.365-437.
18. FAO (1998): The state of World Fisheries and Aquaculture FAO, Rome, Italy 8-9 pp.
19. Fritsch, F.E.and R.Rich (1913): A four year observation of a fresh water pond(bartons pond)near Harpenden. Ann.Biol.Lacust.6:pp.1-183.
20. Government of India, Minstry of Agriculture,New Delhi pp 2007.

21. Jhingran A.G. (1988): Reservoir Fisheries in India. Jour. Ind. Fish Assoc. 18: 269-270
22. Leena Gopi (1993): Ph. D. Thesis Mumbai Uni.Mumbai.
23. Natrajan A.V. (1979): Reservoir Fisheries of India, CIFRI, Barrackpore.
24. Pramod Singh: Problem of Wasteland and Forest Ecology of India
25. R. K Sapru: Environment Management in India (2Vol)
26. Raghavachari M et al (1984): Development of Reservoir Fisheries in India-Some issues & Recommendations. Strategy for the development of Inland
27. Fishery Resources in India, Concept Publishing Company.Pp214.
28. Rao K.S. et al. (1988): Studies on the morphometry and hydrology of Gandhisagar reservoir with special reference to its fisheries. Fish Tech. 25 :21-28.
29. Siddiqui R. (1996): A Study of Socio-Economic Problems of the Fisherman in Tamilnadu & Orissa. Fishing Chimes, 16(8):35-36
30. Sugunan V.V. (1995): Reservoir Fisheries of India, F.A.O. Fish Tech. Pap. No. 345 pp 423.

