भारत सरकार
Government of India
जल शक्ति मंत्रालय,
Ministry of Jal Shakti,
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग,
Department of Water Resources,
River Development and
Ganga Rejuvenation

केंद्रीय भूमि जल बोर्ड
Central Ground Water Board

NAQUIM 2.0

जलभृत प्रबंधन योजना
Aquifer Management Plan
ओडिशा के झारसुगुड़ा और संबलपुर जिलों के कुछ हिस्सों में
Parts of Jharsuguda and Sambalpur Districts
ओडिशा
Odisha

दक्षिण पूर्वी क्षेत्र
South Eastern Region (SER)
Bhubaneswar
2024

भारत सरकार

Government of India

जल शक्ति मंत्रालय

Ministry of Jal Shakti

जलसंसाधनविभाग, नदीविकास और गंगा संरक्षण

Department of Water Resources

River Development and Ganga Rejuvenation

केंद्रीय भूमि जल बोर्ड

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जलभृत प्रबंधन योजना

Aquifer Management Plan

ओडिशा के झारसुगुड़ा और संबलपुर जिलों के कुछ हिस्सों में

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ओडिशा

Odisha

प्राथमिकताप्रकार: जलसंकटग्रस्तक्षेत्र

Priority Type: Industrial Clusters

E Office File No. MHQ/1/2024-M(HQ)-Part(15) – comp no. 17242

दक्षिण पूर्वी क्षेत्र

South Eastern Region (SER)

Bhubaneswar

2024

डॉ. सुनील कुमार अम्बष्ट
अध्यक्ष
Dr. Sunil Kumar Ambast
Chairman

सत्यमेव जयते

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन,
नदी विकास और गंगा संरक्षण विभाग
केन्द्रीय भूमि जल बोर्ड
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development & Ganga Rejuvention
Central Ground Water Board

Message

National Aquifer Mapping and Management Programme (NAQUIM) was initiated by Central Ground Water Board (CGWB) in 2012 with the goal of mapping and managing aquifers across India to promote sustainable groundwater use. So far the entire mappable area of 25 lakh km^2 has been covered under the NAQUIM programme. While these initial efforts have been highly impactful, they faced certain limitations especially in terms of spatial resolution.

Taking it forward, CGWB has now initiated **NAQUIM 2.0,** the next phase of aquifer mapping designed to provide a deeper, more detailed understanding of India's groundwater systems. During 2023-24, CGWB had completed NAQUIM 2.0 studies in 68 study areas. The study areas were selected in consultation with the State/UT government agencies.

I am confident that this report of NAQUIM 2.0 study will serve as a critical resource for government agencies, research institutions, NGOs, and the general public. By fostering a collaborative approach to groundwater management, this report will play a key role in safeguarding and sustaining India's precious ground water resources.

(Dr. Sunil Kumar Ambast)

Chairman, CGWB

N. Varadaraj
Member (East)

भारत सरकार जल शक्ति
मंत्रालय
जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग केंद्रीय भूजल बोर्ड
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Government of India
Ministry of Jal Shakti
Department of Water Resources, River Development & Ganga Rejuvenation
Central Ground Water Board
Bhujal Bhawan, NH-IV,Faridabad.

FOREWORD

CGWB, SER, Bhubaneswar had completed the National Aquifer Mapping and Management (NAQUIM) study across the state of Odisha in March, 2023. Based on the broader recommendations of NAQUIM, CGWB, SER, Bhubaneswar took up a focused study in the industrial Cluster area of parts of Jharsuguda and Sambalpur District, Odisha. The NAQUIM 2.0 initiative aims to enhance our understanding of groundwater dynamics and quality in these priority regions, thereby supporting effective water resource management and sustainability. The study was undertaken in close collaboration with the State Water Resources Department, ensuring that the findings and recommendations are aligned with regional priorities and will effectively address local water management challenges.

It is with great pleasure that I present to you the report on NAQUIM 2.0 for the industrial area of parts of Jharsuguda District and Sambalpur District. This study represents a significant advancement in our ongoing efforts to understand and manage groundwater resources in the industrial cluster area.

The findings presented *in this* report are the result of rigorous research and analysis conducted by the Central Ground Water Board (CGWB), South Eastern Region (SER), Bhubaneswar. They provide critical insights into the aquifer systems and impact of industrial activities on ground water regime in parts of Jharsuguda and Sambalpur districts, offering valuable data for planningand implementing strategies to safeguard our vital water resources.

I extend my heartfelt thanks to The Regional Director and the team involved in this comprehensive study. Their dedication and expertise have been instrumental in achieving the milestones of this assignment. I also express my gratitude to the stakeholders and local communities for their cooperation and support throughout this process.

Date: 14.11.2024 **(N. Varadaraj)**

डॉ बी के साहू
कार्यालय का प्रमुख

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प्रस्तावना

भूजल एक महत्वपूर्ण संसाधन है जो विभिन्न क्षेत्रों के लोगों की आजीविका को बनाए रखता है। जैसे-जैसे जनसंख्या का दबाव बढ़ता है, कृषि, उद्योग और घरेलू उपयोग की आवश्यकताओं को पूरा करने के लिए भूजल की मांग बढ़ गई है। तदनुसार, भूजल विकास से लेकर भूजल प्रबंधन तक एक आदर्श बदलाव आया है और ऐसे मुद्दों को संबोधित करने के उद्देश्य से केंद्रीय भूजल बोर्ड (सीजीडब्ल्यूबी) ने NAQUIM (राष्ट्रीय जलभृत मानचित्रण और प्रबंधन) अध्ययन के तहत जलभृतों का मानचित्रण किया है। पूरे ओडिशा राज्य के लिए CGWB द्वारा क्षेत्रीय स्तर पर किए गए NAQUIM अध्ययन के पहले चरण के सफल समापन के बाद, जलभृत मानचित्रण (NAQUIM 2.0) अध्ययन के अगले चरण को और अधिक आगे बढ़ाने की आवश्यकता है पहचाने गए समस्याग्रस्त क्षेत्रों के लिए अधिक डेटा ग्रैन्युलैरिटी के साथ विस्तृत तरीके से। यह अध्ययन विशेष रूप से स्थानीय स्तर पर भूजल संसाधनों के इष्टतम और टिकाऊ प्रबंधन के लिए रणनीति विकसित करने के लिए महत्वपूर्ण है।

लगभग 460 वर्ग किमी क्षेत्र को कवर करने वाले झारसुगुड़ा और संबलपुर जिलों के कुछ हिस्सों में भूजल व्यवस्था पर औद्योगिक गतिविधियों के प्रभाव पर वर्तमान अध्ययन वर्ष 2023-24 के दौरान NAQUIM 2.0 अध्ययन के तहत लिया गया था। क्षेत्र में प्रमुख प्रकार के उद्योग स्टील और एल्यूमीनियम के हैं। यह क्षेत्र ज्यादातर ग्रेनाइट नीस और गोंडवाना संरचनाओं से घिरा हुआ है। अध्ययन के तहत क्षेत्र में पानी की गुणवत्ता का पता लगाने के लिए सतही पानी और भूजल का रासायनिक विश्लेषण किया गया था और पानी के निर्वहन के प्रभाव का पता लगाने के लिए उनका सहसंबंध भी किया गया था। भूजल प्रणाली पर सतही जल निकायों में औद्योगिक अपशिष्ट। क्षेत्र के लिए एक व्यापक भूजल प्रबंधन योजना तैयार करने के लिए क्षेत्र के भूजल संसाधन का भी अनुमान लगाया गया था। इन क्षेत्रों में प्राथमिक चुनौती मौजूदा भूजल संसाधनों का स्थायी प्रबंधन है, जो इस अध्ययन को विशेष रूप से महत्वपूर्ण बनाता है। अध्ययन क्षेत्र का चयन भूजल विकास निदेशालय, जल संसाधन विभाग और ओडिशा सरकार के अनुमोदन से किया गया था। अध्ययन में कृषि, ओडिशा लिफ्ट सिंचाई निगम, लघु सिंचाई, ग्रामीण जल आपूर्ति और स्वच्छता, और अर्थशास्त्र और सांख्यिकी विभाग जैसी राज्य सरकारी एजेंसियों के योगदान के साथ, क्षेत्र डेटा का व्यापक संग्रह, संकलन और विश्लेषण शामिल था।

वर्तमान रिपोर्ट एक कुशल टीम के समर्पित प्रयासों का परिणाम है: डॉ. सत्यम शुक्ला, सहायक हाइड्रोजियोलॉजिस्ट; श्री. आशुतोष चौधरी, वैज्ञानिक-बी; श्री. राजेश बाबू अन्नवरपु, सहायक भूभौतिकीविद्; श्रीमती. बिंदु सिंह, वैज्ञानिक-बी; श्री. टी सुरेश, एसटीए (भूभौतिकी) और श्री.

टीम के नेतृत्वकर्ता श्री बी.एन. देहुरी, सहायक रसायनज्ञ के मार्गदर्शन में। तरूण मिश्रा, वैज्ञानिक-डी. उम्मीद है कि यह रिपोर्ट उपयोगकर्ता एजेंसियों, योजनाकारों, प्रबंधकों, शिक्षाविदों और शोधकर्ताओं के लिए एक मूल्यवान संसाधन के रूप में काम करेगी, जो भूजल प्रबंधन के लिए मार्गदर्शन और संदर्भ प्रदान करेगी।

भुवनेश्वर

डॉ बी के साहू
कार्यालय प्रमुख

14.08.2024

Dr. B K Sahoo
Head of Office

भारतसरकार
Government of India
जल शक्ति मंत्रालय
Ministry of Jal Shakti
जल संसाधन विभाग
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Department of Water Resources
River Development and Ganga Rejuvenation
केंद्रीय भूजल बोर्ड
Central Ground Water Board

PR E FACE

Groundwater is a critical resource that sustains the livelihoods of people across regions. As population pressures increase, the demand for groundwater has surged to meet the requirements of agriculture, industry, and domestic use. Accordingly there has been a paradigm shift from ground water development to ground water management and with an aim to address such issues Central Ground Water Board (CGWB) has undertaken mapping of aquifers under NAQUIM (National Aquifer Mapping and Management) studies. After the successful completion of the 1st phase of the NAQUIM studies by CGWB for the entire state of Odisha which was carried out on regional scale, there has been a need to carry out the next phase of aquifer mapping (NAQUIM 2.0) studies in a more detailed manner with more data granularity for the identified problematic areas. This study is crucial for developing strategies for the optimal and sustainable management of ground water resources, particularly at the local level.

The present study on impact of industrial activities on ground water regime in parts of Jharsuguda and Sambalpur districts covering an area of around 460 sq.km was taken up under NAQUIM 2.0 studies during the year 2023-24. The major type of industries in the area are of steel and aluminium. The area is mostly underlain by granite gneiss and Gondwana formation.Under the study the chemical analysis of surface water and ground water was carried out to ascertain the quality of water in the area and their correlation was also carried out to explore the effect of discharge of industrial effluents into surface water bodies on ground water system. The ground water resource of the area was also estimated to devise a comprehensive ground water management plan for the area.

The primary challenge in these areas is the sustainable management of existing groundwater resources, making this study particularly critical. The selection of the study area was made with the approval of the Directorate of Ground Water Development, Department of Water Resources, and Government of Odisha. The study involved the extensive collection, compilation, and analysis of field data, with contributions from state governmental agencies such as Agriculture, Odisha Lift Irrigation Corporation, Minor Irrigation, Rural Water Supply & Sanitation, and the Department of Economics & Statistics.

The present report is the result of the dedicated efforts of a skilled team: Dr. Satyam Shukla, Assistant Hydrogeologist; Sh. Ashutosh Choudhary, Scientist-B; Sh. Rajesh Babu Annavarapu, Assistant Geophysicist; Smt. Bindu Singh, Scientist-B; Sh. T Suresh, STA (Geophysics) and Sh. B. N. Dehury, Assistant Chemist under the guidance of team lead, Sh. Tarun Mishra, Scientist-D. This report is expected to serve as a valuable resource for user agencies, planners, managers, academicians, and researchers, offering guidance and reference for groundwater management.

Bhubaneswar
14.08.2024

(Dr. B K Sahoo)
Head of Office

NAQUIM 2.0/2023-24/Theme: Industrial Clusters

Aquifer Management Plan, Parts of Jhasuguda and Sambalpur Districts, Odisha

Contributor's Page

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कार्यकारी सारांश

NAQUIM 2.0 के अंतर्गत मुख्य रूप से औद्योगिक क्लस्टर को कवर करने वाला अध्ययन क्षेत्र झारसुगुड़ा जिले के झारसुगुड़ा और कोलाबीरा ब्लॉक के कुछ हिस्सों और संबलपुर जिले के रेंगाली ब्लॉक के कुछ हिस्सों में स्थित है। क्षेत्र जांच के तहत कुल क्षेत्रफल 456 वर्ग किमी है। हाइड्रोलॉजिकल रूप से यह क्षेत्र अर्ध-समेकित संरचना और समेकित संरचना से बना है। गोंडवाना बलुआ पत्थर, शेल और कोयला अर्ध-समेकित संरचना के भीतर पाए जाते हैं। उथले (फ्रीटिक) जलभृत के जल स्तर से प्रीमॉनसून गहराई 2.22 से 10.5 mbgl तक होती है और जल स्तर 187.8 m amsl से 233.01 mamsl तक भिन्न होता है और उथले (फ्रीटिक) जलभृत के जल स्तर से पोस्टमॉनसून गहराई 0.88 से 5.25 mbgl तक होती है और जल स्तर 192.51 m amsl से 234.5 mamsl तक भिन्न होता है। खंडित जलभृत का वार्षिक उतार-चढ़ाव अधिकांश कुओं में 0.58 से 19.56 मीटर तक बढ़ रहा है और केवल तीन कुओं (परमिटिला, पंचपाड़ा, बदमल चौक) में 1.91 से 4.61 मीटर तक गिर रहा है। दशकीय जल स्तर की प्रवृत्ति अध्ययन क्षेत्र के सुदूर उत्तर में 18.59 वर्ग किलोमीटर क्षेत्र में 0.48 मीटर की गिरावट और शेष क्षेत्र में 0.4 से 1.35 मीटर तक की वृद्धि दर्शाती है। ओडिशा के 31.03.2023 तक संसाधन मूल्यांकन की सहायता से भूजल संसाधन का आनुपातिक आधार पर मूल्यांकन किया जाता है। यह देखा गया है कि झारसुगुड़ा ब्लॉक का हिस्सा सेमीक्रिटिकल श्रेणी में आता है, लेकिन कोलाबीरा, किरीमिरा और रेंगाली ब्लॉक का हिस्सा सुरक्षित श्रेणी में आता है। कुल मिलाकर अध्ययन क्षेत्र में निष्कर्षण का चरण 64.35% है और श्रेणी 'सुरक्षित' है।

चार हाइड्रोकेमिकल स्वरूपों में से, Ca+Mg अधिकांश भूजल नमूनों में मौसमों के बावजूद Na+K से अधिक है और CO3+HCO3 भी प्री मानसून के दौरान 44% और पोस्ट मानसून के 73% (40 में से 29) नमूनों में Cl+SO4 से अधिक है। क्षारीय (Na+K) धातुएं दोनों मौसमों के कुछ भूजल नमूनों में क्षारीय पृथ्वी तत्वों (Ca+Mg) से अधिक हैं और उन 56% नमूनों में जहां प्री मानसून में मजबूत एसिड कमजोर एसिड से अधिक हैं और 28% पोस्ट मानसून में हैं। नाइट्रेट का मान पता लगाने की सीमा से नीचे से लेकर 151 mg/l तक है। प्री मानसून में एक्वीफर के फ्रैक्चर ज़ोन में 76.25 mbgl की गहराई पर हंसमुराकाटापली (H. कटापली) में अधिकतम नाइट्रेट (151 mg/l) पाया गया और पोस्ट मानसून नमूने 177 mg/l प्रदर्शित करते हैं। मानसून के बाद झारसुगुड़ा जिले के कोलाबीरा ब्लॉक के परमानपुर में नाइट्रेट की अधिकतम 219 मिलीग्राम/लीटर मापी गई। संबलपुर जिले के रेंगाली में फ्लोराइड की उच्चतम सांद्रता का पता चला है। दोनों मौसमों में सफाई नाला के पानी में प्रदर्शित उच्च फ्लोराइड सामग्री मानवजनित गतिविधियों की ओर इशारा करती है, जिसमें उच्च संचित फ्लोराइड सामग्री के निपटान के साथ-साथ अपशिष्ट जल का अंतर्देशीय निर्वहन शामिल हो सकता है। सल्फेट और फ्लोराइड की उच्च सांद्रता वाला पानी भागीपाली में भेडन नदी में विलीन हो गया। अध्ययन क्षेत्र में फ्लोराइड की उच्च सामग्री जलभृतों में लिथोलॉजी और भूवैज्ञानिक गठन के कारण हो सकती है। गहरे जलभृत में नाइट्रेट संदूषण नहीं है, जबकि उथला जलभृत नाइट्रेट से दूषित है। भौतिक-रासायनिक डेटा से पता चलता है कि 51% उपयुक्त हैं, 16% अनुपयुक्त हैं और 33% नमूने वैकल्पिक स्रोतों की अनुपस्थिति में पीने के प्रयोजनों के लिए इस्तेमाल किए जा सकते हैं, जैसा कि पीने के पानी की विशिष्टता IS 10500:2012 के अनुसार मानसून से पहले किया जाता है। वे कम या उच्च pH (<6.50 और >8.50), उच्च कठोरता, क्षेत्र में नाइट्रेट और फ्लोराइड संदूषण के कारण पीने के प्रयोजनों के लिए अनुपयुक्त हैं। डेटा से यह भी पता चला है कि फ्रैक्चर्ड ज़ोन में 33 में से केवल 2 नमूने उच्च फ्लोराइड से दूषित हैं, जबकि अपक्षयित क्षेत्र में 7 में से 5 नमूने मानसून के बाद के नमूने में बहुत अधिक नाइट्रेट सांद्रता से दूषित हैं।

Executive Summary

The study area covering mainly Industrial Cluster under NAQUIM 2.0 is located in parts of Jharsuguda and Kolabira Blocks of Jharsuguda District and part of Rengali Block of Sambalpur DistrictS.The total area under field investigation is 456 sq.Hydrogeologically the area composed of semiconsolidated formation and consolidated formation. Gondwana sandstone, shale and coal are found within semiconsolidated formation.Premonsoon depth to water level of shallow(phreatic) aquifer ranges from 2.22 to 10.5 mbgl and Water table varies from 187.8 m amsl to 233.01 mamsl and postmonsoon depth to water level of shallow(phreatic) aquifer ranges from 0.88 to 5.25 mbgl and Water table varies from 192.51 m amsl to 234.5 mamsl. Annual fluctuation of fractured aquifer varies from 0.58 to 19.56 m rising in majority of the wells and 1.91 to 4.61 m falling only in three wells (Parmitilla, Panchpada, Badmal Chawk) .Decadal water level trend shows 0.48 m decline in 18.59 sq.km area near extreme north of the study area and rising from 0.4 to 1.35 m in rest of the area. The groundwater resource is assessed on proportionate basis with the help of resources assessment as on 31.03.2023 of Odisha. It is observed that Jharsuguda Block part is falling under Semicritical category, but Kolabira, Kirimira and Rengali Block part is falling under Safe Category. Overall the stage of Extraction of the study area is 64.35% and category is 'Safe'.

Among the four hydrochemical facies, Ca+Mg exceeds Na+K in most of the groundwater samples irrespective of seasons and also CO_3+HCO_3 exceeds Cl+SO_4 in 44% during pre monsoon and 73% (29 out of 40) samples in post monsoon. Alkaline (Na+K) metals exceed the alkaline earth elements (Ca+Mg) in few groundwater samples of both seasons and in 56% of samples where strong acids exceed weak acids in pre monsoon and 28% in post monsoon.The nitrate value ranges from below detection limit to 151 mg/l. The maximum nitrate (151 mg/l) found at Hansamurakatapali (H.Katapali) at a depth of 76.25 mbgl in the fracture zone of the aquifer in pre monsoon and while post monsoon sample exhibit 177 mg/l. The maximum 219 mg/l of nitrate was measured at Parmanpur of Kolabira block, Jharsuguda district during the post monsoon.The highest concentration of fluoride is detected at Rengali, Sambalpur district.The high Fluoride content exhibited in the Safai Nala's water in both seasons indicated anthropogenic activities which may have included the inland discharge of wastewater into it along with disposed of high accumulated fluoride content materials. The water carrying high concentrations of sulfate and fluoride merged with the Bheden river at Bhagipali.The high content of fluoride in the study area may be due to lithology and geological formation in the aquifers.There is no nitrate contamination in the deeper aquifer whereas the shallow aquifer is contaminated with nitrate. Aluminium concentration above permissible limit (0.2 mg/l) are observed in 13 hand pumps and 1 bore well sample. The physico-chemical data shows that 51% are suitable, 16 % Unsuitable and 33% of samples can be used for drinking purposes in absence of alternate sources as per drinking water specification IS 10500:2012 during pre monsoon.They are unfit for drinking purposes due to low or high pH (<6.50 and >8.50), high hardness, nitrate and fluoride contamination in the area. The data also revealed that only 2 samples out of 33 are contaminated with high fluoride in the fractured zone whereas 5 samples out of 7, in the weathered zone are contaminated with very high nitrate concentrations in post monsoon sampling.

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भारतसरकार

Government of India

जल शक्ति मंत्रालय

Ministry of Jal Shakti

जल संसाधन विभाग

नदी विकास और गंगा संरक्षण

Department of Water Resources

River Development and Ganga Rejuvenation

केंद्रीय भूजल बोर्ड

Central Ground Water Board

1. INTRODUCTION

The study area covering mainly Industrial Cluster under NAQUIM 2.0 is located in parts of Jharsuguda and Kolabira Blocks of Jharsuguda District and part of Rengali Block of Sambalpur District (Fig-1,2). The total area under field investigation is 456 sq. km. Out of 456 sq. km, 255.59 sq. km area is falling in Jharsuguda district and 200.25 sq. km area is falling in Sambalpur district. The study area lies between geographic coordinates $21^0$36.648' to $21^0$55.157' North latitudes and between $83^0$55.246' to $84^0$8.306' East longitudes. The area falls in the Survey of India Toposheet Numbers 64O/13, 64O/14, 73 C/1 and 73 C/2. Area of the Jharsuguda district part is

255.59 sq.km having 46 villages with 15 GP and one Municipality falling in Jharsuguda, Kolabira and Kirimira Blocks.The area of the Sambalpur District is 200.25 sq.km having 31 villages and one CT with 11 GP falls in parts of Rengali Block part.Village-wise area, number of households and population as per 2011 cesus are summarized in Table 1a and 1b.There are 35 number of mili-watershed having a cumulative area of 257.6 sq.km in Jharsuguda part of the district and 29 number of mili-watershed with a cumulative area of 198.4 sq km in Sambalpur part of the district.Rainfall of the study area is 1752.75 mm (Year-2023). Major drainages of the study area are IB river, Bheden river and Matwali nalla. Total population of the study area is 218711 as per 2011 census. Main geomorphic features are pediments, buried pediments, lateritic upland, denudational hills and etc. Main soils are sandy to gravelly soil and lateritic soil. Main rock types are Lower Gondwana Shale and Precambrian granite/granite gneiss.

Fig.1. Location of the study area in Odisha State

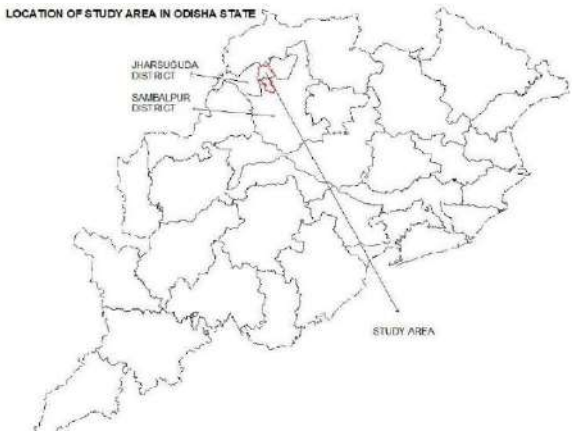


Fig.2a. Base Map of the Study Area

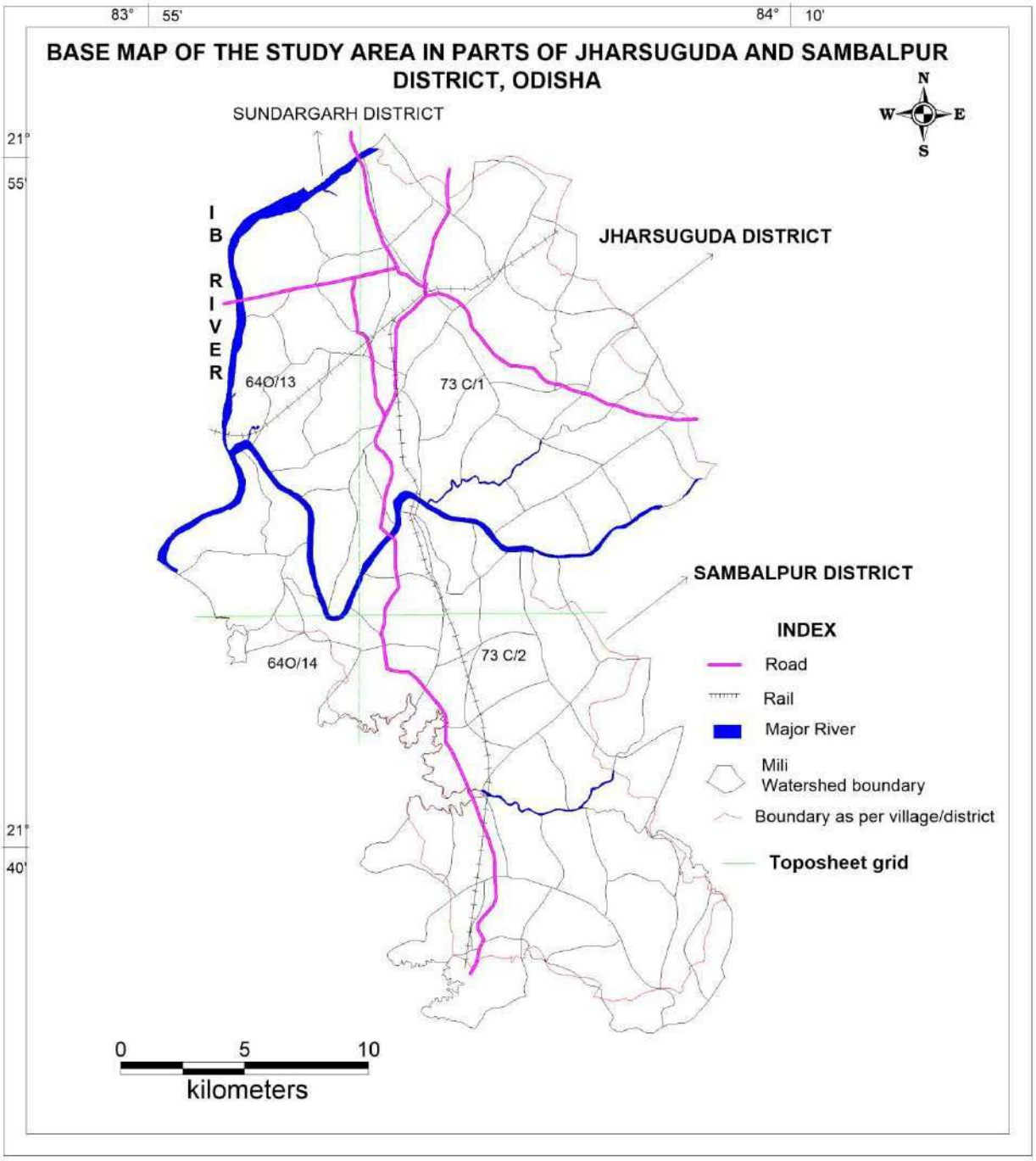
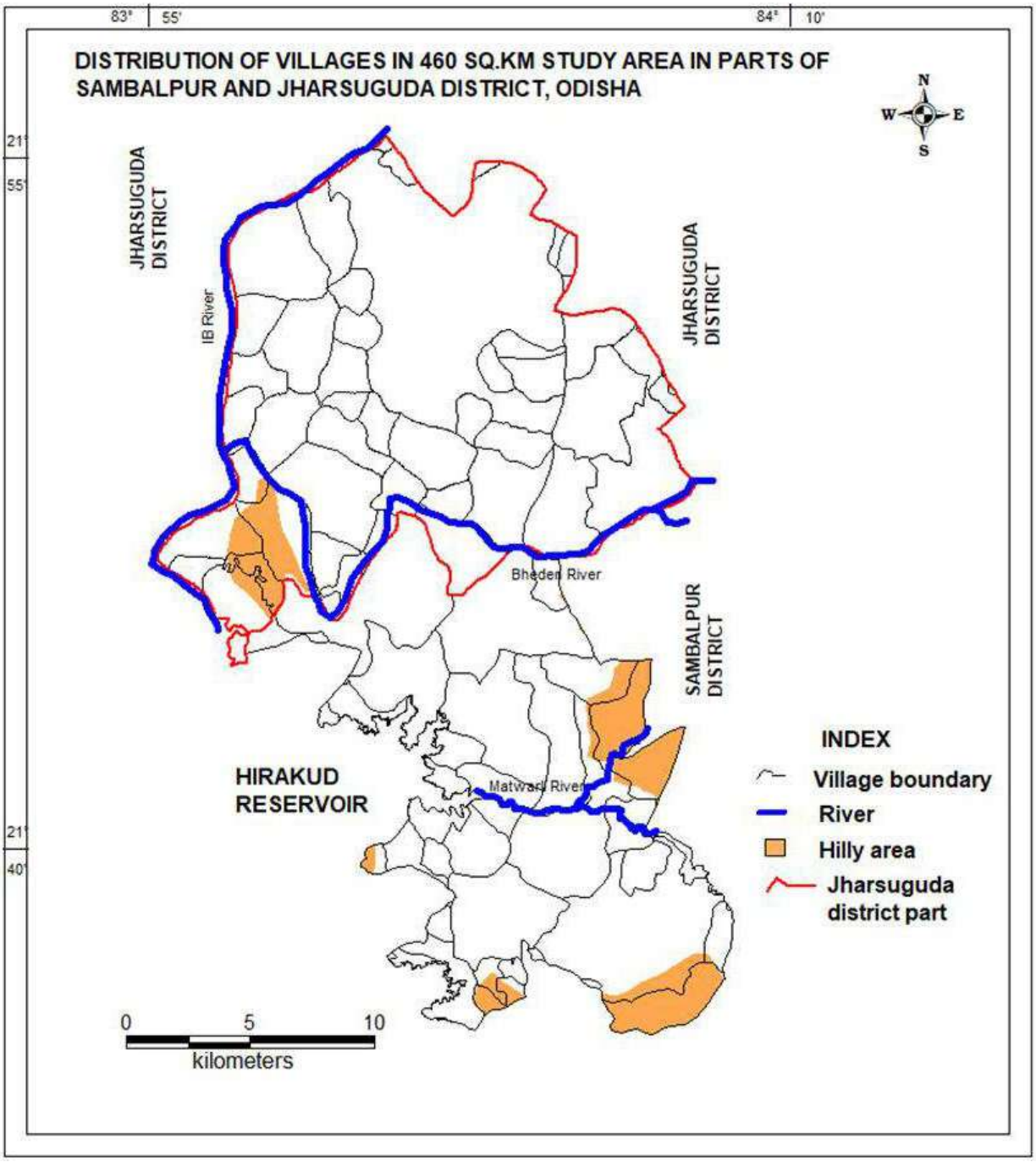


Fig.2b. Administrative Map of the Study Area



2. ABOUT THE STUDY AREA

Administrative details are summarized in Table 1a and 1b.

Table-1a: Administrative area details in Jharsuguda District part,Odisha

Serial Number	Name of District	Name of Block	Name of GP	Name village	Area (ha) falls in study area	Total population (2011 census)	Number of households (2011 census)
1	Jharsuguda	Kirimira	Arda	Arda	109.2	4357	984
2	Jharsuguda	Jharsuguda	Badmal	Badmal	138.6	2875	681
3	Jharsuguda	Jharsuguda	Badmal	Beherapali	355.2	230	47
4	Jharsuguda	Jharsuguda	Badmal	Brundamal	690.1	2934	752
5	Jharsuguda	Jharsuguda	Badmal	Pandripathar	245.1	1271	299
6	Jharsuguda	Jharsuguda	Dalki	Banjara	211.7	1146	108
7	Jharsuguda	Jharsuguda	Dalki	Dalki	175.1	924	229
8	Jharsuguda	Jharsuguda	Dalki	Kurebaga	367.4	1097	310
9	Jharsuguda	Jharsuguda	Dalki	Kumudapali	358.4	547	140
10	Jharsuguda	Jharsuguda	Dalki	Purna	190.4	433	109
11	Jharsuguda	Jharsuguda	Durlaga	Durlaga	37.97	2325	589
12	Jharsuguda	Jharsuguda	Durlaga	Saletikra	109.7	447	111
13	Jharsuguda	Jharsuguda	H Katapali	Beherapat	227.6	1405	354
14	Jharsuguda	Jharsuguda	H Katapali	Hansamurakatapali	1201	4969	1142
15	Jharsuguda	Jharsuguda	H Katapali	Lahandabud	594.6	1652	408
16	Jharsuguda	Jharsuguda	Hirma	Hirma	1138	4369	1033
17	Jharsuguda	Jharsuguda	Hirma	Kukurjangha	452.6	1329	310
18	Jharsuguda	Jharsuguda	Hirma	Kumbhari	263.6	604	141
19	Jharsuguda	Jharsuguda	Hirma	Luhurenkachhar	72.95	82	27
20	Jharsuguda	Jharsuguda	Hirma	Tarekela	189.8	682	160
21	Jharsuguda	Jharsuguda	Hirma	Tumbela (Tumbekela)	139.5	453	116
22	Jharsuguda	Jharsuguda	Jamera	Jamera	314.5	1906	444
23	Jharsuguda	Jharsuguda	Jamera	Jamuapali	299.1	611	166
24	Jharsuguda	Jharsuguda	Jamera	Singhabaga	593.4	1272	291
25	Jharsuguda	Jharsuguda	Jharsuguda MC	Jharsuguda MC	7047	97730	6605
26	Jharsuguda	Jharsuguda	Katikela	Bhagipali	234.8	261	67
27	Jharsuguda	Jharsuguda	Katikela	Bhurkamunda	893.7	1213	364
28	Jharsuguda	Jharsuguda	Katikela	Katikela	949.5	1423	340
29	Jharsuguda	Kolabira	Kelendamal	Gudigaon	506.9	1762	386
30	Jharsuguda	Kolabira	Kelendamal	Kelenda	241.4	1370	303
31	Jharsuguda	Kolabira	Kelendamal	Kelendamal	4.055	833	193
32	Jharsuguda	Kolabira	Kelendamal	Khunapali	107.7	626	140

33	Jharsuguda	Jharsuguda	Kherual	Kherual	304.9	622	144
34	Jharsuguda	Jharsuguda	Malda	Khait	242.8	262	64
35	Jharsuguda	Jharsuguda	Malda	Malda	813.4	1181	291
36	Jharsuguda	Jharsuguda	Malda	Rampur	589.1	1162	267
37	Jharsuguda	Jharsuguda	Marakuta	Budhipadar	366.2	1255	275
38	Jharsuguda	Jharsuguda	Marakuta	Marakuta	811.4	2214	511
39	Jharsuguda	Kolabira	Paramanpur	Siriapali	1118	1779	395
40	Jharsuguda	Kolabira	Parmanpur	Parmanpur	1311	2678	639
41	Jharsuguda	Jharsuguda	Patrapali	Bhurusund	78.7	147	39
42	Jharsuguda	Jharsuguda	Patrapali	Dumermunda	163.6	398	93
43	Jharsuguda	Jharsuguda	Patrapali	Patrapali	527	1851	449
44	Jharsuguda	Jharsuguda	Patrapali	Patrapali	228	1539	375
45	Jharsuguda	Jharsuguda	Sripura	Sripura	625.4	1974	524
46	Jharsuguda	Jharsuguda	Talpatia	Talpatia	28.81	2208	576
				TOTAL	25559.685	158051	21007

Table-1b: Administrative area details in Sambalpur District part,Odisha

Serial Number	Name of District	Name of Block	Name of GP	Name village	Area (ha) falls in study area	Total population (2011 census)	Number of households (2011 census)
1	Sambalpur	Rengali	Bamaloi	Bamaloi	1368	2621	607
2	Sambalpur	Rengali	Bamaloi	Dharopani	537.6	1125	280
3	Sambalpur	Rengali	Bamaloi	Tilaimal	973.7	1936	459
4	Sambalpur	Rengali	Ghichamura	Derba	1300	2200	502
5	Sambalpur	Rengali	Ghichamura	Gumakarama	219.2	1437	357
6	Sambalpur	Rengali	Jangla	Bhoipali	369.8	448	107
7	Sambalpur	Rengali	Jangla	Bhursipali	405.4	841	200
8	Sambalpur	Rengali	Jangla	Jangala	1206	3134	761
9	Sambalpur	Rengali	Jhankarpali	Basupali	105.7	1404	345
10	Sambalpur	Rengali	Katarbaga	Brahmanipali	1200	2460	598
11	Sambalpur	Rengali	Katarbaga	Katar-baga	2083	5054	1283
12	Sambalpur	Rengali	Katarbaga	Laumal	105.7	400	97
13	Sambalpur	Rengali	Katarbaga	Ludhapali	289.4	352	88
14	Sambalpur	Rengali	Katarbaga	Nuatiligi	181	64	18
15	Sambalpur	Rengali	Katarbaga	Thurupali	220.3	654	174
16	Sambalpur	Rengali	Khinda	Dantamura	281.4	425	93
17	Sambalpur	Rengali	Khinda	Khinda	1300	2807	718
18	Sambalpur	Rengali	Khinda	Talabira	700	2150	585
19	Sambalpur	Rengali	Lapanga	Gurupali	238.1	889	239
20	Sambalpur	Rengali	Lapanga	Kharhiapali	834	1567	372

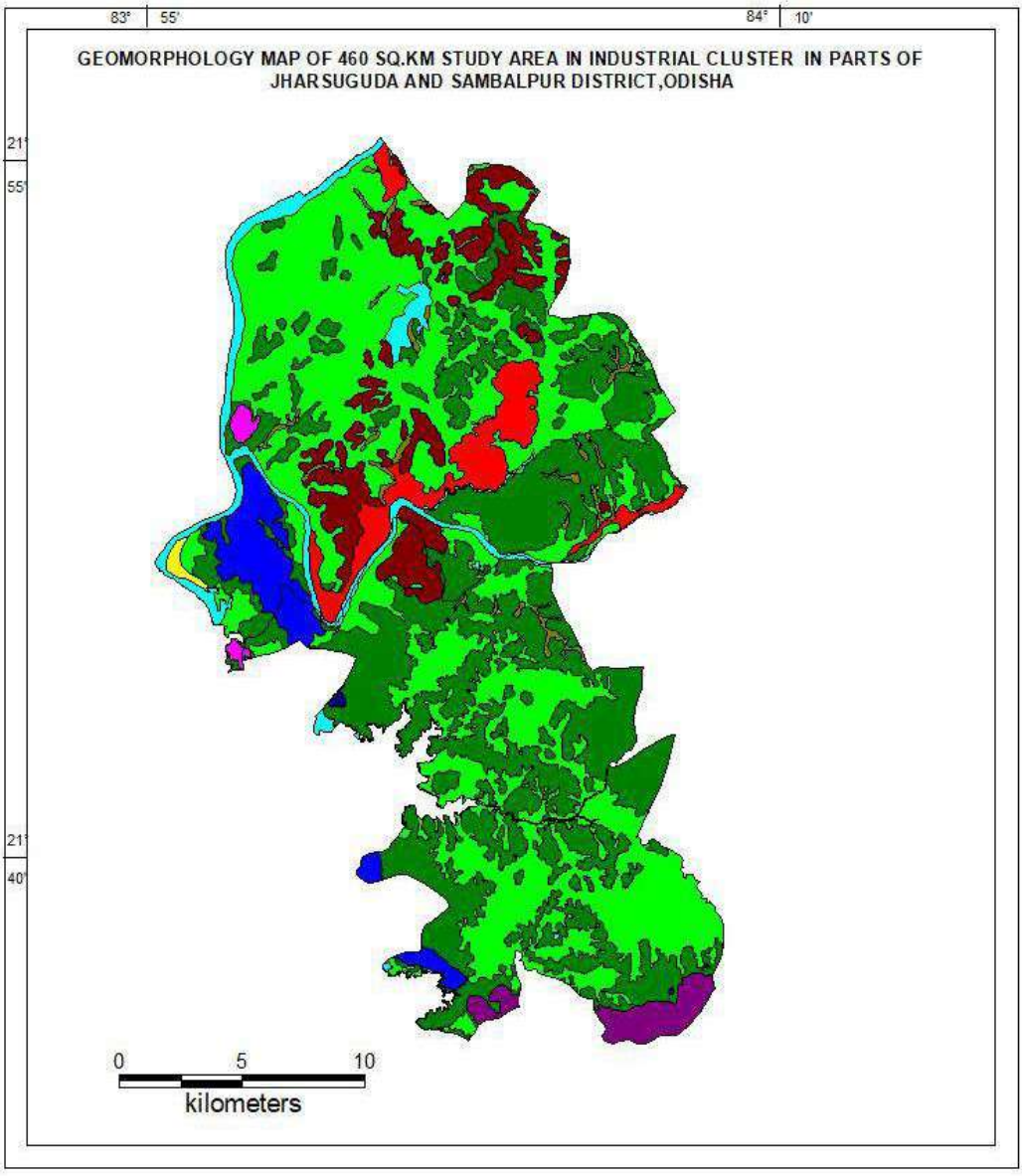
21	Sambalpur	Rengali	Lapanga	Lapanga	1037	2884	737
22	Sambalpur	Rengali	Lapanga	Pudapada	142.2	525	134
23	Sambalpur	Rengali	Nishanbhanga	Babuchakuli	241.5	1418	331
24	Sambalpur	Rengali	Nishanbhanga	Jharmunda	140.3	605	154
25	Sambalpur	Rengali	Nishanbhanga	Nishanbhanga	485.8	2127	514
26	Sambalpur	Rengali	Nishanbhanga	Pondloi	238.1	1128	276
27	Sambalpur	Rengali	Rengali	Rengali CT	1224	10867	2529
28	Sambalpur	Rengali	Salad	Kurla	458.6	366	94
29	Sambalpur	Rengali	Salad	Nuarampela	123.3	2311	567
30	Sambalpur	Rengali	Salad	Salad	241.5	1749	417
31	Sambalpur	Rengali	Thelkoloi	Dhubenchhaper	200	1028	272
32	Sambalpur	Rengali	Thelkoloi	Thelkoloi	455	3684	1039
33	Sambalpur	Rengali		Forest+Hill	1120		
TOTAL					20025.6	60660	14947

GEOMORPHOLOGY: Main geomorphic features are pediments, lateritic upland, denudational hill, structural hill, residual hill , flood plae, valley etc. Areawise details with percentage are given in Table 2.0.

Table 2.0.Geomorhic units in study area parts of Jharsuguda and Sambalpur District, Odisha.

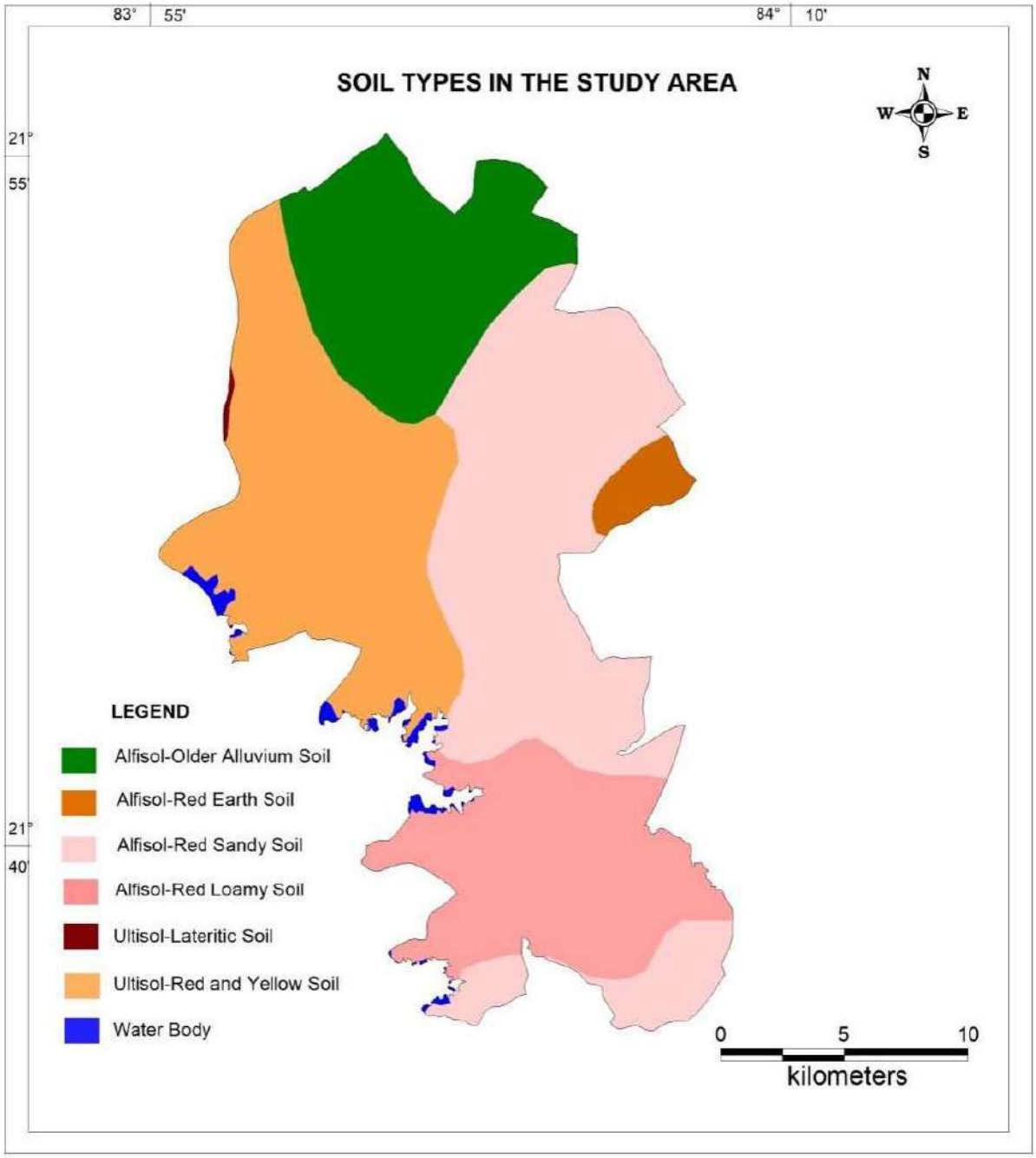
Gepmorphic Unit	**Area (Sq.km)**	**Percent**
Pediment	370.57	81.23792
Denudational hill	18.77	4.114838
Flood Plane	1.05	0.230185
Inselberg	0.039	0.00855
Lateritic Upland	32.27	7.074365
Residual Hill	0.395	0.086594
Structural Hill	8.45	1.852445
Valley fill	5.83	1.278077
Water body	18.78	4.117031
	456.154	

Fig 3. Geomorphology of the study area (parts of Jharsuguda and Sambalpur district)



SOIL: Mainly two types of soil are available,viz; Alfisols and Utlisol. The former is available in 75% area and the latter is available in only 20% of the area.

Fig.4. Soil types in the study area



ELEVATION AND SLOPE: Highest elevation and lowest elevation in the study area are 547 mamsl and 167 mamsl respectively. But overall elevation in the study area ranges from 180to 220 mamsl. 99% of the study area has a slope less than 20, whereas on 1% area is having more than 20 slope (fig 5 & 6).

Fig 5.Elevation map of the study area.

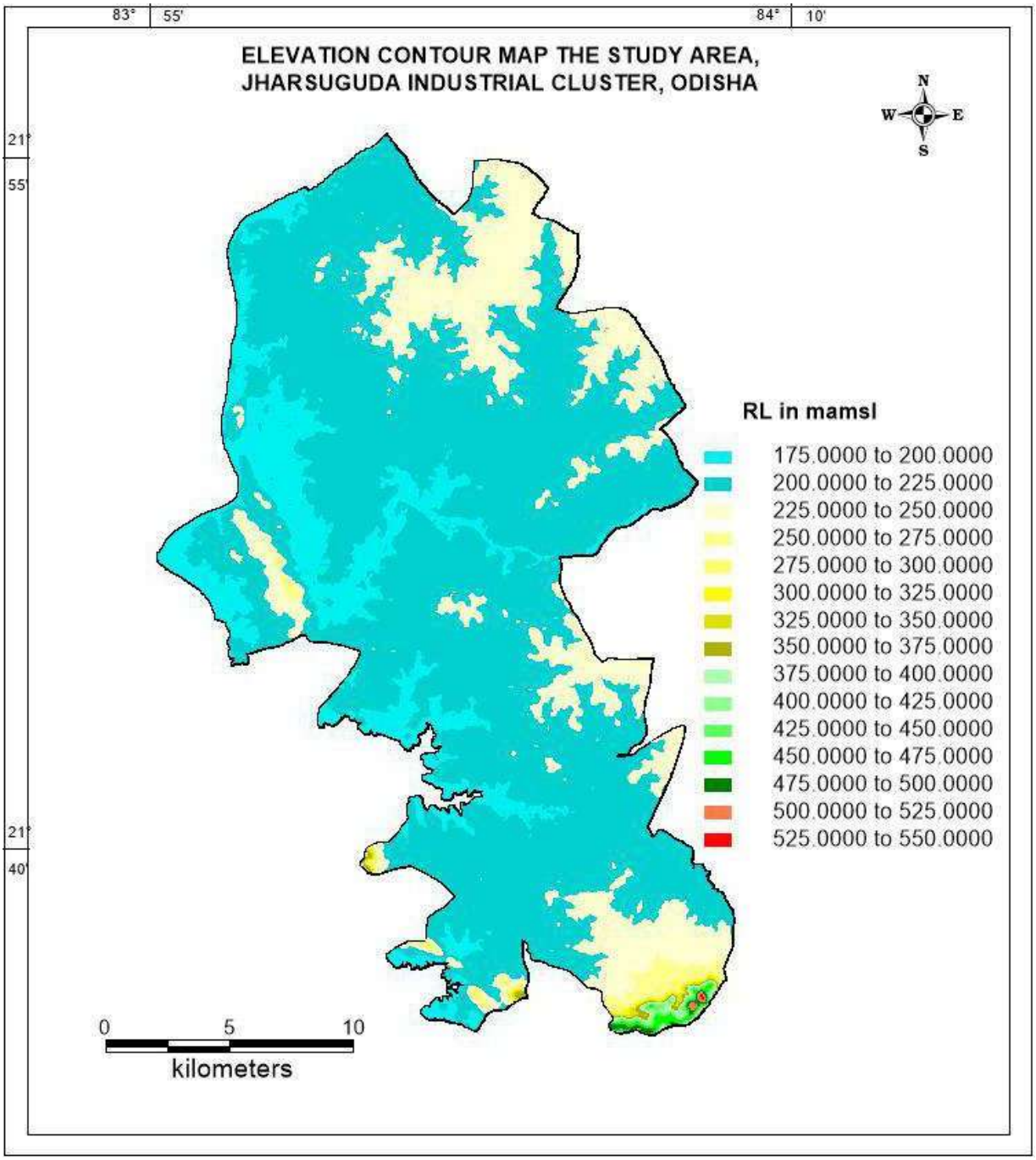
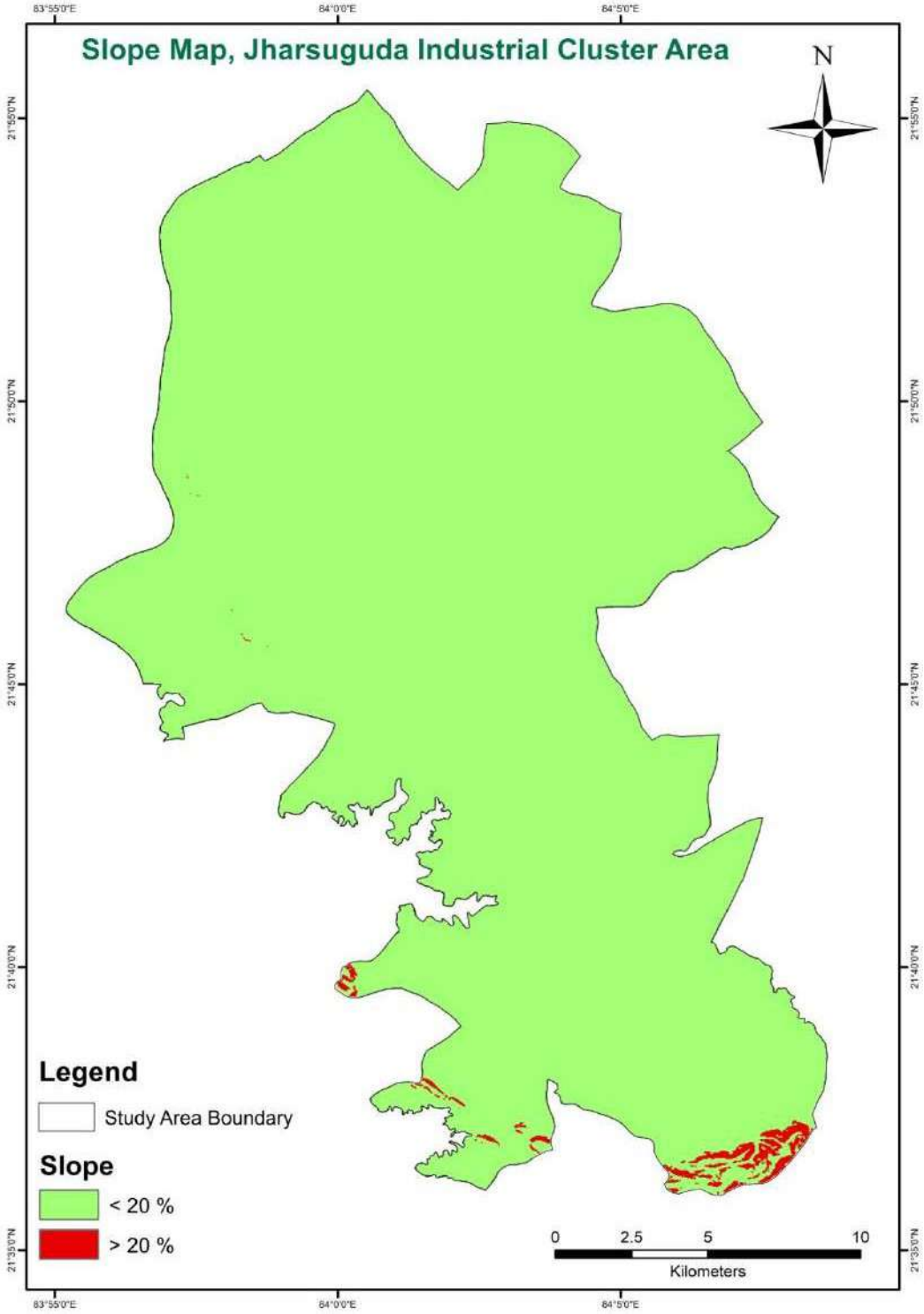


Fig 6.Slope map of the study area.



RAINFALL: Average total rainfall in the study area is 1752.75 mm during the year 2023. Rainfall in Kirimira Block is highest and rainfall in Jharsuguda Block during 2023 is the lowest.Normal rainfall in Jharsuguda District is 1362.8 mm, whereas normal rainfall in Sambalpur District is 1496.7 mm. Total number of rainy days in Jharsuguda, Kirimira, Kokabira and Rengali Blocks are 76,76,79 and 87 days resepectively. So rainfall deviation is positive with respect to the Normal rainfall for both Jharsuguda and Sambalpur district during the year 2023. Monthly rainfall details and number of rainy days are summarized in Table 3a and 3b.

Table 3a. Rainfall in mm for the 456 sq. km study area

Rainfall in mm in 2023	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Jharsuguda Block	0	0	34	38	19.5	265	287	333	284	126	0	63	1449.5
Kolabira Block	0	0	43.1	24.2	27.6	164.5	321	500	353	88	4	64	1589.4
Kirimira Block	0	0	23.4	44	35.9	273	429	646	405	121	55	63	2095.3
Rengali Block	0	0	33.8	32.4	20	367.6	482	395	384	112	0	50	1876.8

Table 3b.Number of rainy days for the 456 sq. km study area

Number of rainy days	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Jharsuguda	0	0	5	3	3	10	13	16	18	5	0	3	76
Kolabira	0	0	5	4	5	9	13	16	18	5	1	3	79
Kirimira	0	0	4	4	6	9	11	18	16	4	1	3	76
Rengali	0	0	4	6	3	8	19	20	20	5	0	2	87

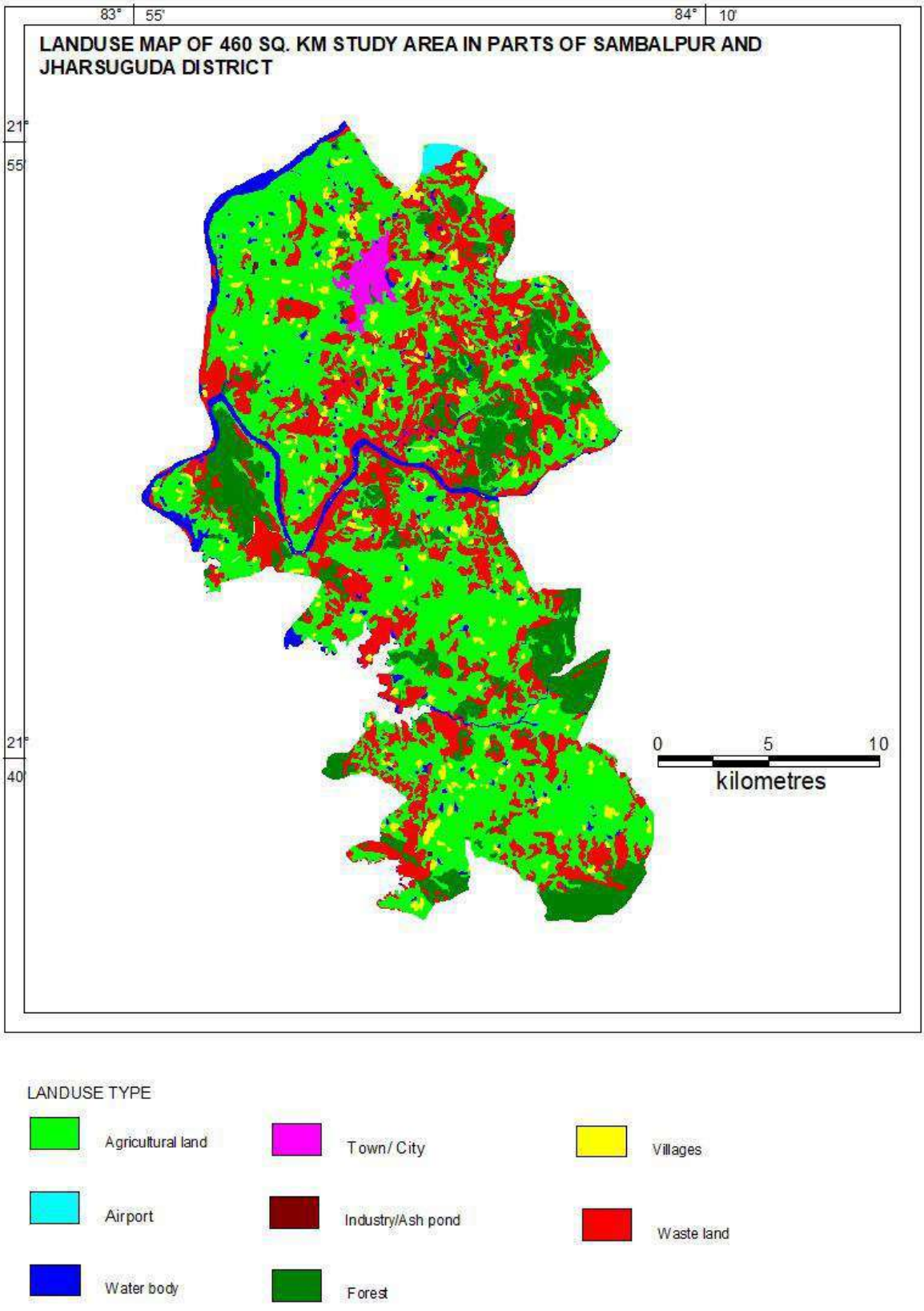
LANDUSE: Landuse pattern as per Census 2011 are summarized in Table 4 and Fig 7.

Table 4. Landuse pattern of the 456 sq km study area

Area in hector

Name of District	Forests	Area under Non-agricultural Uses	Barren and Un-cultivable land	Permanent Pastures and Other Grazing Lands	Land Under Miscellaneous Tree Crops etc.	Culturable Waste Land	Fallow lands other than current fallows	Current Fallows	Net Area Sown
Sambalpur part	3661.4	637.9	4989.8	2004	361.8	5046.1	2182.5	1702.9	969.5
Jharsuguda part	3040.7	1660	752.6	140.2	926.5	2171.7	545.5	10418.5	1499.4
Total	6702.1	2297.9	5742.4	2144.2	1288.3	7217.8	2728	12121.4	2468.9
Percent	16%	5%	14%	5%	3%	17%	6%	28%	6%

Fig. 7. Landuse pattern of the study area



IRRIGATION: More than 80% cultivated area is rain fed and very few area is irrigated. There are mainly three types of irrigation schemes exists in the study area;viz; Mega Lift irrigation, Minor Irrigation and Lift Irrigation. Details of irrigation are summarized in table 5a,b,c and d1 and d2. Under Mega Lift Irrigation project there are 6 number of clusters and total irrigation potential is 1911 ha. Out of 6 schemes only three scheme at Katikela,Paramanpur and Patrapali are presently functional with irrigation potential utilized is 700 ha during kharif (**85 ham water utlized**).Under Minor Irrigation project there are 18 number of schemes and total irrigation potential area is 729ha ha during kharif and 10 ha in rabi season.Presently 5 schemes are working in Jharsuguda District with a utilized irrigation potential of 224 ha (**water utilization of 72.4 ham**). 7 schemes are working in Sambalpur District with a utilized irrigation potential of 505 ha (**water utilization of 132.44 ham**).Under River Lift irrigation (OLIC Flow)project there are 46 number of schemes and total designed ayacut area is 2376 ha (created irrigation potential).But presently 17 schemes out of 46 schemes are functional.So at present irrigation potential is 840 ha (water utilization capacity 41.65 ham) under MI scheme.Under Bore Well Lift Irrigation project total number of bore wells installed is 223 with designed irrigated area of 446 ha. Agriculture department also installed 63 number of bore wells in Jharsuguda district part with an irrigated area of 126 ha. Total irrigation draft by government borewell is considered as **166.36 ham**. Irrigation is also done through private bore wells and large number of water conservation structures constructed under MGNREGA schemes. The details of the schemes are summarized in Table 5e1 and e2.

Table 5a. Villagewise Ayacut Area of Megalift Projects in the study area

Sl.No.	Name of the Scheme	Cluster Name	Source	Block	G.P Name	Village	CCA in Ha.	Functional
1	Katikela	Cluster III	Bheden River	Jharsuguda	Katikela	Katikela	180.24	Yes
2	Katikela	Cluster III	Bheden River	Jharsuguda	Parmanpur	Parmanpur	465.21	Yes
3	Katikela	Cluster III	Bheden River	Jharsuguda	Patrapali	Patrapali	62.81	Yes
4	Banjibora	Cluster DMF	IB	Jharsuguda	H Katapali	Jharsuguda Katapali	479.35	No
5	Banjibora	Cluster DMF	IB	Jharsuguda	H Katapali	Lahandabud	203.72	No
6	Banjibora	Cluster DMF	IB	Jharsuguda	Jharsuguda	Jharsuguda Town Unit	519.91	No
						Total	**1911**	

Table 5b.Village and GP wise Ayacut Area of Minor Irrigation Projects in the study area

Sl.No.	Name of the Scheme	G.P	Village	Designed Ayacut in Ha		Functional	Water utilization in ham	Canal Length in Km	
				Khariff	Rabi			Left	Right
1	Ekatali	Jharsuguda(M)	Jharsuguda(M)	41.00	0	Yes	72.4 ham	0	0

2	Jharianala	Jharsuguda(M)	Jharsuguda(M)	41.00	0	Yes		0	0
3	Kantatikra	Hirma	Hirma	40.00	0	Yes		0	0
4	Punabastikata	Jharsuguda(M)	Jharsuguda(M)	57.00	0	Yes		0	0
5	Sripura	Sripura	Jharsuguda	45.00	0	Yes		0	0
6	Brahmanipalli	Brahmanipalli	Brahmanipalli	80.00	0	Yes		0	0
7	Jharnapali-II	Katarbaga	Nuatelgi	41.00	0	Yes		0	0
8	Jharnapali Kata No-1	Katarbaga	Nuatelgi	49.00	0	Yes		1.61	0
9	Kashipali	Rengali	Kashipali	49.00	0	Yes	132.44 ham	2.23	0
10	Katarbaga	Katarbaga	Katarbage	105.00	0	Yes		0	1.12
11	Salad	Salad	Salad	41.00	10.00	Yes		1.144	0.3
12	Thapapali	Jhankarpali	Thapapali	140.00	0	Yes		0	4.37
Total				**729.00**	**10**	Yes	204.84ham		

Table 5c. Villagewise Ayacut Area of River Lift Irrigation Projects in the study area

Sl.No.	Name of the Scheme	G.P	Village	Designed Ayacut in Ha		Type	Functional	Sources of water
				Khariff	Rabi			
1	Kurebaga	Dalki	Kurebaga	20	20	River Lift	No	Local Nallah
2	Ganthiabud	H.Kantapali	Ganthiabud	40	40	River Lift	Yes	River Ib
3	Tareikela	Hirma	Tareikela	40	24	River Lift	Yes	River Veden
4	Kumbhari	Hirma	Kumbhari	40	24	River Lift	Yes	River Veden
5	Kumbhari-II	Hirma	Kumbhari	20	20	River Lift	Yes	River Veden
6	Tumbeikela-II	Hirma	Tumbeikela	40	40	River Lift	No	River Veden
7	Hirma	Hirma	Hirma	40	40	River Lift	No	River Veden
8	Kumbhari-V	Hirma	Kumbhari	20	20	River Lift	Yes	River Veden
9	Kumbhari-III	Hirma	Kumbhari	20	20	River Lift	Yes	River Veden
10	Kumbhari-IV	Hirma	Kumbhari	20	20	River Lift	Yes	River Veden
11	Kumbhari - VI	Hirma	Kumbhari	40	40	River Lift	Yes	River Veden
12	Jamera	Jamera	Jamera	40	24	River Lift	No	River Ib
13	Jamera-II	Jamera	Jamera	40	40	River Lift	No	River IB

14	Panchapada	Jsg. Muncipalty.	Panchapada	40	24	River Lift	No	River Ib
15	Panchpada - II	Jsg. Muncipalty.	Panchpada	40	40	River Lift	No	River Ib
16	Panchpada - III	Jsg. Muncipalty.	Panchpada	40	40	River Lift	No	River Ib
17	Panchpada - IV	Jsg. Muncipalty.	Panchpada	40	40	River Lift	No	River Ib
18	H.Kantapali-II	H.Kantapali	H.Kantapali	20	12	River Lift	No	River Ib
19	H.Kantapali-III	H.Kantapali	H.Kantapali	20	12	River Lift	No	River Ib
20	H.Kantapali-IV	H.Kantapali	H.Kantapali	20	12	River Lift	No	River Ib
21	H.Katapali-V	H.Kantapali	H.Katapali	20	20	River Lift	Yes	River Ib
22	H.Kantapali-VI	H.Kantapali	H.Kantapali	20	20	River Lift	No	River Ib
23	Katikela-I	Katikela	Katikela	20	12	River Lift	No	River Veden
24	Katikela-II	Katikela	Katikela	20	12	River Lift	No	River Veden
25	Bhagipali-II	Katikela	Bhagipali	20	20	River Lift	No	River Veden
26	Bhurkamunda-II	Katikela	Bhurkamunda	20	20	River Lift	No	River Veden
27	Gudigaon - I	Keldamal	Gudigaon	20	20	River Lift	Yes	Brahamani Nala
28	Gudigaon - II	Keldamal	Gudigaon	20	20	River Lift	Yes	Brahamani Nala
29	Malda	Malda	Malda	40	24	River Lift	Yes	River Veden
30	Khait	Malda	Khait	40	24	River Lift	Yes	River Veden
31	Malda-III	Malda	Malda	20	20	River Lift	No	River Veden
32	Malda-II	Malda	Malda	20	20	River Lift	No	River Veden
33	Marakuta	Marakuta	Marakuta	40	40	River Lift	No	River IB
34	Paramanpur-II	Paramanpur	Paramanpur	20	12	River Lift	Yes	River Veden
35	Paramanpur-III	Paramanpur	Paramanpur	20	12	River Lift	Yes	River Veden
36	Siriapali	Parmanpur	Siriapali	20	20	River Lift	Yes	Local nallah
37	Rampur-II	Patrapali	Rampur	20	12	River Lift	No	River IB
38	Rampur-III	Patrapali	Rampur	20	12	River Lift	No	River IB
39	Rampur-I	Patrapali	Rampur	40	24	River Lift	No	River Veden
40	Patrapali	Patrapali	Patrapali	24	24	River Lift	No	River Veden
41	Dumermunda	Patrapali	Dumermunda	20	20	River Lift	Yes	Hirakund Reservoir

42	Bhagipali	Sripura	Bhagipali	40	24	River Lift	No	River Veden
43	Bhurkamunda	Sripura	Bhurkamunda	40	24	River Lift	No	River Veden
44	Sripura	Sripura	Sripura	40	24	River Lift	No	River Veden
45	Talpatia-II	Talpatia	Talpatia	20	20	River Lift	No	River IB
46	Thelkoli	Khiinda	Thelkoli	20	20	River Lift	No	River Veden
			Total	**1304**	**1071**			

Table 5d1. Villagewise Borewell Lift Irrigation Projects in the study area of Jharsuguda District part

Sl. No.	Name of the District	Name of the block	Name of the G.P.	Name of the Village	Total Depth of B/W (M)	Yield (LPS)	S.W.L.(M)	Daily running hour	Yearly running hour	Total Irrigated area	Unit Draft (ham)
1	Jharsuguda	Kolabira	Kelendamal	Gudigaon	102.00	1.75	10.00	4	600	2	0.378
2	Jharsuguda	Kolabira	Kelendamal	Gudigaon	101.00	1.82	11.00	4	600	2	0.39312
3	Jharsuguda	Kolabira	Kelendamal	Gudigaon	90.00	1.75	11.00	4	600	2	0.378
4	Jharsuguda	Kolabira	Kelendamal	Gudigaon	106.00	1.75	6.00	4	600	2	0.378
5	Jharsuguda	Jharsuguda	Dalki	Kumudapali	94.00	1.98	3.70	4	600	2	0.42768
6	Jharsuguda	Jharsuguda	Dalki	Kumudapali	94.00	1.98	7.60	4	600	2	0.42768
7	Jharsuguda	Jharsuguda	Dalki	Kumudapali	94.00	2.05	6.30	4	600	2	0.4428
8	Jharsuguda	Jharsuguda	Dalki	Kumudapali	85.00	2.05	5.60	4	600	2	0.4428
9	Jharsuguda	Jharsuguda	Dalki	Kumudapali	94.00	2.1	6.20	4	600	2	0.4536
10	Jharsuguda	Jharsuguda	Badmal	Brundamal	99.00	1.98	5.60	4	600	2	0.42768
11	Jharsuguda	Jharsuguda	Badmal	Brundamal	94.00	2.15	5.30	4	600	2	0.4644
12	Jharsuguda	Jharsuguda	Badmal	Brundamal	99.00	2.1	4.80	4	600	2	0.4536
13	Jharsuguda	Jharsuguda	Badmal	Brundamal	99.00	2.08	7.20	4	600	2	0.44928
14	Jharsuguda	Kolabira	Kelendamal	Kelda	99	1.78	6.8	4	600	2	0.38448
15	Jharsuguda	Kolabira	Keladamal	Gudigaon	98.00	1.99	6.70	4	600	2	0.42984
16	Jharsuguda	Kolabira	Keladamal	Gudigaon	98.00	1.95	7.60	4	600	2	0.4212
17	Jharsuguda	Kolabira	Keladamal	Gudigaon	99.00	2.08	6.20	4	600	2	0.44928

18	Jharsuguda	Kolabira	Kelendamal	Gudigaon	99.00	2.18	5.60	4	600	2	0.47088
19	Jharsuguda	Kolabira	Parmanpur	Sriapali	100	2.33	6.6	4	600	2	0.50328
20	Jharsuguda	Kolabira	Parmanpur	Sriapali	137	2.25	5.4	4	600	2	0.486
21	Jharsuguda	Kolabira	Parmanpur	Sriapali	116	2.35	6.3	4	600	2	0.5076
22	Jharsuguda	Kolabira	Parmanpur	Sriapali	99	2.28	5.4	4	600	2	0.49248
23	Jharsuguda	Kolabira	Parmanpur	Sriapali	137	2.26	7.2	4	600	2	0.48816
24	Jharsuguda	Kolabira	Parmanpur	Sriapali	130	2.27	7.8	4	600	2	0.49032
25	Jharsuguda	Kolabira	Parmanpur	Sriapali	92	2.25	7.2	4	600	2	0.486
26	Jharsuguda	Kolabira	Parmanpur	Sriapali	86	2.27	7.3	4	600	2	0.49032
27	Jharsuguda	Kolabira	Parmanpur	Sriapali	136	2.18	7.3	4	600	2	0.47088
28	Jharsuguda	Kolabira	Parmanpur	Parmanpur	93	2.5	7.2	4	600	2	0.54
29	Jharsuguda	Jharsuguda	Panchpada	Phatamal	125	2.33	7.4	4	600	2	0.50328
30	Jharsuguda	Jharsuguda	Panchpada	Phatamal	70	2.37	7.4	4	600	2	0.51192
31	Jharsuguda	Jharsuguda	Panchpada	Phatamal	108	2.37	7.5	4	600	2	0.51192
32	Jharsuguda	Jharsuguda	Panchpada	Phatamal	107	2.33	7.6	4	600	2	0.50328
37	Jharsuguda	Jharsuguda	H Kantapali	H Kantapali	104	2.1	7	4	600	2	0.4536
38	Jharsuguda	Jharsuguda	H Kantapali	H Kantapali	101	2	8	4	600	2	0.432
39	Jharsuguda	Jharsuguda	H Kantapali	H Kantapali	98	1.9	10	4	600	2	0.4104
40	Jharsuguda	Jharsuguda	Hirma	K. Katapali	93	2.1	9	4	600	2	0.4536
41	Jharsuguda	Jharsuguda	Hirma	K. Katapali	93	1.9	10	4	600	2	0.4104
42	Jharsuguda	Jharsuguda	Hirma	K. Katapali	85	1.9	8	4	600	2	0.4104
43	Jharsuguda	Jharsuguda	Katikela	Dapaka	102	1.8	8.57	4	600	2	0.3888
44	Jharsuguda	Jharsuguda	Katikela	Dapaka	74	1.8	10.7	4	600	2	0.3888
45	Jharsuguda	Jharsuguda	Katikela	Dapaka	99	1.75	7.7	4	600	2	0.378
46	Jharsuguda	Jharsuguda	Katikela	Dapaka	102	2.3	9.18	4	600	2	0.4968
47	Jharsuguda	Jharsuguda	Katikela	Dapaka	92	2.2	9.18	4	600	2	0.4752
48	Jharsuguda	Jharsuguda	Katikela	Dapaka	65	2.2	14	4	600	2	0.4752
49	Jharsuguda	Kolabira	Paramanpur	Dapaka	76	1.95	9.2	4	600	2	0.4212
50	Jharsuguda	Kolabira	Paramanpur	Dapaka	73	1.75	15.6	4	600	2	0.378

51	Jharsuguda	Kolabira	Paramanpur	Dapaka	75	1.85	18.3	4	600	2	0.3996
52	Jharsuguda	Kolabira	Paramanpur	Dapaka	66	1.8	13.1	4	600	2	0.3888
53	Jharsuguda	Kolabira	Kelendamal	Kelenda	74	1.95	13.1	4	600	2	0.4212
54	Jharsuguda	Kolabira	Kelendamal	Kelenda	75	1.75	9.5	4	600	2	0.378
55	Jharsuguda	Kolabira	Kelendamal	Kelenda	65	1.9	13.1	4	600	2	0.4104
56	Jharsuguda	Jharsuguda	Hirma	K. Katapali	79.00	2.20	9.00	4	600	2	0.4752
57	Jharsuguda	Jharsuguda	Katikela	Dapaka	81.00	1.78	3.70	4	600	2	0.38448
58	Jharsuguda	Jharsuguda	Katikela	Dapaka	85.00	1.96	5.20	4	600	2	0.42336
59	Jharsuguda	Jharsuguda	Katikela	Dapaka	85.30	1.90	8.20	4	600	2	0.4104

Table 5d2. Villagewise Borewell Lift Irrigation Projects in the study area of Sambalpur District part

Sl.No	Name of the Block	Name of the G.P	Village Name	Depth of B/W (m)	Yield (LPS)	SWL(m)	Daily running hour	Yearly running hour	Total Irrigated area (Ha)	Unit Draft(ham)
1	Rengali	Bamaloi	Baragad	89.68	2.3	6.08	4	600	2	0.4968
2	Rengali	Bamaloi	Baragad	89.68	2.2	6.08	4	600	2	0.4752
3	Rengali	Bamaloi	Baragad	89.68	2	7.904	4	600	2	0.432
4	Rengali	Bamaloi	Baragad	94.848	1.8	7.904	4	600	2	0.3888
5	Rengali	Bamaloi	Baragad	89.68	3.5	4.864	4	600	2	0.756
6	Rengali	Bamaloi	Baragad	83.904	1.95	6.992	4	600	2	0.4212
7	Rengali	Bamaloi	Pipalkani	83.904	1.75	7.904	4	600	2	0.378
8	Rengali	Bomaloi	Darhopani	94.848	1.9	6.08	4	600	2	0.4104
9	Rengali	Bomaloi	Darhopani	85.728	1.9	6.08	4	600	2	0.4104
10	Rengali	Bomaloi	Darhopani	97.584	1.75	6.992	4	600	2	0.378
11	Rengali	Bomaloi	Darhopani	85.728	2	4.864	4	600	2	0.432
12	Rengali	Bomaloi	Darhopani	89.68	2.1	10.032	4	600	2	0.4536
13	Rengali	Bomaloi	Darhopani	93.632	1.85	11.856	4	600	2	0.3996
14	Rengali	Bomaloi	Darhopani	95.76	1.9	6.992	4	600	2	0.4104
15	Rengali	Bomaloi	Darhopani	85.728	1.8	7.904	4	600	2	0.3888
16	Rengali	Bomaloi	Darhopani	81.776	2	6.08	4	600	2	0.432
17	Rengali	Ghichamura	Derba Hadmunda	89.68	1.75	6.992	4	600	2	0.378
18	Rengali	Ghichamura	Derba Hadmunda	50.768	4	7.904	4	600	2	0.864

19	Rengali	Ghichamura	Derba Hadmunda	78.736	4.2	3.04	4	600	2	0.9072
20	Rengali	Jangala	Jangala Laripali	91.808	2	7.904	4	600	2	0.432
21	Rengali	Jangala	Jangala Laripali	91.808	2	6.08	4	600	2	0.432
22	Rengali	Jangala	Lahamani	91.808	3	6.08	4	600	2	0.648
23	Rengali	Jangala	Lahamani	91.808	2.5	6.08	4	600	2	0.54
24	Rengali	Jangala	Lahamani	95.76	1.75	7.904	4	600	2	0.378
25	Rengali	Jangala	Lahamani	85.728	2	4.864	4	600	2	0.432
26	Rengali	Jangala	Lahamani	69.92	1.8	10.032	4	600	2	0.3888
27	Rengali	Jangala	Lahamani	85.728	2.5	6.08	4	600	2	0.54
28	Rengali	Jangala	Lahamani	94.848	2.3	7.904	4	600	2	0.4968
29	Rengali	Jangala	Lahamani	90.592	1.9	9.12	4	600	2	0.4104
30	Rengali	Jangala	Salepada	83.904	2.4	4.864	4	600	2	0.5184
31	Rengali	Jangala	Salepada	47.728	3.5	3.04	4	600	2	0.756
32	Rengali	Katarabaga	Golamal	97.584	3	6.992	4	600	2	0.648
33	Rengali	Katarabaga	Golamal	89.376	2.40	6.992	4	600	2	0.5184
34	Rengali	Katarabaga	Golamal	97.584	2.20	6.992	4	600	2	0.4752
35	Rengali	Katarbaga	BADMAL	84.816	2.7	3.952	4	600	2	0.5832
36	Rengali	Katarbaga	BADMAL	84.816	2.5	6.08	4	600	2	0.54
37	Rengali	Katarbaga	Bagmundiapada	90.592	2.5	6.08	4	600	2	0.54
38	Rengali	Katarbaga	Bagmundiapada	92.72	2.3	4.864	4	600	2	0.4968
39	Rengali	Katarbaga	Bagmundiapada	85.728	2.2	3.952	4	600	2	0.4752
40	Rengali	Katarbaga	Bandhtikira	83.904	2	6.08	4	600	2	0.432
41	Rengali	Katarbaga	Bandhtikira	85.728	3	3.952	4	600	2	0.648
42	Rengali	Katarbaga	Bhuliatikira	84.816	2	6.08	4	600	2	0.432
43	Rengali	Katarbaga	Bhuliatikira	90.592	2.4	4.864	4	600	2	0.5184
44	Rengali	Katarbaga	BRAHMANIPALI	90.592	2.6	3.952	4	600	2	0.5616
45	Rengali	Katarbaga	BRAHMANIPALI	96.672	3.62	3.04	4	600	2	0.78192
46	Rengali	Katarbaga	BRAHMANIPALI	96.672	1.9	3.952	4	600	2	0.4104
47	Rengali	Katarbaga	Bramhanipal	85.728	2.5	6.992	4	600	2	0.54
48	Rengali	Katarbaga	Bramhanipal	84.816	1.9	6.992	4	600	2	0.4104
49	Rengali	Katarbaga	Bramhanipal	85.728	1.9	6.992	4	600	2	0.4104
50	Rengali	Katarbaga	Chandamal	81.776	2	6.08	4	600	2	0.432
51	Rengali	Katarbaga	Chandamal	83.904	2	6.08	4	600	2	0.432
52	Rengali	Katarbaga	Chandamal	83.904	3	3.952	4	600	2	0.648
53	Rengali	Katarbaga	Golamal	92.72	2.1	3.952	4	600	2	0.4536
54	Rengali	Katarbaga	Golamal	97.584	2.3	6.08	4	600	2	0.4968
55	Rengali	Katarbaga	Golamal	88.768	2.5	4.864	4	600	2	0.54
56	Rengali	Katarbaga	Golamal	97.584	2.0	3.952	4	600	2	0.432
57	Rengali	Katarbaga	Golamal	84.816	2.5	6.08	4	600	2	0.54

58	Rengali	Katarbaga	Golamal	97.584	2.2	6.992	4	600	2	0.4752
59	Rengali	Katarbaga	Golamal	92.72	2.5	4.864	4	600	2	0.54
60	Rengali	Katarbaga	Kadelpitha	85.728	3.3	3.952	4	600	2	0.7128
61	Rengali	Katarbaga	Kadelpitha	83.904	2.2	4.864	4	600	2	0.4752
62	Rengali	Katarbaga	Kadelpitha	85.728	2.4	4.864	4	600	2	0.5184
63	Rengali	Katarbaga	Kadelpitha	85.728	2.4	4.864	4	600	2	0.5184
64	Rengali	Katarbaga	Kadelpitha	89.68	1.9	6.08	4	600	2	0.4104
65	Rengali	Katarbaga	Kadelpitha	81.776	2.2	3.952	4	600	2	0.4752
66	Rengali	Katarbaga	Kadelpitha	84.816	2.4	4.864	4	600	2	0.5184
67	Rengali	Katarbaga	Kadelpitha	77.824	2.3	4.864	4	600	2	0.4968
68	Rengali	Katarbaga	Kadelpitha	89.68	2.8	3.952	4	600	2	0.6048
69	Rengali	Katarbaga	Kadelpitha	85.728	2.8	4.864	4	600	2	0.6048
70	Rengali	Katarbaga	Katarbaga	85.728	2.4	6.08	4	600	2	0.5184
71	Rengali	Katarbaga	Katarbaga	99.712	2.8	6.992	4	600	2	0.6048
72	Rengali	Katarbaga	Katarbaga	99.712	2.75	7.904	4	600	2	0.594
73	Rengali	Katarbaga	Katarbaga	99.712	3	6.08	4	600	2	0.648
74	Rengali	Katarbaga	Katarbaga	85.728	2.75	3.952	4	600	2	0.594
75	Rengali	Katarbaga	Katarbaga	83.904	2	6.08	4	600	2	0.432
76	Rengali	Katarbaga	Katarbaga	82.688	3	3.952	4	600	2	0.648
77	Rengali	Katarbaga	Katarbaga	85.728	3	3.952	4	600	2	0.648
78	Rengali	Katarbaga	Katarbaga	83.904	1.8	6.992	4	600	2	0.3888
79	Rengali	Katarbaga	Katarbaga	84.816	1.9	6.08	4	600	2	0.4104
80	Rengali	Katarbaga	Kendupada	87.856	3.3	4.864	4	600	2	0.7128
81	Rengali	Katarbaga	Kendupada	83.904	3.5	3.952	4	600	2	0.756
82	Rengali	Katarbaga	Kendupada	88.768	1.9	6.08	4	600	2	0.4104
83	Rengali	Katarbaga	Kendutikra	83.904	2.1	3.952	4	600	2	0.4536
84	Rengali	Katarbaga	Kendutikra	85.728	2.2	4.864	4	600	2	0.4752
85	Rengali	Katarbaga	Kendutikra	89.68	2.4	6.08	4	600	2	0.5184
86	Rengali	Katarbaga	Ludhapali	85.728	2.2	3.952	4	600	2	0.4752
87	Rengali	Katarbaga	Ludhapali	88.768	2.2	3.952	4	600	2	0.4752
88	Rengali	Katarbaga	Ludhapali	85.728	2.5	3.952	4	600	2	0.54
89	Rengali	Katarbaga	Ludhapali	85.728	2.3	4.864	4	600	2	0.4968
90	Rengali	Katarbaga	Ludhapali	84.816	2.3	4.864	4	600	2	0.4968
91	Rengali	Katarbaga	Pardeshipali	79.04	2.75	6.08	4	600	2	0.594
92	Rengali	Katarbaga	Pardeshipali	79.04	2.4	9.12	4	600	2	0.5184
93	Rengali	Katarbaga	Pardeshipali	79.04	2	9.12	4	600	2	0.432
94	Rengali	Katarbaga	Pradhanpali	89.68	1.9	7.904	4	600	2	0.4104
95	Rengali	Katarbaga	Pradhanpali	95.76	2.9	6.08	4	600	2	0.6264
96	Rengali	Katarbaga	Pradhanpali	93.632	2	6.08	4	600	2	0.432
97	Rengali	Katarbaga	Pradhanpali	85.728	2.4	6.08	4	600	2	0.5184

98	Rengali	Katarbaga	Thurupali	81.776	2.2	6.08	4	600	2	0.4752
99	Rengali	Katarbaga	Thurupali	83.904	1.78	6.992	4	600	2	0.38448
100	Rengali	Katarbaga	Thurupali	84.816	4	4.864	4	600	2	0.864
101	Rengali	Katarbaga	Thurupali	85.728	2.4	4.864	4	600	2	0.5184
102	Rengali	Katarbaga	Thurupali	82.688	2.5	6.992	4	600	2	0.54
103	Rengali	Katarbaga	Thurupali	91.808	2.4	4.864	4	600	2	0.5184
104	Rengali	Katarbaga	Thurupali	83.904	3	3.952	4	600	2	0.648
105	Rengali	Katarbaga	Thurupali	83.904	2.75	3.952	4	600	2	0.594
106	Rengali	Katarbaga	Thurupali	90.592	2.9	3.952	4	600	2	0.6264
107	Rengali	Katarbaga	Thurupali	99.712	1.9	3.952	4	600	2	0.4104
108	Rengali	Lapanga	Banjiberna	83.904	1.8	6.08	4	600	2	0.3888
109	Rengali	Lapanga	Banjiberna	83.904	1.9	6.992	4	600	2	0.4104
110	Rengali	Lapanga	Banjiberna	89.68	2.4	3.952	4	600	2	0.5184
111	Rengali	Lapanga	Banjiberna	83.904	1.8	6.08	4	600	2	0.3888
112	Rengali	Nishanbhanga	Babuchakuli	90.592	2.15	4.864	4	600	2	0.4644
113	Rengali	Nishanbhanga	Babuchakuli	90.592	1.8	4.864	4	600	2	0.3888
114	Rengali	Nishanbhanga	Babuchakuli	83.904	1.8	4.864	4	600	2	0.378
115	Rengali	Nishanbhanga	Babuchakuli	71.744	2.00	3.952	4	600	2	0.432
116	Rengali	Nishanbhanga	Nishanbhanga	89.68	1.75	6.992	4	600	2	0.378
117	Rengali	Nishanbhanga	Nishanbhanga	89.68	1.9	6.08	4	600	2	0.4104
118	Rengali	Nishanbhanga	Nishanbhanga	55.936	2.9	6.08	4	600	2	0.6264
119	Rengali	Nishanbhanga	Nishanbhanga	90.592	2.15	3.952	4	600	2	0.4644
120	Rengali	Nishanbhanga	Nishanbhanga	88.768	2.5	4.864	4	600	2	0.54
121	Rengali	Nishanbhanga	Nishanbhanga	93.632	1.80	6.992	4	600	2	0.3888
122	Rengali	Nishanbhanga	Nishanbhanga	96.672	2.00	3.952	4	600	2	0.432
123	Rengali	Nishanbhanga	Nishanbhanga	97.584	1.75	4.864	4	600	2	0.378
124	Rengali	Rengali	Badapada	85.728	2.5	4.864	4	600	2	0.54
125	Rengali	Rengali	Badapada	85.728	2.1	3.952	4	600	2	0.4536
126	Rengali	Rengali	Badapada	92.72	2.8	6.08	4	600	2	0.6048
127	Rengali	Rengali	Badapada	77.824	2.6	3.952	4	600	2	0.5616
128	Rengali	Rengali	Badapada	85.728	2.7	4.864	4	600	2	0.5832
129	Rengali	Rengali	Badapada	99.712	2.8	6.08	4	600	2	0.6048
130	Rengali	Rengali	Jambahal	92.72	2.5	6.08	4	600	2	0.54
131	Rengali	Rengali	Jambahal	83.904	2.2	6.08	4	600	2	0.4752
132	Rengali	Rengali	Jambahal	83.904	2.3	4.864	4	600	2	0.4968
133	Rengali	Rengali	Lairapali	85.728	3.5	6.08	4	600	2	0.756
134	Rengali	Rengali	Lairapali	81.776	3.5	3.952	4	600	2	0.756
135	Rengali	Rengali	Lairapali	81.776	3	3.952	4	600	2	0.648

136	Rengali	Rengali	Lairapali	81.776	3.3	3.952	4	600	2	0.7128
137	Rengali	Rengali	Lairapali	65.664	3.2	6.08	4	600	2	0.6912
138	Rengali	Rengali	Panaspada	81.776	2.4	4.864	4	600	2	0.5184
139	Rengali	Rengali	Panaspada	84.816	3.5	3.04	4	600	2	0.756
140	Rengali	Rengali	Panaspada	77.824	2.1	4.864	4	600	2	0.4536
141	Rengali	Rengali	Rayapada	85.728	2.4	6.992	4	600	2	0.5184
142	Rengali	Rengali	Rayapada	91.808	3	6.08	4	600	2	0.648
143	Rengali	Rengali	Rayapada	84.816	1.8	6.992	4	600	2	0.3888
144	Rengali	Rengali	Rengali	69.92	2	4.864	4	600	2	0.432
145	Rengali	Rengali	Rengali	89.68	1.9	6.08	4	600	2	0.4104
146	Rengali	Rengali	Rengali	85.728	2.5	3.952	4	600	2	0.54
147	Rengali	Rengali	Rengali	85.728	2.8	4.864	4	600	2	0.6048
148	Rengali	Rengali	Rengali	90.592	3	4.864	4	600	2	0.648
149	Rengali	Rengali	RENGALIBASTI	84.816	2.2	3.952	4	600	2	0.4752
150	Rengali	Rengali	RENGALIBASTI	85.728	2.5	6.08	4	600	2	0.54
151	Rengali	Rengali	RENGALIBASTI	83.904	2.4	3.952	4	600	2	0.5184
152	Rengali	Rengali	RENGALIBASTI	85.728	2.7	4.864	4	600	2	0.5832
153	Rengali	Rengali	RENGALIBASTI	92.72	2.3	4.864	4	600	2	0.4968
154	Rengali	Rengali	Salepada	81.776	2.85	3.952	4	600	2	0.6156
155	Rengali	Rengali	Salepada	83.904	2.4	4.864	4	600	2	0.5184
156	Rengali	Rengali	Salepada	77.824	1.9	6.08	4	600	2	0.4104
157	Rengali	Rengali	Sian Bahal	85.728	2.3	4.864	4	600	2	0.4968
158	Rengali	Rengali	Sian Bahal	89.68	2.4	4.864	4	600	2	0.5184
159	Rengali	Salad	N.Rampella	68.704	1.92	6.08	4	600	2	0.41472
160	Rengali	Salad	N.Rampella	82.688	1.8	6.08	4	600	2	0.3888
161	Rengali	Salad	Salad	85.728	2	6.992	4	600	2	0.432
162	Rengali	Salad	Salad	95.76	3.5	3.952	4	600	2	0.756
163	Rengali	Salad	Salad	83.904	2	4.864	4	600	2	0.432
164	Rengali	Salad	Salad	85.728	3	4.864	4	600	2	0.648

Table 5e1. GP wise number of conservation structures in the study area of Sambalpur District part

GP name	Checkdam	Contour bund	Flood diversion channel	Gabbion anicut	Open well	Percolation tank	Trench	Distributary canal and embankment	Farm pond	Soak pit	Excavation
Bomaloi	3	4	1	2	7	11	4	1	3	14	3
Ghichamura	2	0	0	0	8	3	11	2	8	90	3
Jangla	7	5	0	0	8	2	4	0	1	30	4
Jhankarpali	4	1	1	0	10	3	11	0	70	24	9
Katarbaga	4	0	0	0	1	7	11	0	20	21	4
Khinda	1	0	0	0	3	1	2	3	9	42	3
Lapanga	1	1	0	0	9	5	4	0	4	9	2
Nishanbanga	4	0	0	0	6	7	14	8	6	19	6
Rengali	1	2	1	0	1	4	3	0	2	65	4
Salad	8	4	0	0	5	9	3	3	6	42	6
Thelkoloi	0	0	0	0	1	1	0	0	0	9	0
Total	**35**	**17**	**3**	**2**	**59**	**53**	**67**	**17**	**129**	**365**	**44**
										Cumulative Number	**791**

Table 5e2. GP wise number of conservation structures in the study area of Jharsuguda District part

GP name	Checkdam	Contour bund/Nallah Bund	Flood diversion channel	Gabbion anicut	Open well	Percolation tank	Trench	Distributary canal and embankment	Farm pond	Soak pit	Excavation	RWH/ WHS
H Katapali	5	2	0	0	12	6	0	0	1	0	0	0
Marakuta	5	4	0	0	3	3	0	0	4	0	1	1
Jamera	11	4	1	0	11	1	0	0	3	0	0	1
Malda	1	3	0	0	12	4	0	0	3	0	0	2
Patrapali	5	3	0	0	6	6	0	0	1	0	0	1

Hirma	6	3	0	0	23	9	0	0	2	1	0	1
Badmal	13	2	0	0	5	3	0	0	0	3	0	1
Sripura	2	2	0	0	0	5	0	0	0	0	0	0
Katikela	3	1	0	0	2	9	1	0	2	1	0	0
Dalki	17	0	0	0	4	21	0	0	8	1	0	1
Durlaga	0	1	0	0	24	4	0	0	2	0	0	0
Talpatia	7	2	0	0	26	4	2	0	0	1	0	2
Parmanpur	11	0	0	0	38	0	3	0	7	0	0	0
Keldamal	5	0	0	0	19	0	0	0	3	0	0	0
Total	**91**	**27**	**1**	**0**	**185**	**75**	**6**	**0**	**36**	**7**	**1**	**10**
											Cumulative Number	**439**

CROPPING PATTERN: As per Distrct Agriculture Office, Jharsuguda rainfed cropped area is 9302 ha and net irrigated area is 541 ha.As per Distrct Agriculture Office, Sambalpur rainfed cropped area is 16032 ha and net irrigated area is 242.5 ha.The details of crops are mainly paddy during kharif season and vegetables during Rabi season.Sumarrized details of cropping pattern are given in 6a and b.

Table 6a.Cropping pattern in the study area of Jharsuguda District part

Village	Cropping pattern	Type of crop (Season wise) with area (Ha)	Total Cultivated area (Ha)	Total Cultivable area (Ha)	Gross cropped Area (Ha)	Net Irrigated area (Ha)	Irrigation Type (Furrow/drip /sprinkler)
Banjara	Paddy/Non	kh-5,Rabi-1	7	7	6	NIL	
Badmal	Paddy/Non	KH-(Paddy- 65), RABI-(Non-paddy-30)	95	115	180	12	Furrow
Beherapali	Paddy/Non	KH-(Paddy- 40), RABI-(Non-paddy-1)	41	46	70	2	Furrow
Beherapat	Paddy/Non	KH-(Paddy- 82), RABI-(Non-paddy-20)	102	104	115	NIL	Furrow
Bhagipali	Paddy/Non	KH-15,RABI-2	30	36	19	1	Furrow
Bhurkamunda	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Bhurusund	Paddy/Non	NIL	15	12	14	1	furrow
Brundamal	Paddy/Non	KH-(Paddy- 75), RABI-(Non-	111	160	240	15	Furrow

		paddy-36)					
Budhipadar	Paddy/Non	KH-(Paddy- 100), RABI-(Non-paddy-35)	135	158	69	3	Furrow
Dalki	Paddy/Non	KH-54,RABI-5	83	96	72	5	Furrow
Dumermunda	Paddy/Non	KH-8,RABI-2	17	19	15	2	Furrow
Durlaga	Paddy/Non	KH-(Paddy- 107), RABI-(Non-paddy-38)	145	599.6	165	20	Furrow
Hansamurakatapali	Paddy/Non	KH-(Paddy- 107), RABI-(Non-paddy-38)	752	756	762	15	Furrow
Hirma	Paddy/Non	kh-141, rabi-142	183	195	190	2	Furrow
Jamera	Paddy/Non	KH-(Paddy- 100), RABI-(Non-paddy-40)	140	182	151	40	Furrow
Jamuapali	Paddy/Non	KH-(Paddy- 70), RABI-(Non-paddy-10)	80	188	70	30	Furrow
Katikela	Paddy/Non	KH-260,RAB-24	360	300	360	85	
Khait	Paddy/Non	KH-RABI	17	30	20	2	Furrow
Kherual	Paddy/Non	KH-(Paddy- 100), RABI-(Non-paddy-30)	130	155	220	10	Furrow
Kukurjangha	Paddy/Non	KH-(Paddy- 155), RABI-(Non-paddy-20)	165	165	220	5	Furrow
Kumbhari	Paddy/Non	KH-(Paddy- 106), RABI-(Non-paddy-15)	145	130	110	2	Furrow
Kurebaga	Paddy/Non	KH-77,RABI-12	125	130	101	10	Furrow
Kumudapali	Paddy/Non	KH-60,RABI-7	86	86	74	2	Furrow
Lahandabud	Paddy/Non	KH-240 ,RABI-93	326	330	336		Furrow
Luhurenkachhar	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Malda	Paddy/Non	KH-72, RABI-12	89	121.55	100	6	Furrow
Marakuta	Paddy/Non	KH-RABI	320	588	340	20	Furrow
Pandripathar	Paddy/Non	KH-(Paddy- 85), RABI-(Non-paddy-30)	115	135	210	20	Furrow
Patrapali	Paddy/Non	KH-(Paddy- 116), RABI-(Non-paddy-35)	150	181.24	170	5	Furrow
Purna	Paddy/Non	KH-38,RAB-5	58	75	48	NIL	NIL
Rampur	Paddy/Non	KH-92, RABI-28	120	121.55	122	4	Furrow

Saletikra	Paddy/Non	KH-(Paddy- 121), RABI-(Non-paddy-42)	163	186.8	170	2	Furrow
Singhabaga	Paddy/Non	KH-(Paddy- 79), RABI-(Non-paddy-25)	104	163	79	25	Furrow
Sripura	Paddy/Non	KH-(Paddy- 290), RABI-(Non-paddy-55)	345	380	430	30	Furrow
Talpatia	Paddy/Non	KH-(Paddy- 300), RABI-(Non-paddy-160)	460	465.2	470	60	Furrow
Tarekela	Paddy/Non	KH-86, RABI-54	140	150	148	6	Furrow
Tumbela (Tumbekela)	Paddy/Non	KH-(Paddy-84), RABI-(Non-paddy-20)	104	85	90	2	Furrow
Jharsuguda MC	NA	NA	NA	NA	NA	NA	NA
Gudugaon	Paddy/Nonpaddy	Kharif paddy-250, Rabi nonpaddy-110	360	444	804	20	Sprinkler, furrow, drip
Kelenda	Paddy/Nonpaddy	Kharif paddy-130, Rabi nonpaddy-52	182	210	392		Furrow
Kelendamal	Paddy/Nonpaddy	Kharif paddy-195, Rabi nonpaddy-65	260	292	552	20	Furrow, drip
Khunapali	Paddy/Nonpaddy	Kharif paddy-100, Rabi nonpaddy-32	132	156	288		Furrow
Parmanpur	Paddy/Nonpaddy	Kharif paddy-392, Rabi nonpaddy-88	480	503	983	25	Furrow
Siriapali	Paddy/Nonpaddy	Kharif paddy-340, Rabi nonpaddy-72	412	456	868	32	Furrow
Total			**7284**	**8712.94**	**9843**	**541**	

Kh-Kharif

Table 6b.Cropping pattern in the study area of Sambalpur District part

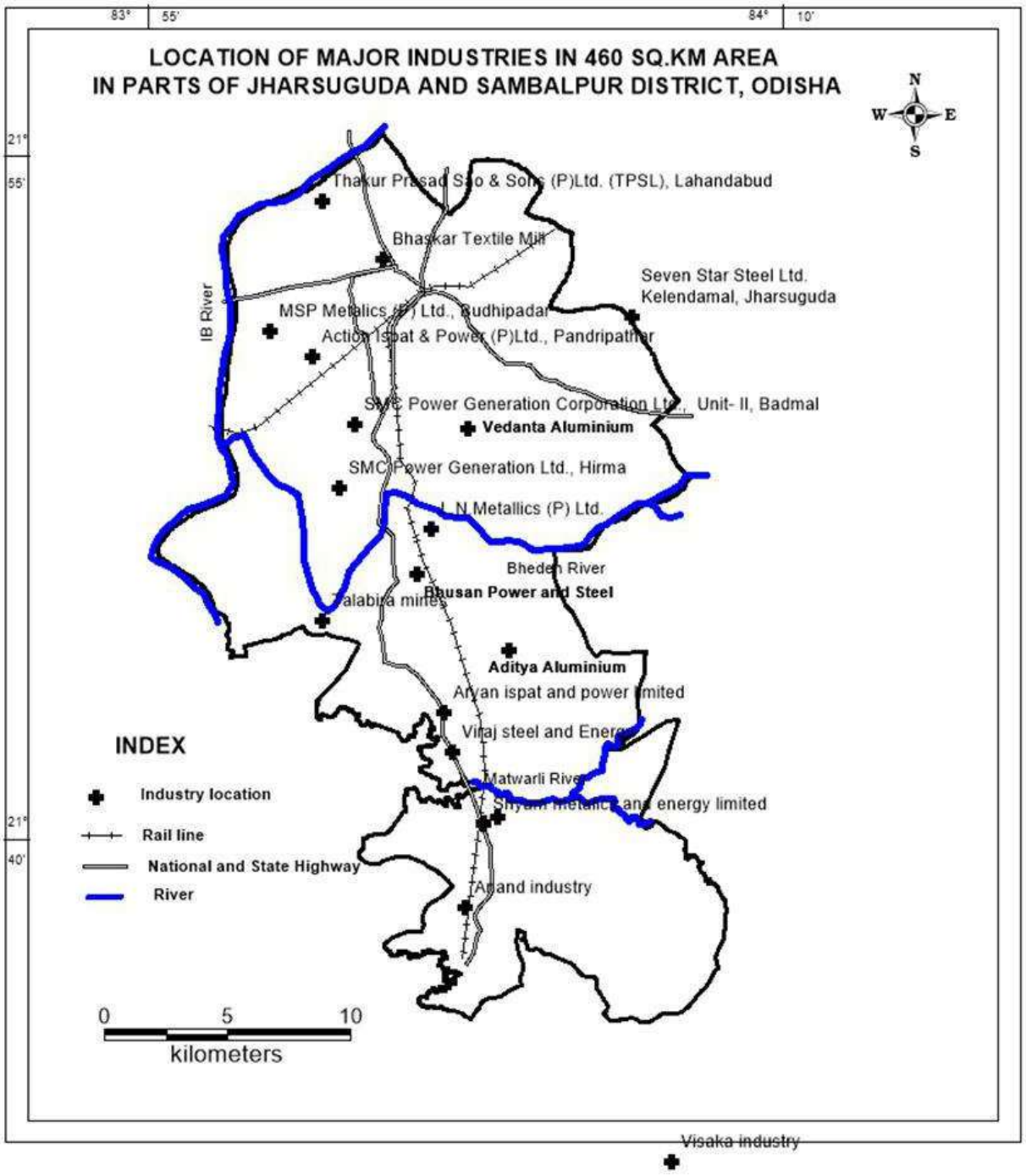
Village	Cropping pattern	Type of crop (Season wise) with area (Ha)	Total Cultivated area (Ha)	Total Cultivable area (Ha)	Gross cropped Area (Ha)	Net Irrigated area (Ha)	Irrigation Type (Furrow/drip/sprinkler)
Babuchakuli	Pddy/Non Paddy	Kharif-Paddy-230, Rabi Non Paddy-140	370	410	880	0	Furrow
Bamaloi	Pddy/Non Paddy	Kharif paddy-170, Rabi Non Paddy-177	347	380	727	0	

Basupali	Pddy/Non Paddy	Kharif paddy-285, Rabi Non Paddy-50	335	345	680	5.5	Furrow
Bhoipali	Pddy/Non Paddy	Kharif paddy-90, Rabi Non Paddy-82	172	195	367	0	
Bhursipali	Pddy/Non Paddy	Kharif paddy-105, Rabi Non Paddy-90	195	220	415	0	0
Brahmanipali	Pddy/Non Paddy	Kharif paddy-300, Rabi Non Paddy-150	450	480	930	0	0
Dantamura	Pddy/Non Paddy	Kharif paddy-40, Rabi Non Paddy-20	60	75	135	5	sprinkler
Derba	Pddy/Non Paddy	Kharif paddy-220, Rabi Non Paddy-40	260	300	560	10	Bore well
Dharopani	Pddy/Non Paddy	Kharif paddy-140, Rabi Non Paddy-145	285	295	580	0	0
Dhubenchhapel	Pddy/Non Paddy	Kharif paddy-10, Rabi Non Paddy-2	12	15	27	2	sprinkler
Gumakarama	Pddy/Non Paddy	Kharif paddy-220, Rabi Non Paddy-40	260	275	535	10	Bore well
Gurupali	Pddy/Non Paddy	Kharif paddy-90, Rabi Non Paddy-65	155	165	320	0	0
Jangala	Pddy/Non Paddy	Kharif paddy-160, Rabi Non Paddy-100	260	280	540	0	0
Jharmunda	Pddy/Non Paddy	Kharif paddy-75, Rabi Non Paddy-40	115	130	245	0	0
Katar-baga	Pddy/Non Paddy	Kharif paddy-400, Rabi Non Paddy-200	600	650	1250	0	0
Kharhiapali	Pddy/Non Paddy	Kharif paddy-240, Rabi Non Paddy-105	345	360	705	0	0
Khinda	Pddy/Non Paddy	Kharif paddy-160 , Rabi Non Paddy-20	180	195	375	10	River lift
Kurla	Pddy/Non Paddy	Kharif paddy-0, Rabi Non Paddy-0	0	0	0	0	0
Lapanga	Pddy/Non Paddy	Kharif paddy-260, Rabi Non Paddy-80	340	360	700	0	0
Laumal	Pddy/Non Paddy	Kharif paddy-100, Rabi Non Paddy-50	150	180	330	0	0
Ludhapali	Pddy/Non Paddy	Kharif paddy-150, Rabi Non Paddy-75	225	290	515	0	0

Nishanbhanga	Pddy/Non Paddy	Kharif paddy-140, Rabi Non Paddy-35	155	165	320	0	0
Nuarampela	Pddy/Non Paddy	Kharif paddy-218, Rabi Non Paddy-95	313	340	653	50	MLIP
Nuatiligi	Pddy/Non Paddy	Kharif paddy-50, Rabi Non Paddy-25	75	80	155	0	0
Pondloi	Pddy/Non Paddy	Kharif paddy-90, Rabi Non Paddy-15	205	205	410	0	0
Pudapada	Pddy/Non Paddy	Kharif paddy-20, Rabi Non Paddy-5	25	35	60	0	0
Salad	Pddy/Non Paddy	Kharif paddy-180, Rabi Non Paddy-120	368	380	748	20	MIP
Talabira	Pddy/Non Paddy	Kharif paddy-60, Rabi Non Paddy-30	90	100	190	5	sprinkler
Thelkoloi	Pddy/Non Paddy	Kharif paddy-60, Rabi Non Paddy-30	90	110	200	20	River lift
Thurupali	Pddy/Non Paddy	Kharif paddy-200, Rabi Non Paddy-100	300	330	650	0	0
Forest+Hill	Pddy/Non Paddy	0	0	0	0	0	0
Tilaimal	Pddy/Non Paddy	Kharif paddy-145, Rabi Non Paddy-400	295	325	620	0	0
Rengali CT	Pddy/Non Paddy	Kharif paddy-400, Rabi Non Paddy-130	530	680	1210	105	Furrow-100, Sprinkler-5
Total			**7562**	**8350**	**16032**	**242.5**	

DETAILS OF THE INDUSTRIES: Details of industry data taken from the Brief Industry Profile of Jharsuguda and Sambalpur district published by Ministry of MSME, Government of India during the year 2019-20. There are 14 number of large scale industries, 20 number of Medium scale industries and 20 number of MSME located in the study area parts of Jharsuguda District. Similarly there are 8 number of large scale industries, 2 number of Medium scale industries and 2 number of MSME clusters located in the study area parts of Sambalpur District.Large scale industries are mainly thermal power plant cum iron, steel, aluminium type.Water requirement of all major industries are met by surface water supply schemes.The details are given Annexure-1.These are located adjacent to the highway connecting Sambalpur – Jharsuguda .Talabira Coal mine under Neveyli Lignite Corporation is also located at near Khinda and Patrapali village.Location of major industries are given in Fig.8.

Fig.8: Location of Major Industries in the Study area



3. PRIORITY AREA

Main industrial units are Industrial machinery, Metal and Steel plants (Bhusan Steel Plant, Vedanta Aluminium), Thermal power plants etc. Reported contaminants as per pollution study are Fe,Mn, Pb and F. Possible sources of contaminants will be the Industrial effluent discharges, fly ash discharge from Thermal Power Plant. The priority area is chosen only on the basis of pollution study in Industrial cluster in parts of Jharsuguda and Sambalpur District during the year 2010 and 2016.

4. PREVIOUS STUDY

The Sambalpur and Jharsuguda District were geologically studied by Geological Survey of India and prepared the geological map of the district of the district. The district has been covered under Regional Systematic Hydrogeological Survey by the officers of CGWB,SER,Bhubaneswar during the year 1988-89. Ground Water exploration in both the district have been conducted during 1988-2005 as well as during 2019-23. NAQUIM study of the Jharsuguda District carried out in AAP 2019-20 and also NAQUIM study of Sambalpur District carried out during AAP 2022-23. District brochure have been compiled during 2007. Industrial pollution cluster report have been compiled during 2010 and published recently. Ground water resources assessment report published during 2001,2004,20013,2017,2020,2022.

5. OBJECTIVES OF THE PRESENT STUDY

The objectives of the study are

i) Demarcation of contaminants zone (zonation of the area, aquifer identification of poor quality),

ii) Identification of fresh ground water sources for drinking water supply.

iii) Drinking water source sustainability plan (Recharge area identification, measures for source sustainability, and if required, identification of alternate source for water supply).

iv) Tracing sources for contamination.

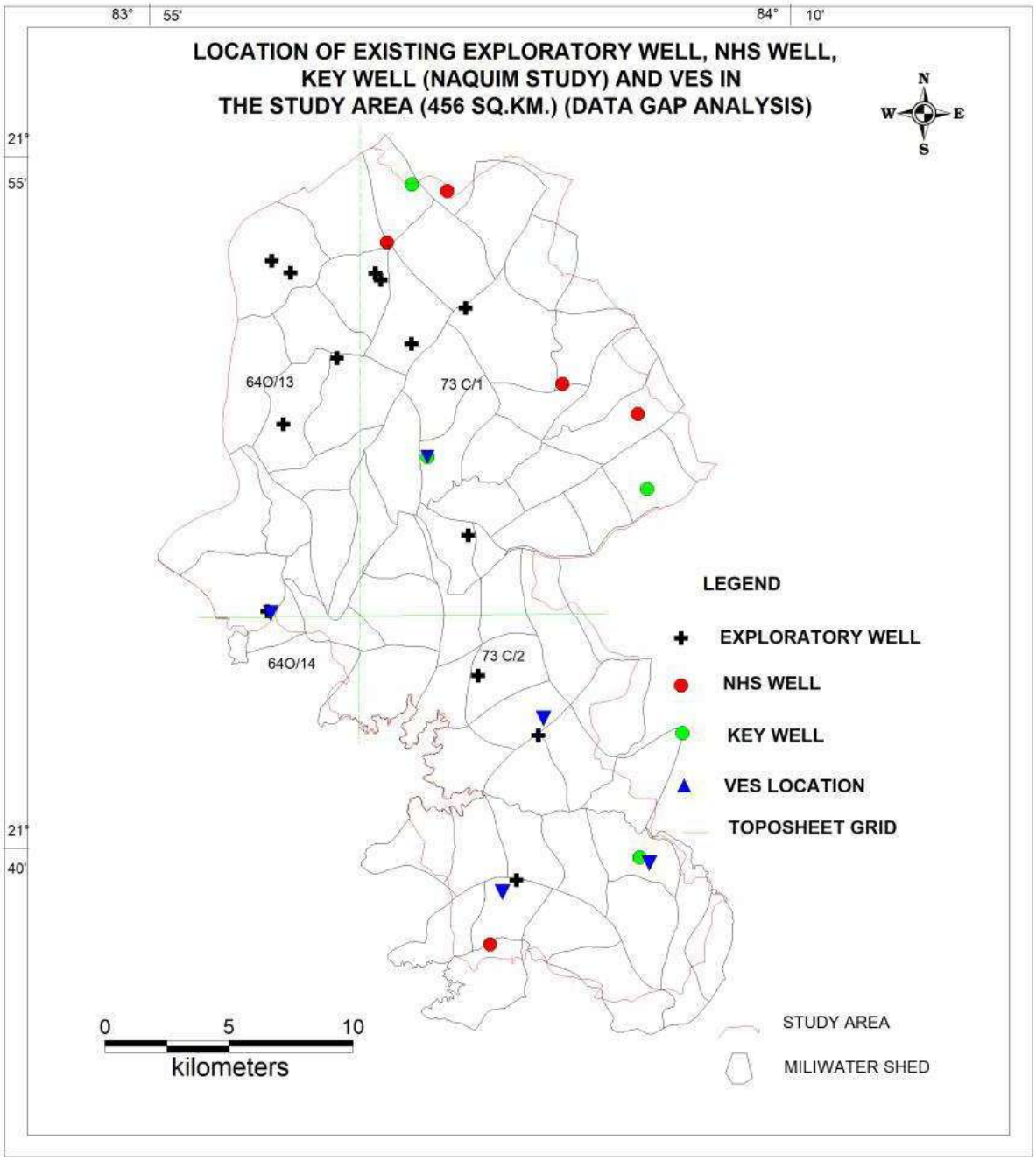
v) Suggesting regulatory measures for prevention of contamination.

EXISTING DATA: The total number of exploratory well, NHS well, Key wells and VES are 13, 4, 4 and 5 numbers respectively (Fig.9).

DATA GAP ANALYSIS: There are 64watershed present in the study area. Out of this monitoring well present only in 9 watershed and VES presnt only in 5 watershed.EW present only in 10 watershed area.(Fig.9).

DATA GENERATION: There are 107 key wells fixed for water level monitoring, 201 number of samples collected for basic parameter analysis and 160 samples collected for heavy metal analysis, 6 EW,1 OW constructed by departmental rig, 40 number of inhouse VES conducted, 17 number of pumping test conducted, 108 number of farmers feedback collected and villagwise data collected for population, household, number of ponds number of water conservation structure from BDO,Rengali,Kolabira and Jharsuguda Block,, irrigation data from Watershed, MI,OLIC,Megalift irrigation department, rainfall data, land use data, geomorphology data from State Government, NHS data from Ground Water Departments and cropping pattern data from Agriculture departments. The details are discussed in different chapters.

Fig.9:Location of Existing EW,NHS, Key Well and VES in study area



6. HYDROGEOLOGY AND AQUIFER DISPOSITION

Hydrogeologically the area composed of semiconsolidated formation and consolidated formation. Gondwana sandstone, shale and coal are found within semiconsolidated formation. There are four number of exploratory wells constructed in semiconsolidated Gondwana Formation upto a maximum drilling depth of 150 mbgl with a discharge of only 0.5 lps. Under consolidated formation there are 14 number of exploratory wells constructed in granite gneissupto maximum depth of 200 mbgl with a discharge ranges from 0.2 lps to 7.8 lps.Only one exploratory well constructed in micaschist having discharge of 0.23 lps. No exploratory drilling conducted in the quartzite formation. (Table-7).The area occupied by semiconsolidated formation is 110.5 sq.km and by consolidated formation is 345 sq.km. Hydrogeological map is given in Fig.11.

Table 7: Details of Exploratory Drilling Conducted Study Area

Sl. No.	District	Block	Location	Latitude in decimal	Longitude in decimal	Depth drilled (mbgl)	Lithology	Depth to Bed rock (mbgl)	Fracture zone deciphered (mbgl)	SWL (mbgl)	Discharge (lps)	Drawdown (m)	T
1	Sambalpur	Rengali	Lapanga	21.7291	84.0447	188	Gr. Gneiss	21		4.6	0.2		
2	Sambalpur	Rengali	Rengali	21.6965	84.1095	166.3	Gr. Gneiss	16.4	15,44,50,155	5.94	7	19.51	
3	Sambalpur	Rengali	Rengali	21.6965	84.1095	172.4	Gr. Gneiss	16.9	26	6.5	1.4	-	
4	Sambalpur	Rengali	Sasan	21.7075	84.0682	200	Gr. Gneiss	38.52		3.8	0.3	-	
5	Jharsuguda	Jharsuguda	Sarbahal	21.8441	83.9897	200	Gr. Gneiss	NA	43	NA	3.5	NA	14.37
6	Jharsuguda	Jharsuguda	Jharsuguda	21.8747	84.0046	200	Mica. Schist,	NA	24	NA	1.5	NA	NA
7							Granite gneiss						
8	Jharsuguda	Jharsuguda	H Katapalli	21.8749	83.9717	56.9	Gr. Gneiss intruded by pegmatite	17.6	19-21, 30-35	NA	1.8	NA	37.97
9	Jharsuguda	Jharsuguda	JhandaChack	21.8492	84.0187	150	Gr. gneiss	14.6	58-59	NA	0.4	NA	NA
10	Jharsuguda	Jharsuguda	Patrapalli	21.7525	83.9625	150	Gondwana Shale	19.5	66-68	NA	0.5	NA	NA
11	Jharsuguda	Jharsuguda	Singhabaga	21.8201	83.9689	150	Gondwana Shale	10.98	NA	NA	0	NA	NA
12	Jharsuguda	Jharsuguda	Orissa state armed police barrack	21.8723	84.0067	105	Micaschist intruded by granite	19.5	49	NA	0.5	NA	NA
13	Jharsuguda	Jharsuguda	GhutghutiPata	21.8792	83.9644	51	Gondwana Siltstone, shale	NA	NA	NA	0	NA	NA
14	Jharsuguda	Jharsugu	Sripura	21.7799	84.0408	151	Gr.	21.5	60-62	NA	0.8	NA	N

		da					gneiss						A
15	Jharsuguda	Jharsuguda	Bhadeimunda	21.8621	84.0399	137	Gr. gneiss	18.02	18-19, 60-62	NA	0	NA	NA
16	Jharsuguda	Kolabira	Parmanpur	21.80292	84.10766	199.5	Gr. gneiss	19.6	129.4-135	NA	0.23	NA.	NA
17	Jharsuguda	Kolabira	Siriapali	21.831159	84.088533	199	Gr. gneiss	20	98.9-111	NA	0.23	NA.	NA
18	Sambalpur	Rengali	Golamal	21.649758	84.094301	107.9	Gr. gneiss	15.4	62,97.70	7.1	7.8	20.19	10
19	Sambalpur	Rengali	Khinda	21.742613	83.98663	132.4	Gondwana sandstone,shale	19.5	83.60-86.60	18.5	0.5		

As per table 7 and Annexure-2, it can be inferred that aquifer can be grouped into upper weathered zone and lower fracture zone.Thickness of weathered zone varies from 10.98 to 38.52 mbgl, but average thickness is about 20 meter.So thickness of aquifer within weathered zone varies from 6.48 to 34.02 meter, considering 4.5 mbgl average water level. But fracture zone is seen in different depth below weathered zone upto a depth of 100 mbgl.Thickness of fracture zone varies from 0.5 to 1.5 meter. T value of fractured aquifer varies from 10 to 37.97 m/day.On the basis of lithology data two dimensional cross sections and three dimensional model also prepared (Fig.10,12).

Fig.10: Three Dimensional panel diagram in study area

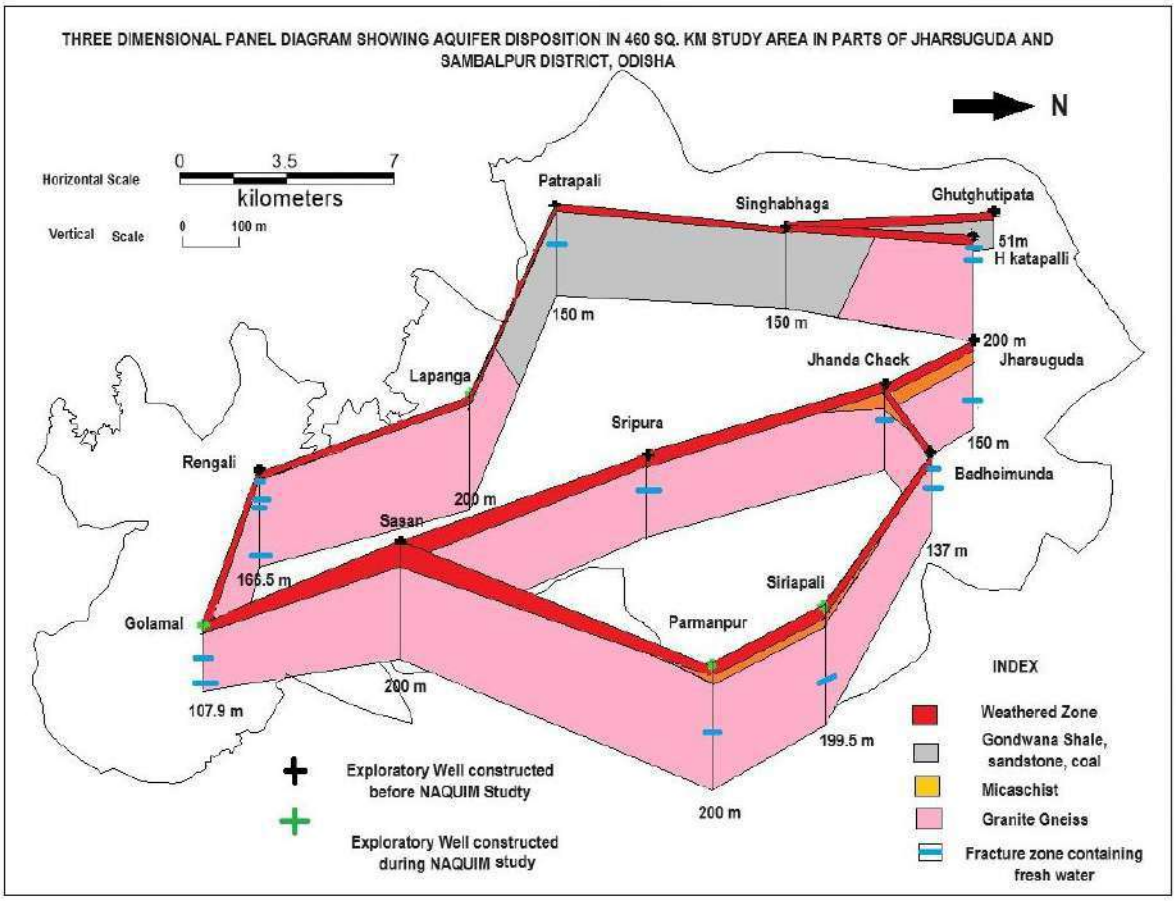


Fig.11. Hydrogeological map of the Study area.

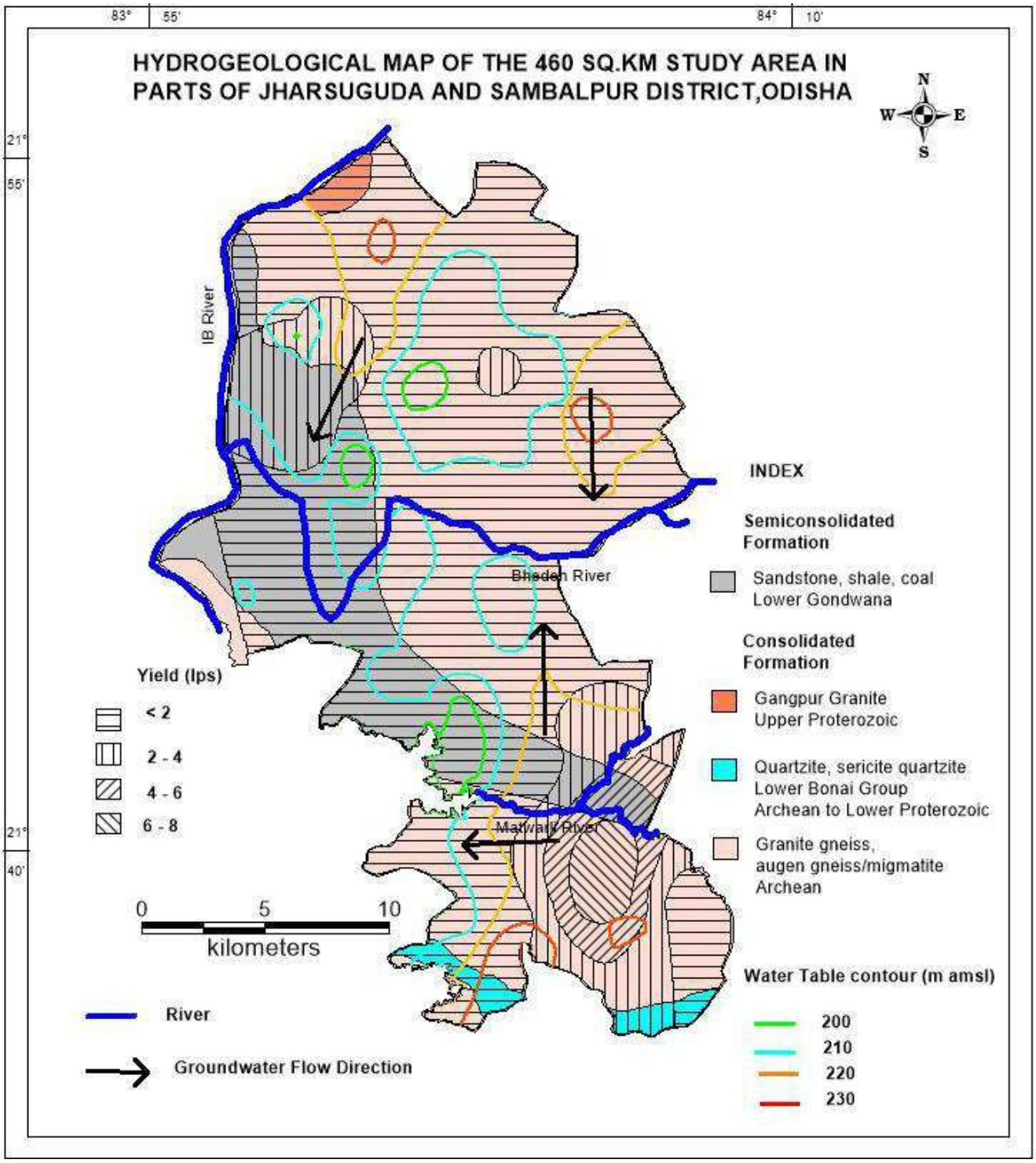


Fig.12a. Cross section in different direction.

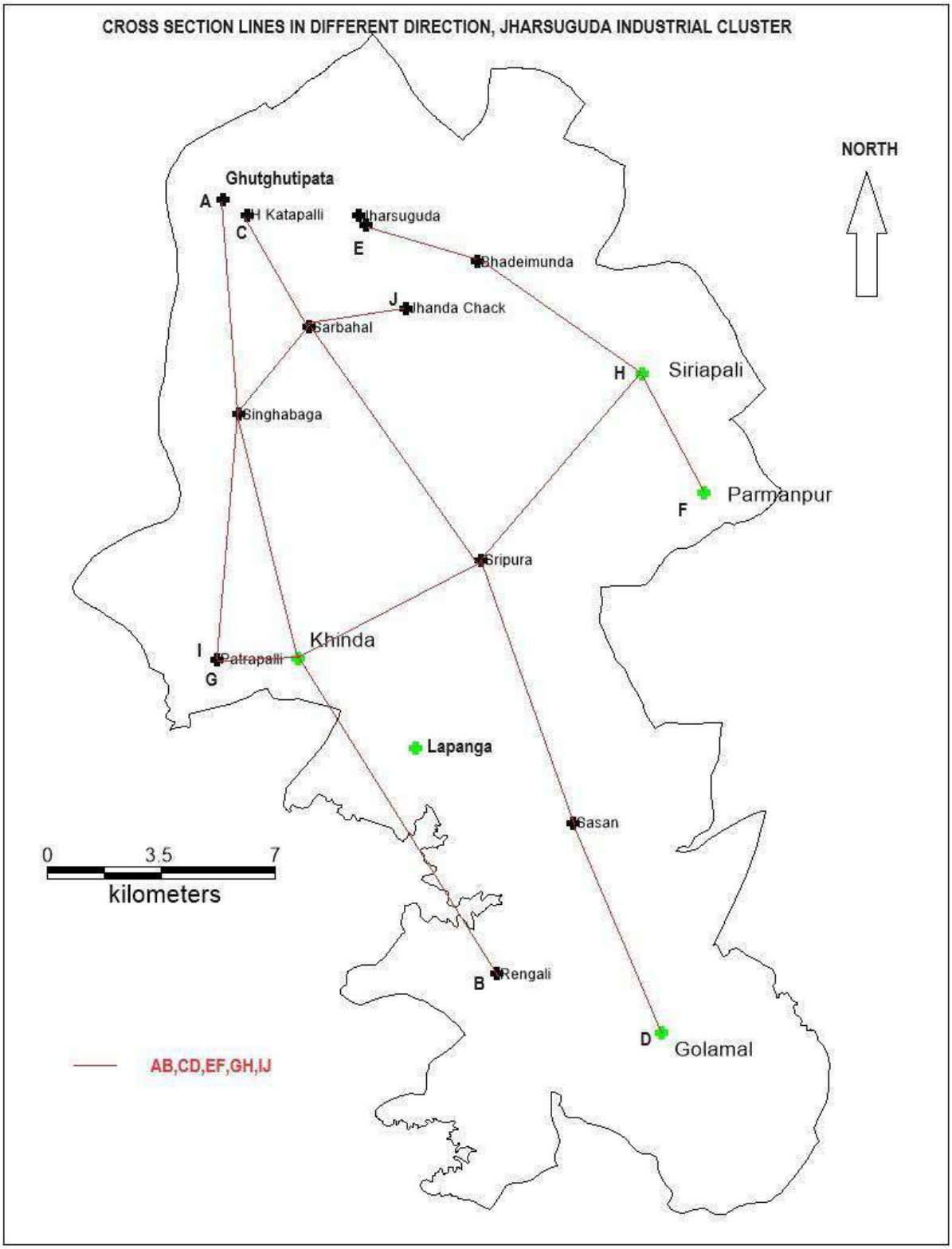


Fig.12b. Cross Section in AB direction.

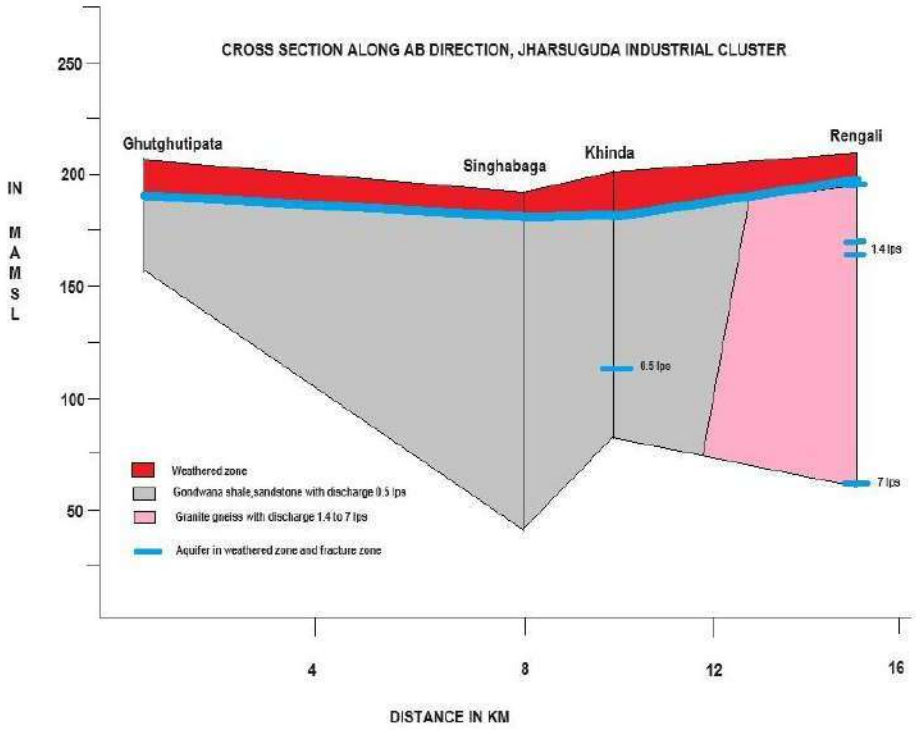


Fig.12c. Cross Section in CD direction.

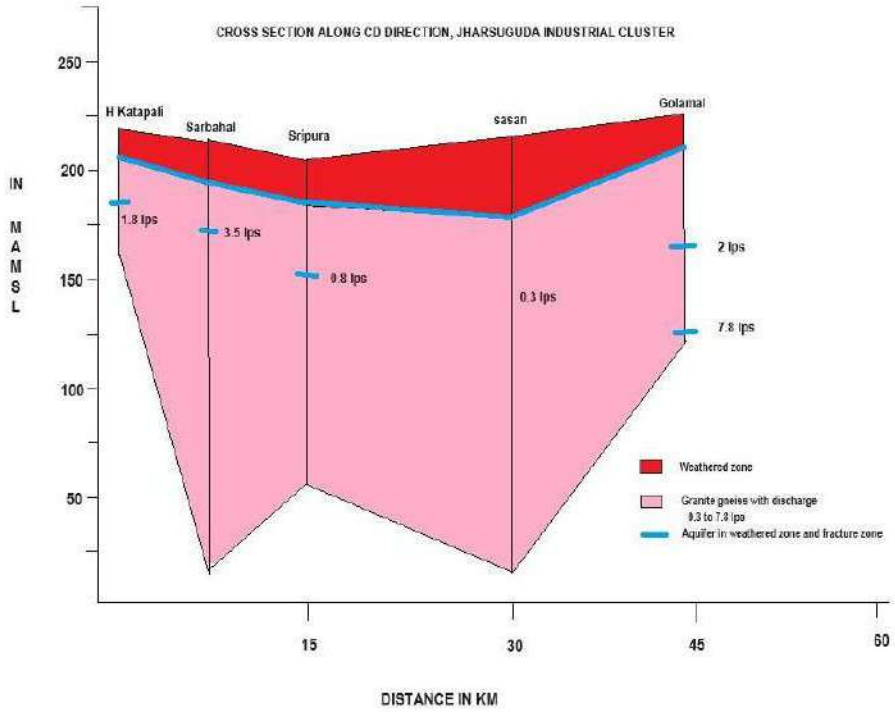


Fig.12d. Cross Section in EF direction.

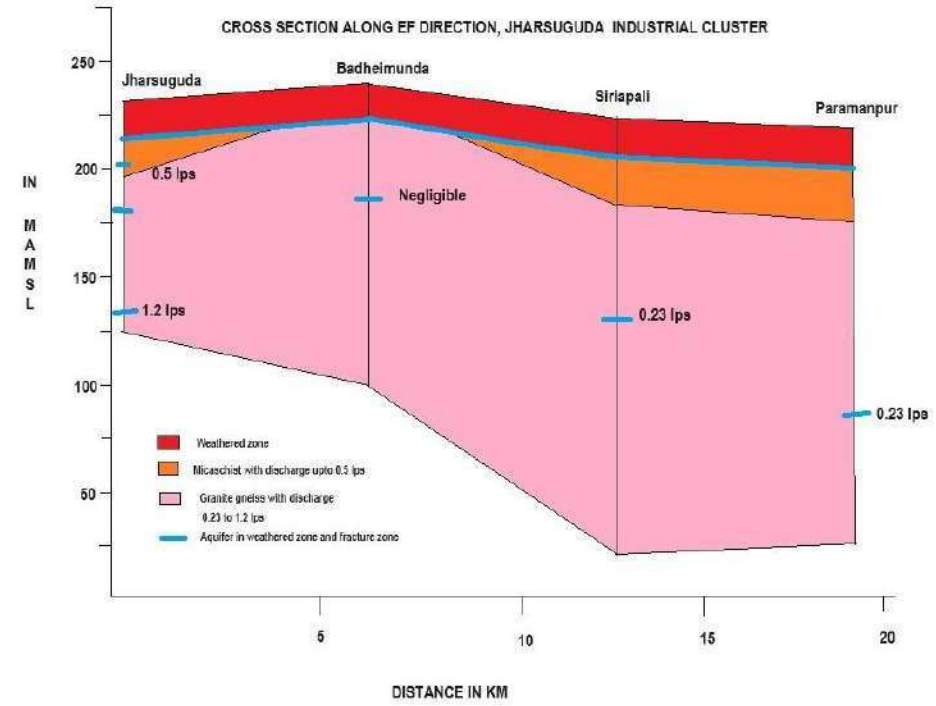


Fig.12e. Cross Section in GH direction.

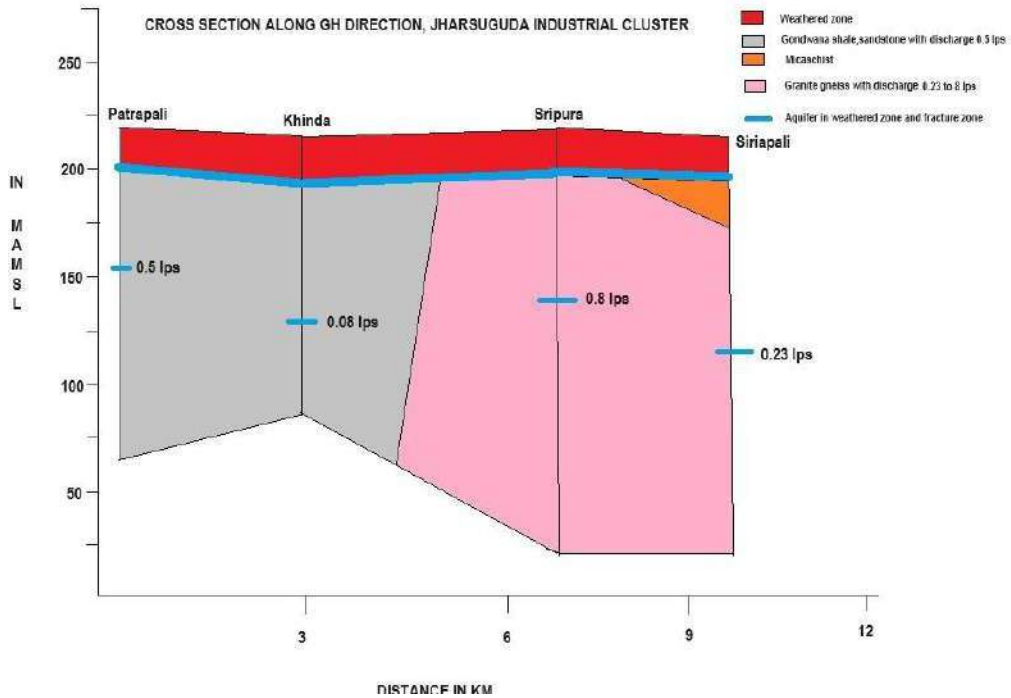
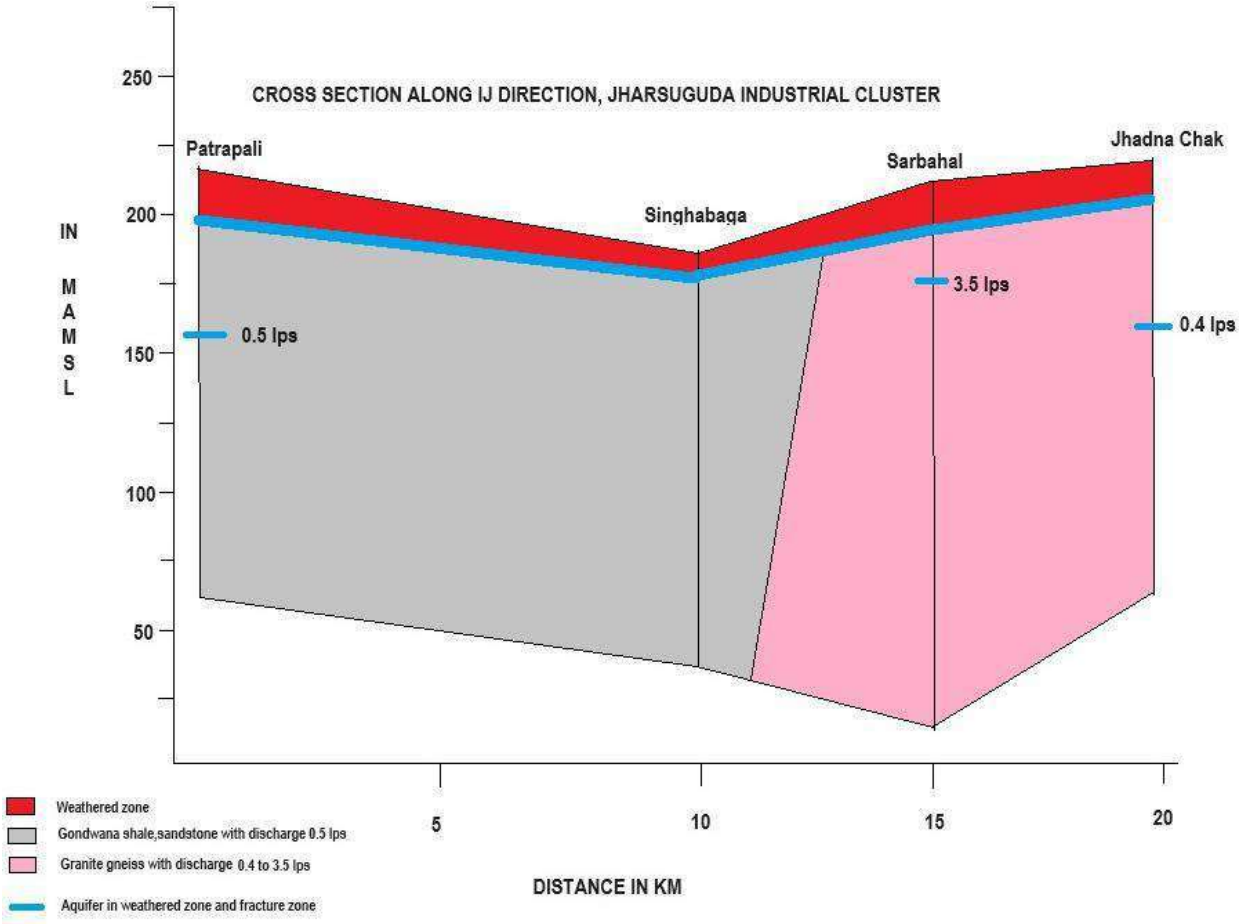


Fig.12f. Cross Section in IJ direction.



7. AQUIFER-WISE GROUND WATER LEVEL

Premonsoon depth to water level of shallow(phreatic) aquifer ranges from 2.22 to 10.5 mbgl and Water table varies from 187.8 m amsl to 233.01 mamsl and postmonsoon depth to water level of shallow(phreatic) aquifer ranges from 0.88 to 5.25 mbgl and Water table varies from 192.51 m amsl to 234.5 mamsl (Fig.13a,b,c,d). Annual fluctuation of shallow aquifer varies from 0.3 to 6.37 m rising (Fig.13e). Premonsoon depth to water of deep (fractured) aquifer ranges from 1.91 to 38.4 mbgl and Water table varies from 169.9 m amsl to 229.3 mamsl and postmonsoon depth to water of deep(fractured) aquifer ranges from
1.35 to 23.27 mbgl and Water table varies from 185.03 m amsl to 231.63 mamsl (Fig.14a,b,c,d). Annual fluctuation of fractured aquifer varies from 0.58 to 19.56 m rising in majority of the wells and 1.91 to 4.61 m falling only in three wells (Parmitilla, Panchpada, Badmal Chawk) (Fig.14e).Decadal water level trend shows 0.48 m decline in 18.59 sq.km area near extreme north of the study area and rising from 0.4 to 1.35 m in rest of the area (Fi.15). Few Hydrographs are given in Fig.16.

Table.8a: Details of Dug Wells showing RL, MP, Dia, Depth , Water Level (pre and post),fluctuation and Water Table.

Sl. No.	Name	Type	Long	Lat	RL mamsl	MP	SWL(mbgl)Pre	Water Table (pre)	SWL(mbgl)Post	Water Table (post)	Fluctuation (m)	Dia	Deph (m)
1	Jharsuguda	Dug well	84.00307	21.85326	226.5	0.7	4.3	222.2	1.24	225.26	3.06	3.55 m	11.5
2	Beherapat	Dug well	83.99444	21.86551	224.7	0.62	8.41	216.29	4.63	220.07	3.78	3.7 m	15
3	Lahanabud	Dug well	83.98215	21.88674	220.7	0.72	8.48	212.22	2.11	218.59	6.37	2.73 m	15
4	Budhipadar	Dug well	83.95944	21.85813	213.5	0.68	7	206.5	2.92	210.58	4.08	4.63 m	20
5	Marakuta	Dug well	83.97377	21.85218	202.5	0.51	3.38	199.12	1.69	200.81	1.69	3.03 m	5.83
6	Pandripathar	Dug well	83.9848	21.84424	222.5	0.52	7.08	215.42	3.32	219.18	3.76	2.68 m	7.54
7	Singhabaga	Dug well	83.98162	21.83044	220.4	0.42	7.43	212.97	2.83	217.57	4.6	2.35 m	9.52
8	Brundamal	Dug well	84.01107	21.80793	218.8	0.32	3.2	215.6	1.95	216.85	1.25	1.42 m	5.8
9	Kukurjhanga	Dug well	84.00282	21.81977	221.3	0.42	6.1	215.2	2.58	218.72	3.52	4.38 m	8.56
10	Hirma	Dug well	83.98641	21.79581	213.5	0.38	4.47	209.03	3.67	209.83	0.8	1.1 m	7.2
11	Dhuben Chhapal	Dug well	84.00784	21.74445	212	0.58	8.77	203.23	2.9	209.1	5.87	1.54 m	12.54
12	Ramchandrapur	Dug well	84.01692	21.77851	209.1	0.3	4.82	204.28	3.1	206	1.72	2.31 m	6.9

13	Tumbeikala	Dug well	84.00164	21.78428	217	0.5	7.46	209.54	3.6	213.4	3.86	1.6 m	10
14	Khinda	Dug well	83.98997	21.74173	212.7	0.65	7.35	205.35	5.25	207.45	2.1	3.8 m	11.72
15	Khodupada	Dug well	83.97113	21.73952	211.2	0.2	5.3	205.9	2.6	208.6	2.7	4.1 m	13.52
16	Malda	Dug well	83.97012	21.7822	208.6	0.55	7.11	201.49	3.8	204.8	3.31	3.2 m	17
17	Dumramunda	Dug well	83.93947	21.7754	202.8	0	5.9	196.9	1.75	201.05	4.15	3.9 m	6.45
18	Patrapali	Dug well	83.95264	21.76184	212.3	0.75	4.25	208.05	2.05	210.25	2.2	2.8 m	7.4
19	Brundamal 2	Dug well	84.02291	21.80957	210.2	0.6	5.94	204.26	2.2	208	3.74	3.6 m	8.54
20	Bhagipali	Dug well	84.03712	21.7926	220.6	0	4.85	215.75	2.2	218.4	2.65	4.25 m	5.5
21	Katikela	Dug well	84.07573	21.78817	218.3	0.5	8.3	210	3.8	214.5	4.5	1.32 m	10.42
22	Dabka	Dug well	84.09459	21.79644	225	0.3	10.5	214.5	4.2	220.8	6.3	4.62 m	11.53
23	Paramanpur	Dug well	84.10872	21.79761	217	0.72	4.78	212.22	2.58	214.42	2.2	2.3 m	8.25
24	Kaputikra	Dug well	84.09027	21.80913	216.5	0.68	7.06	209.44				1.64 m	7.8
25	Tharkimal	Dug well	84.07536	21.82243	222.6	0.32	10.14	212.46	5.13	217.47	5.01	2.20 m	11.52
26	Siriapali	Dug well	84.08394	21.82607	234.5	0.7	3.43	231.07		234.5		2.46 m	7.3

27	Siriapali 2	Dug well	84.0773	21.83469	205.1	0.6	8.2	196.9	2	203.1	6.2	4.3 m	14
28	Dalki	Dug well	84.05107	21.84463	208.4	0	6.69	201.71	3.16	205.24	3.53	5.13 m	8.22
29	Badheimunda	Dug well	84.03426	21.86573	206.6	0.8	4.4	202.2	1.7	204.9	2.7	2.84 m	13.2
30	Phulchanger	Dug well	84.03773	21.71672	203.3	0.6	7.04	196.26	4.54	198.76	2.5	2.26 m	8.05
31	Bamaloi	Dug well	84.03725	21.69799	198.8	0	8.1	190.7	4.45	194.35	3.65	3.72 m	9
32	Kaliapada	Dug well	84.04504	21.68237	218.7	0.75	2.65	216.05	2.35	216.35	0.3	1.5 m	8.95
33	Charupada	Dug well	84.05454	21.67924	223.2	0.68	3.63	219.57	1.92	221.28	1.71	1.3 m	8
34	Binjipali	Dug well	84.06654	21.69537	223.8	0	4.93	218.87	1.8	222	3.13	2.72 m	8.7
35	Baragarh	Dug well	84.07167	21.70759	224.7	0	6.4	218.3	2.4	222.3	4	4.23 m	10.5
36	Tileimal	Dug well	84.07042	21.72066	225.8	0.4	6	219.8	1.4	224.4	4.6	1.6 m	8.2
37	Bomlai 2	Dug well	84.05928	21.72498	217.4	0.55	5.75	211.65	2.97	214.43	2.78	2.0 m	7.4
38	Banjiberna	Dug well	84.04051	21.7471	221.5	0	6.45	215.05	2.6	218.9	3.85	2.7 m	8.5
39	Gumkarma	Dug well	84.0532	21.75048	202.5	0	7.58	194.92	1.5	201	6.08	1.7 m	10
40	Derba	Dug well	84.07368	21.74531	218.5	0.15	6.97	211.53	3.85	214.65	3.12	3.21 m	8.04

41	Lapanga	Dug well	84.02235	21.72701	216	0.44	7.84	208.16	4.36	211.64	3.48	2.27 m	11.14
42	Jharmunda	Dug well	84.02623	21.66501	210.4	0.47	6.43	203.97	1.63	208.77	4.8	2.16 m	8.05
43	Rengali	Dug well	84.04081	21.641	211.5	0.45	5.61	205.89	3.35	208.15	2.26	1.82 m	8.09
44	Rampela	Dug well	84.05437	21.63106	235.2	0.6	2.22	232.98	0.88	234.32	1.34	1.1 m	3.2
45	Bagmunda	Dug well	84.09091	21.63128	224.7	0.4	5.4	219.3	1.33	223.37	4.07	5.15 m	6.5
46	Kadalipita	Dug well	84.09584	21.62391	226.5	0.28	7.02	219.48	2.62	223.88	4.4	4.22 m	10.1
47	Brahmanpalli	Dug well	84.10143	21.63718	237.2	0.45	4.19	233.01	2.85	234.35	1.34	3.06 m	10
48	Thuropali	Dug well	84.14029	21.64101	223	0.35	5.41	217.59	2.05	220.95	3.36	2.23 m	10.5
49	Katarbaga	Dug well	84.12605	21.64579	226.6	0.43	4.37	222.23	2.65	223.95	1.72	2.7 m	6.53
50	Parmitila	Dug well	84.08879	21.64927	224.3	0.55	6.57	217.73	3.65	220.65	2.92	2.86 m	10
51	Industrial JSM	Dug well	84.00798	21.88622	233.1	0.65	3.15	229.95	1.55	231.55	1.6	3.23 m	9.65
52	Panchapada JSM	Dug well	84.00832	21.89937	231.8	0.32	4.04	227.76	2.58	229.22	1.46	2.2 m	8.3
53	Malimunda	Dug well	84.0599	21.90238	218.1	0	5.41	212.69	2.1	216	3.31	3.06 m	8.4
54	Jharmunda 2	Dug well	84.06992	21.86879	217.6	0.46	5.59	212.01	2.64	214.96	2.95	3.93 m	10

55	Kallopatra	Dug well	83.99848	21.80655	196.6	0.41	8.8	187.8	4.09	192.51	4.71	3.14 m	9.5
56	Gauntiapada	Dug well	84.01922	21.83308	200.9	0.25	6.57	194.33	1.85	199.05	4.72	3.12 m	7.28
57	Kurebaga	Dug well	84.0571	21.81601	210.9	0.22	7.57	203.33	3.88	207.02	3.69	2.21 m	9.1

Table.8b: Details of Hand pump and Bore Wells showing RL, MP, Dia, Depth , Water Level (pre and post),fluctuation and Water Table.

Sl. No.	Name	Type	Long	Lat	RL mamsl	MP	SWL(mbgl)Pre	Water Table (pre)	SWL(mbgl)Post	Water Table (post)	Fluctuation (m)	Dia	Deph (m)
1	Jharsuguda	B/W	84.005669	21.853553	223.1	1.72	5.38	217.72	1.7	221.4	3.68	20 cm	61
2	Beherapat	H/P	83.994148	21.865582	224.2	0.54	11.4	212.8	5.49	218.71	5.91	15 cm	45.75
3	Lahanabud	H/P	83.982527	21.885863	223.8	0.63	9.73	214.07	1.97	221.83	7.76	15 cm	36.6
4	Hansamurkatapali	B/W	83.969153	21.882346	213.3	0.41	5.58	207.72	1.64	211.66	3.94	15 cm	67.1
5	Budhipadar	H/P	83.960419	21.858582	214.3	0.68	8.73	205.57	4.42	209.88	4.31	15 cm	45.75
6	Marakuta	H/P	83.97444	21.851851	207.2	0.3	5.08	202.12	2.78	204.42	2.3	15 cm	45.75
7	Pandripathar	H/P	83.984723	21.845592	214	0.5	7.98	206.02	3.7	210.3	4.28	15 cm	45.75
8	Dipaparha	B/W	84.001351	21.844321	206.4	0.25	3.44	202.96	1.8	204.6	1.64	20 cm	45.75
9	Singhabaga	H/P	83.981618	21.83044	204.9								45.75
10	Badmal	B/W	84.007792	21.823102	207.1	0.55	10.89	196.21	6.55	200.55	4.34	20 cm	76.25
11	Brundamal(Badmal)	H/P	84.008217	21.817009	219.5	0.65	20.75	198.75	17.25	202.25	3.5	15 cm	91.5
12	Kukurjhanga	B/W	84.00376	21.819537	213.6	2.15	6.15	207.45	2.1	211.5	4.05	15 cm	91.5
13	Kukurjhanga	H/P	84.00268	21.819963	216	0.51	10.76	205.24	5.44	210.56	5.32	15 cm	61
14	Hirma	H/P	83.986409	21.795814	216.3								
15	Hirma	H/P	83.995265	21.789547	216.2	0.4	6.21	209.99	3.05	213.15	3.16	15cm	76.25
16	Dhuben Chhapal	B/W	84.014996	21.747346	216.2	0.1	5.54	210.66	2.36	213.84	3.18	15 cm	61
17	Ramchandrapur	H/P	84.021955	21.778789	216.7	0.55	6.72	209.98	4.75	211.95	1.97	15 cm	45.75
18	Khinda	B/W	83.990346	21.741346	209.8	1.55	9.29	200.51	1.7	208.1	7.59	20 cm	91.5
19	Malda	H/P	83.970278	21.781165	197.7								61
20	Brundamal 2	H/P	84.023132	21.808986	210.3	0.7	6.6	203.7	2.3	208	4.3	15 cm	61
21	Bhagipali	H/P	84.037831	21.792756	219.4	0.42	10.74	208.66	5.63	213.77	5.11	15 cm	61
22	Bhagipali	B/W	84.037782	21.792901	219	0.65	10.97	208.03	5.97	213.03	5	15 cm	61

23	Dabka	H/P	84.094386	21.796149	224.6	0.36							61
24	Kaputikra	H/P	84.090444	21.80974	217.4	0.8							61
25	Siriapali	B/W	84.084979	21.826942	233.7	0	5.45	228.25				15 cm	61
26	Dalki	H/P	84.051067	21.844633	211.3								
27	Badheimunda	B/W	84.03444	21.86556	209.1	0.35	7.15	201.95				20 cm	76.25
28	Phulchanger	H/P	84.036928	21.718568	204.2	0.7	13.43	190.77	7.63	196.57	5.8	15 cm	76.25
29	Bamaloi	H/P	84.0373	21.697246	199.4	0.45	7.89	191.51	3.55	195.85	4.34	15 cm	61
30	Kaliapada	B/W	84.044813	21.68213	222.9	0.45	4.33	218.57	3.31	219.59	1.02	20 cm	76.25
31	Charupada	H/P	84.054641	21.679038	229	0.5							61
32	Baragarh	B/W	84.07187	21.707625	224.9	0.8	7.43	217.47	2.63	222.27	4.8	20 cm	76.25
33	Tileimal	H/P	84.07042	21.720659	217.8								61
34	Banjiberna	B/W	84.040745	21.74708	226.9	0.45	6.57	220.33	2.95	223.95	3.62	20 cm	76.25
35	Gumkarma	B/W	84.052668	21.75014	216.1	0.55	7.7	208.4	4.65	211.45	3.05	20 cm	76.25
36	Derba	H/P	84.07476	21.744192	219.3	0.5							76.25
37	Ramchandranagar	B/W	84.051699	21.658579	208.4	1	29.86	178.54	10.3	198.1	19.56	20 cm	122
38	Ramchandranagar	B/W	84.051952	21.657626	208.3	1.5	38.4	169.9	23.27	185.03	15.13	20 cm	122
39	Jharmunda	B/W	84.02807	21.663659	208.3	0.56	10.08	198.22	5.14	203.16	4.94	20 cm	76.25
40	Rengali	H/P	84.040195	21.641545	233.4								
41	Rengali	B/W	84.038057	21.643552	236.6	0.4	19.2	217.4	12.38	224.22	6.82	20 cm	91.5
42	Rengali 2	B/W	84.047365	21.634737	233.1	0.25	3.8	229.3	2.45	230.65	1.35	20 cm	91.5
43	Rampela	B/W	84.053121	21.629385	226.5	0.35	4.12	222.38				20 cm	76.25
44	Bagmunda	H/P	84.090905	21.631281	227.6	0.5							76.25
45	Kadalipita	B/W	84.094995	21.622688	233.7	0.45	8.75	224.95	3.81	229.89	4.94	20 cm	97.6
46	Thuropali	H/P	84.140238	21.641396	225.1								76.25
47	Katarbaga	H/P	84.126517	21.645545	225.6	0.5							61
48	Lubhapali	H/P	84.106424	21.658202	225.1	0.5							76.25
49	Parmitila	H/P	84.089008	21.647267	218.3	0.55							
50	Parmitila	B/W	84.088833	21.647416	217.5	0.51	14.38	203.12	16.29	201.21	**-1.91**	20 cm	76.25

51	OMP JSM	H/P	84.032837	21.89443	213.7								
52	OMP JSM	B/W	84.029665	21.888868	234.4	0.43	6.37	228.03	2.77	231.63	3.6	20 cm	
53	Tewararidham	B/W	84.009312	21.853296	234.7	0.4	7.86	226.84				15 cm	61
54	Industrial JSM	H/P	84.007995	21.887121	238	0.58							61
55	Bidyanagar JSM	H/P	84.007176	21.889337	223.1	0.4	4.88	218.22	3.47	219.63	1.41	15 cm	61
56	Panchapada JSM	B/W	84.005723	21.898031	226.8	0.85	4.18	222.62	1.35	225.45	2.83	15 cm	76.25
57	Panchapada JSM	H/P	84.007156	21.908428	217.7	0.4	16.82	200.88	19.4	198.3	**-2.58**	15 cm	45.75
58	Malimunda	H/P	84.059223	21.902222	220.8	0.41	6.1	214.7	2.86	217.94	3.24	15 cm	36.6
59	Sarasmal 2	B/W	84.080517	21.89298	221.3	0.58	5.5	215.8	3.26	218.04	2.24	15 cm	76.25
60	Keldamal	B/W	84.110957	21.866342	221.4	0.6	4.57	216.83	2.3	219.1	2.27	20 cm	76.25
61	Jharmunda 2	H/P	84.067939	21.86631	219.3	0.62	8.93	210.37	4.38	214.92	4.55	15 cm	61
62	Dalki 2	H/P	84.051102	21.864883	211.7	0.53	4.13	207.57	2.27	209.43	1.86	15 cm	61
63	Kallopatra	H/P	83.998063	21.806409	196.2	0.3	10.78	185.42	5.7	190.5	5.08	15 cm	24.4
64	Badmal Chawk	B/W	84.009003	21.82295	198.1	0.35	1.91	196.19	6.52	191.58	**-4.61**	20 cm	46.87
65	Gauntiapada	H/P	84.020276	21.834679	202.4	0.45	10.13	192.27	9.55	192.85	0.58	15 cm	30.5
66	Kurebaga	H/P	84.052574	21.821111	200.9	0.8	6.58	194.32	1.7	199.2	4.88	15 cm	76.25
67	Nabasanga	H/P	84.0315	21.6483	207.3	0.5			8.7	198.6			47
68	Siryapali Ash pond	Industrial B/W	84.067125	21.817046	193.2	0.85 m		193.2		193.2		22 cm	91.5

Fig.13a:Depth to water level map shallow aquifer (Premonsoon,2023)

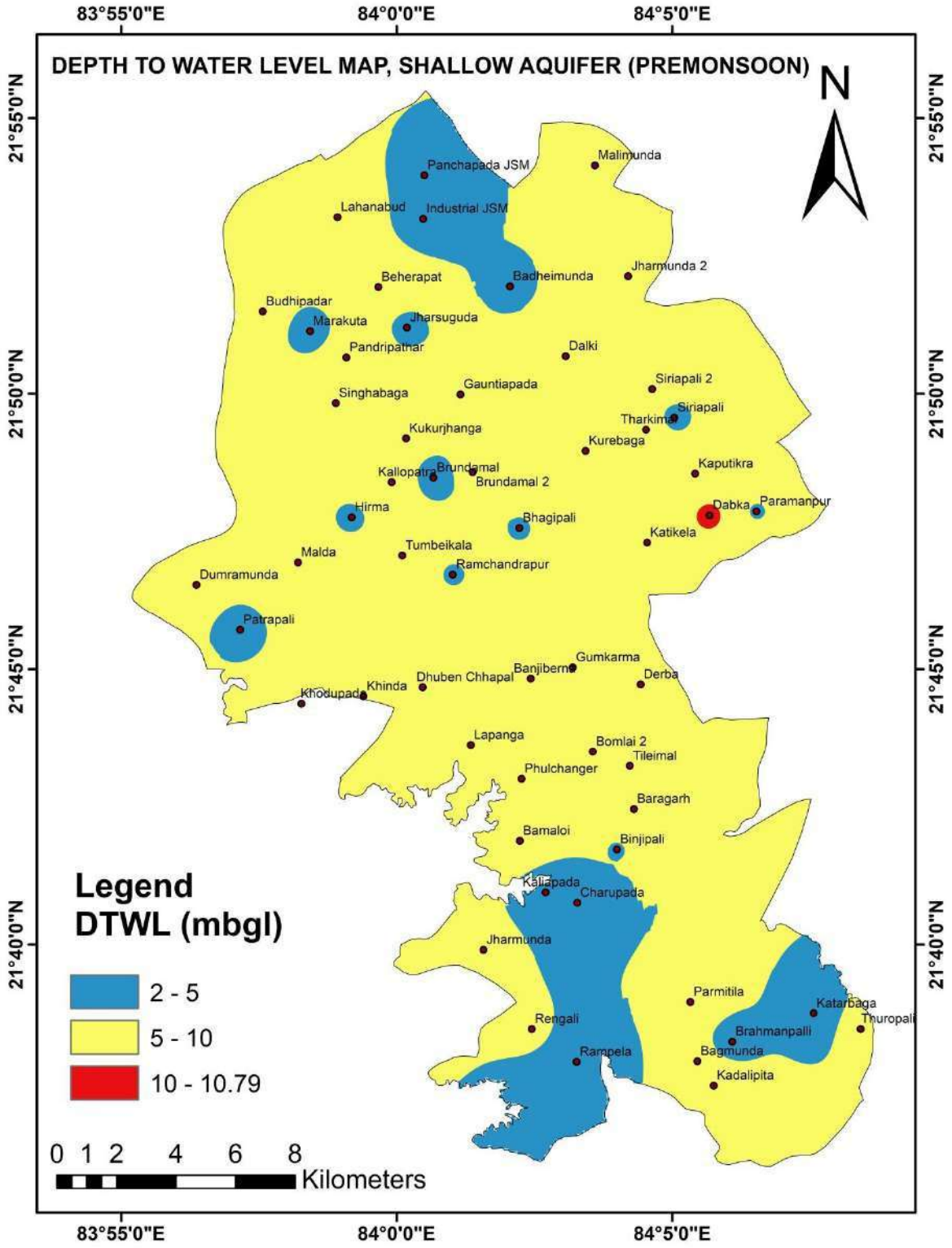


Fig.13b.Depth to water level map shallow aquifer (Postmonsoon,2023)

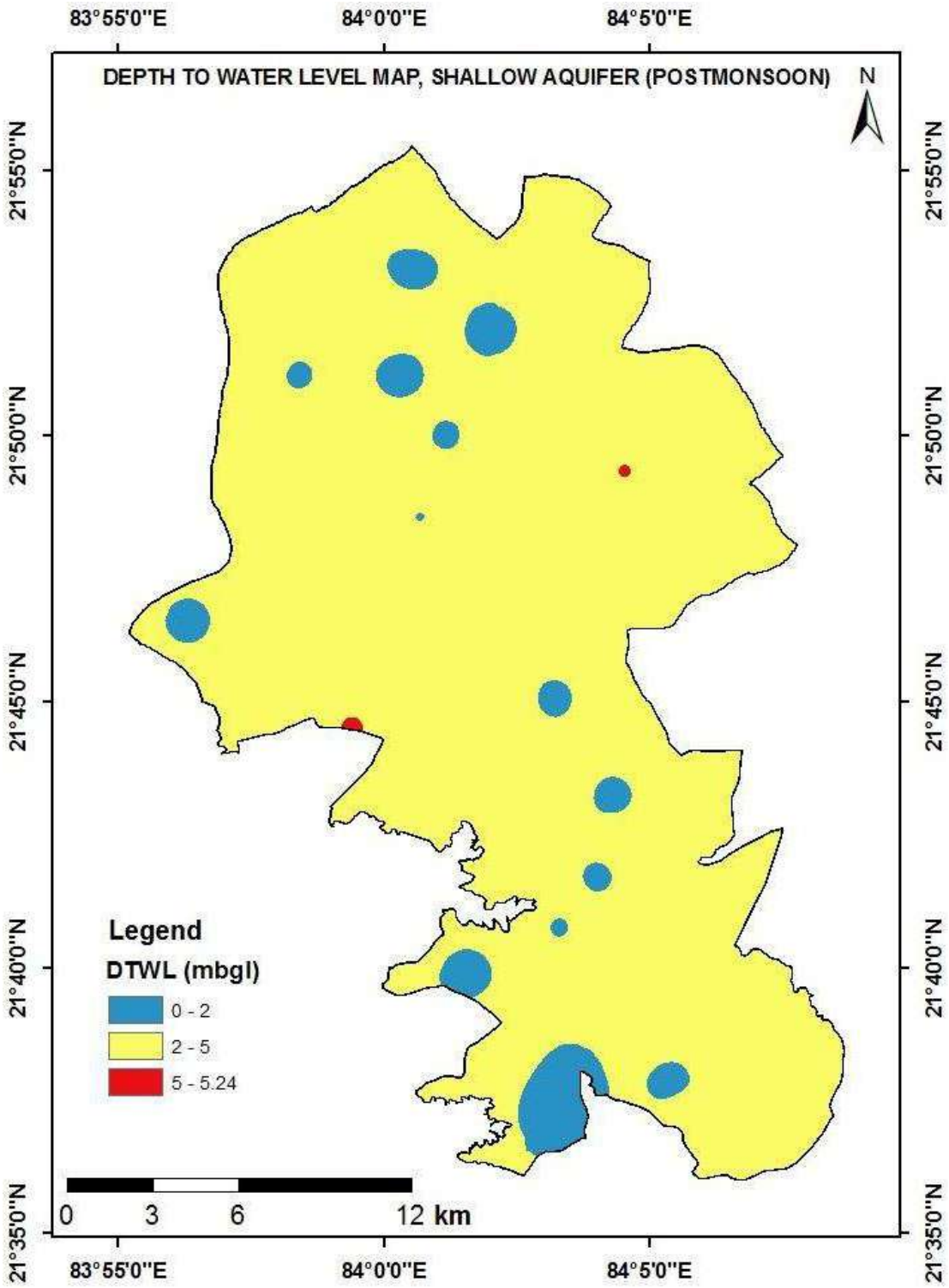


Fig.13c.Water Table Contour map shallow aquifer (Premonsoon,2023)

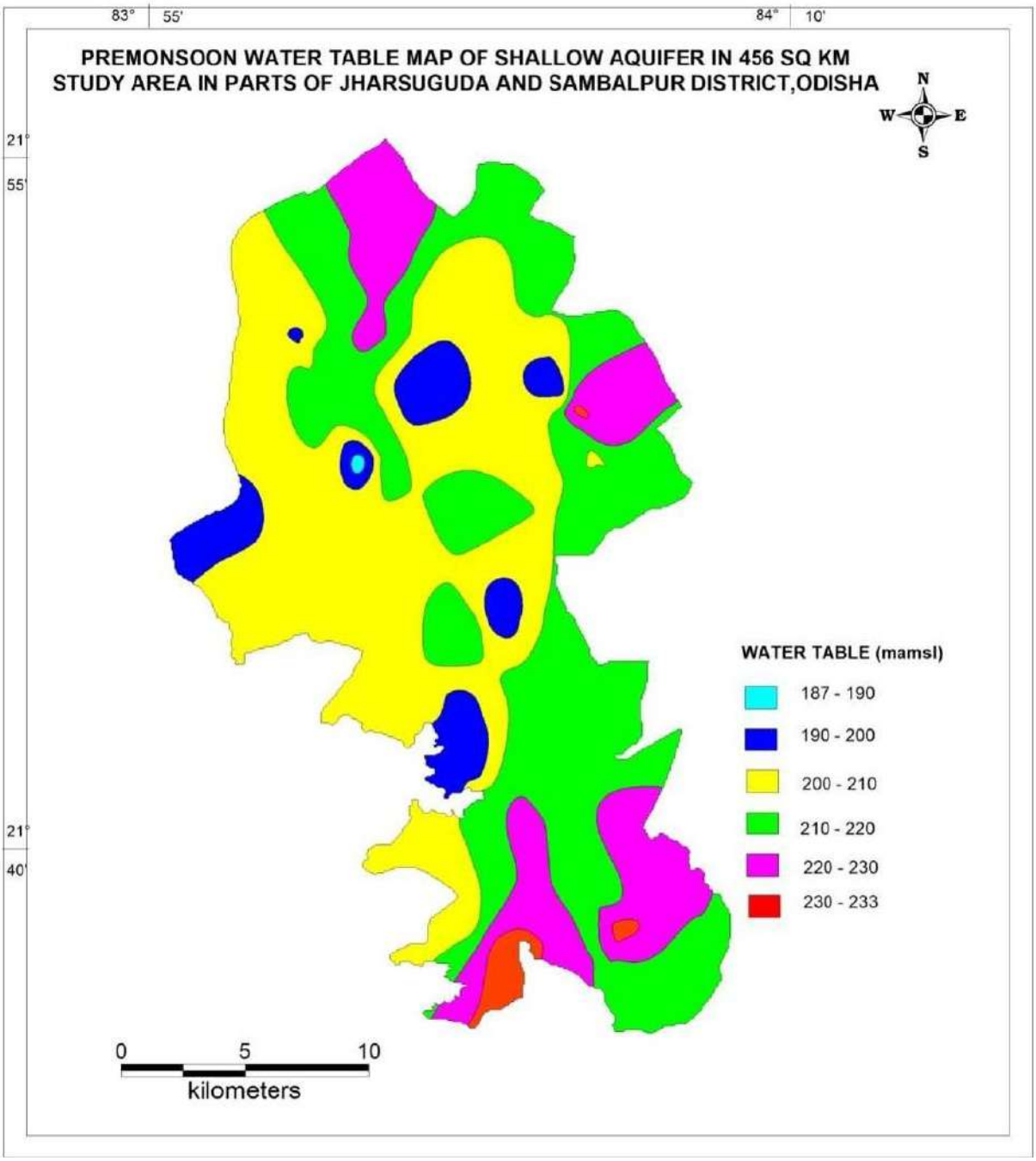


Fig.13d.Water Table Contour map shallow aquifer (Postmonsoon,2023)

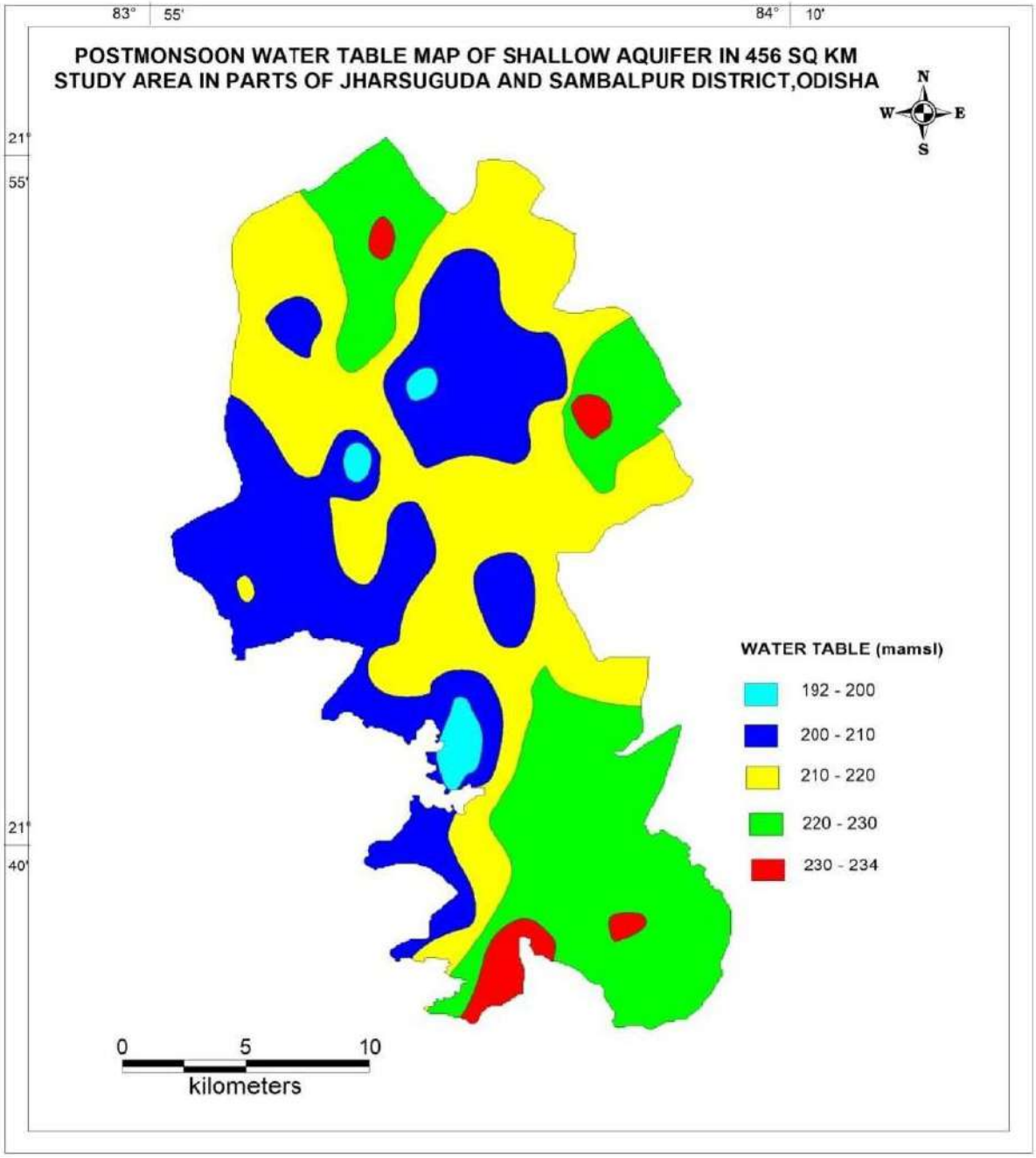


Fig.13e.Fluctuation of water level shallow aquifer (Pre and Postmonsoon,2023)

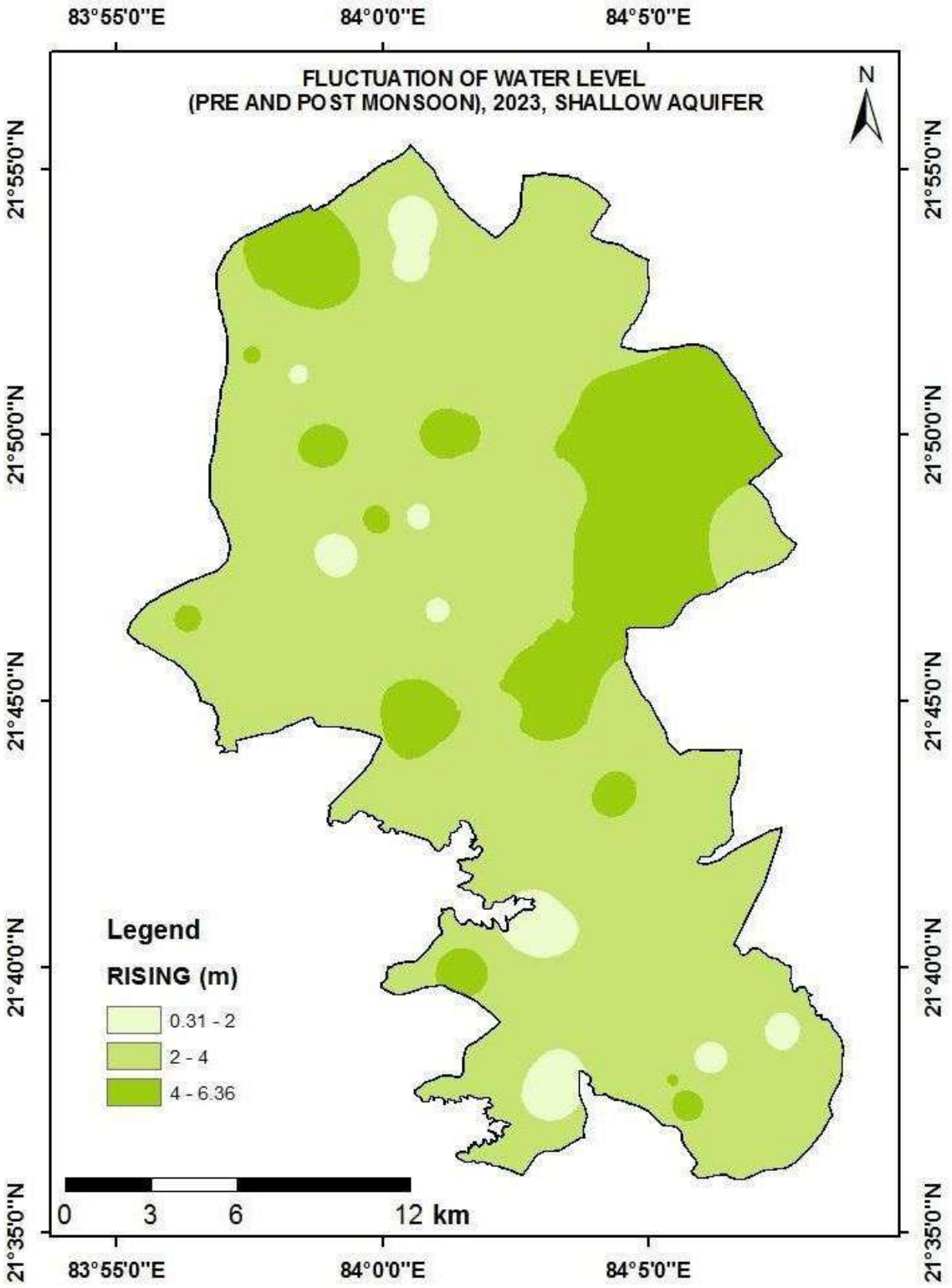


Fig.14a.Depth to water level map fractured aquifer (Premonsoon,2023)

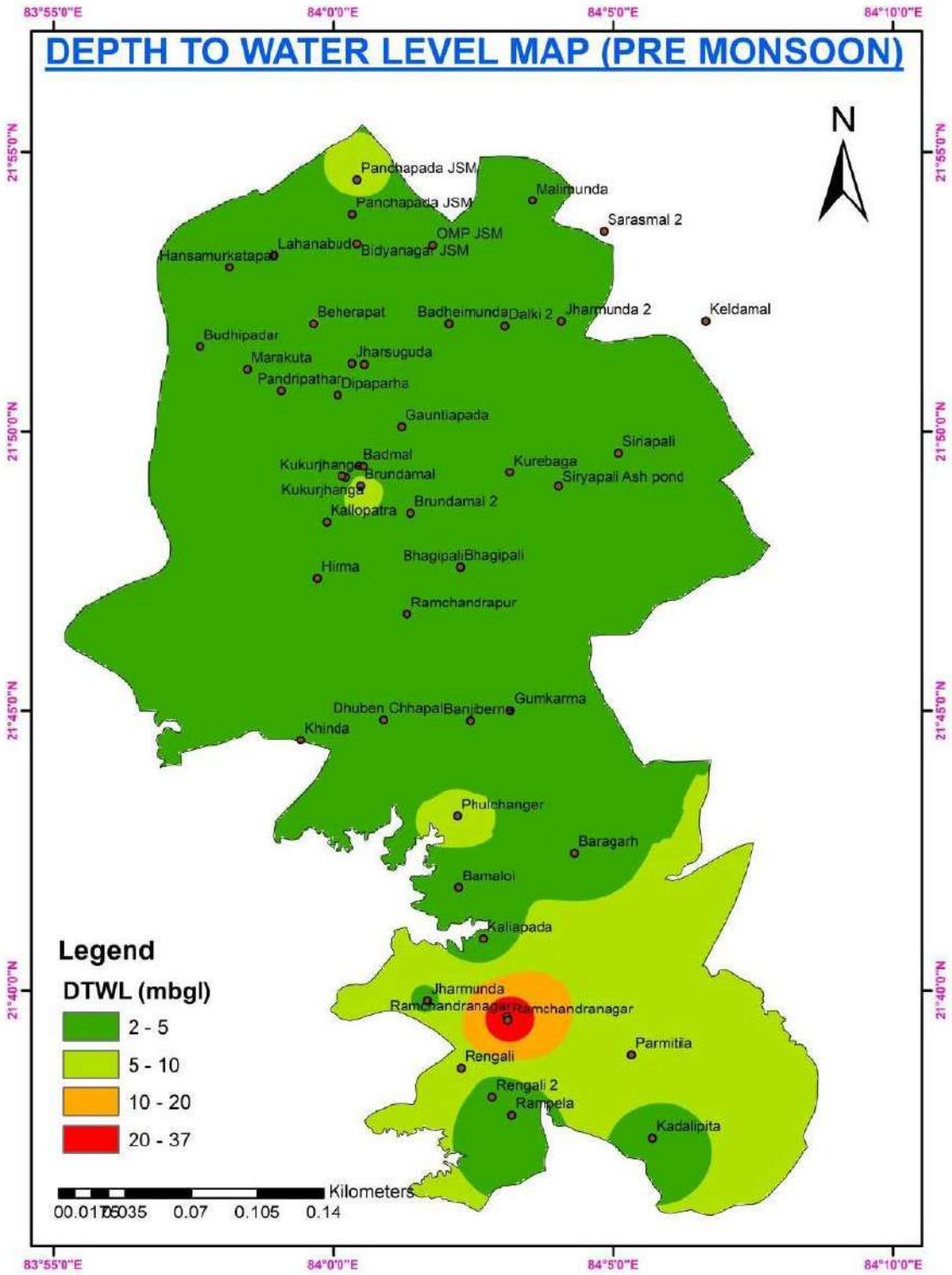


Fig.14b.Depth to water level map fractured aquifer (Postmonsoon,2023)

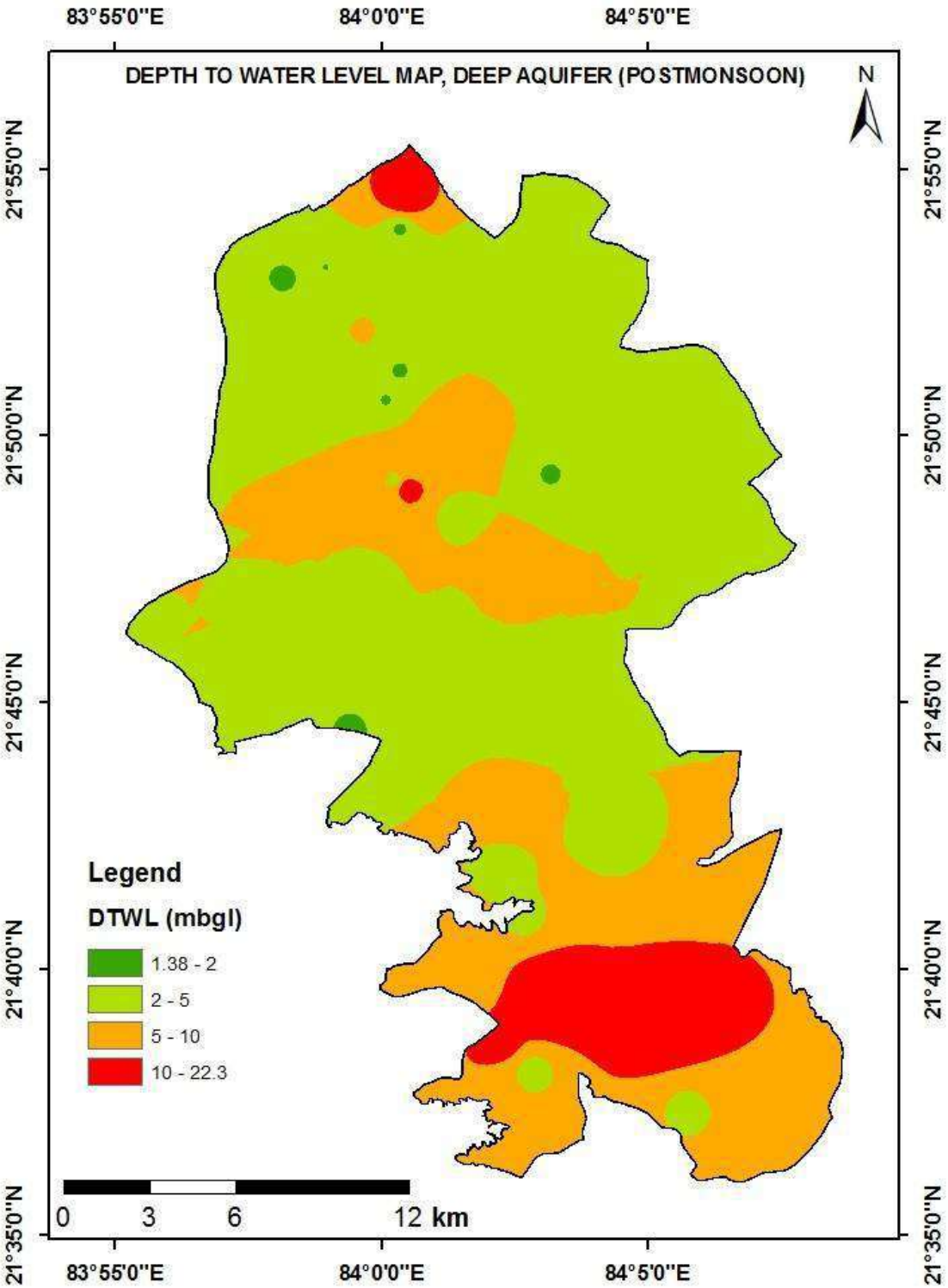


Fig.14c.Water Table Contour map fractured aquifer (Premonsoon,2023)

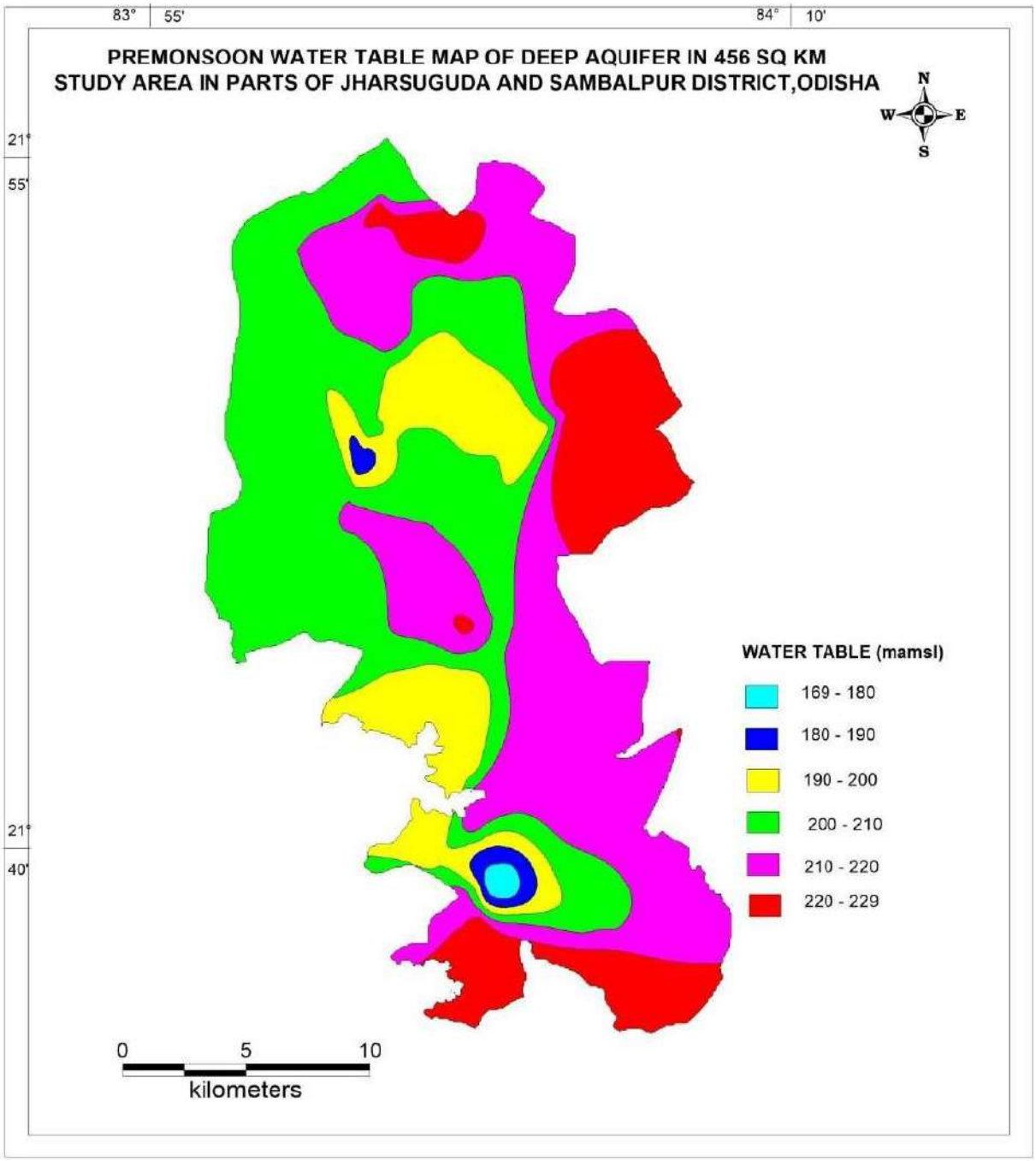


Fig.14d.Water Table Contour map fractured aquifer (Postmonsoon,2023)

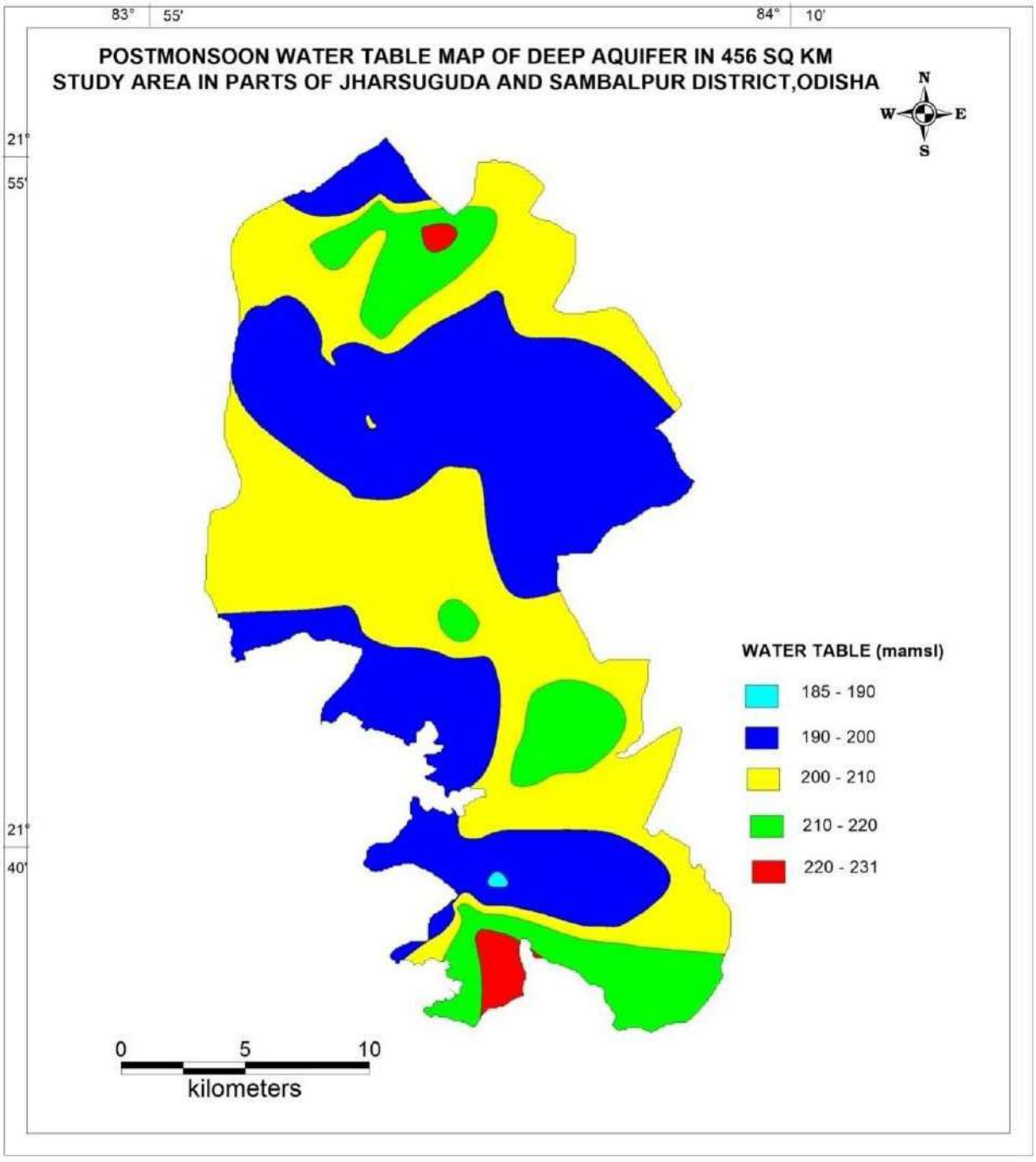


Fig.14e.Fluctuation of water level fractured aquifer (Pre and Postmonsoon,2023)

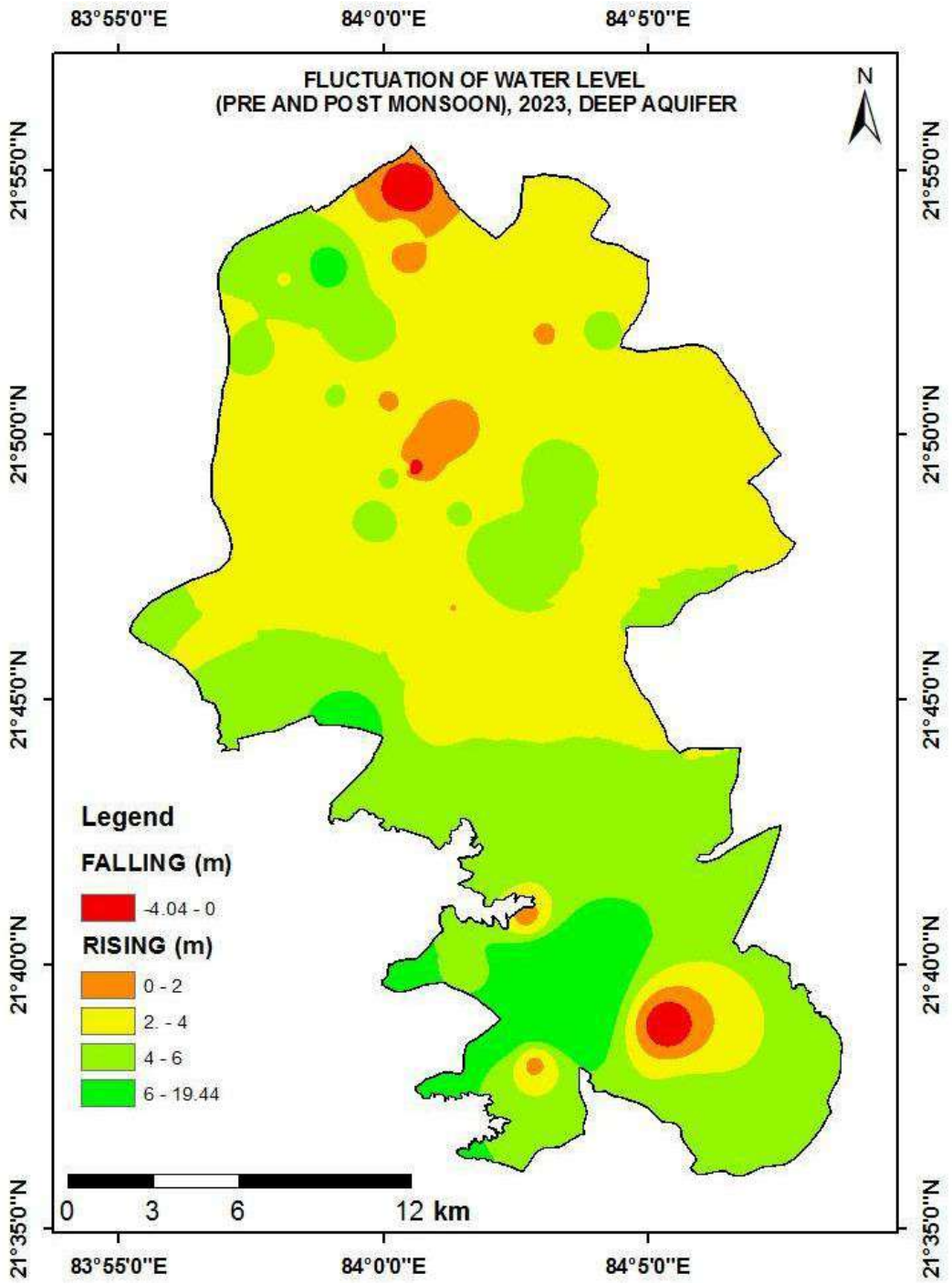


Fig.15.Post monsoon decadal trend of water level in study area

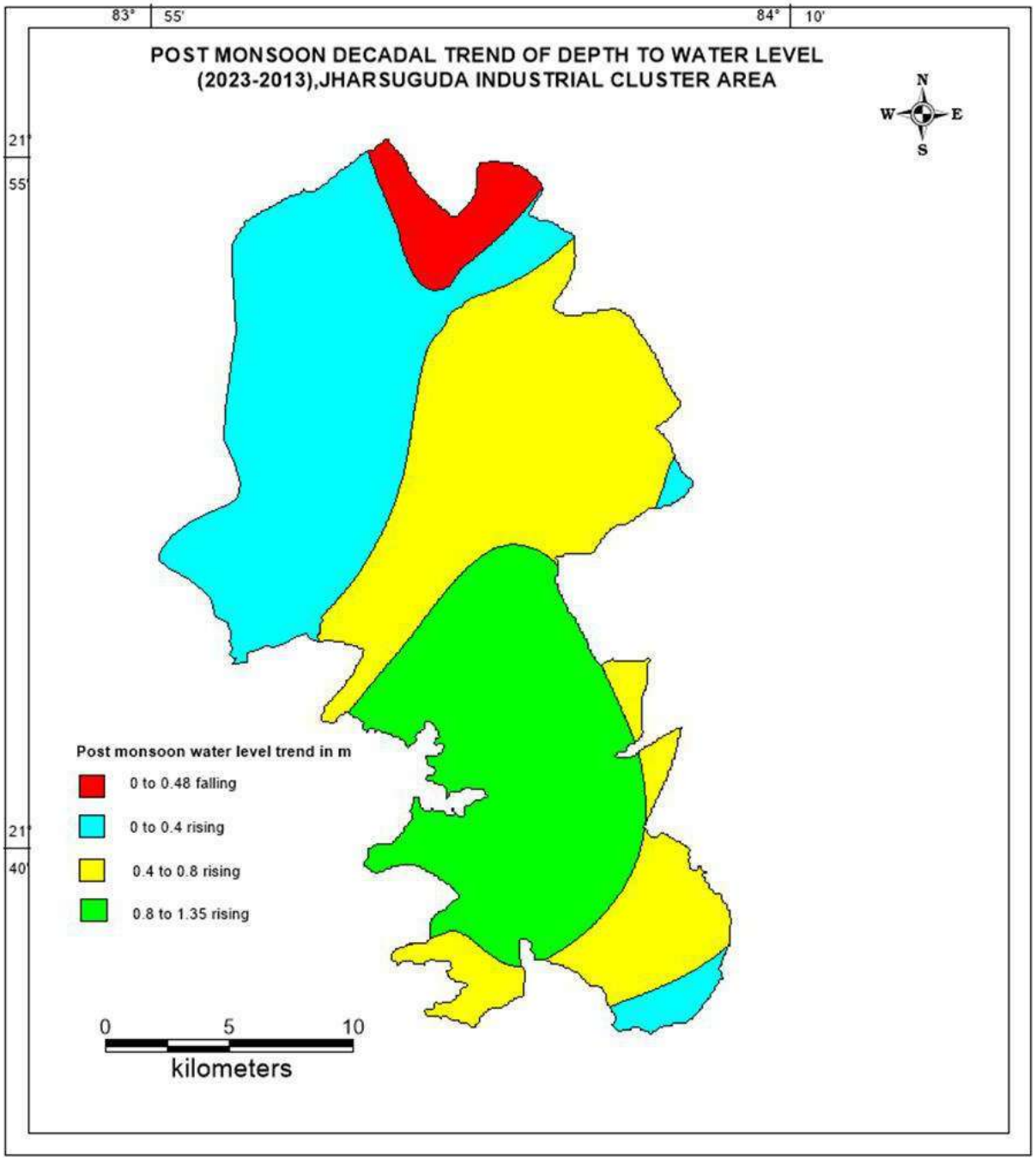
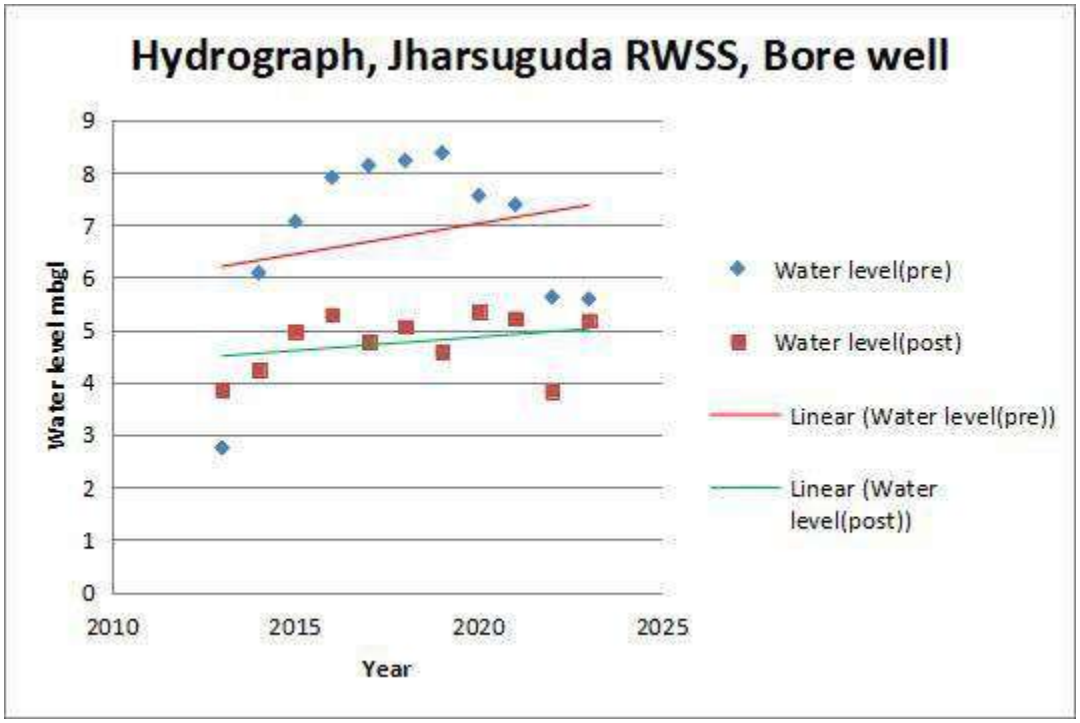
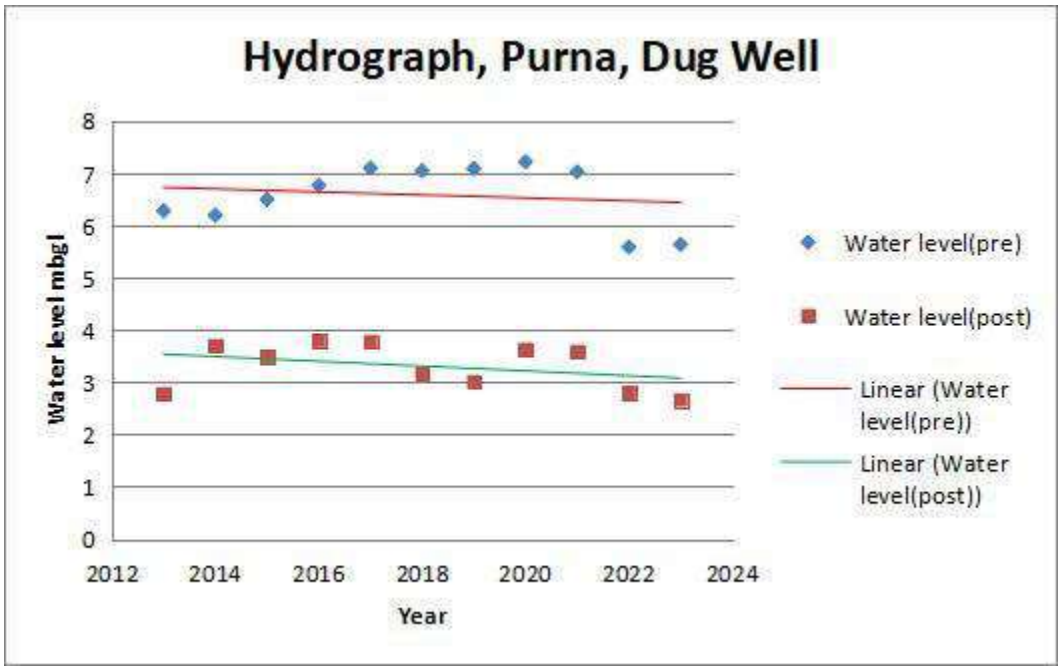
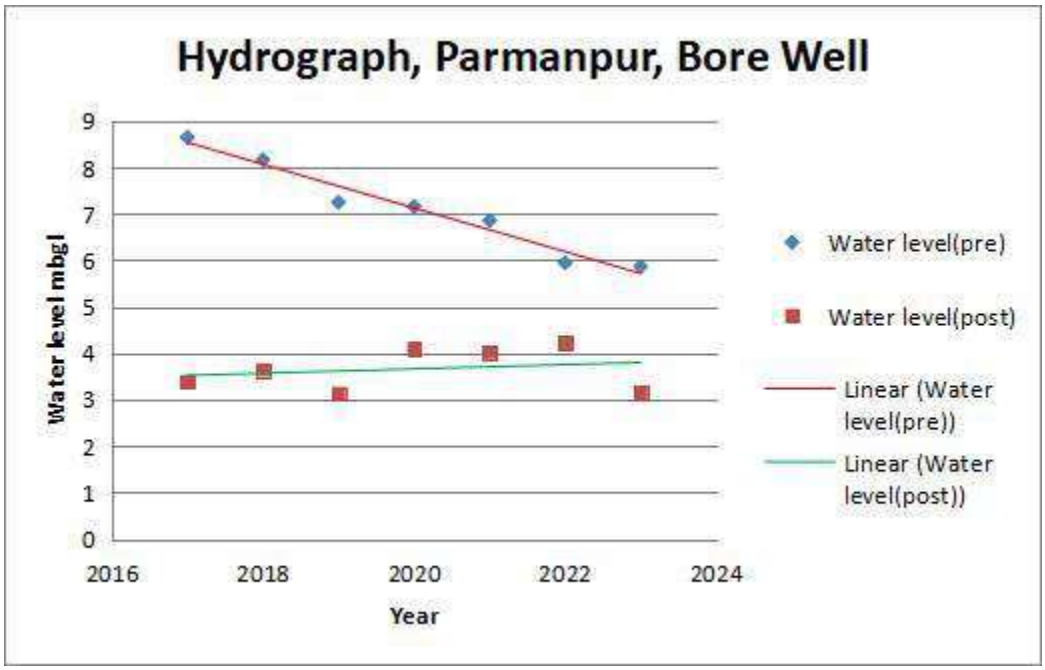
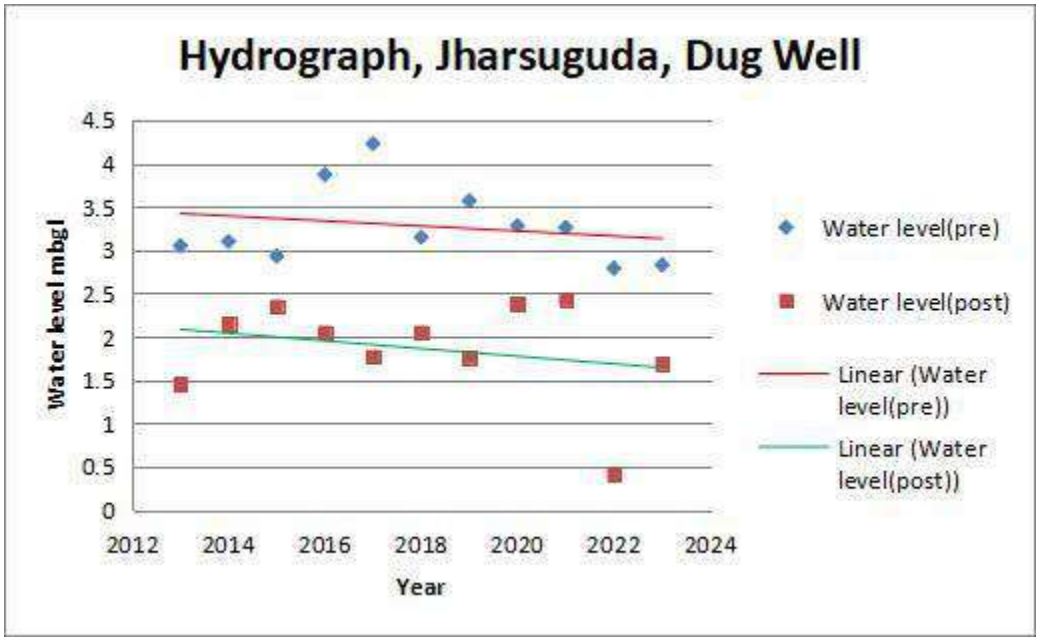


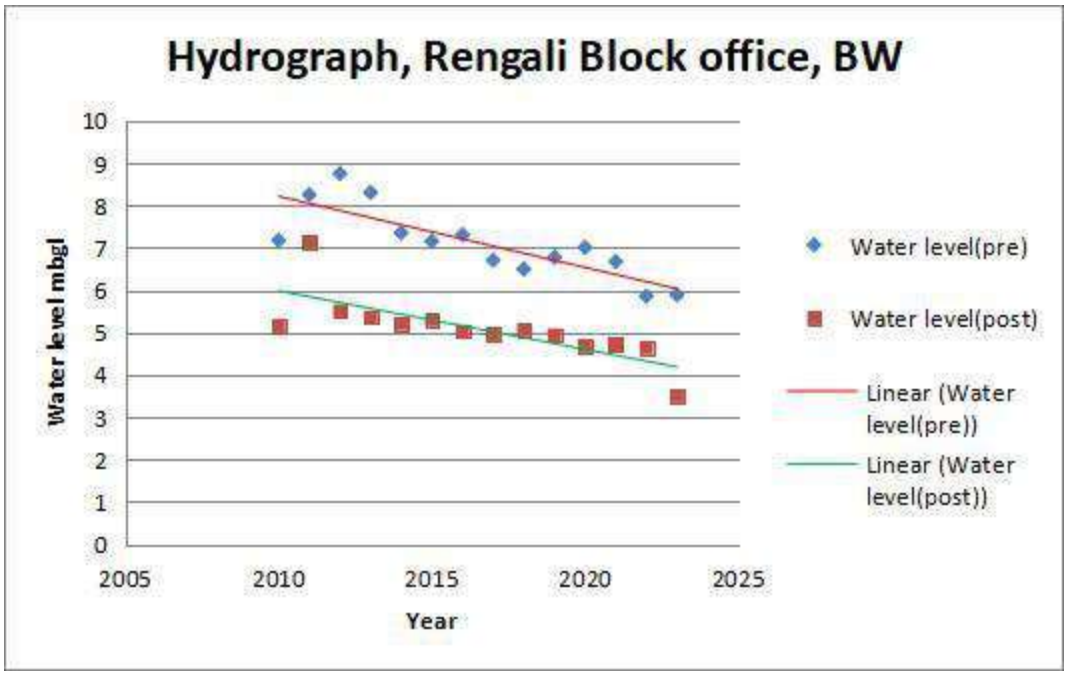
Fig.16. Hydrographs of Few Representative wells of the study area

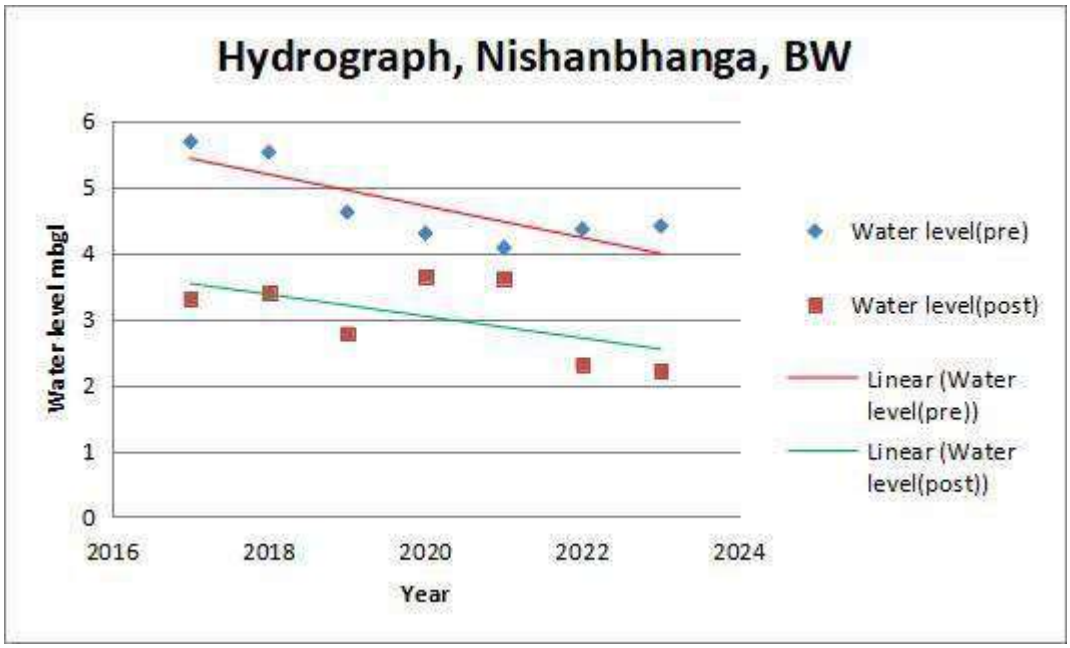


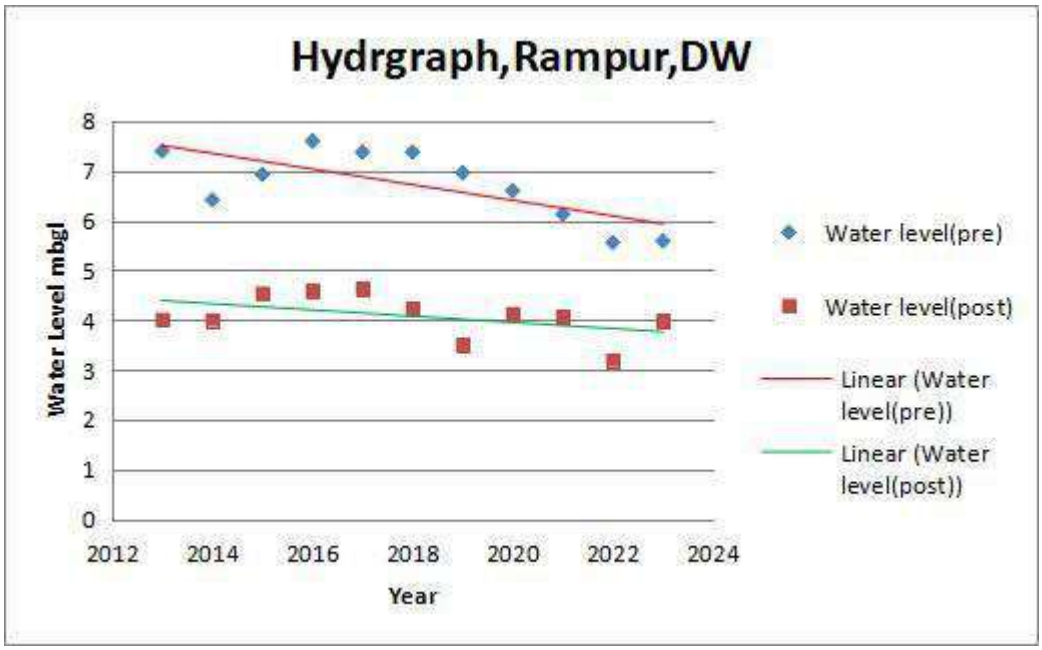



Hydrograph, Parmanpur, Bore Well
Water level mbgl
9
8
7
6
5
4
3
2
1
0
2016
2018
2020
2022
2024
Year
Water level(pre)
Water level(post)
Linear (Water level(pre))
Linear (Water level(post))


Hydrograph, Jharsuguda, Dug Well
Water level mbgl
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2012
2014
2016
2018
2020
2022
2024
Year
Water level(pre)
Water level(post)
Linear (Water level(pre))
Linear (Water level(post))


Hydrograph, Rengali Block office, BW
Water level mbgl
Year
Water level(pre)
Water level(post)
Linear (Water level(pre))
Linear (Water level(post))


Hydrograph, Nishanbhanga, BW
Water level mbgl
Year
Water level(pre)
Water level(post)
Linear (Water level(pre))
Linear (Water level(post))


Hydrgraph,Rampur,DW
Water Level mbgl
Year
0
1
2
3
4
5
6
7
8
2012
2014
2016
2018
2020
2022
2024
Water level(pre)
Water level(post)
Linear (Water level(pre))
Linear (Water level(post))

8. DELINEATION OF RECHARGE AREA

Recharge area can be delineated on the basis of slope map, land use map and post monsoon depth to water level map of the study area. As per slope map it has observed that 99 % area is having a slope of <20.Only 33 sq.km hilly area having a slope of >20. Landuse map shows 52% area occupied by argricultural land, 12 % area occupied by forest and 27% area occupied by waste land.So recharge is possible in majority of the area.On the basis of DEM 335.31 sq.km area is demarcated as both discharge and recharge area, 13.39 sq. km as only recharge area, 130.52 sq.km as discharge channel and water storage pocket and 3.56 sq.km as runoff area (Fig.17).On the basis of post monsoon depth to water level map of hand pump/ bore wells more than 5 mbgl water level area which correspond to 112.17 sq. km is demarcated as recharge area (Fig.18).

Fig.17. Recharge, discharge and runoff area demarcation on the basis of DEM, Jharsuguda Industrial Cluster

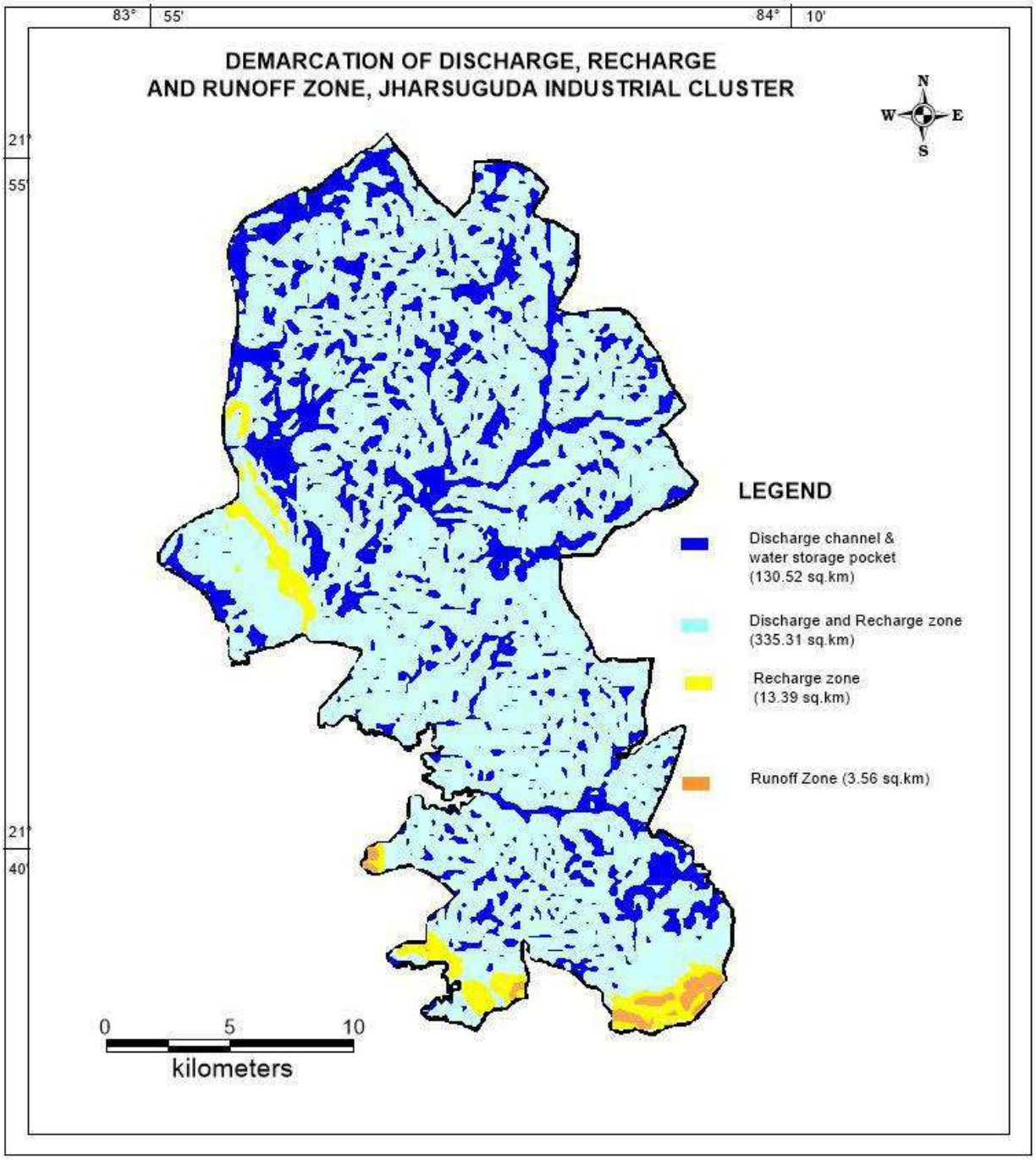
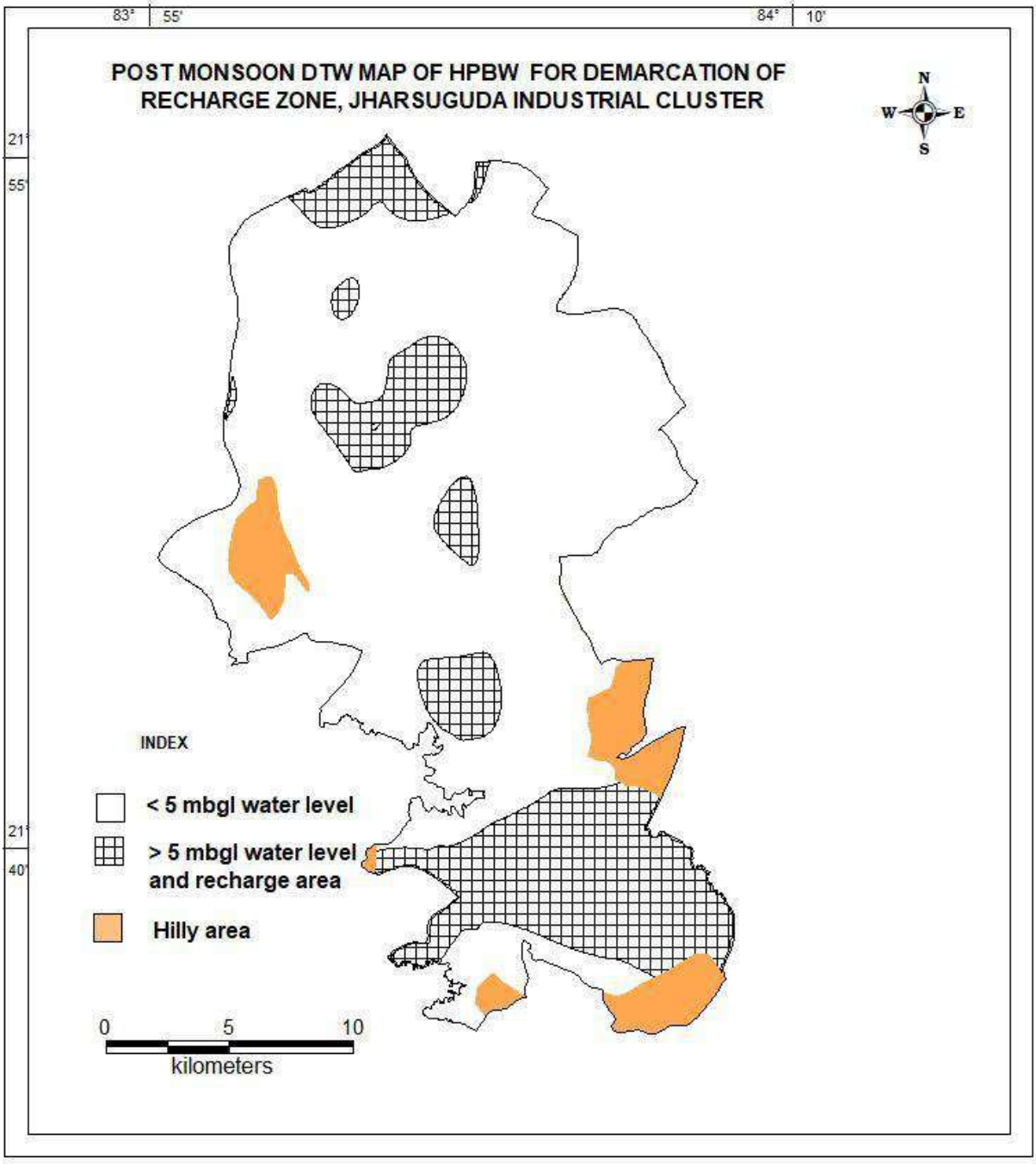


Fig.18. Recharge, discharge and runoff area demarcation on the basis of post monsoon depth to water level, Jharsuguda Industrial Cluster



9. ESTIMATION/REFINEMENT OF PARAMETERS USED FOR RESOURCE ASSESSMENT

Under this head to find out the bore well wise irrigation draft 122 bore well data from Jharsuguda,Kolabira Block Block part and 164 bore well data from Rengali Block have been collected and unit draft for individual bore wells have been calculated. In Rengali Block part bore well unit draft is varies from 0.378 ham to 0.9 ham and in Jharsuguda,Kolabira Block bore well draft varies from 0.378 ham to 0.54 ham.So average unit draft for bore wells situated in Jharsuguda district may be considered as 0.44 ham and in Rengali Block it is considered as 0.518 ham. The details ares summarized in Table 5d1 and 5d2. As per CGWA total 62 number of bore well given to different industry/infrastructure/mining unit.Here unit draft is calculated as 1.1 ham (Table 9). For computation of transmissivity (T) and permeability (K) 100 minute duration pumping test and recovery test of 17 borewells uniformly distributed in study area have been conducted. Out of 17 bore wells two borewells are within 33 mbgl depth ranges and 14 borewells between 50 to 100 mbgl depth ranges and one borewell is within 175 mbgl depth. Discharge of shallow borewell ranges from 1.33 to 2.0 lps with T value ranges from 2.1 m^2/day to 6.57 m^2/day.T value for rest of the borewell tapping little bit deeper aquifer ranges from 0.56 to 136.64 m^2/day (Table-10,Fig 18).

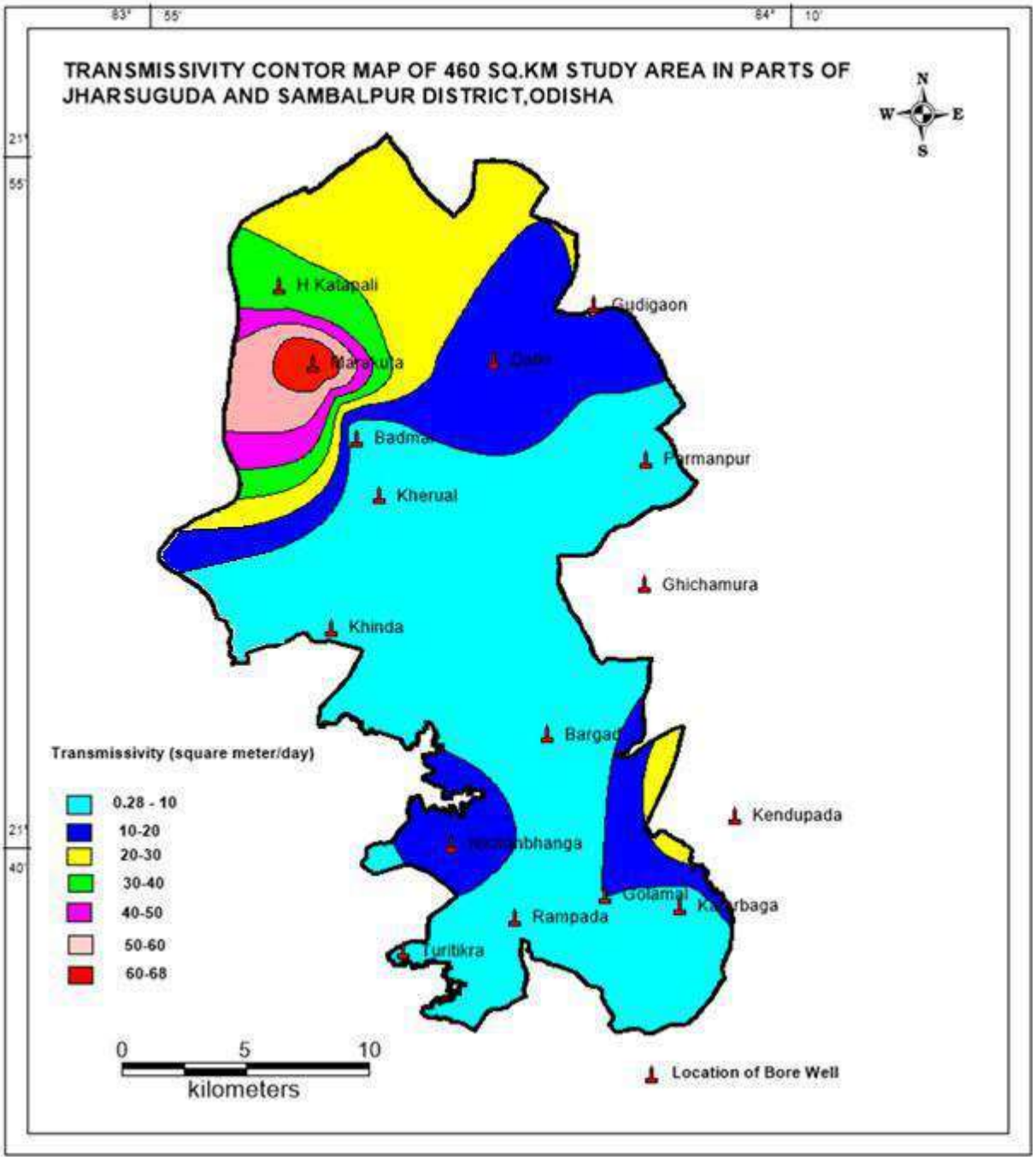
Table 9: Unit draft calculation for industrial bore well

Name of Block	**No of Bore well**	**Annual withdrawal (ham)**
Jharsuguda	35	40.03
Kolabira	7	11.17
Rengali	20	17.27
Total	62	68.47
Unit draft		**1.10**

Table10: Discharge,Transmissivity and Permeability calculation of Shallow and Deeper Aquifer

Name	Lat	Long	Depth of well (mbgl)	Duration of pumping (minutes)	90% recouperation time (minutes)	Discharge (lps)	Drawdown (m)	T (m^2/day)	K (m/day)
Badmal	21.81508	83.99705	58.2	12	23	1.48	6	4.88	9.76
Dalki	21.84353	84.05052	60	100	40	2.09	11.38	17.4	34.8
Marakuta	21.84237	83.97996	80	100	30	3.46	3.05	68.32	136.64
Gudigaon	21.8636	84.08983	50	100	60	1.02	7.72	20.17	40.34
Parmanpur	21.80747	84.11002	95	50	100	1	9.03	3.95	7.9
H Katapali	21.87033	83.96671	80	90	30	1	4.4	31.64	63.28
Kherual	21.79449	84.00604	80	12	70	1	4.5	5.27	10.54
Bargad	21.70783	84.07184	33	40	110	2	19.23	2.1	4.2
Lohamani	21.70783	84.07184	100	60	70	1.66	14.31	3	6
Turitikra	21.62963	84.01548	80	25	60	0.33	3.92	1.68	3.36
Nishanbhanga	21.76232	84.10982	80	18	60	2	4.67	18.61	37.22
Ghichamura	21.76232	84.10982	80	60	90	0.58	23.6	0.59	1.18
Kendupada	21.67844	84.14479	80	70	50	4	9.4	35.15	70.3
Katarbaga	21.64579	84.12335	30	60	40	1.33	9.48	6.57	13.14
Khinda	21.74651	83.98706	175	25		0.71	31.42	0.28	0.56
Golamal	21.64976	84.0943	107	50	70	7.6	20.19	10	20
Rampada	21.64172	84.05918	80	50	80	1.33	16.74	2.5	5

Fig19. Transmissivity of the Bore Wells in Jharsuguda Industrial Cluster Area



10. ASSESSMENT OF GROUND WATER RESOURCES

The groundwater resource is assessed on proportionate basis with the help of resources assessment as on 31.03.2023 of Odisha. It is observed that Jharsuguda Block part is falling under Semicritical category, but Kolabira, Kirimira and Rengali Block part is falling under Safe Category. Overall the stage of Extraction of the study area is 64.35% and category is 'Safe' (Table-11a).

Table 11a: Ground Water Resources Assessment of Study Area (on proportionate basis)

Sl. No	State	District	Assessment Unit Name	Assessment Unit Type	Total Area of Assessment Unit (Ha)	Net availability (ham)	Irrigation draft (ham)	Domestic daft (ham)	Industrial draft (ham)	Total draft (ham)	Stage of extraction %	Pre Monsoon of GW Trend	Post Monsoon of GW Trend	Allocation of Ground Water Resource for Domestic Utilisation for	Net Annual Ground Water Availability for Future Use (ham)	Total Ground Water Availability in Unconfined Aquifier (ham)	Total Ground Water Availability in the area (ham)	Category of unit
1	Odisha	Jharsuguda	Jharsuguda	Watershed	22270.63	2384.386	618.0947	770.8338	341.0693	1729.998	72.56	Falling	Falling	809.1528	616.0695	2384.386	2384.386	Semicritical
2	Odisha	Jharsuguda	Kirimira	Watershed	109.2	12.04731	4.239565	0.677794	0.31603	5.233389	43.44	Rising	Rising	77.592	753.3073	1336.156	1336.156	Safe
3	Odisha	Jharsuguda	Kolabira	Watershed	3289.055	350.5139	125.9871	24.35593	17.8126	168.1556	47.97	Rising	Rising	103.944	709.5825	1379.442	1379.442	Safe
4	Odisha	Sambalpur	Rengali	Watershed	20025.6	1620.318	732.1487	100.3766	74.42495	906.9502	55.97	Rising	Rising	101.3131	712.430941	1618.168	1618.168	Safe
			Industrial Cluste area	Watershed	45694.49	4367.265	1480.47	896.2441	433.6229	2810.337	64.35			1092.002	2791.39024	6718.152	6718.152	Safe

Actual dynamic resources assessment has carried out after obtaining data from different State Govt. Departments.The details are as follows (Table-11b):

Table 11 b: Dynamic Groundwater Resource Assessment of Jharsuguda Industrial Cluster Area (On Actual Basis)

Population	As per Censu	Growth in 13 years	Total projected Population in 2024	Daily water consumption(lt)	Daily water consumption (ham)	Annual consumption in ham
Total Rural Polulation	120981	20445.79	141426.8	8485607.3	0.8485	309.7025
Total urban population	97730	16516.37	114246.4	15423260	1.54	562.1
Total	218711		255673.2	23908867		871.8025

1. Domestic draft : 872 ham
2.Industrial draft : 68.47 ham (As per CGWA)
3.Irrigation draft by bore well is 166.36 ham (As per OLIC Bore well)+by dug well is 14.33 ham (by 59 dug wells in Sambalpur,128 in Jharsuguda district with unit draft of 0.079 ham)=180.69 ham
(Total number of irrigation bore well in Jharsuguda is 122 (unit draft is 0.44 ham)
(Total number of irrigation bore well in Sambalpur part is 164 (unit draft is 0.518 ham)
Number of private irrigation bore well is taken 20% of the OLIC bore well.
Total geograhic area is 456 sq.km
Gondwana shale covers 11050 ham area
Gneiss Precambrian covers 34500 ham area
RIF for Shale is 4%
RIF of gneiss is 2%
Specific yield for shale is 1.5%
Specific yield of gneiss is 0.3%
Recharge by WTF method 985.455 ham
Annual Fluctuation of B/W/HP water level is taken as 3.66 m
Normal rainfall : 1.43 meter
Recharge by RIF method :1618.76 ham
PD factor = -24.3185 %
4.Recharge by RIF method calculated: 1295.008 ham
5.Pond recharge : 237.96 ham (Total pond area is 809.4 ha and total number of pond is 325)
6.Recharge by water conservation structures : 119.82 ham
7.Return flow by Surface water irrigation (OLIC Flow 16.16 ham, MI 79.5 ham, Mega lift 32.3 ham)=127.96 ham
8.Return flow by ground water irrigation : 43.23 ham
9.Total annual ground water resources :(1295+237.97+119.82+127.96+43.23)=1823.98ham
10.Net ground water availability : 1641.58 ham (total extractable dynamic resources)
11.Total ground water draft (domestic draft+irrigation draft+industrial draft) =1121.16 ham
12.Stage of ground water extraction = 68.32 %
13.Category : 'Safe'

14.Ground water for future use : 520.42 ham
15. Total Static resources of weathered zone : 3634 ham (2237 ham in Shale, 1397 ham in granite)
16. Projected Population as on 2025 : 258997
Population Density in thousands/sqkm = 0.5679759, Allocation=11.2464 mm/year
Allocation for domestic use : 512.84 ham

11.0 GROUNDWATER QUALITY

11.1 Introduction

National Aquifer Mapping (NAQUIM) 2.0 is designed to provide detailed information on groundwater issues to support its management decisions at ground level. The issues are different in different areas in the country.The proposed studies are prioritized on specified issues. Broadly 11 priority areas are identified in the country based on groundwater related issues, and one of them is Industrial Clusters and Mining Areas.

Under Industrial Clusters and Mining Areas, the CGWB, SER, Bhubaneswar has undertaken the study on entitled "Industrial Cluster Area in parts of Jharsuguda (Jharsuguda and Kolabira blocks) and Sambalpur (Rengali block) districts of Odisha" under NAQUIM 2.0 programme during AAP 2023-24 with the objective to delivery the groundwater quality information to support its management decisions at ground level. The assessment of groundwater quality of the area would be able to define the sources for suitability drinking and irrigation purposes and also impact of industrialization on it in the local region.

Jharsuguda , located in the western part of Odisha , is known for its various industries and also characterized by a hot dry summer where temperature rises upto 44°C. The day temperature recorded the highest in the state in the month of May in a year. The district is surrounded by the districts of Odisha Sundargarh, Sambalpur and Bargarh districts. It is one of the most industrially developed districts of Odisha state. Simultaneously, urbanization also developed in the district due to the establishment of various industries. During the course of development activities, the quality of resources is impacted particularly water resources ; however, the extent of the impact is determined by the intensity of these activities and their area of influence in a given environment and time. The impact of developmental activities on the enhanced presence of ion concentrations and TDS in shallow and deep underground aquifers over the years has been reported by Li et al. (2015). The probability of contamination of aquifers by the seepage of run-off water owing to the steep rate of progress due to urbanization and industrialization particular in Jharsuguda and Kolabira blocks of Jharsuguda and Rengali block of Sambalpur districts have been studied under NAQUIM 2.0.

11.2 Sample Collection

The representative groundwater samples were collected by keeping in mind to fulfill the objectives of NAQUIM 2.0 study on groundwater quality of the districts during the pre monsoon (June-2023) and post monsoon. There are 129 groundwater samples collected from different dug wells (56) and

hand pumps/bore wells (73) and also 17 samples collected from different surface water bodies and waste waters from various industries to trace out the contamination level, if any, in terms of physico-chemical parameters and heavy metals. During the post monsoon period, a total of 40 groundwater samples were collected, in which 7 dug wells and 33 hand pumps/ tube wells to assess the groundwater quality. In addition to these 15 samples were collected from different surface water bodies and waste waters from various industries for the evaluation of basic parameters and heavy metals in the study area.

11.3 Sample Analysis

The samples were analyzed for 15 basic parameters, including pH, Electrical Conductivity, Total Dissolved Solids (TDS), Total Hardness (TH), Alkalinity, Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Carbonate (CO3), Bicarbonate (HCO3), Chloride (Cl), Sulphate (SO4),Nitrate (NO3) and fluoride (F) by following the standard methods for the examination of water and wastewater, prepared and published jointly by APHA,AWWA,and WEF (23rd Edition,2017) and also for the heavy metals include, Uranium (U), Copper (Cu), Iron (Fe), Manganese (Mn), Arsenic (As), Lead (Pb) and Zinc (Zn).

The correctness of analysis is balanced as per the following equation and the percent of errors restricted to 5%.

The analytical results of samples collected from the study area during premonsoon and post monsoon are presented in the annexures 3, 4 ,5 and 6.The quality of groundwater in the study area exhibits significant variations due to factors such as physiography, soil texture, and underlying soil formations.

11.4 Statistical Analysis

Groundwater quality defines the concentration of physico- chemical characteristics present in the sample. The statistical summary of analysed samples for major ions and physical parameters are shown in table 11.1 for premonsoon and post monsoon. The mean pH in premonsoon is 7.52 , higher than in the post monsoon season (7.29) in groundwater samples in the study area. The groundwater is slightly acidic to high alkaline in nature. The electrical conductivity (EC) in pre monsoon ranged between 137- 2082 micromhos/cm at 25°C with mean 591 micromhos/cm at 25°C, and the post monsoon groundwater samples varied from 187 to 1956 micromhos/cm at 25°C with mean 719 micromhos/cm at 25°C. The mean Total Dissolved Solids (TDS) in groundwater samples the premonsoon and post monsoon are 321 mg/l and 403 mg/l respectively .

Fig 20. Sampling locations in the study area (Premonsoon)

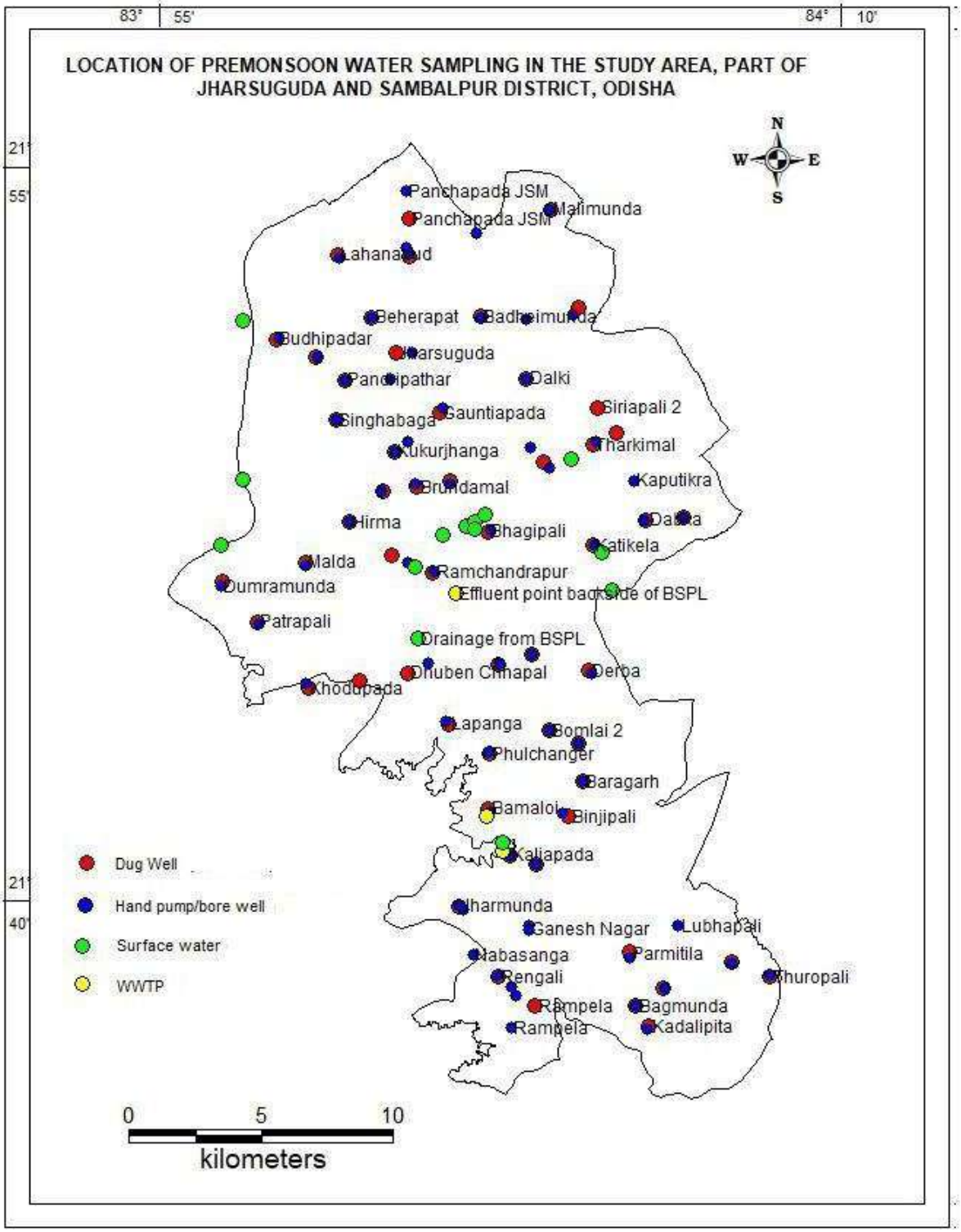
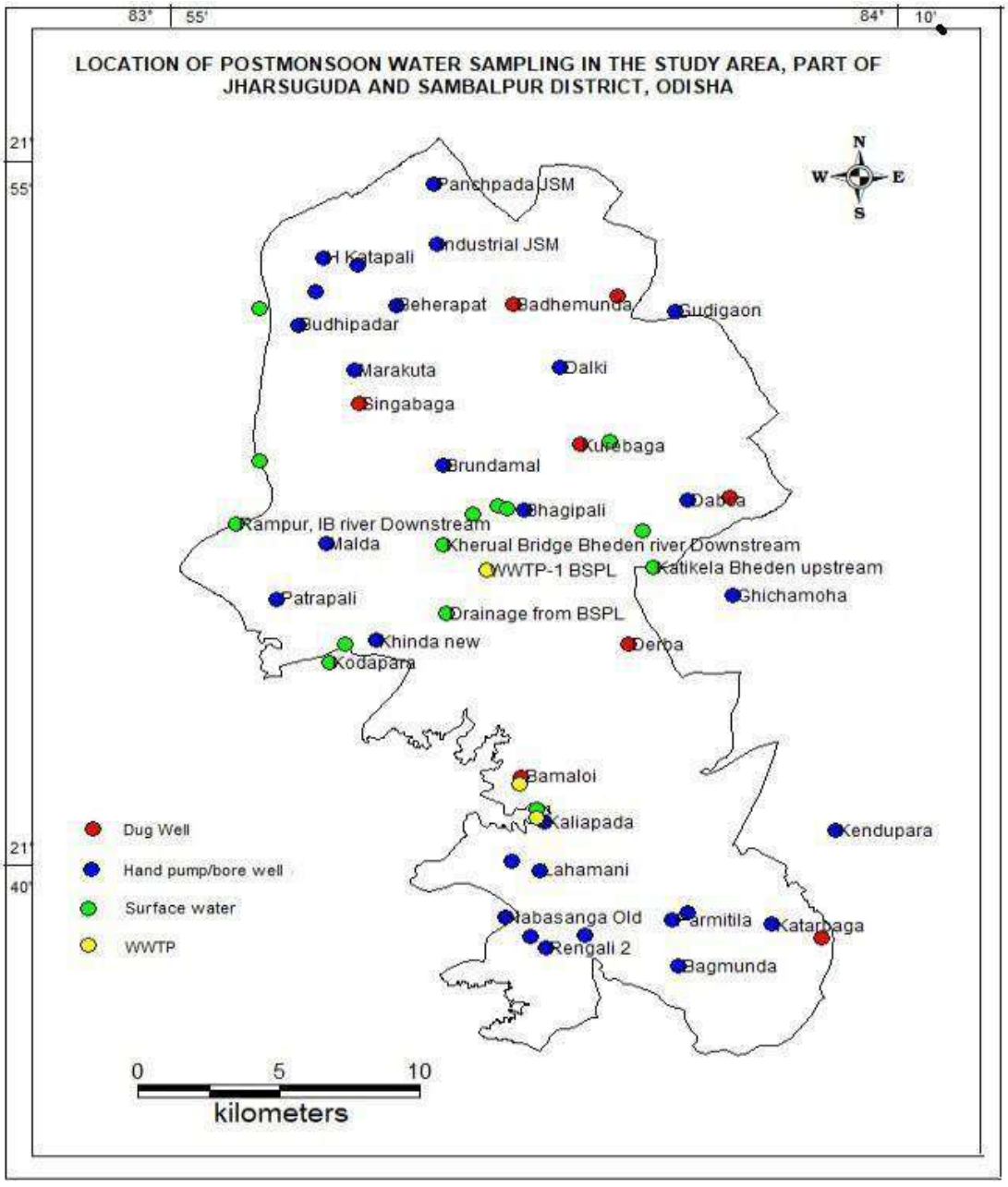


Fig 21: Sampling locations in the study area(Postmosoon)



Tabel 12: Statistical summary of physico-chemical parameters of groundwater in the study area during pre monsoon and post monsoon

Parameters	Premonsoon			Post Monsoon			% Variation
	MIN	MAX	AVERAGE	MIN	MAX	AVERAGE	
pH	6.42	8.57	7.52	5.78	7.95	7.29	3.06
EC µS/cm	137	2082	591	187	1956	719	-21.66
TDS mg/l	75	1153	321	97	1152	403	-25.55
Total Hardness mg/l, as $CaCO_3$	50	815	198	66	673	241	-21.72
Total Alkalinity mg/l, as $CaCO_3$	25	410	117	50	375	171	-46.15
Ca^{++}mg/l	8	160	40	20	185	58	-45.00
Mg^{++}mg/l	1.2	108	24	2	51	23	4.17
Na^{+}mg/l	3.5	216	39	7	220	52	-33.33
K^{+}mg/l	0.8	70	6.81	1.3	44.5	7.62	-11.89
$CO_3^{=}$mg/l	0	0	0	0	0	0	-
HCO_3^{-}mg/l	31	500	143	61	458	208	-45.45
Cl^{-} mg/l	11	482	98	3	391	81	17.35
SO_4^{2-}mg/l	0	158	24	1	187	36	-50.00
NO_3^{-}mg/l	0	151	19	0	219	44	-131.58
F^{-} mg/l	0	2.24	0.44	0.1	2.64	0.51	-15.91

The table 12 shows the mean pH, Mg and Cl are lower in post monsoon than pre monsoon, may be due to dilution effect whereas the other remaining concentrations show higher in post monsoon which indicated the more mineralization when contact with rain water.

The maximum uranium concentration observed at Nabasanga of Rengali block in Sambalpur district is 46.73 g/l and there is no significant concentrations of uranium found in other area . The excess concentrations of U in a single site (Nabasanga) may be attributed from natural sources.

The percent of variation (% Variation) between pre monsoon and post monsoon is observed higher for mean nitrate values than any other ions.

11.5 Geochemical Classification of groundwater

The hydrochemical characteristics of groundwater can be understood by plotting the major ions in the Piper trilinear diagrams for the both seasons (Fig 22 and 23) and different water types of ions in groundwater are summarized in the table 13 for both seasons. The table 13 shows that most of the samples are mixed type (not exceeding 50%) irrespective of the cations while bicarbonate is the dominant among the anions in both seasons. However, calcium is the dominant cation in few samples (22 out of 129) collected during pre monsoon and bicarbonate is the most dominant among anions followed by chloride in both seasons.

Table 13: Different water types of ions in groundwater

Ions	Premonsoon		Post Monsoon	
	No of Samples	% of Samples	No of Samples	% of Samples
Calcium Type	22	17	7	18
Magnesium Type	4	3	0	0
Sodium Type	9	7	6	15
Mixed Cations	94	73	27	67
Bicarbonate Type	56	43	28	70
Chloride Type	48	37	6	15
Sulphate Type	1	1	0	0
Mixed Anions	24	19	6	15

The different hydrochemical facies of groundwater samples presented in table 14. Among the four hydrochemical facies, Ca+Mg exceeds Na+K in most of the groundwater samples irrespective of seasons and also CO_3+HCO_3 exceeds Cl+SO_4 in 44% during pre monsoon whereas in 73% (29 out of 40) samples in post monsoon. Alkaline (Na+K) metals exceed the alkaline earth elements (Ca+Mg) in few groundwater samples of both seasons and in 56% of samples where strong acids exceed weak acids in pre monsoon and 28% in post monsoon.

Table 14: Distribution of different Hydrochemical Facies of groundwater in the study area

Hydrochemical Facies	Premonsoon		Post Monsoon	
	No of Samples	% of Samples	No of Samples	% of Samples
Ca+Mg	120	93	34	85
Na+K	9	7	6	15
CO_3+HCO_3	57	44	29	73
Cl+SO_4	72	56	11	28

The classification of groundwater for both seasons is presented in table 15. The table 15 shows that most groundwater is classified under Ca-Mg-HCO_3/Cl type in both seasons. Few samples classified under Na-HCO_3/Cl type in both seasons Fig 22 and 23.

Table 15: Comparison of water type between pre monsoon and post monsoon of groundwater in the study area

Water Type	Premonsoon		Post Monsoon	
	No of Samples	% of Samples	No of Samples	% of Samples
Ca-Mg-HCO_3	52	40	25	62
Na-HCO_3	4	3	3	8
Ca-Mg-Cl	67	52	9	22
Na-Cl	5	4	3	8
Ca-Mg-SO_4	1	1	0	0
Na-HCO_3-Cl	0	0	0	0
TOTAL	129	100	40	100

This may be due to the dilution of chloride ions and enhancement of bicarbonate ions in groundwater samples of postmonsoon . The occurrence of dissolved ions in groundwater due to weathering of rock minerals and equilibrium between dissolved carbonate and bicarbonate during infiltration of rainwater in the area.

Fig. 22. Piper diagrams of groundwater samples in the study area during pre monsoon

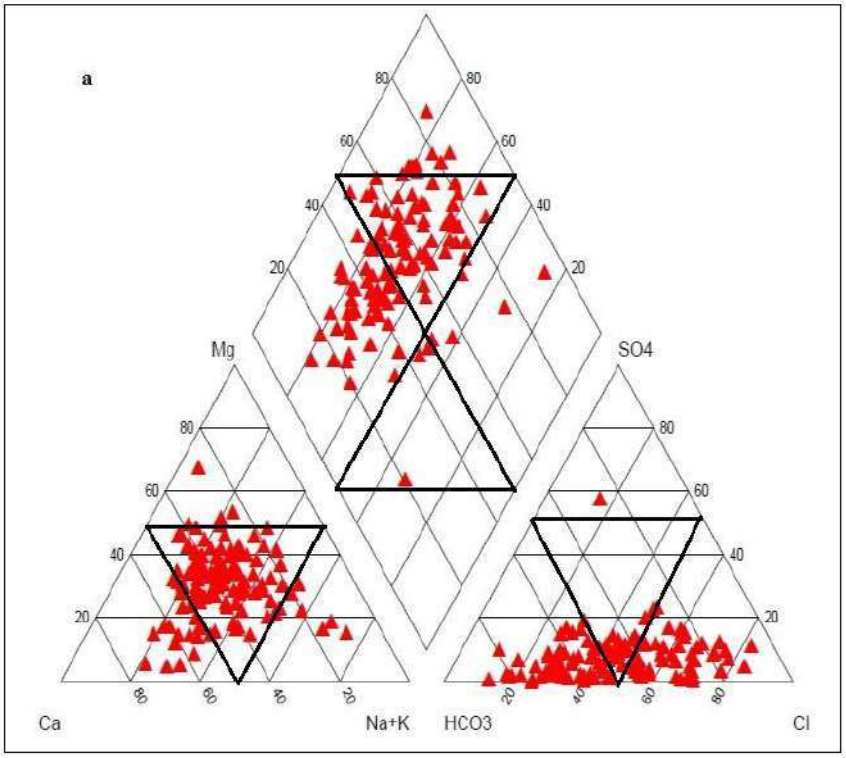


Fig.23 Piper diagrams of groundwater samples in the study area during post monsoon

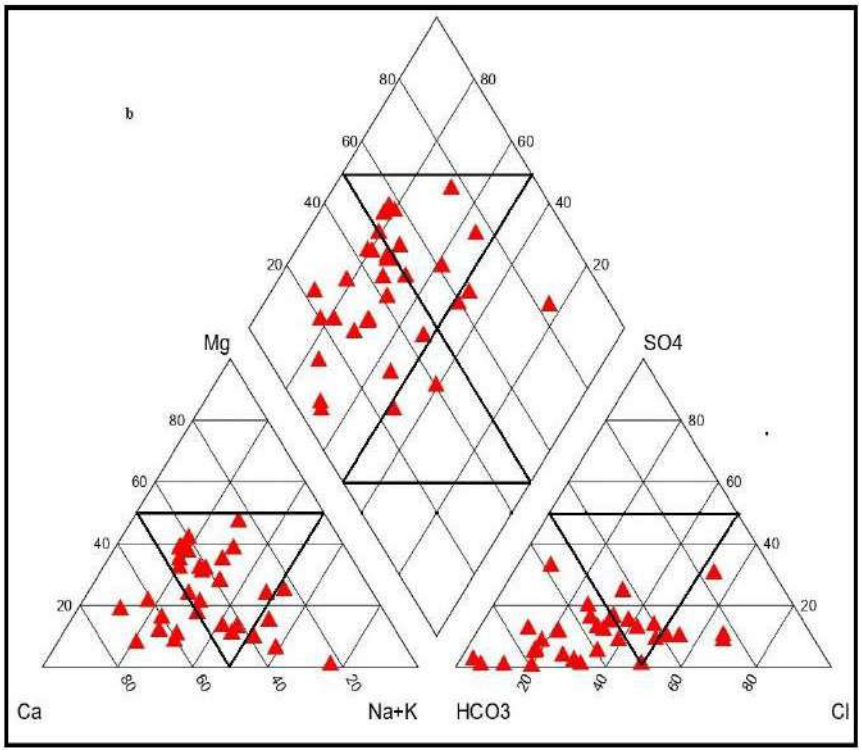


Fig. 24 Chadha's diagram for classification of groundwater during pre monsoon

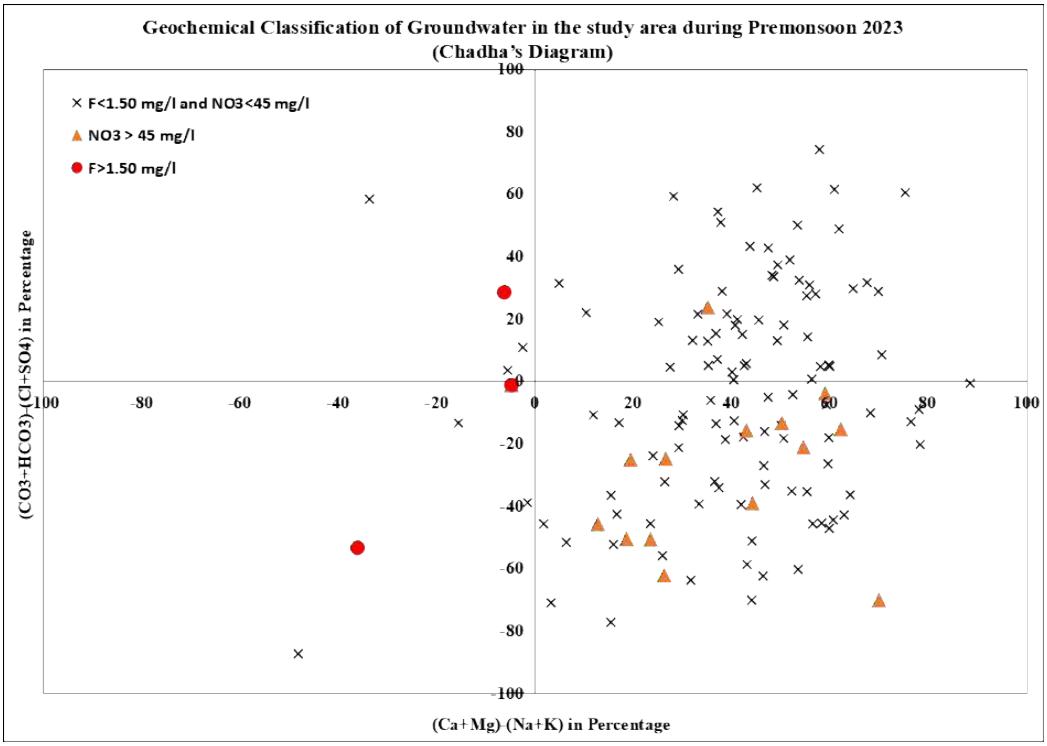
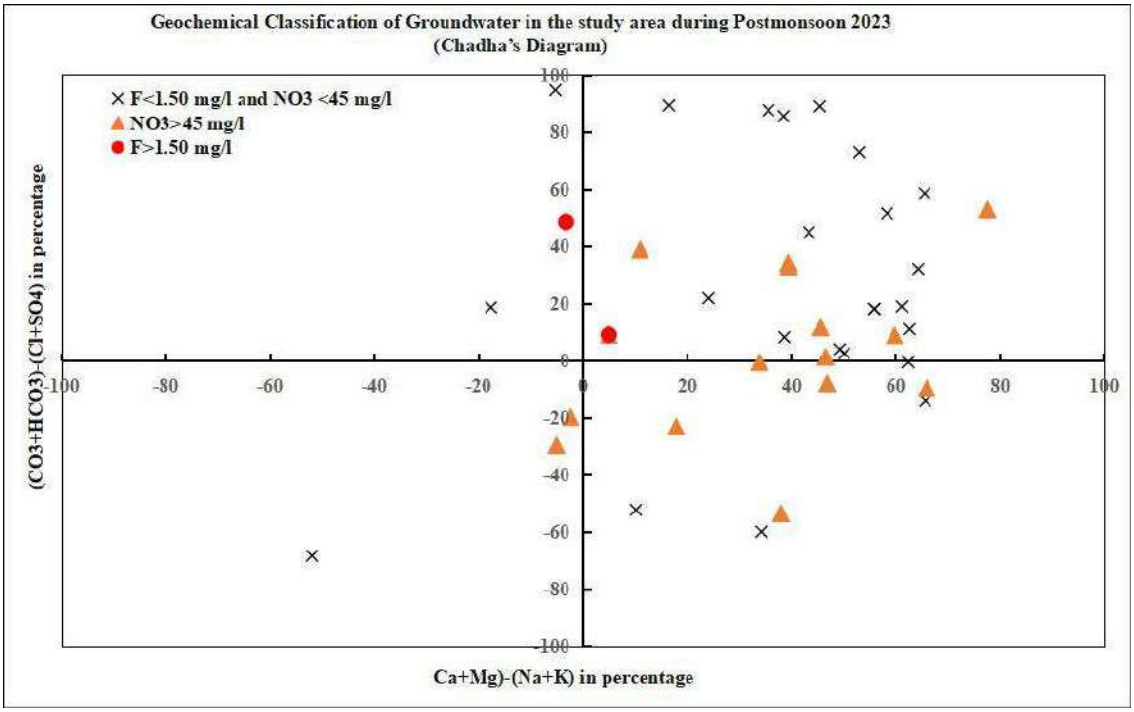


Fig. 24 also shows the alkaline earths (Ca+Mg) exceed the alkalies (Na+K) in most of the groundwater samples in pre monsoon. Further, the fig. 24 reveals the occurrence of high nitrate (>45 mg/l) found in all groundwater samples where the strong acids ($Cl+SO_4$) exceed weak acids (CO_3+HCO_3), except in one sample collected from Bagmunda (HP), Sambalpur district where bicarbonate exceeds $Cl+SO_4$. The enrichment of Cl and SO4 and nitrate contamination may be due to anthropogenic activities in the area. The leacheate of domestic sewage and excess application of nitrogen rich fertilizers may raise the nitrate in groundwater. The fig also confirms the occurrence of high fluoride (>1.50 mg/l) in the samples where the alkalies (Na+K) exceed alkaline earths, (Ca+Mg) in pre monsoon sampling.

The groundwater classification of post monsoon samples also presented in Fig. 25 which shows the most of the samples fall in first quadrant which shows the alkaline earths (Ca+Mg) exceed the alkalies (Na+K) and weak acids (CO_3+HCO_3) exceed strong acids ($Cl+SO_4$). Further, the fig 25 reveals that the occurrence of high nitrate (>45 mg/l) distributed in Ca+Mg dominance over Na+K and except two samples, namely Bamaloi (DW) of Sambalpur district and Kurebaga (DW) of Jharsuguda district are fall where Na+K exceeds the Ca+Mg which indicates the anthropogenic sources. The samples collected from Rengali and Nabasanga of Sambalpur district exceed the 1.50 mg/l of fluoride where bicarbonate exceeds the Cl and sulphate in the fracture zone. This confirms the geogenic occurrence of higher fluoride in the fracture zone than the weather zone.

Fig.25. Chadha's diagram for classification of groundwater during Post Monsoon



11.6 Distribution of Chloride

In the present study, chloride concentration of groundwater ranged between 11-482 mg/l with mean 98 mg/l during pre monsoon The maximum chloride was measured at Rengali 2, Sambalpur distinct is 482 mg/l in the fracture zone during pre monsoon and 287 mg/l in post monsoon. The acceptable limit of chloride is 250 mg/l in drinking water specification (IS 10500:2012) . The source of chloride in groundwater may be due to domestic sewage and inland discharge of industrial waste water.Because sewage water and industrial effluents are high in chloride, their inland discharge results in high chloride levels in freshwater. The locations having chloride concentration more than 250 mg/l in groundwater is presented in table 16.

Table 16. Locations having chloride concentration more than 250 mg/l in groundwater

Sl No	Districts	Blocks	Villages	Sources	Depth mgbl	Cl mg/l
Premonsoon						
1	Jharsuguda	Jharsuguda	Beherapat	DW	15	262

Sl No	Districts	Blocks	Villages	Sources	Depth mgbl	Cl mg/l
Premonsoon						
2	Jharsuguda	Jharsuguda	Budhipadar	DW	20	277
3	Sambalpur	Rengali	Tileimal	DW	8.2	344
4	Jharsuguda	Jharsuguda	Dumramunda	HP	76.25	408
5	Sambalpur	Rengali	Rengali	HP	60	252
6	Sambalpur	Rengali	Rengali 2	HP	60	482
7	Jharsuguda	Jharsuguda	H. Katapali	BW	76.25	464
8	Sambalpur	Rengali	Lapanga	BW	106.75	372
9	Sambalpur	Rengali	Jharmunda	BW	76.25	255
Post Monsoon						
10	Sambalpur	Rengali	Rengali 2	HP	60	287
11	Jharsuguda	Jharsuguda	H Katapali	BW	67.1	391

DW: Dug Well;HP: Hand Pump; BW: Bore Well

The higher concentrations of the chloride in pre monsoon than post monsoon season is due to the dilution effect.

11.7 Distribution of Nitrate

The distribution of nitrate (NO_3^-) in groundwater exhibits significant variations in the study area.The nitrate value ranges from below detection limit to 151 mg/l. The maximum nitrate (151 mg/l) found at Hansamurakatapali (H.Katapali) at a depth of 76.25 mbgl in the fracture zone of the aquifer in pre monsoon and while post monsoon sample exhibit 177 mg/l. The maximum 219 mg/l of nitrate was measured at Parmanpur of Kolabira block, Jharsuguda district during the post monsoon in the weathered zone (8.25 mbgl). The locations having more than 45 mg/l of nitrate in groundwater during pre Monsoon and post monsoon are presented in table 17 and 18 respectively.

Table 17. Locations having more than 45 mg/l of nitrate in groundwater during Pre Monsoon

Sl No	Dist	Blocks	Village	Source	Depth mgbl	NO_3 mg/l
1	Jharsuguda	Kolabira	Paramanpur	DW	8.25	72
2	Jharsuguda	Jharsuguda	Badheimunda	DW	13.2	64
3	Sambalpur	Rengali	Bamaloi	DW	9	92
4	Sambalpur	Rengali	Derba	DW	8.04	96
5	Jharsuguda	Jharsuguda	Jharmunda 2	DW	10	53
6	Jharsuguda	Jharsuguda	Kurebaga	DW	9.1	66
7	Jharsuguda	Jharsuguda	Budhipadar	HP	45.75	49
8	Jharsuguda	Jharsuguda	Brundamal 2	HP	61	84
9	Jharsuguda	Jharsuguda	Bhagipali	HP	61	84
10	Jharsuguda	Kolabira	Dabka	HP	61	69
11	Sambalpur	Rengali	Rengali	HP	60	82
12	Sambalpur	Rengali	Rengali 2	HP	60	64
13	Sambalpur	Rengali	Bagmunda	HP	76.25	53
14	Jharsuguda	Jharsuguda	Panchapada JSM	HP	45.75	54
15	Jharsuguda	Jharsuguda	H. Katapali	BW	76.25	151

DW: Dug Well;HP: Hand Pump; BW: Bore Well

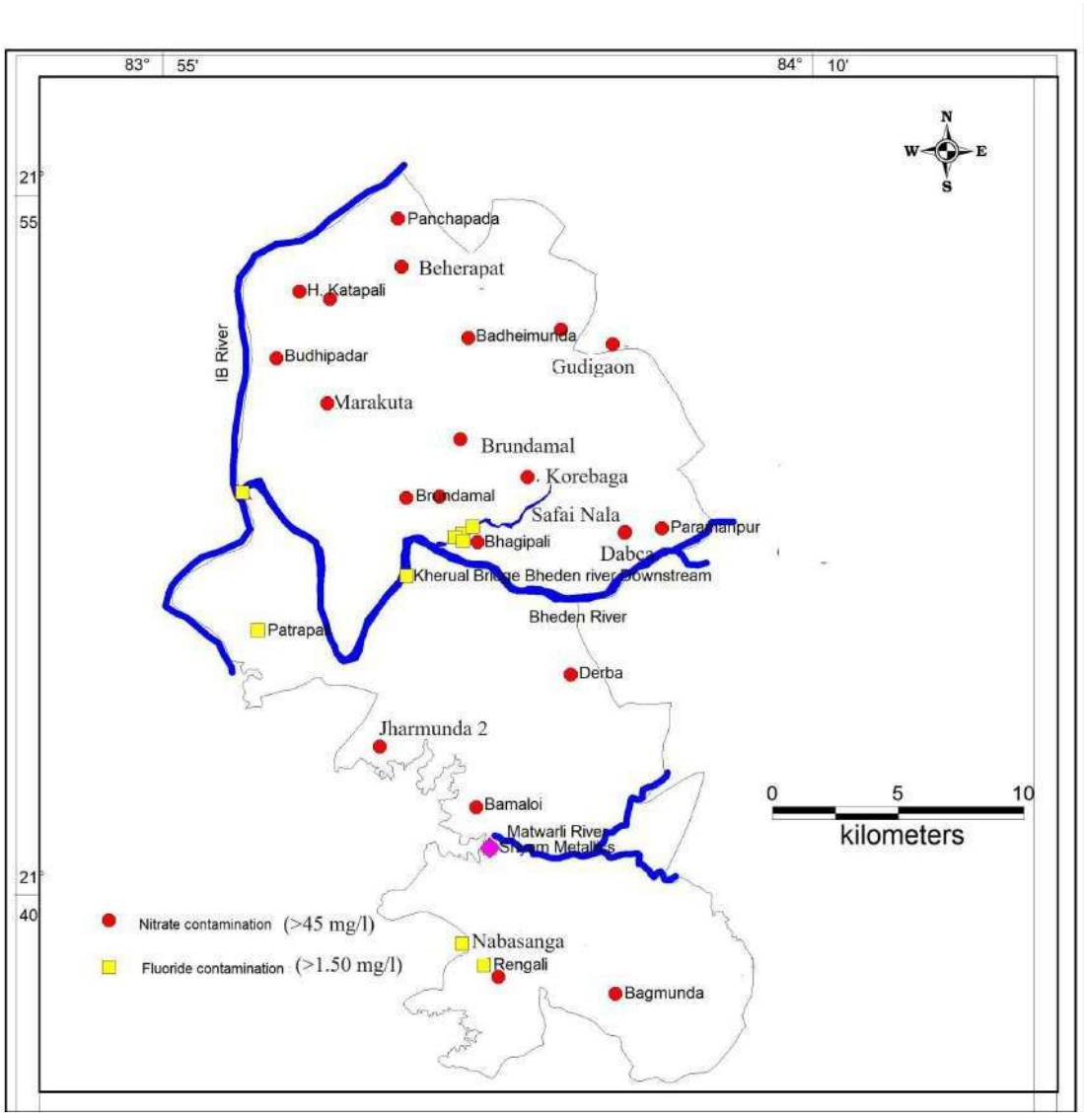
Table 18. Locations having more than 45 mg/l of nitrate in groundwater during Post Monsoon

Sl No	Dist	Blocks	Village	Source	Depth mgbl	NO_3 mg/l
1	Jharsuguda	Jharsuguda	Brundamal	HP	97.6	88
2	Jharsuguda	Jharsuguda	Bhagipali	HP	61	107
3	Sambalpur	Rengali	Rengali	HP	60	82
4	Jharsuguda	Kolabira	Dabca	HP	61	51
5	Jharsuguda	Jharsuguda	H Katapali	BW	76.25	177
6	Sambalpur	Rengali	Bagmunda	HP	76.25	65
7	Jharsuguda	Jharsuguda	Panchpada	HP	45.75	94
8	Jharsuguda	Jharsuguda	Marakuta	BW	90	51
9	Jharsuguda	Jharsuguda	Gudigaon	BW	50	55
10	Sambalpur	Rengali	Derba	DW	8.08	85
11	Sambalpur	Rengali	Bamaloi	DW	9	195
12	Sambalpur	Rengali	Thuropali	DW	10.5	54
13	Jharsuguda	Jharsugud	Kurebaga	DW	9.1	84
14	Jharsuguda	Kolabira	Parmanpur	DW	8.25	219
15	Jharsuguda	Jharsuguda	Budhipadar	HP	45.75	59

DW: Dug Well;HP: Hand Pump; BW: Bore Well

Nitrate in the study area is found to be comparatively very high concentration in post monsoon as compared to the pre monsoon. 15 samples exceed the acceptable limit (45 mg/l) of drinking water specification of IS 10500:2012 in each season . Out of 73, 9 groundwater samples, and 10 samples, out of 33 exceed the acceptable limit (45 mg/l) of nitrate in pre monsoon and post monsoon respectively. Some of the locations namely, Bhagipali, Bagmunda, Panchpada, Kurebaga, Paramanpur and Budhipadar are having higher nitrate concentration in post monsoon than pre monsoon. The rise in nitrate may be due to anthropogenic activities through which the nitrate enters into the groundwater table in the rainy season. It is also concluded that nitrate contamination exhibits in both weathered and fractured zones in both seasons.

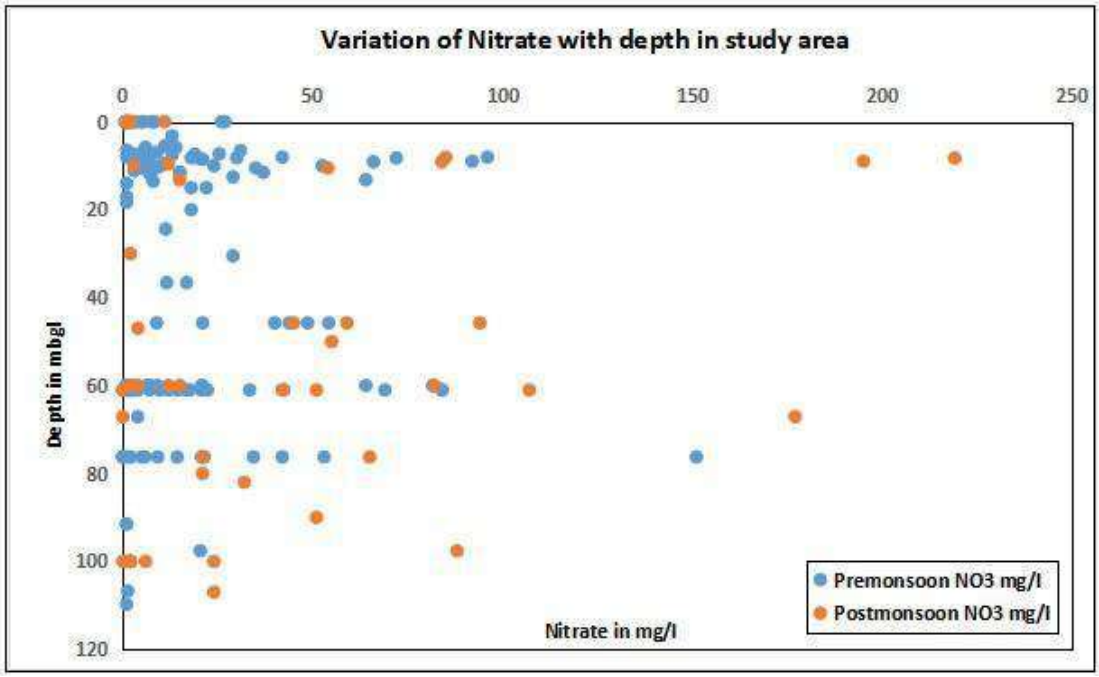
Fig 26. Locations having Nitrate more than 45 mg/l in groundwater of the study area



The distribution map (Fig.26) of nitrate shows the higher concentration of nitrate was observed in the northern part of the study area and in the weather zone of the aquifer. This signifies that the

area may be contaminated with nitrate due to anthropogenic activities and also diffused the fractured zone in some locations.

Fig. 27. Scatter diagram of nitrate concentration versus depth to water level during pre and post monsoon



The scatter diagram (Fig 27) shows that most of the samples in the range of 45-80 mbgl were contaminated with nitrate.The nitrate contamination is observed in the weather zone.

11.8 Distribution of Fluoride

The fluoride content in groundwater exhibits significant variability, ranging from levels below the detection limit to as high as 2.24 mg/L. The highest concentration of fluoride is detected at Rengali, Sambalpur district.The maximum permissible limit of fluoride is 1.50 mg/l as per drinking water specification (IS 10500:2012). It has been observed that only in 3 locations namely, Patrapalii of Jharsuguda district and, Rengali and Nabasanga of Sambalpur district exceed the 1.50 mg/l of fluoride (Fig 28 and table 19) in the fracture zone while the weather zone of aquifer is free from fluoride contamination in the study area in both seasons. The high fluoride contamination in the study area may be due to geogenic. The fig 29 shows the variation of fluoride with depth of source.

Table 19. Locations having more than 1.5 mg/l of Fluoride in groundwater

Season	District	Block	Village	Source	F in mg/l
Pre monsoon	Jharsuguda	Jharsuguda	Patrapali	HP	2.02
	Sambalpur	Rengali	Rengali	HP	2.24
	Sambalpur	Rengali	Nabasanga	HP	1.63
Post Monsoon	Sambalpur	Rengali	Rengali	HP	2.64
	Sambalpur	Rengali	Nabasanga	HP	1.65

DW: Dug Well;HP: Hand Pump; BW: Bore Well

Fig.28. Locations having Fluoride more than 1.50 mg/l in groundwater of the study area

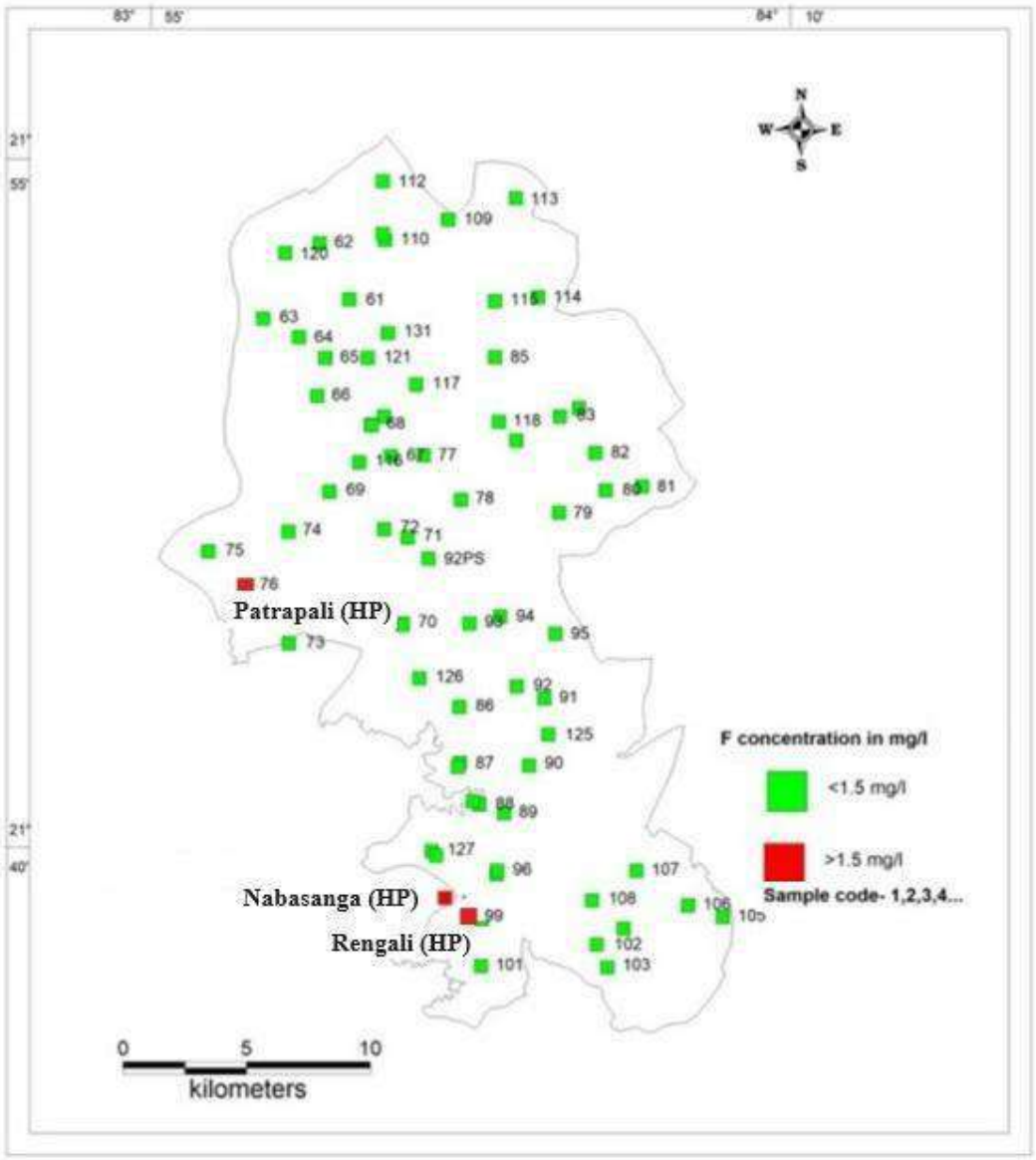
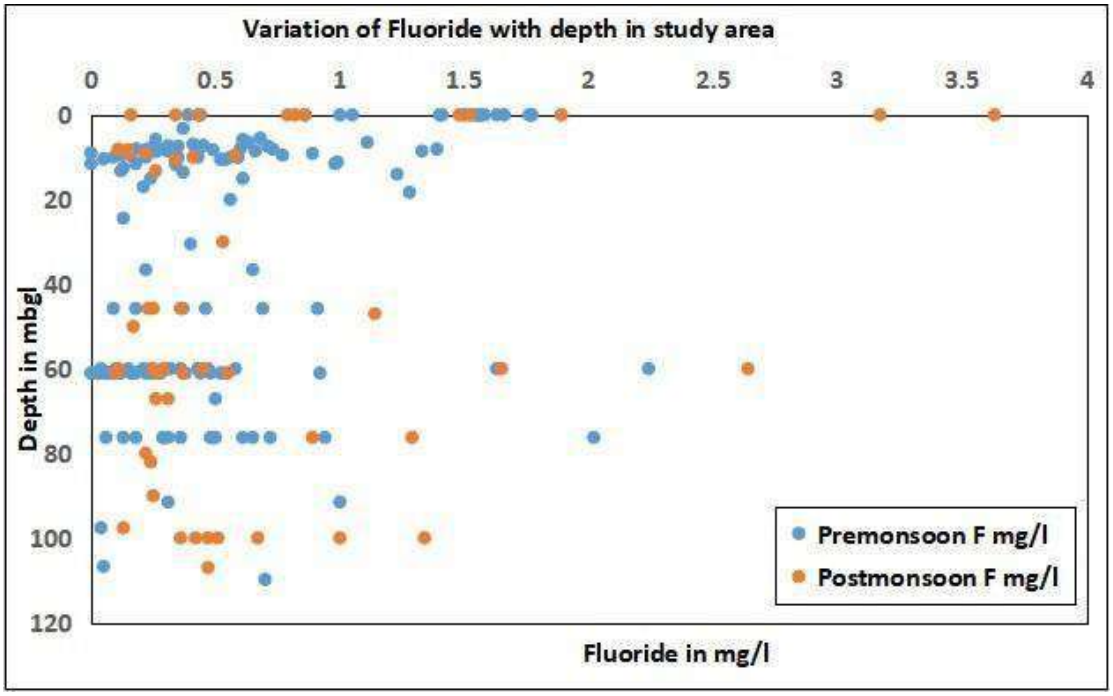


Fig. 29. Scatter diagram of fluoride concentration versus depth to water level during pre and post monsoon



11.9 Distribution of Trace and Toxic elements in the study area

The test results of trace and toxic elements of groundwater samples collected during premonsoon under NAQUIM 2.0 study is presented in Annexyre -IV and for other samples is shown in annexure V. The distribution of trace and toxic (T&T) elements varies from from location to location and the area under study is free from cupper, arsenic, cadmium and chromium contamination. The range of T & elements found in the groundwater samples is presented in table 20. The number of groundwater samples exceeding the maximum permissible limit of drinking water specification of IS 10500:2012 is summarized in the table 21.

Table 20. Minimum and Maximum of trace and toxic elements observed in groundwater samples in the study are under NAQUIM 2.0

Trace and Toxic Elements	Minimum	Maximum
Al mg/l	0	1.05
Cu mg/l	0	0.54
Fe mg/l	0	105.64
Mn mg/l	0	3.28
Se mg/l	0	0.01

Trace and Toxic Elements	Minimum	Maximum
Zn mg/l	0	36.45
U mg/l	0	0.07
Cd mg/l	0	0
Pb mg/l	0	0.1
Ni mg/l	0	0.06
As mg/l	0	0
Cr mg/l	0	0.04

Table 21. Number of groundwater samples exceed the maximum permissible limit of of drinking water specification of IS 10500:2012

Sl No	T & T elements	Acceptable limit	Permissible limit in absence of Alternate sources	No of Groundwater samples exceed Max. Permissible limit
1	Al mg/l	0.03	0.2	14
2	Cu mg/l	0.05	1.5	Nil
3	Fe mg/l	0.3	No Relaxation	64
4	Mn mg/l	0.1	0.3	25
5	Se mg/l	0.01	No Relaxation	2
6	Zn mg/l	5	15	2
7	U mg/l	0.03	No Relaxation	4
8	Cd mg/l	0.003	No Relaxation	Nil
9	Pb mg/l	0.01	No Relaxation	5
10	Ni mg/l	0.02	No Relaxation	3
11	As mg/l	0.01	No Relaxation	Nil
12	Cr mg/l	0.05	No Relaxation	Nil

The locations having more than the maximum permissible limit for Aluminium, Zinc, Uranium , and lead are shown in the following tables (22-25).

Table 22: Locations having Al more than 0.2 mg/l

Dist.	Block	Village	Source	Latitude	Longitude	Al mg/l
Jharsuguda	Jharsuguda	Pandripathar	DW	21.844239	83.984796	0.25
Jharsuguda	Jharsuguda	Singhabaga	DW	21.83044	83.981618	0.21
Jharsuguda	Jharsuguda	Brundamal	DW	21.807925	84.01107	0.47
Jharsuguda	Jharsuguda	Kukurjhanga	DW	21.81977	84.002815	0.28
Sambalpur	Rengali	Ramchandrapur	DW	21.778512	84.016923	0.24
Sambalpur	Rengali	Khodupada	DW	21.739521	83.97113	0.25
Jharsuguda	Jharsuguda	Katikela	DW	21.788169	84.075728	0.56
Jharsuguda	Jharsuguda	Badheimunda	DW	21.865727	84.034259	0.3
Sambalpur	Rengali	Derba	DW	21.745313	84.073679	0.72
Sambalpur	Rengali	Jharmunda	DW	21.665009	84.026229	0.82
Sambalpur	Rengali	Rengali	DW	21.640998	84.040813	1.05
Sambalpur	Rengali	Rampela	DW	21.631055	84.054368	0.31
Sambalpur	Rengali	Bagmunda	DW	21.631281	84.090905	0.23
Jharsuguda	Jharsuguda	Siria Bagicha	BW	21.853555	84.005669	0.31

Table 23: Locations having Zn more than 15 mg/l

Dist.	Block	Village	Source	Latitude	Longitude	Zn mg/l
Sambalpur	Rengali	Khodupada	HP	21.740707	83.970437	36.45
Jharsuguda	Jharsuguda	Kurebaga	HP	21.821111	84.052574	24.16

Table 24: Locations having U more than 0.03 mg/l

Dist.	Block	Village	Source	Latitude	Longitude	U mg/l
Jharsuguda	Jharsuguda	Brundamal 2	HP	21.808986	84.023132	0.06
Sambalpur	Rengali	Rengali	HP	21.641545	84.040195	0.07
Sambalpur	Rengali	Kadalipita	HP	21.623161	84.095028	0.07
Jharsuguda	Jharsuguda	Siria Bagicha	BW	21.8535553	84.005669	0.07

Table 25: Locations having Pb more than 0.01 mg/l

Dist.	Block	Village	Source	Latitude	Longitude	Pb mg/l
Jharsuguda	Jharsuguda	Kukurjhanga	HP	21.819963	84.00268	0.02
Sambalpur	Rengali	Khodupada	HP	21.740707	83.970437	0.07
Jharsuguda	Jharsuguda	Malda	HP	21.781165	83.970278	0.03
Sambalpur	Rengali	Charupada	HP	21.679038	84.054641	0.1
Sambalpur	Rengali	Derba	HP	21.744192	84.07476	0.02

11.10 Assessment of Groundwater for Drinking Purposes

The suitability of the groundwater for drinking purposes is assessed according to the drinking water specification, IS 10500:2012 prescribed by the Bureau of Indian Standards, New Delhi. The parameters, namely, pH, Total Dissolved Solids (TDS), Total Hardness (TH), Alkalinity, Calcium (Ca), Magnesium (Mg), Chloride (Cl), Sulphate (SO_4), Nitrate (NO_3) and Fluoride (F) are being considered for the assessment.The analytical data show the parameters pH. Total Hardness (TH), Nitrate (NO_3) and Fluoride (F) are the critical characteristics in assessing the suitability for drinking purposes in both seasons. In few samples pH is lower than 6.5 and in some exceed the 8.50, while in some samples the high hardness , nitrate and fluoride contamination make it unfit for drinking as per IS 10500:2012. The list of locations exceeding the maximum permissible limit of drinking water specification in the study area are presented in the table 26 and 27 for pre monsoon and post monsoon respectively and the status of suitability is summarized in the table 28 .

Table 26. List of locations exceed the maximum permissible limit of drinking water specification in the study area during Pre Monsoon-2023

Sl No	Dist	Blocks	Village	Source	pH	TH as $CaCO_3$, mg/l	NO_3 mg/l	F mg/l
1	Jharsuguda	Jharsuguda	Beherapat	DW	6.42	265	18	0.24
2	Jharsuguda	Kolabira	Paramanpur	DW	7.53	180	72	0.49
3	Jharsuguda	Jharsuguda	Badheimunda	DW	7.23	185	64	0.12
4	Sambalpur	Rengali	Bamaloi	DW	6.69	200	92	0.23
5	Sambalpur	Rengali	Derba	DW	6.43	170	96	0.18
6	Jharsuguda	Jharsuguda	Jharmunda 2	DW	7.65	280	53	0.35
7	Jharsuguda	Jharsuguda	Kurebaga	DW	7.7	185	66	0.89
8	Jharsuguda	Jharsuguda	Budhipadar	HP	7.83	175	49	0.09
9	Jharsuguda	Jharsuguda	Patrapali	HP	8.15	160	0	2.02
10	Jharsuguda	Jharsuguda	Brundamal 2	HP	7.78	370	84	0.11
11	Jharsuguda	Jharsuguda	Bhagipali	HP	7.85	290	84	0.03
12	Jharsuguda	Kolabira	Dabca	HP	7.75	320	69	0.92
13	Sambalpur	Rengali	Bamaloi	HP	8.57	100	22	0.18
14	Sambalpur	Rengali	Rengali	HP	7.95	405	82	2.24
15	Sambalpur	Rengali	Rengali 2	HP	7.84	640	64	0.32
16	Sambalpur	Rengali	Rampela	HP	7.7	620	9	0.15
17	Sambalpur	Rengali	Bagmunda	HP	7.91	345	53	0.94
18	Jharsuguda	Jharsuguda	Panchapada	HP	7.52	325	54	0.37
19	Jharsuguda	Jharsuguda	H. Katapali	BW	7.68	815	151	0.29

Sl No	Dist	Blocks	Village	Source	pH	TH as $CaCO_3$, mg/l	NO_3 mg/l	F mg/l
20	Sambalpur	Rengali	Nabasanga	HP	7.61	235	1.4	1.63

DW: Dug Well;HP: Hand Pump; BW: Bore Well

Table 27. List of locations exceed the maximum permissible limit of drinking water specification in the study area during Post Monsoon-2023

Sl No	Districts	Blocks	Villages	Sources	pH	TH as $CaCO_3$, mg/l	NO_3 mg/l	F mg/l
1	Jharsuguda	Jharsuguda	Brundamal	HP	7.74	393	88	0.13
2	Jharsuguda	Jharsuguda	Bhagipali	HP	7.95	308	107	0.37
3	Sambalpur	Rengali	Rengali	HP	7.73	400	82	2.64
4	Sambalpur	Rengali	Nabasanga Old	HP	7.65	210	15	1.65
5	Jharsuguda	Kolabira	Dabca	HP	7.67	411	51	0.55
6	Jharsuguda	Jharsuguda	H Katapali	BW	6.96	673	177	0.26
7	Sambalpur	Rengali	Bagmunda	HP	7.21	381	65	0.89
8	Jharsuguda	Jharsuguda	Panchpada	HP	7.72	341	94	0.25
9	Jharsuguda	Jharsuguda	Dalki	BW	6.23	76	21	0.22
10	Jharsuguda	Jharsuguda	Marakuta	BW	6.71	190	51	0.25
11	Jharsuguda	Kolabira	Gudigaon	BW	5.78	102	55	0.17
12	Jharsuguda	Jharsuguda	H Katapali	BW	6.05	109	32	0.24
13	Sambalpur	Rengali	SMEL	BW	6.42	205	12	0.29
14	Sambalpur	Rengali	Viraj	BW	6.48	170	3	0.25
15	Sambalpur	Rengali	Derba	Dug	7.41	157	85	0.11
16	Sambalpur	Rengali	Bamaloi	Dug	7.8	223	195	0.22

Sl No	Districts	Blocks	Villages	Sources	pH	TH as $CaCO_3$, mg/l	NO_3 mg/l	F mg/l
17	Sambalpur	Rengali	Thuropali	Dug	7.68	297	54	0.34
18	Jharsuguda	Kolabira	Kurebaga	Dug	7.7	156	84	0.15
19	Jharsuguda	Kolabira	Parmanpur	Dug	7.33	456	219	0.15
20	Jharsuguda	Jharsuguda	Budhipadar	HP	7.61	126	59	0.23

DW: Dug Well;HP: Hand Pump; BW: Bore Well

The table 26 shows only 2 out of 129 are having lower pH (<6.50) and only one sample has a pH more than 8.50 in premonsoon while the pH is less than 6.50 in 5, out of 40 samples are unsuitable for drinking purposes. Irrespective of seasons, 15 locations have nitrate contamination in the study area. Out of seven samples collected from the weather zone (dug wells), 2 (29%) used for drinking purposes and remaining 71 % (5 out of 7) are unsuitable due to high nitrate contamination in the post monsoon period. The fluoride concentrations exceed the maximum permissible limit in 3 groundwater samples, Patrapali, Rengali and Nabasanga during pre monsoon and two samples, at Rengali and Nabasanga of Sambalpur district during the post monsoon period (table 11.8).

Table 28. Status of drinking suitability of groundwater

Parameters	**Premonsoon**			**Post Monsoon**		
	Suitable %	**Acceptable %**	**Unsuitable %**	**Suitable %**	**Acceptable %**	**Unsuitable %**
pH	98	0	2	87	0	13
TDS	84	16	0	77	23	0
Hardness	60	37	2	48	49	3
Alkalinity	88	12	0	62	38	0
Calcium	96	4	0	75	25	0
Magnesium	71	29	0	62	38	0
Chloride	93	7	0	95	5	0

Parameters	Premonsoon			Post Monsoon		
	Suitable %	Acceptable %	Unsuitable %	Suitable %	Acceptable %	Unsuitable %
Sulphate	100	0	0	100	0	0
Nitrate	88	0	12	62	0	38
Fluoride	93	5	2	85	10	5
Overall	51	33	16	13	37	50

Table 28 shows 51% are suitable, 16 % Unsuitable and 33% of samples can be used for drinking purposes in absence of alternate sources for drinking purposes as per drinking water specification IS 10500:2012 during pre monsoon. Out of 129 groundwater samples collected from different locations in the study area, 15 are unfit due to nitrate contamination and 3 are contaminated with fluoride.

During the post monsoon, overall, 50% (20 out of 40 groundwater samples) are unfit for drinking purposes as per drinking water specification (IS 10500:2012). The unfit for drinking purposes due to low or high pH (<6.50 and >8.50), high hardness, nitrate and fluoride contamination in the area. Only 13 % are suitable and 37% of samples can be used for drinking purposes in absence of alternate sources. The data also revealed that only 2 samples out of 33 are contaminated with high fluoride in the fractured zone whereas 5 samples out of 7, in the weathered zone are contaminated with very high nitrate concentration during the post monsoon.

The percentage of unsuitability of groundwater in pre monsoon (16%) is lower than the post monsoon (505) mostly due to nitrate contamination in both weather and fracture zone of the aquifer. Further there is no fluoride contamination (>1.50 mg/l) in the weathered zone irrespective of seasons whereas it exhibits in the fractured zone in both seasons. The nitrate contamination (45 mg/l) was observed in both weathered and fractured zones irrespective of seasons. The scattered diagram of nitrate and fluoride versus depth to water level indicates the contamination in groundwater.

11.11 Assessment of Groundwater for Irrigation purposes

The utilization of groundwater for irrigation purposes is the most widespread application globally. However, it is crucial to assess the chemical quality of groundwater when considering its suitability for irrigation, as poor-quality groundwater can lead to salinity issues, specific ion toxicity, and soil infiltration problems. These factors can have a detrimental impact on crop production. To evaluate the water quality constraints for irrigation, several empirical indices have been developed based on

field experience and experiments. Parameters such as Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), percentage of Sodium (% Na), Magensium Ratio (MR) and Kelly Ratio (KR) are calculated and taken into account when assessing groundwater samples for their suitability in irrigation practices. These parameters serve as indicators to evaluate the potential impact of the groundwater's chemical composition on soil and crop health during irrigation activities.

Table 29. Statistical summary of indices of groundwater for irrigation purposes

Parameters	Pre-Monsoon			Post-Monsoon		
	Min	Max	Mean	Min	Max	Mean
SAR	0.15	7.31	1.19	0.31	7.73	1.55
RSC	-13.8	4.20	-1.62	-9.55	1.78	-1.71
%Na	4.63	73.8	27.17	10.1	74.94	28.79
MR	6.67	74.73	44.7	5.37	66.69	33.19
KR	0.05	2.85	0.44	0.11	3.12	0.53

All groundwater samples based on SAR are found within the range of excellent category (<10). All samples collected during premonsoon and post monsoon periods showed that the groundwater is of excellent quality, except two samples located at Patrapali of Jharsuguda and Lapanga of Sambalpur districts due to high residual sodium carbonate (RSC). The groundwater sample collected from Dhuben and Chhapal (RSC=4.20) of Sambalpur district are unsuitable for irrigation purposes.Among the samples evaluated for Na% values, only 29% and 32% of the total groundwater samples fall in excellent for premonsoon and post monsoon respectively. It also reveals that 4% and 3% (>60 %Na) of the groundwater

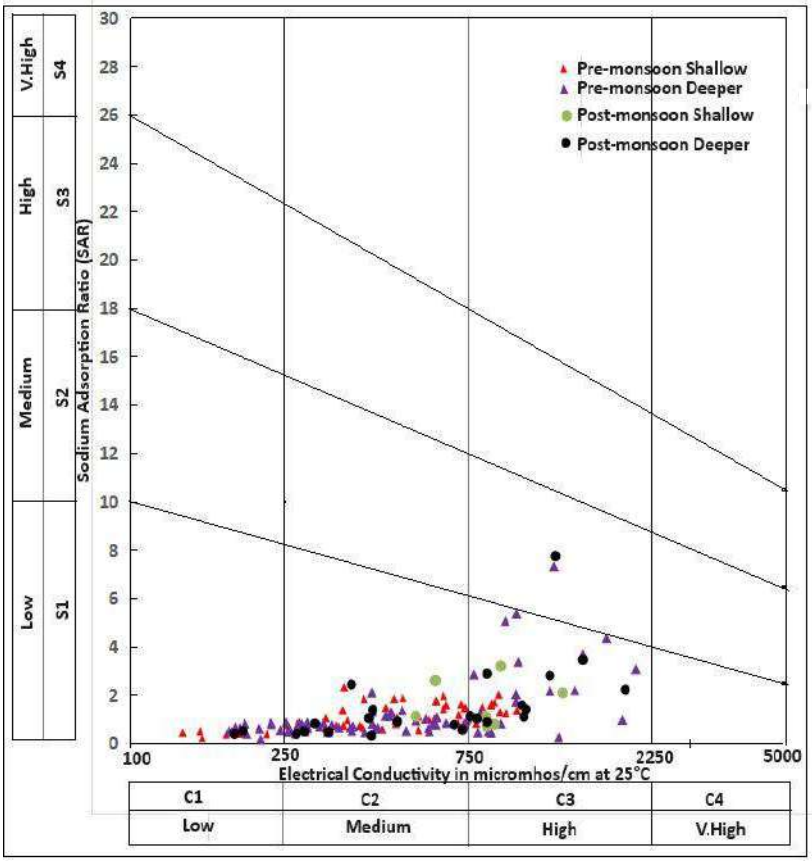
Table 30. Status of indices for Irrigation in the study area

Parameters	Ranges	Water Type/ Classification	% of Samples	
			Pre-monsoon	Post Monsoon
SAR	<10 10-18 18-26 >26	Excellent Good Doubtful Unsuitable	100 0 0 0	100 0 0 0
RSC	<1.25 1.25-2.50	Good Doubtful	6 93	13 87

	>2.50	Unsuitable	1	0
%Na	<20 20-40 40-60 60-80 >80	Excellent Good Permissible Doubtful Unsuitable	29 60 7 4 0	32 46 19 3 0
MR	<50 >50	Safe Unsafe	65 35	87 13
KR	<1.0 >1.0	Suitable Unsuitable	94 6	87 13

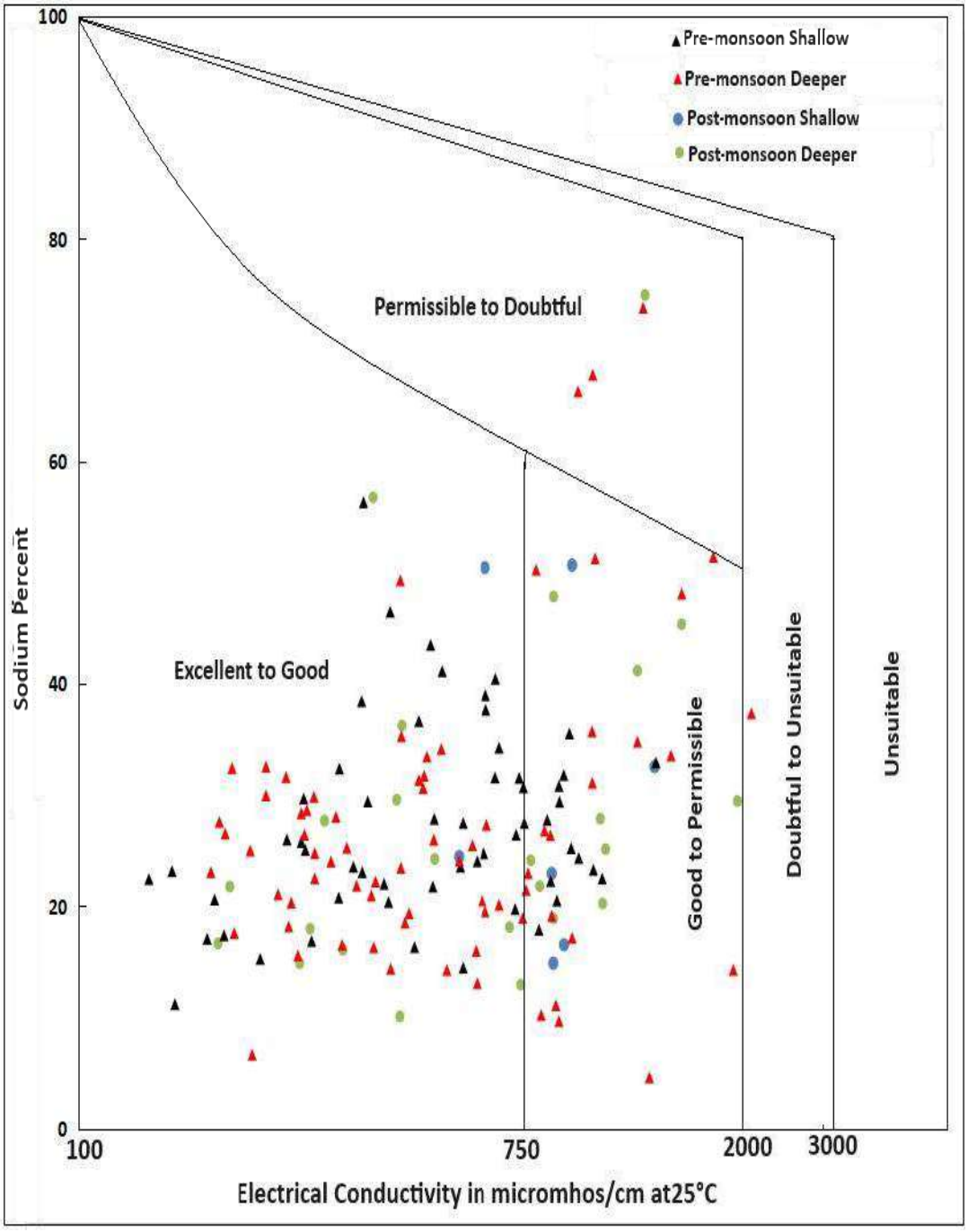
samples fall in the unsuitable category due to high sodium in premonsoon and post monsoon respectively. Most of the samples (65%) in the study area have MR< 50%, indicating the suitability for irrigation purposes (Table) in the premonsoon period whereas the MR<50% for post monsoon period is 87%, indicating the dilution of groundwater and safe for irrigation purposes. Additionally, the calculated KR values < 1 are 94% and 87% for premonsoon and post monsoon period respectively which are indicating the suitability for irrigation.

Fig. 30. USSL diagram for classification of irrigation inn the study area during premonsoon and post monsoon



Overall, most indices suggest that the groundwater in the study area is suitable for irrigation except few locations in Jharsuguda and Sambalpur districts.

Fig.31. Wilcox diagram for classification of irrigation inn the study area during premonsoon and post monsoon



11.12 Chemical Characteristics of wastewater and Decant water

There are 14 large scale industries, 20 Medium scale industries and 20 MSME located in the study area parts of Jharsuguda District (Jharsuguda and Kolabira blocks). Similarly there are 8 large scale industries, 2 Medium scale industries and 2 MSME located in the study area parts of Sambalpur District. Mostly industries are machinery, Metal, Steel and Thermal Power plants types operating in the districts. Ash generation from the thermal power plant is the major industrial waste and is being disposed of in slurry form in the earmarked ash pond areas.

There are three waste water samples collected from the three different industries (M/s Shyam Metallic & Energy Limited, Pandloi, Sambalur, M/s Viraj Steel & Energy Limited, Gurupali, Sambalpur and M/s Bhushan Steel and Power Limited, Sambalpur) and one inland discharged effluent sample collected from the drainage located near the M/s BSPL. In addition to these wastewater, one sample collected from the decant pond (M/s Vedanta Limited, Jharsuguda) located at Siriapali, Jharsuguda. Also water samples collected from natural ponds, located near to the ash ponds where the fly ash deposited by M/s Vedanta Limited, Jharsugud to assess its quality.The analytical results of wastewaters collected from various industries are presented in table 31 and 32 for basic and Trace and toxic elements respectively. .

The electrical conductivity values of waste waters are in the range of 1122-4571 µS/cm at 25°C and categorized as high saline in nature. Chloride was recorded in the range of 89–1620 mg/l. Sulfate was observed in the range of 83-800 mg/l. Nitrate concentration was observed from 5.3 -27 mg/l. The presence of fluoride was detected in all the wastewater samples and in the range of 1.30–1.77 mg/l. The fluoride content of decant pond water, located at Sariapali (M/s VAL) is 1.77 mg/l and 1.89 mg/l in pre monsoon and post monsoon respectively.

Table 31. Chemical Characteristics of wastewaters of various industries

Parameters	Decant Pond (VAL)	WWTP (SMEL)	WWTP (VSEL)	WWTP (BSPL)	Effluent discharge by BSPL
pH	6.46	8.02	8.47	6.22	7.47
EC µS/cm at 25°C	2644	2380	1122	4571	3000
TDS mg/l	1439	1498	684	2811	1591
Total Hardness mg/l, as $CaCO_3$	875	720	445	805	810
Total Alkalinity mg/l, as $CaCO_3$	140	85	25	45	50
Ca^{++}mg/l	216	148	96	270	228

Parameters	Decant Pond (VAL)	WWTP (SMEL)	WWTP (VSEL)	WWTP (BSPL)	Effluent discharge by BSPL
Mg^{++}mg/l	81	85	50	32	58
Na^{+}mg/l	153	193	43	760	218
K^{+} mg/l	57	28.9	18.7	12	31.3
$CO_3^{=}$mg/l	0	0	54	0	0
HCO_3^{-}mg/l	171	104	31	55	61
Cl^{-}mg/l	670	184	89	1620	567
SO_4^{2-}mg/l	152	800	314	83	431
NO_3^{-}mg/l	26	7.5	5.3	5.6	27
F mg/l	1.77	1.56	1.41	1.3	1.66

The data show that the wastewater contains higher amounts of calcium, chloride, sulphate and fluoride as compared with drinking water specification of IS 10500:2012. The decant pond water, located at Siriapali (M/s Vedanta Aluminium Ltd.) also contains high chloride, sulphate and fluoride. further, M/s BSPL directly discharged its effluents into the drainage that contains high chloride, sulphate and fluoride.The distribution of EC, sulphate and fluoride of waste waters of various industries are presented in the figs 32,33 and 34.

Table 32. Trace and Toxic elements of wastewaters of various industries

Parameters	Decant Pond (VAL)	WWTP (SMEL)	WWTP (VSEL)	WWTP (BSPL)	Effluent discharge by BSPL
Premonsoon					
Al mg/l	11.91	0.54	0.04		0.36
Cu mg/l	0	0.01	0		0.01
Fe mg/l	0.49	0.01	0		2.94
Mn mg/l	1.61	0.03	0		1.27
Se mg/l	0.29	0	0		0

Parameters	Decant Pond (VAL)	WWTP (SMEL)	WWTP (VSEL)	WWTP (BSPL)	Effluent discharge by BSPL
Zn mg/l	0.1	0.02	0.03		1.02
U mg/l	0	0	0		0
Cd mg/l	0.02	0	0		0
Pb mg/l	0	0	0		0
Ni mg/l	0.11	0	0		0.01
As mg/l	0.01	0	0		0
Cr mg/l	0	0.01	0		0
Postmonsoon					
Al mg/l	9.45	1.27	0.01	0.24	0.5
Cu mg/l	0.02	0.01	0.01	0	0.01
Fe mg/l	0.08	0.05	1.62	1.41	5.82
Mn mg/l	1.13	0.23	0.01	0.29	2.19
Se mg/l	0.3	0	0	0	0
Zn mg/l	0.19	0.04	0.04	0.04	0.53
U mg/l	0	0	0	0	0
Cd mg/l	0	0	0	0	0
Pb mg/l	0	0	0.01	0	0.01
Ni mg/l	0.19	0	0	0.01	0.01
As mg/l	0.01	0	0	0	0
Cr mg/l	0	0.06	0	0	0

Fig 32. Electrical Conductivity and Chloride of wastewaters

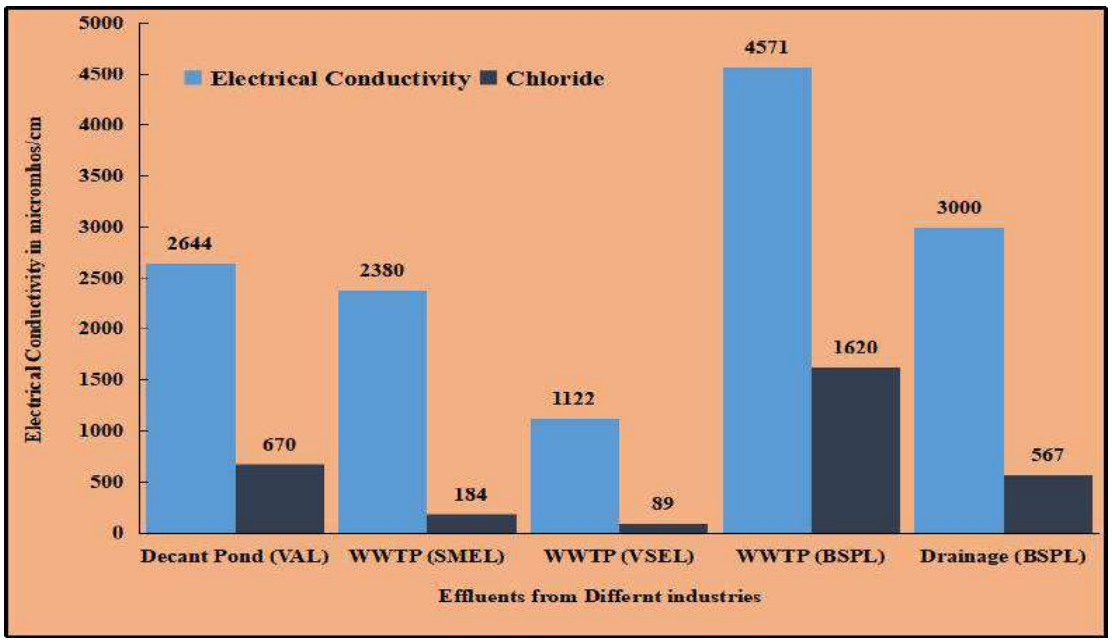


Fig 33. Sulphate of wastewaters

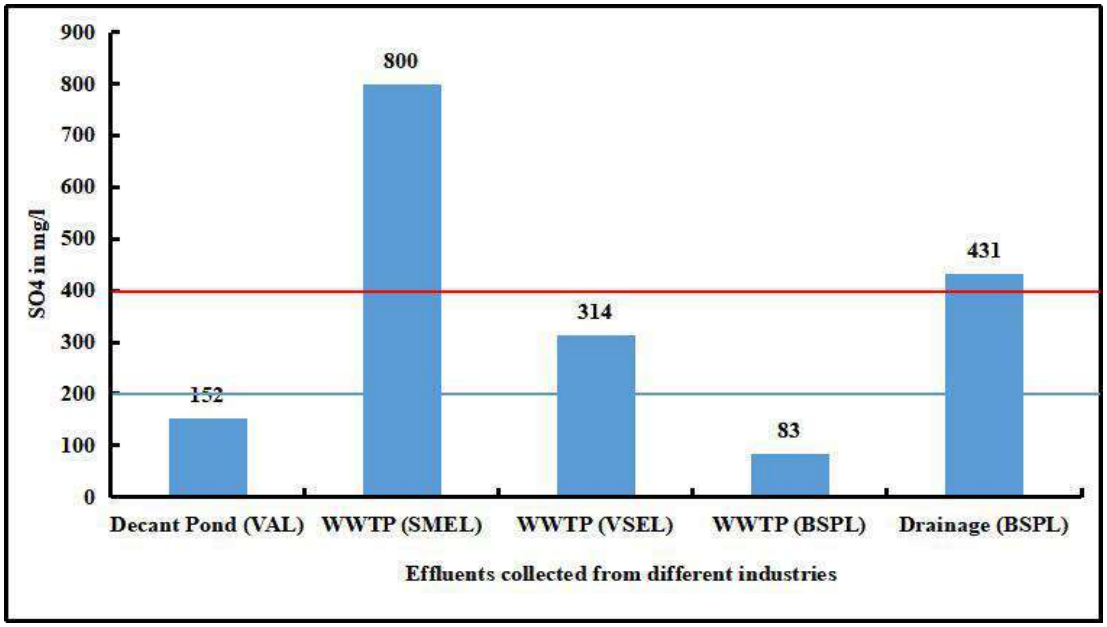
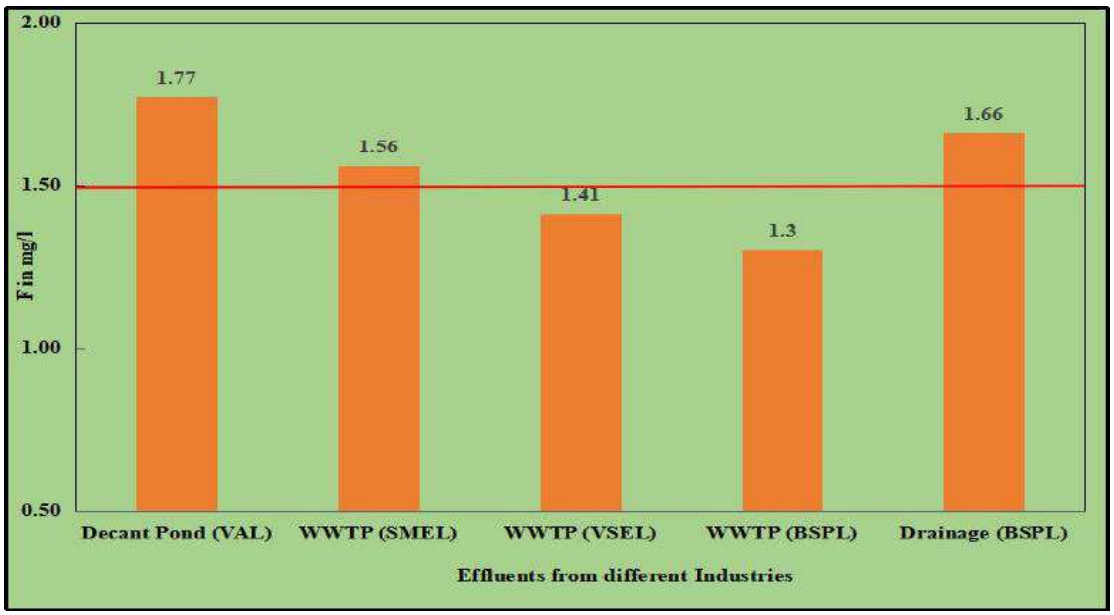


Fig.34. Fluoride of wastewaters



The high values of chloride and sulphate concluded the wastewater discharged into the surface water bodies. The source of fluoride contamination is man made. Further, it is observed that M/s Vedanta Aluminium Limited; Jharsuguda is located at the right bank of Bheden river and the Safai nala, a natural drainage, flows from the back side, and meets to Bheden river at Bhagipali. The runoff of Safai nala has higher TDS,Cl,SO_4 and F values than a natural river water composition. Secondly there is much more difference in the chemical compositions of water between Bheden at Katikela (Upstream) and confluence, between Safai nala and Bheden river at Bhagipali.

So it is concluded that the industry (M/s Vedanta Aluminium Limited) may discharge its under treated wastewater to the Bheden river through the Safai nala which polluted the Bheden river.

On data analysis, the ions namely chloride, sulphate and fluoride are prominent in decanted water as well as in wastewater samples.The higher concentrations of these ions are also observed in runoff of Safai Nala and Bheden river during pre monsoon and post monsoon.

This observation concluded that the wastewater discharged into the Safai nala which ultimately polluted the Bheden river. Further,M/s BSPL discharges its wastewater with high conductivity,chloride, sulphate and fluoride into the natural drainage.

11.13 Impact of Waste water on surface water bodies

There are 12 samples collected from different surface water bodies (Ponds, Nalas, and rivers) in the pre monsoon and 10 in post monsoon. The test results of the surface water presented in the annexure 5 and 6 for premonsoon and post monsoon.

Ib river is the major river, flows along the western side of Jharsuguda town, and meets to Hirakud dam in the Jharsuguda district whereas the river Bheden flows in the south and confluence into Ib

River at Khait, Jharsuguda district. Safai nala is one of the nalas, located in the study area and merges the Bheden river at Bagipali, of Jharsuguda district (Fig 2a).

The analytical results of samples collected from ponds, located at Bhagipali and Katikela are presented in the Table –33,34. for both seasons.

Table 33. Chemical Characteristics of Pond water and Decanted water

Parameters	Premonsoon			Post monsoon		
	Decanted water (VAL)	Pond at Bhagipalii	Pond at Katikela	Decanted water (VAL)	Pond at Bhagipalii	Pond at Katikela
pH	6.46	7.91	8.18	6.57	7.21	6.91
EC µS/cm at 25°C	2644	300	348	1519	208	214
TDS mg/l	1439	146	191	1004	121	128
Total Hardness mg/l, as $CaCO_3$	875	85	115	605	90	80
Total Alkalinity mg/l, as $CaCO_3$	140	50	100	45	70	60
Ca^{++}mg/l	216	22	32	160	20	20
Mg^{++}mg/l	81	7	9	50	10	7
Na^{+}mg/l	153	15	27	77	8	14
K^{+} mg/l	57	8.2	6.7	40.7	4.7	3.9
$CO_3^{=}$mg/l	0	0	0	0	0	0
HCO_3^{-}mg/l	171	61	122	55	85	73
Cl^{-}mg/l	670	43	43	225	18	20
SO_4^{2-}mg/l	152	17	12	420	13	16
NO_3^{-}mg/l	26	4	3	1.6	1	11
F mg/l	1.77	1.77	1.5	1.89	3.63	0.86

Fig.35. Fluoride contents in pond water collected from Bhagipali and Katikela during pre and post monsoon

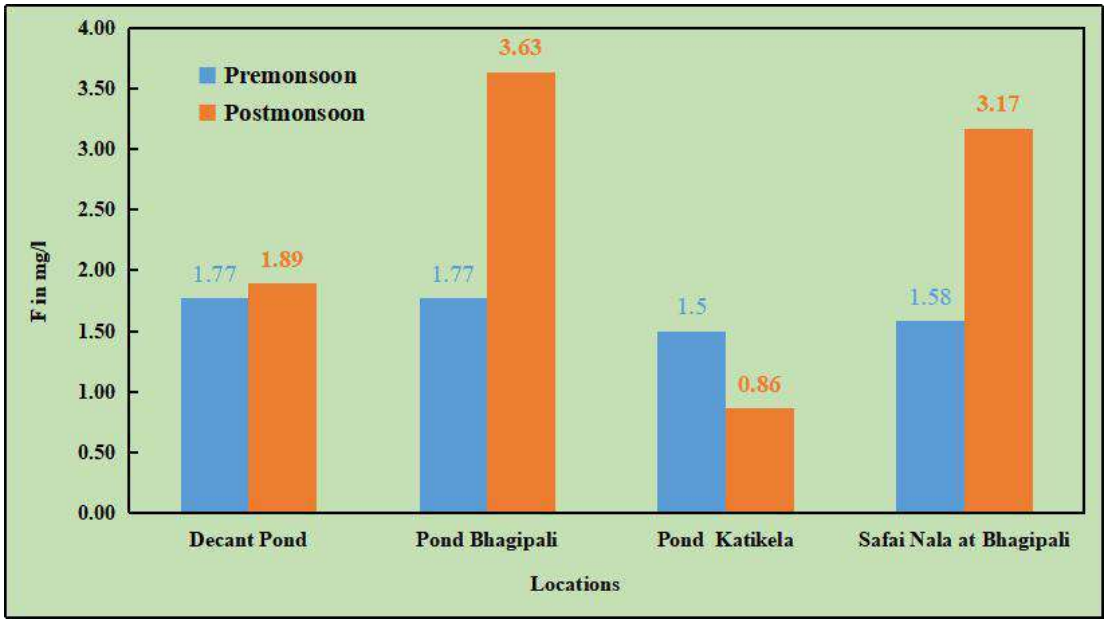


Fig 35 shows the F contents of surface water collected from ponds at Katikela and Bhagipali are 1.50 mg/l and 1.77 mg/l respectively. Fluoride is termed as a critical parameter in all surface water bodies and also wastewaters in the region.The decanted water, released from ash pond located at Siriapali (M/s Vedanta Aluminium Limited), contains high fluoride (1.77 mg/l). On the comparison of chemical data between decant pond and other natural ponds, it is found that the chemical characteristics are higher in decant than pond water.

Table 34. Trace and Toxic elements of Pond water and Decanted water

T and T elements	Premonsoon			Post monsoon		
	Decanted water (VAL)	Pond at Bhagipalii	Pond at Katikela	Decanted water (VAL)	Pond at Bhagipalii	Pond at Katikela
Al mg/l	11.91	0.66	0.69	9.45	0.11	0.04
Cu mg/l	0	0	0	0.02	0	0
Fe mg/l	0.49	0.54	0.14	0.08	0.22	0.11
Mn mg/l	1.61	0.23	0.47	1.13	0.2	0.22
Se mg/l	0.29	0	0	0.30	0	0

T and T elements	Premonsoon			Post monsoon		
	Decanted water (VAL)	Pond at Bhagipalii	Pond at Katikela	Decanted water (VAL)	Pond at Bhagipalii	Pond at Katikela
Zn mg/l	0.1	0.02	0.01	0.19	0	0.01
U mg/l	0	0	0	0	0	0
Cd mg/l	0.02	0	0	0	0	0
Pb mg/l	0	0	0	0	0	0
Ni mg/l	0.11	0	0	0.19	0	0
As mg/l	0.01	0	0	0.01	0	0
Cr mg/l	0	0	0	0	0	0

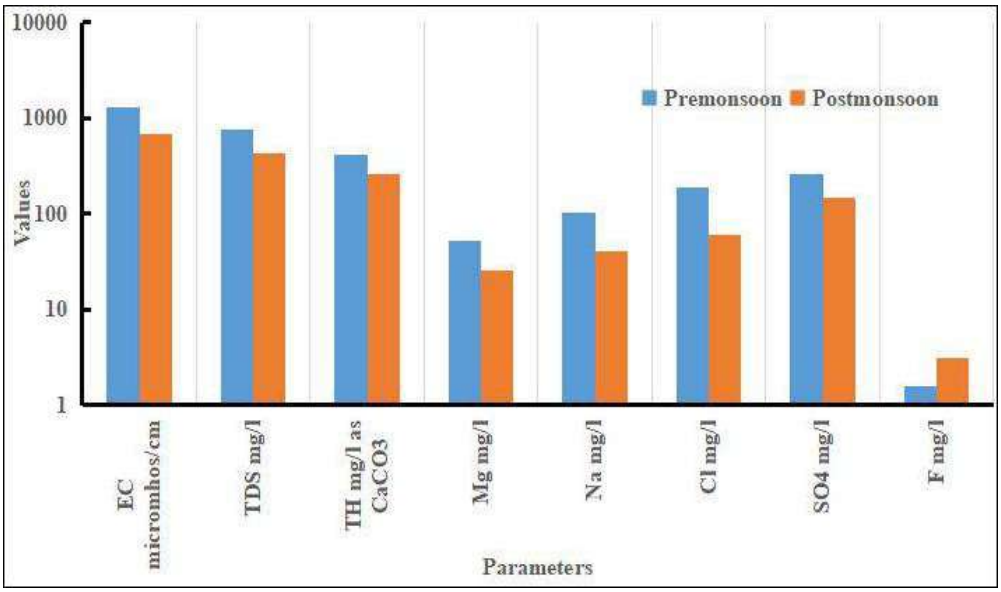
Water quality of Safai Nala: The mean electrical conductivity of water samples collected from three different points (S1,S2 and S3) of Safai nala is 1202 S/cm at 25°C in the pre monsoon. The electrical conductivity of Safai nala at Bhagipali is 657 S/cm at 25°C and 490 S/cm at confluence between Bheden river and Safai nala in post monsoon. The total hardness values vary from 385-425 as $CaCO_3$, mg/l with an average of 408 as $CaCO_3$, mg/l in premonsoon. The sulphate ranged between 260- 389 mg/l with mean 335 mg/l in pre monsoon. The sulphate of Safai Nala measured at Bhagipali is 147 mg/l in post monsoon which is much lower than pre monsoon (335 mg/l). The fluoride exceeded 1.50 mg/l in all samples collected from Safai nala. This indicates it is contaminated with fluoride. The sulphate content exceeded the acceptable limit (200 mg/l) in pre monsoon while it may be diluted to 147 mg/l in post monsoon. The nitrate is below 10 mg/l in both seasons.

Table 35. Chemical Composition of Safai nala water

Parameters	Premonsoon				Post Monsoon
	S1	S2	S3	Mean	Safai Nala at Bhagipali (S3)
pH	8.18	8.2	8.21	8.2	7.22
EC µS/cm at 25°C	1130	1170	1305	1202	675
TDS mg/l	656	732	769	719	425
Total Hardness mg/l, as $CaCO_3$	385	425	415	408	260
Total Alkalinity mg/l, as $CaCO_3$	100	125	100	108	125
Ca^{++}mg/l	70	84	80	78	62
Mg^{++}mg/l	51	52	52	52	26
Na^{+}mg/l	65.6	67	104	79	40
K^{+} mg/l	7.7	7.7	12.7	9.37	7.7
$CO_3^{=}$mg/l	0	0	0	0	0
HCO_3^{-}mg/l	122	153	122	132	153
Cl^{-}mg/l	46	57	191	98	61
SO_4^{2-}mg/l	356	389	260	335	147
NO_3^{-}mg/l	0.5	1	8.3	3.27	2
F mg/l	1.56	1.63	1.58	1.59	3.17

The high Fluoride content exhibited in the Safai Nala's water in both seasons indicated anthropogenic activities which may have included the inland discharge of wastewater into it along with disposed of high accumulated fluoride content materials. The water carrying high concentrations of sulfate and fluoride merged with the Bheden river at Bhagipali. The Bheden river is a tributary of Ib river and merged at Khait, Jharsuguda district.

Fig. 36. Chemical characteristics of water collected from Safai Nala at Bhagipalii during pre and post monsoon



The fig 36. shows higher dissolved salts observed in premonsoon than the post monsoon. This may be due to the dilution effect. However, the fluoride content is higher in post monsoon than premonsoon. The long term analysis of data is presented in **Fig. 37 and 38.** It is concluded from the fig the fluoride, chloride and sulphate persist in the water , show the rising trend and then enter into the Bheden river and are within the maximum permissible limit of drinking specification, IS 10500:2012.

Fig 37. Histogram of Cl and SO4 in water of Safai nala at Bhagipali

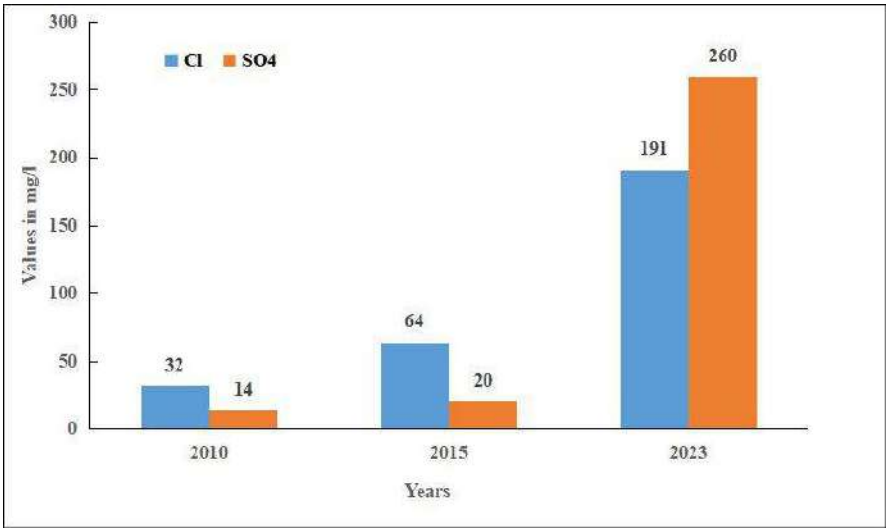
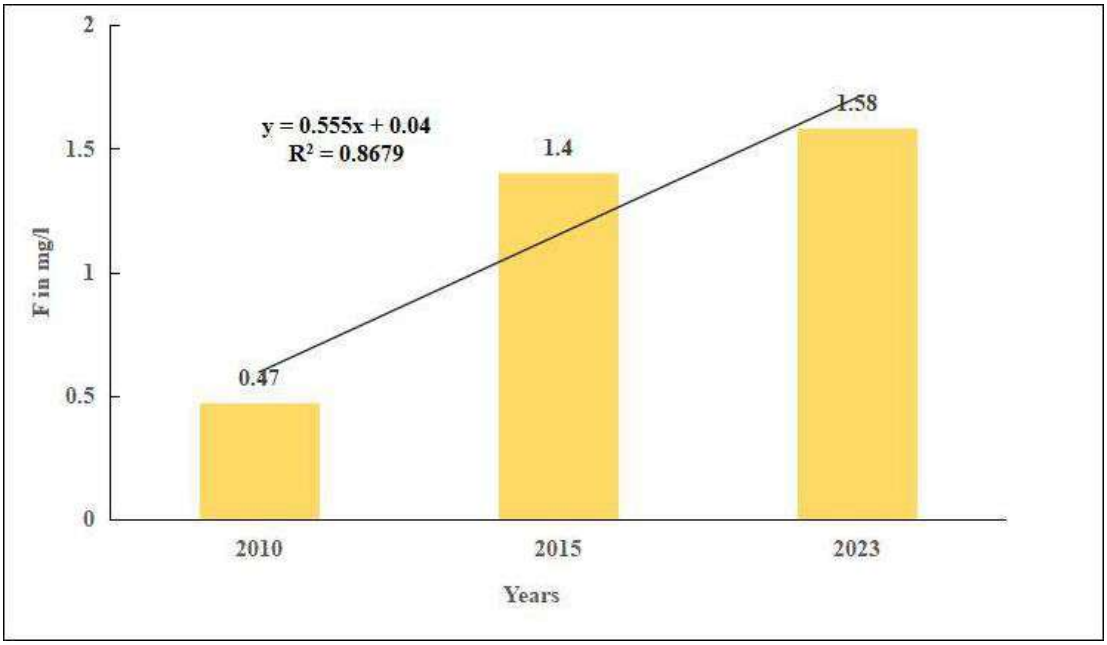


Fig 38. Histogram of Fluoride in water at Safai nala at Bhagipali



The water quality of Safai nala is deteriorating day by day due to anthropogenic activities in the area. The polluted Safai nala water merges with the Bhden river at Bhagipali.

Table 36. Trace and Toxic elements of Safai nala water

T and T Elements	Premonsoon				Post Monsoon
	S1	S2	S3	Mean	Safai Nala at Bhagipali (S3)
Al mg/l	0.06	0.02	0.05	0.04	1.41
Cu mg/l	0	0	0	0	0
Fe mg/l	0	0	0	0	0.92
Mn mg/l	0.49	0	0.04	0.18	0.79
Se mg/l	0	0	0.01	0	0.01
Zn mg/l	0	0	0.01	0	0.03
U mg/l	0	0	0	0	0
Cd mg/l	0	0	0	0	0

T and T Elements	Premonsoon				Post Monsoon
	S1	S2	S3	Mean	Safai Nala at Bhagipali (S3)
Pb mg/l	0	0	0	0	0
Ni mg/l	0	0	0	0	0.01
As mg/l	0	0	0	0	0
Cr mg/l	0	0	0	0	0

Water quality of Bheden River: Bheden river considered one of major tributaries of river Ib merges with river Ib at Rampur of Jharsuguda district. During the field visit, it was found that the river had gone mostly dry and water flow in the river stopped. The runoff flow in the river is marginal during the non-monsoon season. However, four water samples were collected from its bed at different locations to assess its water quality . The sampling locations are presented in Fig 20 & 21 . The chemical characteristics of the Bheden River shows the alkaline in nature and contained higher dissolved ions than the Upstream (Katikela) water in both seasons. The total dissolved solids of water upstream (Bheden at Katikela) is 137 mg/l which is freshwater and much lower than the confluence of Safai nala at Bagipali (863 mg/l) in pre monsoon. After mixing of fluoride contaminated water of Safai nala, the chemical characteristics of Bheden river is changed. Except TDS, TH, calcium, magnesium, sulphate,and fluoride, all remaining ions are within the acceptable limit of drinking water specification of IS 10500:2012.

Table 37. Chemical Characteristics of the Bheden River water during pre monsoon

Parameters	Bheden at Katikela (Upstream)	Bheden-Safai Nala Confluence	Bheden at Kherual Bridge Downstream	Ib-Bheden (Confluence)
pH	8.09	8.17	8.10	8.00
EC µS/cm at 25°C	254	1469	1006	743
TDS mg/l	137	863	614	405
Total Hardness mg/l, as $CaCO_3$	100	485	305	265
Total Alkalinity mg/l, as $CaCO_3$	90	100	95	75

Parameters	Bheden at Katikela (Upstream)	Bheden-Safai Nala Confluence	Bheden at Kherual Bridge Downstream	Ib-Bheden (Confluence)
Ca^{++}mg/l	30	80	72	58
Mg^{++}mg/l	6.07	69.26	304	29
Na^{+}mg/l	13.7	107	77	39
K^{+} mg/l	2.2	12.3	9.6	6.7
$CO_3^{=}$mg/l	0	0	0	0
HCO_3^{-}mg/l	110	122	116	92
Cl^{-}mg/l	21	213	128	156
SO_4^{2-}mg/l	9	320	240	70
NO_3^{-}mg/l	1	2.3	1	1
F mg/l	0.39	1.4	1.76	1.54

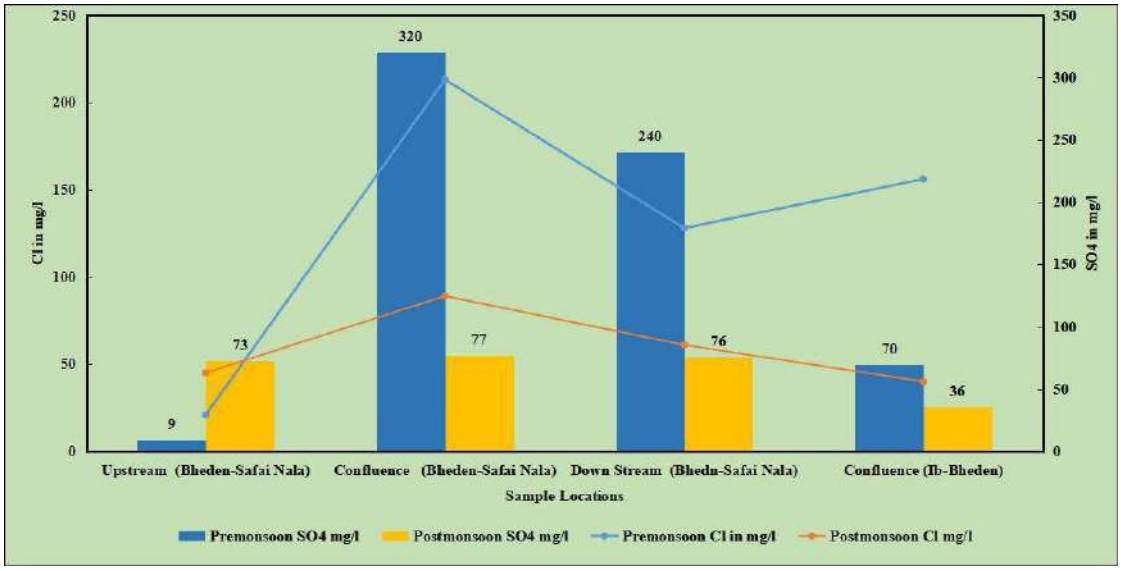
Table 38. Chemical Characteristics of the Bheden River water during Post monsoon

Parameters	Bheden at Katikela (Upstream)	Bheden-Safai Nala Confluence	Bheden at Kherual Bridge Downstream	Ib-Bheden (Confluence)
pH	7.48	7.4	7.45	7.05
EC µS/cm at 25°C	455	490	489	292
TDS mg/l	273	298	294	177
Total Hardness mg/l, as CaCO3	180	200	190	110
Total Alkalinity mg/l, as CaCO3	105	50	90	65
Ca^{++}mg/l	42	44	44	30
Mg^{++}mg/l	18	22	19	9
Na^{+}mg/l	26	29	33	18
K^{+} mg/l	3.9	4.7	4.6	3.6
$CO_3^{=}$mg/l	0	0	0	0

Parameters	Bheden at Katikela (Upstream)	Bheden-Safai Nala Confluence	Bheden at Kherual Bridge Downstream	Ib-Bheden (Confluence)
HCO_3^- mg/l	128	61	110	79
Cl^-mg/l	45	89	61	40
SO_4^{2-}mg/l	73	77	76	36
NO_3^- mg/l	1	1	1	1
F mg/l	0.82	1.48	1.52	0.43

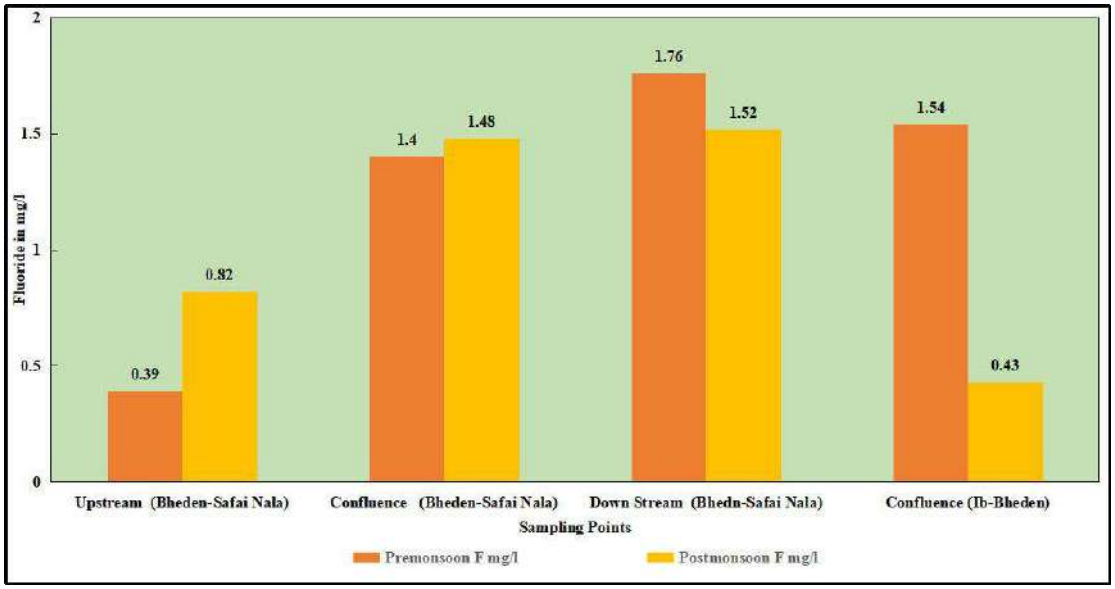
On comparison of quality of Bheden river, between pre monsoon and post monsoon, it is observed that higher concentrations of ions exhibit in pre monsoon than the post monsoon and may be due to the dilution effect. It has been also observed that there are small variations of major ionic concentrations in post monsoon of analyzed samples between upstream, confluence and downstream water of Bheden river (fig 39 to 40).

Fig. 39 :Distribution of Chloride and Sulphate in Bheden river during pre monsoon and post monsoon



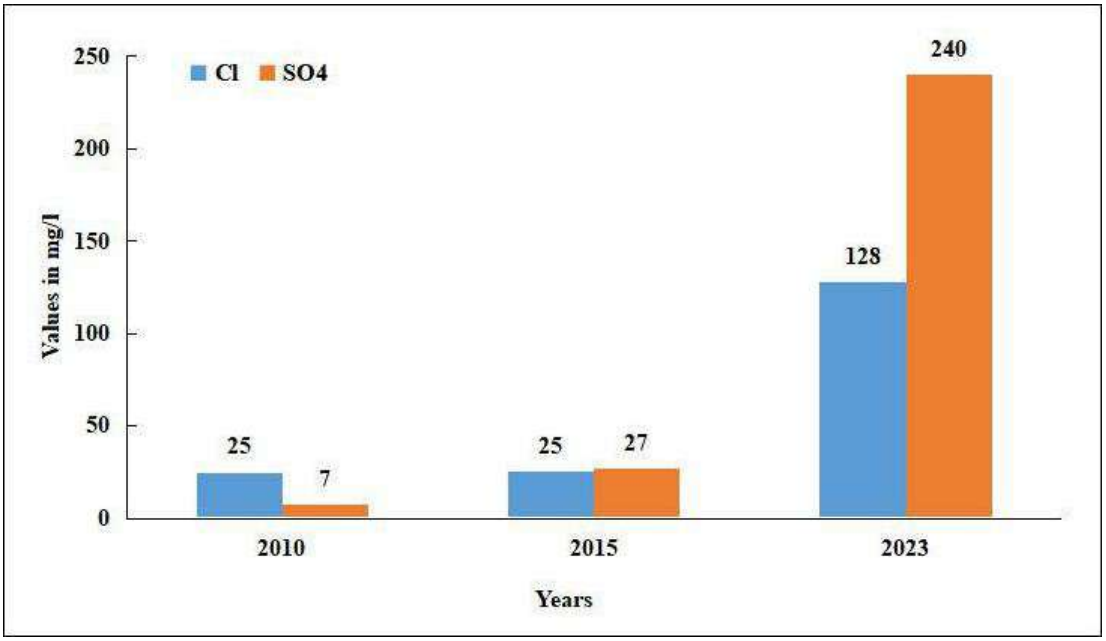
The fig 39 shows the significant variations of chloride and sulphate along the Bheden river between pre and post monsoon. The fig also indicated the dilution effect of sulphate and chloride along the river stretch. But there is no significant changes in sulphate during post monsoon. The sulphate ranged between 73-36 mg/l and it is 36 mg/l at the confluence of Ib river in post monsoon.

Fig. 40. Comparison of Fluoride in water samples along the Bheden river stretches between pre monsoon and post monsoon



The fluoride of Bheden river ranged between 0.39- 1.54 mg/l in pre monsoon. In Fig 40, it has been also observed that the difference of fluoride concentrations of Bheden river at Bhagipali and Kherual is negligible between both seasons. The higher concentration of fluoride also exists (~1.50 mg/l), in post monsoon samples and may be due to the persistence of fluoride rich materials. The presence of higher concentration of fluoride in Bheden river water means that the water is likely contaminated due to anthropogenic activities. The data also confirms the mixing of fluoride contaminated water of Bheden river with the freshwater of Ib river at Khait during the non monsoon period and consequently the water quality of Ib river may deteriorate day by day.

Fig 41. Histograms of Cl and SO4 concentration in runoff of Bheden River at Kherual



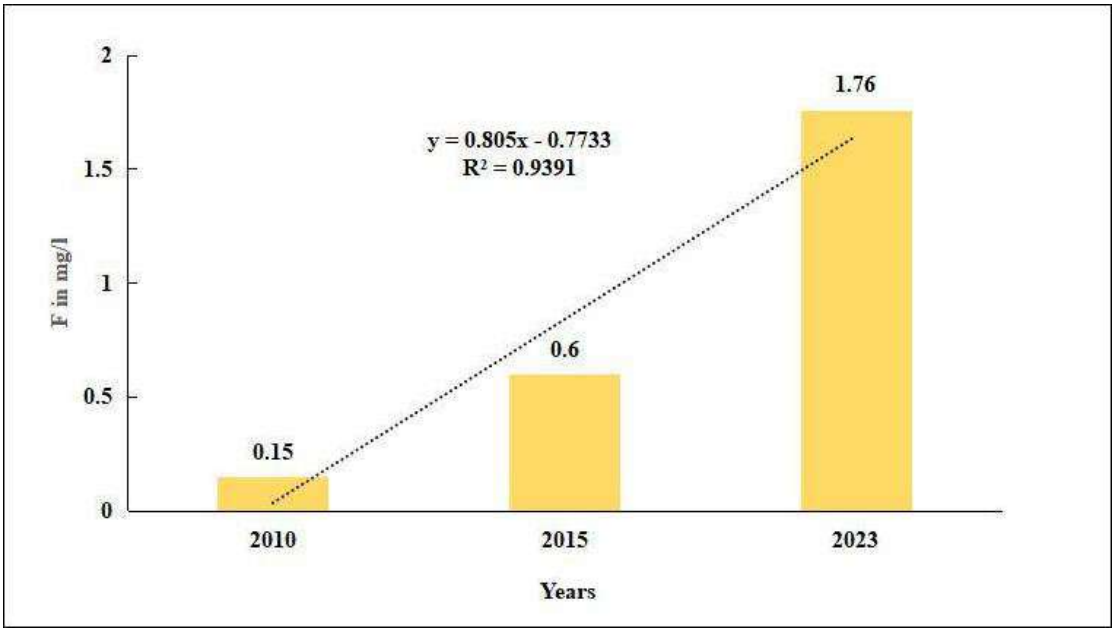
The fig 41 shows the sulphate and chloride are being discharged into the Bheden river. The fluoride contamination is observed along the river.The chloride and sulphate of runoff at Kherual bridge is presented in fig 41 which shows the rising trend and the quality is deteriorated. Further, the fluoride range between 0.15-1.76 mg/l during 2010-2023 (fig 42) at Kherual bridge. The fluoride content of Bhedn at Khait, in premonsoon and post monsoon are 1.54 mg/l and 0.43 mg/l respectively. The lower fluoride concentration is due to the dilution effect. Among the dissolved ions, sulphate and fluoride are more prominent than other ions due to their high contents in effluents. It also concluded that the Bheden water quality is deteriorated day by day.

Table 39.Trace and Toxic elements of the Bheden River water during pre monsoon and Post Monsoon

Trace and Toxic elements	Bheden at Katikela (Upstream)	Bheden-Safai Nala Confluence	Bheden at Kherual Bridge Downstream	Ib-Bheden (Confluence)
Premonsoon				
Al mg/l	0.05	0.01	0.33	0.86
Cu mg/l	0	0	0	0
Fe mg/l	0.05	0	0.17	0.42
Mn mg/l	0.19	0.03	0.28	0.4
Se mg/l	0	0	0	0

Trace and Toxic elements	Bheden at Katikela (Upstream)	Bheden-Safai Nala Confluence	Bheden at Kherual Bridge Downstream	Ib-Bheden (Confluence)
Zn mg/l	0	0	0.01	0.01
U mg/l	0	0	0	0
Cd mg/l	0	0	0	0
Pb mg/l	0	0	0	0
Ni mg/l	0	0	0	0
As mg/l	0	0	0	0
Cr mg/l	0	0	0	0
Postmonsoon				
Al mg/l	0.56	0.38	0.28	0.24
Cu mg/l	0	0	0	0
Fe mg/l	0.38	0.48	0.36	0.2
Mn mg/l	0.24	0.29	0.26	0.15
Se mg/l	0	0	0	0
Zn mg/l	0.01	0.01	0.01	0.01
U mg/l	0	0	0	0
Cd mg/l	0	0	0	0
Pb mg/l	0	0	0	0
Ni mg/l	0	0	0	0
As mg/l	0	0	0	0
Cr mg/l	0	0	0	0

Fig 42. Histogram of Fluoride concentration in runoff of Bheden River at Kherual



The table 39 shows that the water quality of the Bheden river is deteriorating due to industrialization. The higher aluminum value along the Bheden river indicated the contamination due to industrialization.

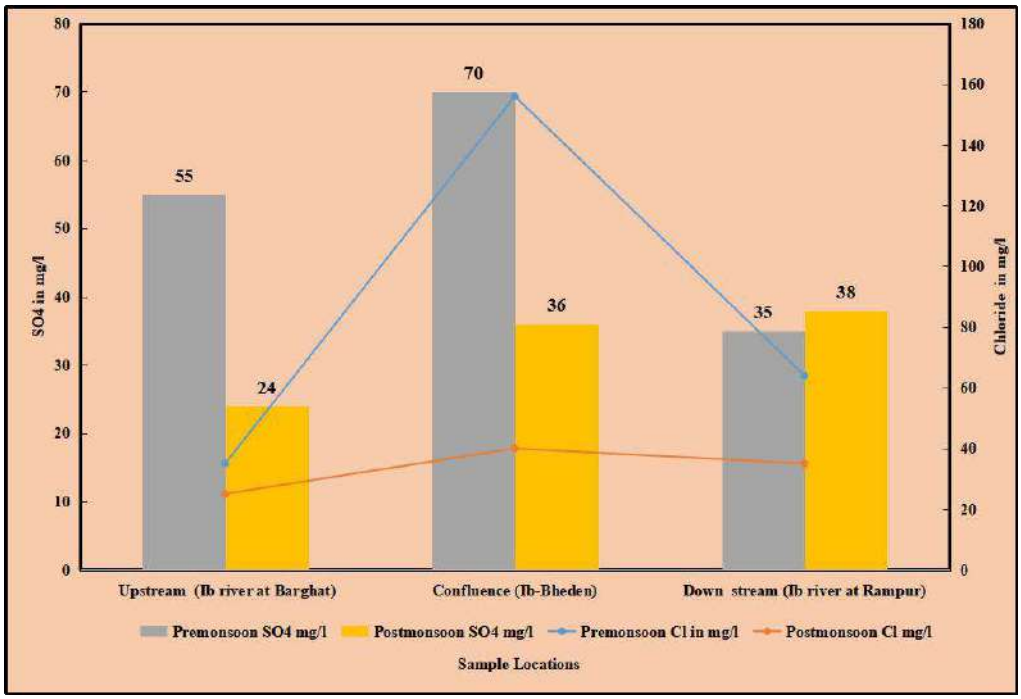
Water quality of Ib River: The Ib river flows along the Western side of Jharsuguda town and the river Bheden merges with it at Rampur, Jharsuguda district.The assessment of quality of Ib river water is essential as it merges in Hirakud Reservoir. Three water samples collected from different locations are analysed for different chemical parameters. The data (table 40) show that concentrations of dissolved ions (EC and TDS) at Khait (confluence between Ib and Bheden) is more than concentrations at upstream (Baraghat) and downstream (Rampur) of Ib river during pre monsoon. The similar trend is also observed for sulfate, Chloride and Fluoride during pre monsoon. During the post monsoon sampling, the river water is diluted as compared to the pre monsoon samples.

Table 40. Chemical Characteristics of Ib river water during Pre and Post Monsoon

Parameters	Pre monsoon			Post monsoon		
	Ib at Baragaht Upstream	Ib-Bheden Confluence	Ib at Rampur Downstream	Ib at Baragaht Upstream	Ib-Bheden Confluence	Ib at Rampur Downstream
pH	7.83	8.00	8.12	7.52	7.05	7.47
EC µS/cm at 25°C	424	743	413	285	292	304

Parameters	Pre monsoon			Post monsoon		
	Ib at Baragaht Upstream	Ib-Bheden Confluence	Ib at Rampur Downstream	Ib at Baragaht Upstream	Ib-Bheden Confluence	Ib at Rampur Downstream
TDS mg/l	206	405	242	158	177	177
Total Hardness mg/l, as $CaCO_3$	120	265	165	120	110	120
Total Alkalinity mg/l, as $CaCO_3$	75	75	100	90	65	70
Ca^{++}mg/l	32	58	40	20	30	26
Mg^{++}mg/l	9.72	29.16	15.79	17	9	13
Na^{+}mg/l	22.9	39	22.4	14	18	19
K^{+} mg/l	4.3	6.7	3.8	2.6	3.6	3.1
$CO_3^{=}$mg/l	0	0	0	0	0	0
HCO_3^{-}mg/l	92	92	122	110	79	85
Cl^{-}mg/l	35	156	64	25	40	35
SO_4^{2-}mg/l	55	70	35	24	36	38
NO_3^{-}mg/l	2.3	1.0	1.3	1.0	1.0	1.0
F mg/l	0.86	1.54	1.00	0.34	0.43	0.16

Fig. 43. Histogram of Chloride and Sulphate along Ib river during pre monsoon and post monsoon



The fig 43 shows concentrations of sulphate and chloride at Khait are more than that at Baraghat and Rampur of Ib river in pre monsoon and post monsoon.

Fig. 44. Histogram of Fluoride along the Ib river during pre monsoon and post monsoon

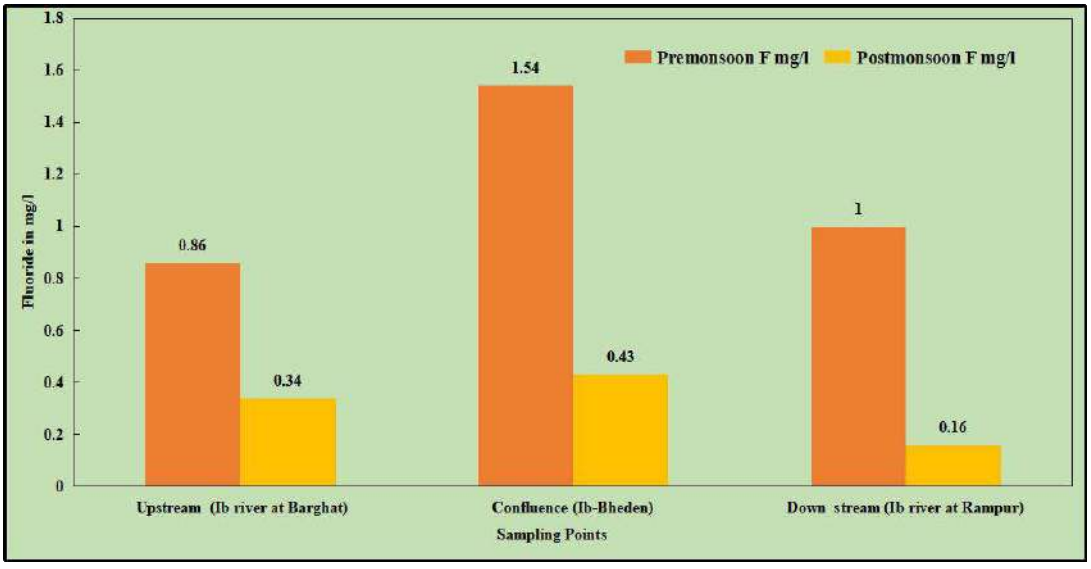


Fig 44 shows concentration of fluoride at Khait is more than that at upstream and downstream of Ib river. The content of sulphate, chloride and fluoride are due to anthropogenic activities and not due to natural sources. The freshwater dilutes these contents to the acceptable limits.

Table 41. Trace and Toxic elements of Ib river water during Pre and Post Monsoon

T and T elements	Pre monsoon			Post monsoon		
	Ib at Baragaht Upstream	Ib-Bheden Confluence	Ib at Rampur downstream	Ib at Baragaht Upstream	Ib-Bheden Confluence	Ib at Rampur Downstream
Al mg/l	0.04	0.86	0.28	0.07	0.24	0.28
Cu mg/l	0	0	0	0	0	0
Fe mg/l	0	0.42	0.15	0.09	0.2	0.25
Mn mg/l	0.04	0.4	0.19	0.03	0.15	0.11
Se mg/l	0	0	0	0	0	0
Zn mg/l	0.03	0.01	0.01	0	0.01	0.01
U mg/l	0	0	0	0	0	0
Cd mg/l	0	0	0	0	0	0
Pb mg/l	0	0	0	0	0	0
Ni mg/l	0	0	0	0	0	0
As mg/l	0	0	0	0	0	0
Cr mg/l	0	0	0	0	0	0

It is concluded that the Safai nala is polluted due to anthropogenic activities and also the pond water. The surface water is contaminated with fluoride due to anthropogenic activities, may be due to the establishment of ash ponds. The decant water shows high content of fluoride and sulphate. Since the contaminated Safai nala merges with the Bheden river at Bhagipali, the water is contaminated and later on diluted to the acceptable limit of drinking water specification.The Bheden river water quality has deteriorated due to the Safai nala. The chemical characteristics of Ib river have not shown any significant changes downstream. But it warns that its water quality is deteriorating not only from the merging of the Bheden river but also anthropogenic activities which may include the discharge of domestic sewage or municipal sewage in the upstream.

As evidenced from the foregoing discussions, the decant water and wastewater are contaminated with fluoride. The ponds and runoff of Safai nala and Bheden river are also fluoride contaminated.

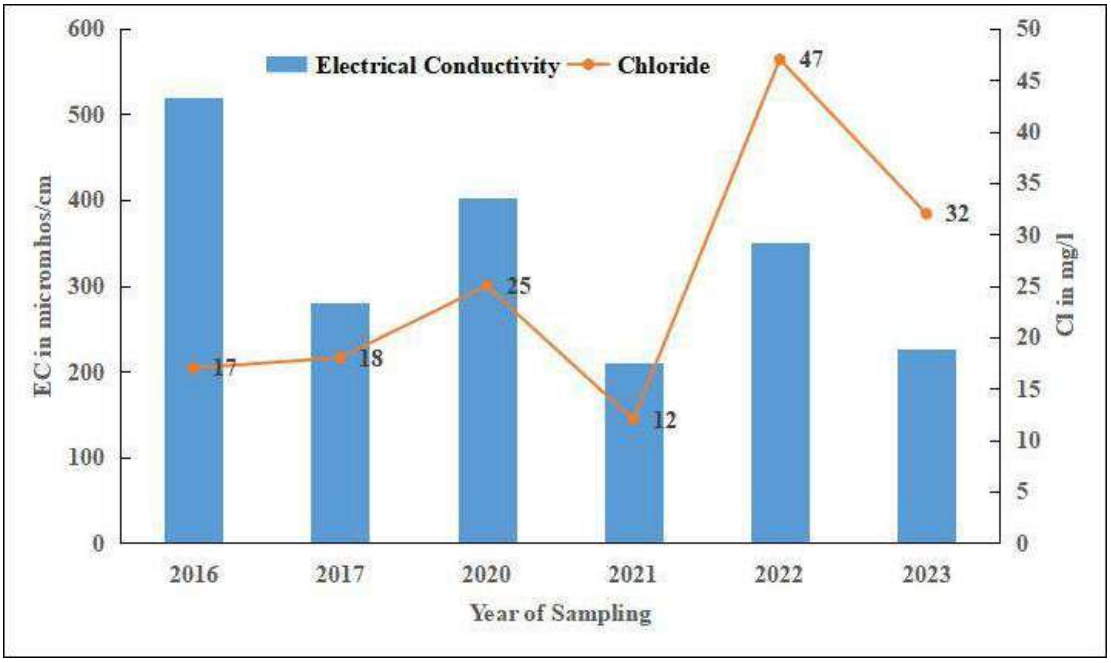
So it is concluded that, the analysed physico-chemical characteristics of the Safai nala and Bheden river showed the fluoride contamination is due to industrialisation. Further the chemical data of Ib river water showed that there is some impact of industrial effluent on it through Bheden river and Safai nala during non-monsoon period. The aluminum values of the Bheden river show the contamination due to industrialisation (M/s VAL). However the higher concentration of chloride showed that the Ib river may be polluted by the municipality wastes.

11.14 Impact of Wastewater on Groundwater quality in the Study Area

Under various issues on groundwater, the impacts of wastewater on groundwater quality in the region close to industries are taken into account. The villages namely, Bhagipali, Bhikramunda, Brundamal, Budhipadar, Jharsuguda,Katikela, Kurebaga,Marakuta of Jharsuguda, and Pandloi and Gurupali of Sambalpur districts are included in assessing the groundwater quality. The analytical data of Siriapali and Jharsuguda, under quality monitoring (NHS) by CGWB,SER Bhubaneswar are also assessed. The chemical data is presented in the Annexures.

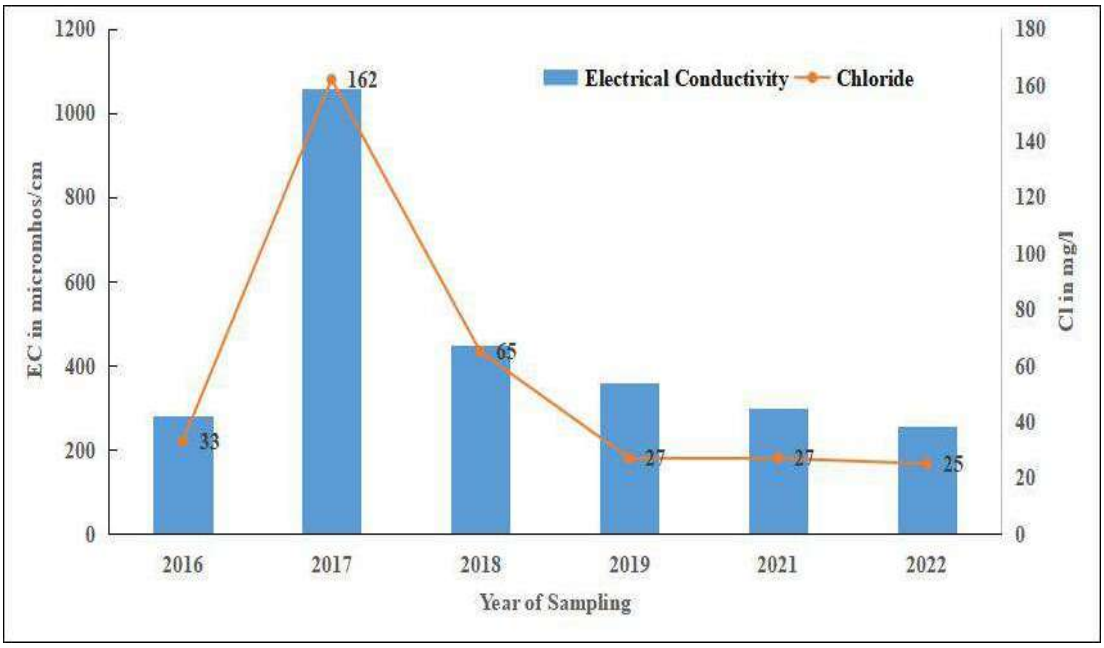
The electrical conductivity of ground water of Jharsuguda monitoring station over a long period (2016 to 2023) ranges between 227 and 520 S/cm, chloride between 12 and 47 mg/l and max. fluoride was found to be 0.54 mg/l. The data concluded that there is no impact of wastewater at this station till today. However, the chloride content was found to be 159 mg/l and nitrate content was 15 mg/l. Fluoride con. is below detection limit at Jharsuguda during sampling under NAQUIM 2.0. This signifies that the well may be affected by domestic wastewater and there is no impact of industrial effluent. Further at Siriapali (CGWB,NHS), the concentration of all parameters are within the acceptable limit as per drinking water specification, IS 10500:2012. The distribution of electrical conductivity and chloride in groundwater samples collected from Jharsuguda and Siriapali locations are presented in fig.45 and 46.

Fig.45. Distribution of Electrical conductivity and Chloride of groundwater samples collected from Jharsuguda



The fig shows the chloride values are within the acceptable limit and there is a rise trend observed in 2022 and 2023 as compared to the previous years. This may be due to the effect of urbanization and may be the percolation of storm water and domestic sewage.

Fig. 46. Distribution of Electrical conductivity and Chloride of groundwater samples collected from Siriapali



This fig shows the Electrical conductivity ranged between 250-1060 S/cm and Chloride between 25-162 mg/l of groundwater samples collected from Siriapali since 2016. The fluoride content is within the acceptable limit of drinking water specification.The data shows there is no impact of wastewater on it and the quality goes on improving.

The fluoride contents in groundwater samples collected from dug well, Hand Pump and Bore well at Kurebaga are 0.89 mg/l, 0.31 mg/l and 1.28 mg/l respectively during pre monsoon. The high content of fluoride in the study area may be due to lithology and geological formation in the aquifers.There is no nitrate contamination in the deeper aquifer whereas the shallow aquifer is contaminated with nitrate (Kurebaga, 66 mg/l). This may be due to the domestic sewage and other anthropogenic activities.

Fig.47. Electrical conductivity of groundwater at Brundamal under different studies

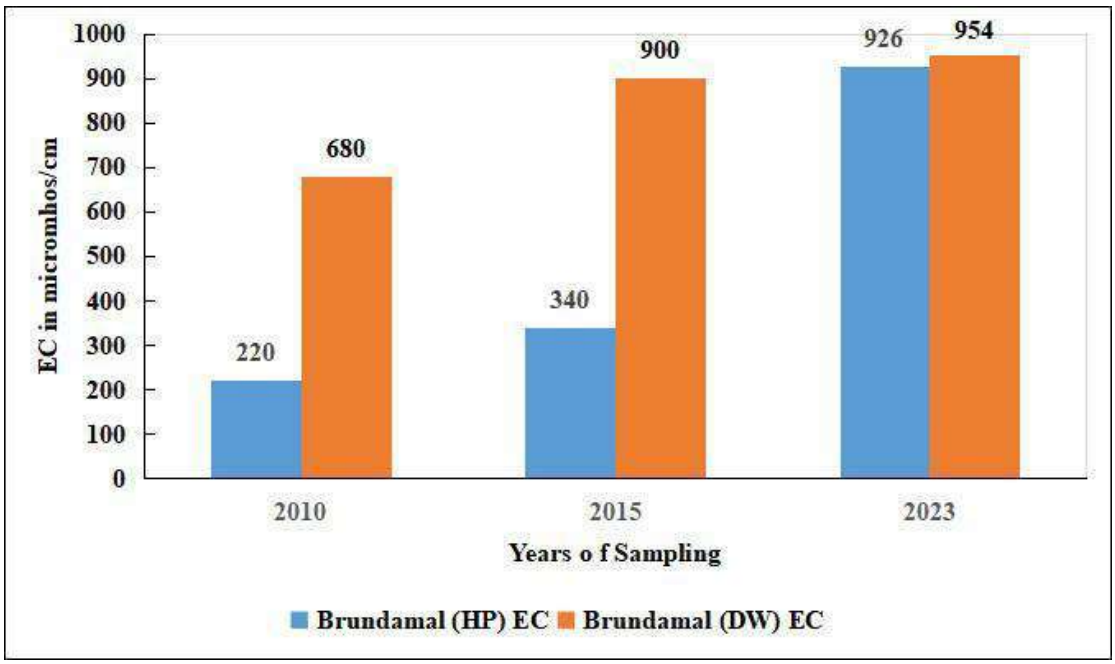


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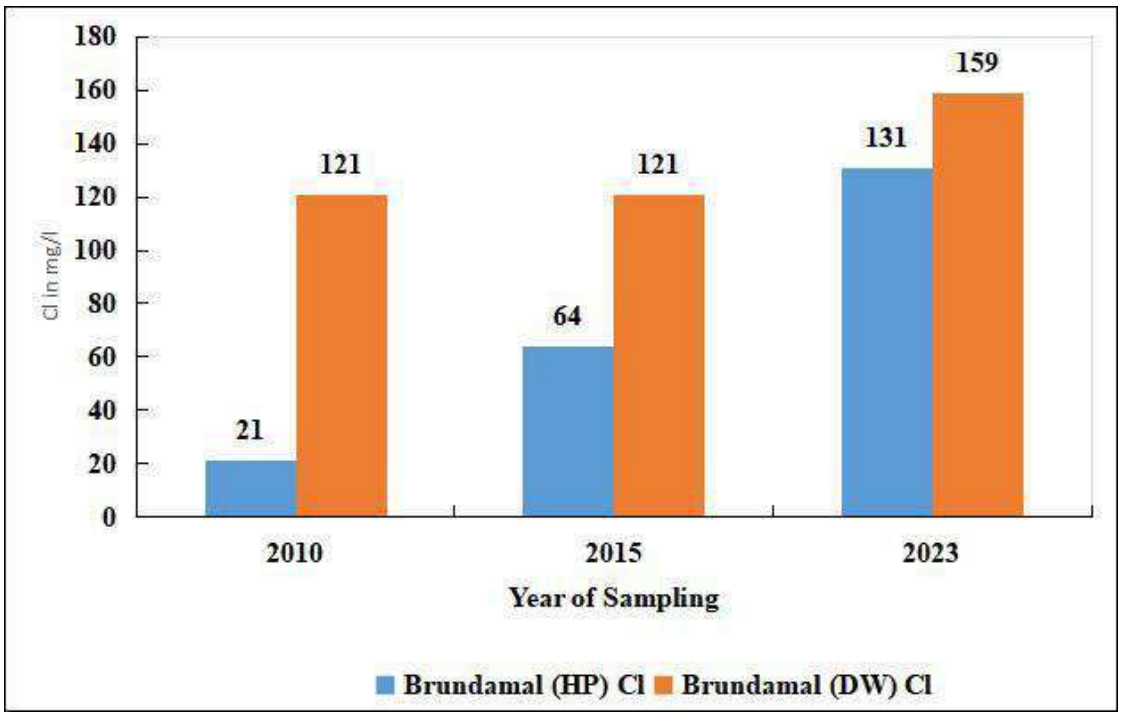
Fig. 48. Chloride of groundwater at Brundamal under different studies.



The analytical data of groundwater shows the nitrate contamination in the proximal samples and no fluoride contamination which signifies there is no impact of wastewater discharged from the industries on groundwater quality in the region. The nitrate contamination in the region may be due to urbanisation.

11.15 Conclusions

Groundwater samples (129 no.) were collected from dug wells, hand pumps and bore wells during pre monsoon and during the post monsoon period 40 groundwater samples were collected to assess the quality of the area. From quality point of view, following conclusions are drawn.

Among the four hydrochemical facies, Ca-Mg-Cl-SO_4 is more significant in pre monsoon whereas it is Ca-Mg-HCO_3 type during post-monsoon.

The alkaline earths (Ca+Mg) exceeded the alkalies (Na+K) in most of the groundwater samples while strong acids (Cl+SO4) exceeded weak acids (CO3+HCO3) in some of the samples in pre monsoon.

The maximum nitrate (151 mg/l) was found at Hansamurakatapali at a depth of 76.25 mbgl in the fracture zone of the aquifer in pre monsoon and in post monsoon it was 177 mg/l. The maximum value of nitrate i.e.219 mg/l in the weathered zone (8.25 mbgl) was found at Parmanpur of Kolabira block, Jharsuguda district during the post monsoon. Nitrate contamination exhibits in both weathered and fractured zones of the aquifer in both seasons.

It has been observed that only in 3 locations namely, Patrapalii of Jharsuguda district and , Rengali and Nabasanga of Sambalpur contaminated with fluoride in pre monsoon and and during post monsoon, 2 locations namely, Rengali and Nabasanga of Sambalpur district in the fracture zone. The weather zone of the aquifer is free from fluoride contamination in both seasons. The geogenic formation contributes more fluoride to groundwater in the fractured zone of the aquifer.

The physico-chemical data shows that 51% are suitable, 16 % Unsuitable and 33% of samples can be used for drinking purposes in absence of alternate sources as per drinking water specification IS 10500:2012 during pre monsoon. Out of 129 groundwater samples collected from different locations in the study area,15 are unfit due to high nitrate in both weathered and fractured zone) and 3 are fluoride contaminated in fractured zone only. During the post monsoon, overall, 50% (20 out of 40 groundwater samples) are unfit for drinking purposes as per drinking water specification (IS 10500:2012). They are unfit for drinking purposes due to low or high pH (<6.50 and >8.50), high hardness, nitrate and fluoride contamination in the area. Only 13 % are suitable and 37% can be used for drinking purposes in absence of alternate sources. The data also revealed that only 2 samples out of 33 are contaminated with high fluoride in the fractured zone whereas 5 samples out of 7, in the weathered zone are contaminated with very high nitrate concentrations in post monsoon sampling.

Out of 129 groundwater samples collected from the study area under NAQUIM 2.0, aluminum concentration exceeded in 14 samples and the maximum value (1.05 mg/l) observed at Rengali (DW) of Sambalpur district. The iron and manganese exceed the maximum permissible limit of drinking water standards of IS 10500:2012 in 64 and 25 samples respectively in the study area where as selenium and zinc exceed in 2 samples each and in 4 samples, the uranium concentration exceeded. The contamination of trace and toxic elements may be due to geological formation in the study area.

Overall, most indices suggest that the groundwater in the study area is suitable for irrigation except few locations in Jharsuguda and Sambalpur districts.

11.16 Recommendations

The pre monsoon analysed physico-chemical parameters collected from surface water bodies and wastewater of industries confirmed the quality of Bheden river water has deteriorated significantly due to the industrialisation. In order to reduce concentration of pollutants to meet the desired level of water quality, the effluents must be treated before inland discharge to the safety level and follow the stipulated norms of discharge of effluents and also landfill of sludges. In addition to this appropriate action may be taken to flow the water through Bheden river throughout the year so that the dilutions of pollutants in the rivers and streams may occur. Furthermore Industries located in the catchment of Bheden river have been instructed to install rain water harvesting structures as well as undertake plantation programmes as a mean to ground water recharge.

12. ARTIFICIAL RECHARGE PLAN

Recharge area is delineated on the basic of elevation (Fi.5),Slope (Fig.6), Landuse map (Fig.7) ,long term mean water level vs. decadal trend map (Fig.50).For delineation slope is considered < 20 , elevation is between 210 to 230 amsl and flow lines are from north to south direction.Landuse is mainly agricultural, waste land and Jharsuguda Municipality area. On the basis of declining water level trend and more tha 3 mbgl mean water level 18.59 sq.km area comprising of Jharsuguda Municipality, part of Durlaga and Talpatia village area can be considered for artificial recharge plan (Fig.49). Roof top rainwater harvesting structure in Bijunagar, Bhuliatakra area of Jharsuguda Municipality may be constructed in every multistorage building, hotels. This area is only 3 sq. km area. In this area if 20 number of rooftop rainwater harvesting structure constructed, then 0.3 ham rainwater will be recharge/conserved annually (Table-42a). Rooftop rainwater will be diverted to the abandoned dugwells through a settling pit .In absence of dug wells a recharge pit of 2 mt by 2 mt by 3 mt along with a 150 mm dia bore well to be inserted in the middle of the pit .The depth of the bore well will be around 20 meter which will only tap the weathered zone. Recharge pit should be filled up with a 0.75 mt lower gravel filled part and then 0.75 mt sand filled part.

Table 42a: Proposed Roof Top Harvesting Structure to be constructed in Jharsuguda Municipality

Sr.No.	Name of the area	Total area considered for AR (in hectares rounded up to one decimal place)	Number of households (2011 census)	No of Houses taken for Artificial Recharge (10% of total households)	Total No of AR Structures (one structure for 10 house holds)	Annual Rainfall runoff Available for recharge (MCM) (No of households x avg rooftop area(150 sqm) x runoff coefficient (80%) x rainfall, (1449 mm))
1	Jharsuguda Municipality	300	200	20	20	0.003

In rest 15 sq. km area occupied by agricultural land where farm pond with a dimension of 10 mt by 10 mt by 3 mt may be constructed in each one hector area of land.So a total 150 farmpond may be constructed and an annual 32.8 ham rainwater can be conserved (Table-42b).

Table 42b: Proposed Water Conservation Structure to be constructed in Jharsuguda Municipality

Sr.No.	Name of the Area	Total area of the village (in hectares rounded up to one decimal place)	10%of village area taken for farm recharge(sq m)	Total number of recharge pits (1 recharge pit / hector) for 10% area	Annual recharge (MCM)= (Area*Runoff 15%*Rainfall 1.45 mm/1000000)
1	Jharsuguda Municipality	1500	1500000	150	0.328

Fig 49: Area demarcated by redline in parts of study area where artificial recharge is to be implemented (A-RWH to be constructed with recharge well, B-Water Conservation structure to be constructed).

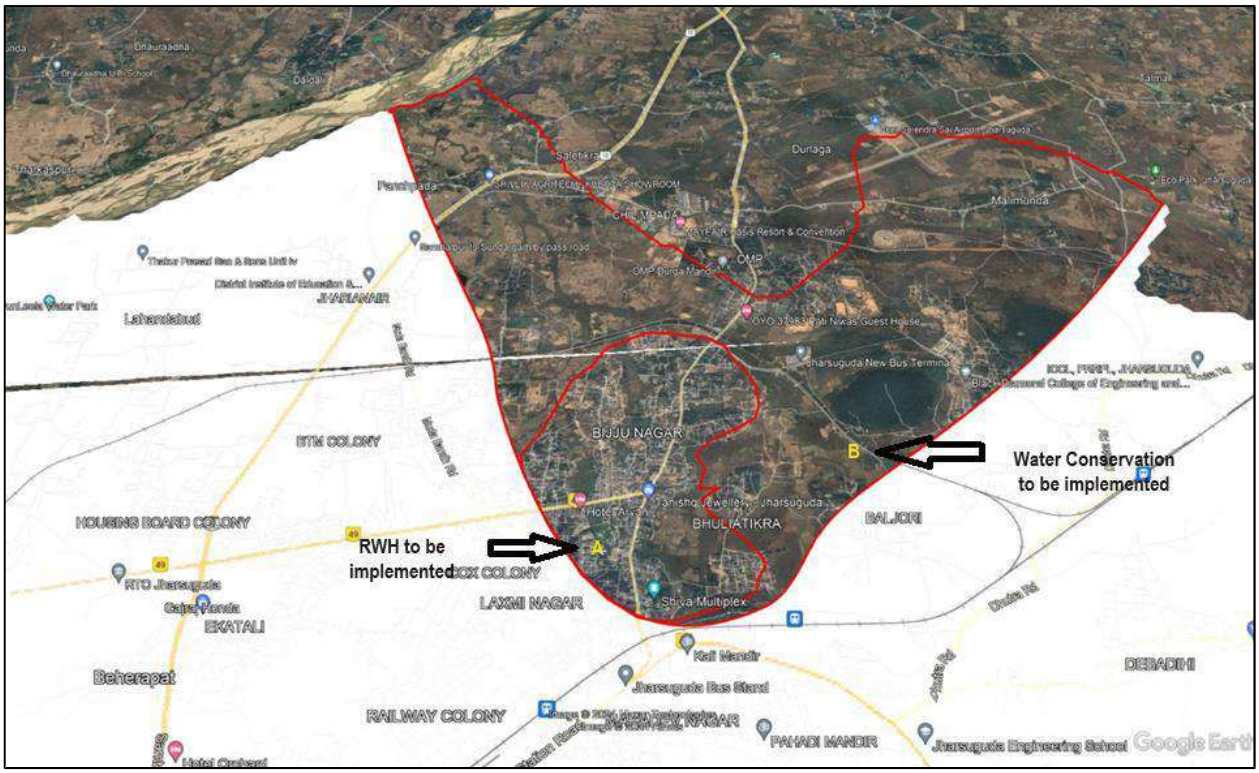
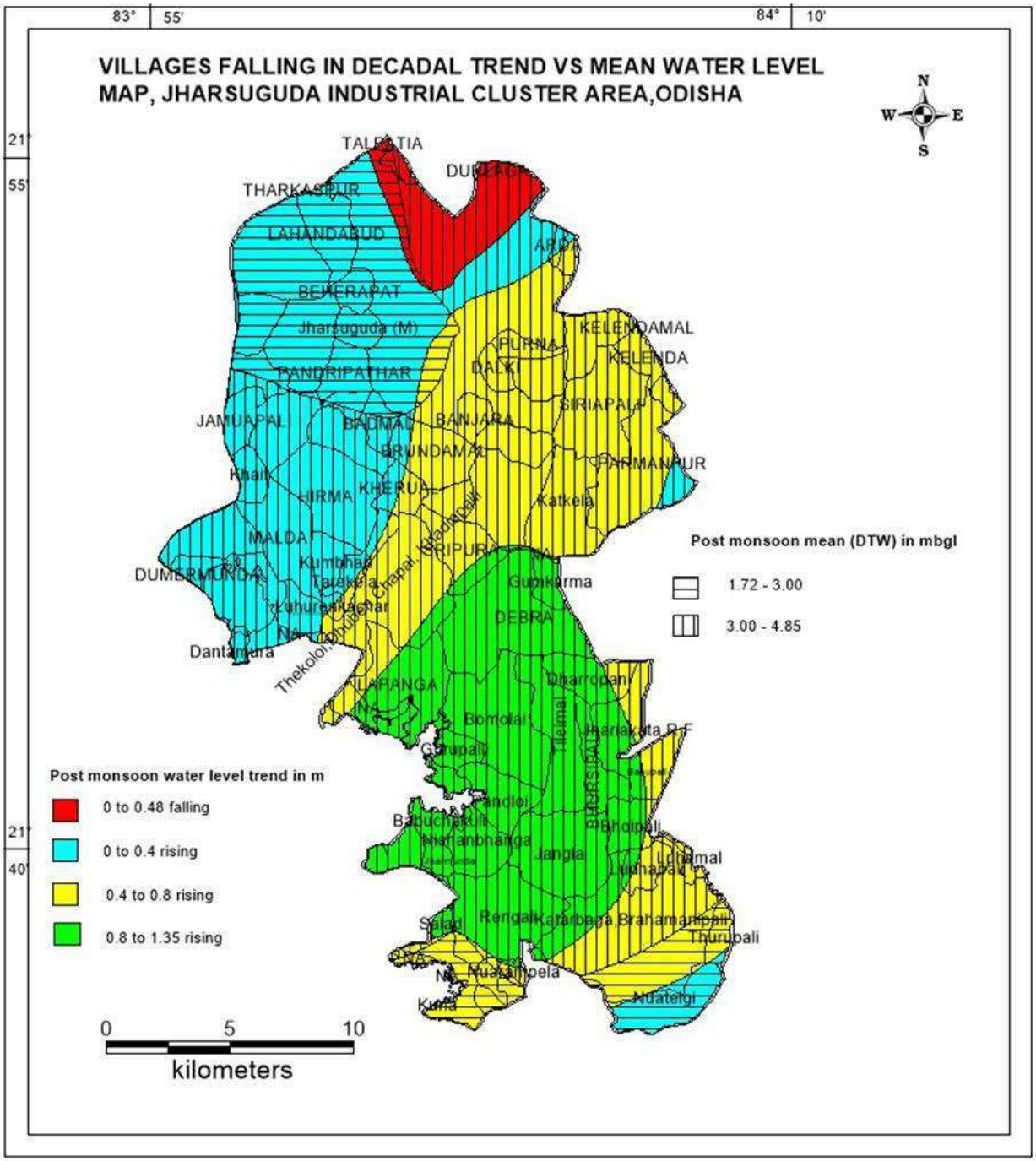


Fig50: Decadal mean vs trend of water level map, Jharsuguda Industrial Cluster



13. OTHER MEASURES

Total Rabi crop area under furrow irrigation in Sambalpur District part is 2474 and in Jharsuguda District part is 1144 ha. So if the whole Rabi crop area can be converted to subsurface drip irrigation then 60% water consumption can be saved.

14. IDENTIFICATION OF POTENTIAL AQUIFERS FOR DRINKING WATER SUPPLY

On the basis of ground water exploration by CGWB (Table-7),VES survey (Annexure-2) and data collected from RWSS departments of Jharsuguda and Rengali District and WATCO of Jharsuguda Municipality, potential water bearing zones(Table 43) are identified. These are summarized in Table - 43a to Table- 43d.There are also 2812 nuber of Hand Pump installed in Jharsuguda Block part and 935 number of hand pump installed in Rengali Block part having average depth 40 to 60 meter and average discharge of 1 to 2 lps.

Table 43a- Potential Water Bearing Zones in Jharsuguda Block part

Identification of potential Aquifer for ground water supply under NAQUIM 2.0, Block-Jharsuguda												
Name of Department/ Office- RWSS												
Sl No	Name of the GP	Village Name	Depth of B/W(m)	Casing depth(m)	Fracture depth	Water Level of B/W	Discharge (lps)	Daily running hour	Yearly Running hour	any quality issue	Age of B/w	Total population covered for RWSS/PHED well
1	BADMAL	SAHUPADA	150	38.9	115	7.5	6.00 lps	8.00	2880	NO	14	600
2	BADMAL	TELIPADA	177	39.62	134	6.7	3.00 lps	4.00	1440	NO	11	580
3	BADMAL	BRUNDAMAL	168	25	126	6.00	4.83 lps	6.00	2160	NO	11	2934
4	BADMAL	PANDRIPATHAR	125	31.4	95	5.00	4.83 lps	5.00	1800	NO	14	1271
5	DALKI	KUMUDAPALI	198	32.3	149	7.5	4.83 lps	6.00	2160	NO	14	547
6	DALKI	DALKI	185	38.2	139	10.00	3.00 lps	4.00	1440	NO	14	924
7	DURLAGA	TALMAL	188	17.2	141	7.00	2.36 lps	4.0	1440	NO	14	1643
8	TALPATIA	TALPATIA	108	18.3	81	4.00	4.83 lps	6.00	2160	NO	14	2208
9	HIRMA	K.KATAPALI	153	13.3	115	6.00	1.5 lps	6.00	2160	NO	14	350
10	MARAKUTA	MARAKUTA	151	24	113	8.00	6.00 lps	4.00	1440	NO	14	2214
11	MARAKUTA	BUDHIPADAR	100	25.1	75	5.00	8.41 lps	4.00	1440	NO	14	1255
12	H.KATAPALI	H.KATAPALI	167	55.3	125	7.00	4.00 lps	6.00	2160	NO	8	2484
13	H.KATAPALI	LAHANDABUD	183	20.5	137	8.00	1.5 lps	4.00	1440	NO	14	1652
14	KATIKELA	KATIKELA	152	14.6	114	7.00	3.00 lps	6.00	2160	NO	10	1423
15	KATIKELA	BHAGIPALI	214	12.4	161	7.00	1.50 lps	8.00	2880	NO	13	261
16	SRIPURA	SRIPURA	151	23.7	113	5.00	8.41 lps	6.00	2160	NO	14	1974
17	MALDA	RAMPUR	168	47.3	126	8.00	2.36 lps	6.00	2160	NO	13	1162
18	PATRAPALI	PATRAPALI	177	26.6	133	7.00	4.83 lps	8.00	2880	NO	14	1800
19	JAMERA	SINGABAGA	180	24.4	135	8.00	4.83 lps	4.00	1440	NO	12	1272

Table 43b - Potential Water Bearing Zones in Kolabira Block part

Information to conduct Ground Water survey by CGWB under NAQUIM 2.0, Block-Kolabira													
Name of Department/ Office			RWS&S										
Sl No	Nam of the Block	Name of the GP	Village Name	Depth of B/W(m)	Casing depth(m)	Fracture depth	Water Level of B/W(m)	Discharge (lps)	Daily running hour	Yearly Running hour	any quality issue	Age of B/w	Total population covered for RWSS/PH ED well
1	KOLABIRA	KELDAMAL	KELDAMAL	180	30		7.2	1.5	5	1800	NO	12	750
3	KOLABIRA	KELDAMAL	GUDIGAON	169.5	30.6		6.3	3.54	4	1440	NO	14	545
5	KOLABIRA	PARMANPUR	PARMANPUR	178.5	30		7.2	4	8	2880	NO	14	1145
6	KOLABIRA	PARMANPUR	SIRIAPALI	173.4	31.2		6.3	2	4	1440	NO	13	789

Table 43c- Potential Water Bearing Zones in Jharsuguda Municipality Area

INDENTIFICATION OF POTENTIAL AQUIFER IN JHARSUGUDA MUNICIPALITY								
Sl. No	Word no	Location	Latitude	Longitude	Depth of the production well (in Mtr.)	Yeild (LPS)	Submersible motor with HP	Detail of the over head tank with capasity (in Ltr.)
1	2	3	4	5	6	7	8	9
1	1	Near Powerhouse Road	21.841813	84.004018	120	0.45	1.5	2000
2	1	Sarbahal Harijanpada (Kisan Pada)	21.832686	84.011966	140	0.45	1.5	2000
3	2	Rohidaspada1	21.840002	84.008238	106	0.45	1.5	2000
4	2	Rohidaspada2	21.841226	84.008506	106	0.78	2	2000
5	3	Near Sitala Mandir	21.854229	84.012545	120	0.78	2	2000
6	4	Near Shiva Mandir	21.859328	84.017228	120	0.13	1	1000
7	4	Near Manas Sinha House	21.859902	84.007048	120	0.45	1.5	2000
8	5	Near Masjid Road	21.864976	84.011505	150	0.13	1	1000
9	6	Ekatali Infront of Sai Mandir	21.865702	84.000283	150	0.45	1.5	2000
10	7	Orampada Suldia Road	21.87531	83.996414	140	0.45	1.5	2000
11	7	BTM Colony (Backside of Kali Mandir)	21.875006	84.002439	140	0.45	1.5	2000
12	8	Jharienair Near Radha Krishna Mandir	21.897827	83.999519	110	0.13	1	1000
13	8	Panchpada Pappada	21.908624	84.003108	110	0.13	1	1000
14	9	Amlipali Infront of Samalei Mandir	21.912475	84.028473	120	0.13	1	1000
15	11	Bhuliatikra Near School	21.871609	84.031289	150	0.78	2	2000
16	11	Bhuliatikra Near Kirtan Mandap	21.871609	84.031278	135	0.78	2	2000
17	11	Bhuliatikra Near Club	21.87099	84.031575	140	0.45	1.5	2000
18	11	Nuapada Infront of ME School	21.883757	84.029996	120	0.45	1.5	2000
19	12	Bandharpada Near Sanyashi House	21.896858	84.06809	110	0.13	1	1000
20	12	O.S.A.P Premises	21.896642	84.037042	110	0.13	1	1000
21	13	Debadihi Near ITI College	21.864902	84.047452	120	0.13	0.75	1000
22	13	Balijori Harijanpada	21.874875	84.042999	135	0.13	0.75	1000
23	13	Litipada Debadihi	21.871622	84.056109	140	0.13	1	1000
24	13	Chhatriakata near community Centre	21.878717	84.051242	140	0.78	2	2000
25	13	Balijori Near Mandap	21.876072	84.041707	110	0.45	1.5	2000
26	13	Baidpada	21.869632	84.059393	110	0.45	1.5	2000
27	14	Badheimunda village	21.861138	84.039428	135	0.13	0.75	1000
28	14	Near Saletax Office	21.863052	84.037963	135	0.13	1	1000
29	15	Near Chituapada Field	21.838147	84.033481	106	0.13	1	1000
30	15	Near Bharat Contractor house	21.829699	84.033837	120	0.45	1.5	2000
31	15	Near Banjari School	21.829988	84.038125	135	0.78	2	2000
32	16	Kalyan Mandap	21.858909	84.025169	135	0.45	1.5	2000
33	17	Mahadev Nagar	21.853449	84.023114	140	0.45	1.5	2000
34	17	Near Orampada	21.856791	84.022201	120	0.78	2	2000
35	18	Municipal Colony	21.858585	84.016835	106	0.13	1	1000
36	18	Pandit Medical Gali	21.862429	84.021017	135	0.45	1.5	2000
37	18	D' Souza Gali	21.859382	84.017269	135	0.45	1.5	2000
38	20	Refuge Colony	21.854584	84.015498	120	0.13	1	1000
39	20	Mungapara	21.874162	84.00567	120	0.45	1.5	2000
40	20	Near Auditorium	21.853836	84.015209	106	0.78	2	2000
41	21	Near End of Buromal	21.834121	84.020562	110	0.13	1	1000
42	21	Tata Galli	21.851661	84.018842	110	0.13	1	1000
43	21	Budapada Near Radha Madhab Mandir	21.837269	84.018981	106	0.78	2	2000
44	22	Near Mani Mohan School	21.852095	84.013188	106	0.13	1	1000

Table 43d - Potential Water Bearing Zones in Rengali Block part

IDENTIFICATION OF POTENTIAL AQUIFER BY CGWB UNDER NAQUIM 2.0, BLOCK-RENGALI													
NAME OF DEPARTMENT/ OFFICE-RWS&S													
Sl No	Name of Block	Name of GP	Village Name	PWS NAME	Depth of B/W(m)	Casing depth (m)	Fracture Depth	Water Level of B/W	Discharge(lps)	Daily Running Hour	Yearly Running Hour	Age of B/W	Total population covered for RWSS/PHED Well
1	Rengali	BOMALOI	BOMALOI	BOMALOI	146.1	16.2		33	4.50 LPS	4	1460	7 YEARS	2621
2	Rengali	BOMALOI	TILEIMAL	TILEIMAL	217.5	41.1		48	2.67 LPS	4	1460	16 YEARS	1936
4	Rengali	GHICHAMURA	GUMKARAMA	GUMKARAMA	165.3	22.2			3.20LPS	4	1460	16 YEARS	1437
5	Rengali	JANGLA	JANGLA	JANGLA	132.6	17.4			2.67LPS	4	1460	16 YEARS	3134
6	Rengali	JANGLA	BHURSIPALI	BHURSIPALI	242.1	27.3			3.23 LPS	4	1460	5 YEARS	841
7	Rengali	JHANKARPALI	JHANKARPALI	SARGIPALI NR.T.W	151.5	17.7			4.50 LPS	4	1460	10 YEARS	2619
8	Rengali	JHANKARPALI	JHANKARPALI	SARGIPALI NR.POND	151.5	6			4.50 LPS	4	1460	11 YEARS	
9	Rengali	JHANKARPALI	BASUPALI	BASUPALI	175.2	21.3		43	2.20 LPS	4	1460	11 YEARS	1404
10	Rengali	KATARBAGA	KATARBAGA	KATARBAGA	142.8	21		33	3.23 LPS	4	1460	4 YEARS	5054
11	Rengali	KATARBAGA	GOLAMAL	GOLAMAL	1.5	28.2		30	4.50 LPS	4	1460	16 YEARS	
12	Rengali	KATARBAGA	BRAHMINIPALI	BRAHMINIPALI	132	21.6			4.50 LPS	4	1460	9 YEARS	2460
13	Rengali	KHINDA	KHINDA	KHINDA	192	0			2.0 lps	4	1460	16 YEARS	2150
14	Rengali	NISHANBHANGA	NISHANBHANGA	NISHANBHANGA	132.9	18			3.23 LPS	4	1460	2 YEARS	2127
15	Rengali	NISHANBHANGA	JHARMUNDA	JHARMUNDA	59.4	17.4			8.40 LPS	4	1460	16 YEARS	605
17	Rengali	NISHANBHANGA	R.C NAGAR	R.C NAGAR NR.POND	82.8	11.4		26	4.50 LPS	4	1460		
18	Rengali	NISHANBHANGA	PONDLOI	PONDLOI	160.5	23.7		29	2.67LPS	4	1460	16 YEARS	1128
19	Rengali	RENGALI	RENGALI	RENGALI	0	0				4	1460		10867
20	Rengali	RENGALI	GANESH NAGAR	GANESH NAGAR	159.3	14.7			4.50LPS	4	1460	15 YEARS	
21	Rengali	SALAD	SALAD	SALAD	265.8	8.1		28	3.23 LPS	4	1460	4 YEARS	1479
22	Rengali	SALAD	NEW RAMPELLA	NEW RAMPELLA	210	29.4		30	1.78LPS	4	1460	15 YEARS	2311

On the basis of above table it can be inferred that ground water is available in dug wells/weathered zone throughout the year except during summer season upto a maximum depth of 40 to 60 mbgl.But during summer season and rest of the year ground water is also available sporadically in fractured aquifer upto a maximum drilling depth of 100 – 150 mbgl.

15. A PLAN FOR DRINKING WATER SOURCE SUSTAINABILTY

As per resources estimation total domestic water demand of the study area is 2,39,08,867 litre/day.In Sambalpur district part of the study area total water supply by bore wells is 1109376 litre/day.In Jharsuguda district rural part of the study area total water supply by bore wells is 1812276 litre/day.In Jharsuguda district urban part of the study area total water supply by bore wells is 70000 litre/day.Therefore total water supply by bore wells is only 18,82,276 litre/day (As per RWSS and WATCO data). Total number of hand pumps 3747 with an average yield of 1 lps.If 1000 litre per day average withdrawal per handpump is considered then total ground water withdrawal by 3747 number of hand pumps will be 3747000 litre /day. Therefore total ground water supply by bore well and hand pumps will be 56,29,276 litre/day.But as on 29.2.2024 Hon'ble chief of Odisha inaugurated drinking water supply by surface water scheme of 19 MLD or 1,90,00,000 litre per day from Surface Water to Jharsuguda Municipality.Therefore total water supply as on date is 2,46,29,276 litre per day.Therefore, presently there will be no demand supply gap is the study area particularly in Jharsuguda Municipality. But rural areas are facing some scarcity of drinking water during summer season.

As per three dimensional panel diagram , ground water is available in weathered zone as well as in fracture zone in granite gneiss. Yield potential of fracture zone generally is very low (1 to 2 lps on an average) within a drilling depth of 150 meter.During pumping test as per Table 10 it is seen that most of the wells after pumping of 60 to 100 minutes, recovery of pumping water level takes 50 to 100 minute time. So after doing geophysical resistivity survey tentative saturated fracture can be identified for construction of any bore wells. As per chemical quality report by CGWB, bore wellsare not at all contaminated except sporadic occurances of fluoride (only at three locations).Ground water yield in Gondwana shale is very low (0.5-1 lps) and occurs below 100 mbgl depth.This is mainly due to the mine seepage at Talabira Coal Mines by NLC.

As per cropping pattern total cultivated area is 14255 hector in the study area. But as per water conservation table there are only 155 number of farm pond present in the study area. If one farm pond per 30 hector of cultivated land can be constructed then total 427 number of farm pond to be constructed.So if volume of one farm pond is 300 m^3,after considering dimension of 10 meter (length) by 10 meter(bredth) by 3 meter (depth) , then total recharge for 180 days water holding periodwill be $100m^2$*0.00144m/day*180 days*427(total number of farm pond)=11068 cubic meter per year (Cosidered only 180 days water availability in ponds) and water conservation capacity of $300m^3$*427=1,28,100 cubic meter.

16. CONCLUSIONS AND RECOMMENDATIONS

i. Industrial cluster area of Jharsuguda district is covering around 456 sq.km area comprising with part of Jharsuguda Block,part of Kolabira block, part of Kirimira block of Jharsuguda district and part of Rengali block of Sambalpur district.

ii. There are 10 full GP, 2 part GP, one Municipality of Jharsuguda Block, 2 GP of Kolabira Block, one GP of Kirimira Block of Jharsuguda District and 11 GP of Rengali Block of Sambalpur district falls in the study area.

iii. Main hydrogeological formations are Precambrian gramite gneiss covering 75% of the study area and Gondwana shale is covering around 25% of the study area.

iv. Yield of bore wells in Gondwana is very low (0.5-1 lps), but yield of bore well in Granite gneiss is quite good (1 to 16.14 lps). Bore well yield in Jharsuguda district is very low, but in Sambalpur district it is quite high.Availability of fracture zone in Rengali Block is quite high than in Jharsuguda District.

v. Major industries are metal and thermal power plant based and their operation solely depends on surface water supply from State Government Department.

vi. Average pre and post monsoon depth to water level in dug well is 6.08 mbgl, 2.77 mbgl respectively, whereas in Bore Well/ Hand pump it is 9.15 mbgl and 5.5 mbgl respectively. Seasonal water level fluctuation is overall rising. Long term decadal trend of post monsoon water level is rising (0.4 m to 1.35 m) in most of the area and falling (0.48 m) only in 18 sq.km area.

vii. 10% of dug well samples are contaminated with nitrate. 12% bore well/ hand pump samples are found contaminated with nitrate. 4% bore well/ hand pump samples are found contaminated with fluoride (Only 3 locations). 2.7% bore well/ hand pump samples are found contaminated with uranium (Only 2 locations during premonsoon).
54.5 % water samples collected from ash pond, nalla, river etc are found contaminated with fluoride.

viii. On the basis of post monsoon depth to water level map of hand pump/ bore wells more than 5 mbgl water level area which correspond to 112.17 sq. km is demarcated as recharge area.

ix. Average total rainfall in the study area is 1752.75 mm during the year 2023. Rainfall in Kirimira Block is highest and rainfall in Jharsuguda Block during 2023 is the lowest.Normal rainfall in Jharsuguda District is 1362.8 mm, whereas normal rainfall in Sambalpur District is 1496.7 mm.

x. Artificial recharge structure is proposed in 18 sq. km area with 20 RWH in 3 sq.km area and 300 farm pond in 3 sq.km. area in Jharsuguda Municipality on the basis of postmonsoon decadal trend and mean water level analysis.

xi. Dynamic ground water resources estimation is carried out after taking the whole millliwater shed boundary.Unit draft of bore well in Jharsuguda district is calculated as 0.44 ham and in Sambalpur District it is calculated as 0.518 ham.Unit draft of dug wells is calculated as 0.079 ham.Unit draft of industrial bore well is calculated as 1.11 ham.Net ground water availability in the study area is calculated as 1641.58 ham and total ground water draft is calculated as 1121.6 ham and stage of ground water extraction is calculated as 68.32%.So category of the assessment unit is considered as 'safe'.

xii. Ground water supply in rural areas can be managed by construction of 427 number of farm pond in agricultural field.

xiii. Bheden river and IB river are contaminated by fluoride which may be due to the disposal of pollutants from nearby metal and thermal power plants and also from ash ponds situated near the bank of Bheden River. The analysed physico-chemical characteristics of the Safai nala and Bheden river showed the fluoride contamination due to industrialisation. Further the chemical data of Ib river water showed that there is some impact of industrial effluent on it through Bheden river and Safai nala in non monsoon period. The aluminum values of the Bheden river show the contamination due to industrialisation (M/s VAL). However the higher concentration of chloride showed the Ib river may be polluted by the municipality wastes. So daily checking of river water quality is needed to prevent pollution in irrigation water applied during khariff and rabi season by MI,OLIC department etc.

xiii. Fluoride, uranimum and nitrate contaminated aquifer tapped by hand pump, bore wells to be sealed by State Government agencies.It is also desirable to conduct 100% chemical quality analysis of water samples from all bore wells/handpumps/dug wells used by public for drinking water purposes.

Xiv.Trace elements have been analysed for 127 locations for Al,Cu,Fe,Mn,Se,Zn,U, Cd,Ni,Pb,As and Cr in the study area.Fe concentration above permissible limit (0.3 mg/l) are observed in 21 dug wells, 40 hand pumps and 2 bore well samples. Mn concentration above permissible limit (0.3 mg/l) are observed in 16 dug wells, 8 hand pumps and 1 bore well samples. Al concentration above permissible limit (0.2 mg/l) are observed in 13 hand pumps and 1 bore well sample. Pb concentration above permissible limit (0.01 mg/l) are observed in 5 hand pump samples. U concentration above permissible limit (0.03 mg/l) are observed in 3 hand pump and 1 BW samples. Ni concentration above permissible limit (0.02 mg/l) are observed in 3 dug well samples. Zn concentration above permissible limit (15 mg/l) are observed in 2 hand pump samples. Contaminated bore wells and dug wells needs to be sealed and restrict the the local people to use these water for driniking.

Xv. Fly ash diposal sites by all thermal power plants near the river Bheden, IB and all tributaries should be stopped. Government should take stringent action to all the thermal power plants for haphazard dumping of flyash at any place.

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References

1. National aquifer mapping and management plan of Jharsuguda District (2020), CGWB, SER, Bhubaneswar.
2. National aquifer mapping and management plan of Sambalpur District (2023), CGWB, SER, Bhubaneswar.
3. Dynamic Ground Water Resources Assessment of Odisha, (2023), CGWB, SER, Bhubaneswar.
4. Report of Pollution study of Jharsuguda district, 2010, 2016, CGWB, SER, Bhubaneswar.

ANNEXURE-1

Surface water allocation and ground water allocation to the major industries located in the study area

OFFICE OF THE ENGINEER-IN-CHIEF, WATER RESOURCES
ODISHA, BHUBANESWAR.

No. WS-IWS-CASE- 363/24 6669/WE Date: 27.02.24
From

Er. Deepak Kumar Mohanty,
Chief Engineer, Water Services.

To

Sri Tarun Mishra, Scientist- D,
Central Ground Water Board, SER, Bhubaneswar.

Sub: Water allocation data in respect of surface water and ground water to the concern industries of Jharsuguda district and Sambalpur district.

Ref: - Your Email dated 13.02.2024

Sir,

With reference to the subject cited above & your request , the Water allocation data in respect of surface water and ground water to the concern industries of Jharsuguda district and Sambalpur district, as available in this office are enclosed herewith for the study purpose only.

Enclosure: - As above.

Yours faithfully,
27.02.24
Chief Engineer, Water Services.

Memo No. 6670 /Dated 27.02.24

Copy submitted to the Engineer-in-Chief, Planning & Design, Bhubaneswar for favour of kind information.

27.02.24
Chief Engineer, Water Services.

WATER ALLOCATION DATA IN RESPECT OF SURFACE WATER AND GROUND WATER TO THE CONCERN INDUSTRIES OF JHARSUGUDA AND SAMBALPUR DISTRICT

Jharsuguda District Study Area Part

Large Scale Industries/Public Sector undertakings

Sl. No.	Name of Industries	Source of Drawal	Drawal Quantity in Cusec	Remarks
1	M/s Indian Oil Corporation Ltd., At/Po-Arda, Dist-Jharsuguda.	GW	0.010	
2	L N. Metalicks,Shreepura	Bheden	0.093	
		GW	0.006	
3	SMC, Power generation Ltd., Hirma, Jharsuguda	Hirakud Reservoir	2.45	
4	S.P.S Sponge Iron Ltd.,Badmal, Jharsuguda(Now SMC, Power generation Ltd.)	Hirakud Reservoir	3.73	
5	Eastern Steel & Power (P) Ltd.(Now M/s TPSL Ltd.), Jharsuguda	River Ib	2.20	
6	Seven Star steels Ltd .	GW	0.102	
		Mahanadi	0.025	
7	Ms Vedanta Alumina Ltd.	Hirakud Reservoir	40.90	
8	Shree Madhab Ispat Pvt. Ltd.	GW		Closed
9	Bhagabati Steel Pvt. Ltd.	GW	0.014	
10	Jay Hanuman Udyog Ltd.	GW	0.05	
11	M/s M.S.P Metalic Ltd. Markuta	GW		Closed
12	Action Ispat Power Ltd,Jharsuguda	GW		Closed

Medium Scale Enterprises

List of the units in Jharsuguda District

1	Fortix Chemicals Pvt Ltd,Jharsuguda	GW	0.002	
2	Thakur Pr. Sao & Son Pvt. Ltd., Unit-IV, Lahandabud, Jharsuguda	GW	0.03	
3	Koshal Ceramics Pvt Ltd, At-Raghunathpali, Po-Kolabira Jharsuguda	GW	0.004	

Sambalpur District Study Part

Large Scale Industries/Public Sector undertakings

1	Bhusan Power & Steel Ltd.,Thelkoloi	Hirakud Reservoir	45.00	
2	Aryan Ispat & Power Pvt.,Rengali	GW	0.018	
	Aryan Ispat & Power Pvt.,Rengali	Mahanadi River	0.49	
3	Rathi Steel & Power Ltd., Sikirdi, Sambalpur			Closed
4	M/s Shyam DRI Pvt. Ltd.	Hirakud Reservoir	5.64	
5	Viraj Steel & Energy Ltd,	Hirakud Reservoir	0.50	
6	Maa Samaleswari Industries, (P), Ltd., Lapanga, sambalpur	Bheden River	0.061	
7	Aditya Aluminium Ltd	Hirakud Reservoir	52.73	

Annexure-2

VES data compilation for the study area

SL NO.	LOCATION	Latitude	Longitude	Direct interpretation of VES layer parameters by software				Inferred lithology	Aquifer Charectristics		
				Layer	Resistivity(ohm.m)	Thickness(m)	Depth(m)		Aquifer	Depth Range(m)	Inferred aquifer water quality
1	Panchpoda	21.9017	84.00316	1	87	2.68	2.68	Top Soil			
				2	25	14.3	17	Highly Weathered Formation	Aquifer 1	3-17	Potable
				3	VH			Granite Formation			
2	Hansamrakatapali	21.8761	83.97738	1	351	1.45	1.45	Top Soil			
				2	94	4	5.45	Top Soil			
				3	28	8.02	13.5	Highly Weathered Formation	Aquifer 1	6-13	Potable
				4	VH			Granite Formation			
3	Beherapat	21.86717	83.9922	1	491	1.64	1.64	Top Soil			
				2	101	32	33.64	Weathered Formation	Aquifer 1	2-33	Potable
				3	4485			Granite Formation			

4	Budhipodar	21.86194	83.96274	1	458	1.66	1.66	Top Soil			
				2	65	16.3	18	Weathered Formation	Aquifer 1	2-18	Potable
				3	VH			Granite Formation			
5	Sarbhal	21.84674	84.00439	1	60.4	2.54	2.54	Top Soil			
				2	83.8	8.72	11.3	Weathered Formation	Aquifer 1	3-23	Potable
				3	60.8	12.5	23.7	Weathered Formation			
				4	169	32.1	55.8	Fractured Granite	Aquifer 2	24-55	Potable
				5	VH			Granite Formation			
6	Jamera	21.84032	83.95549	1	255	1.39	1.39	Top Soil			
				2	37.3	7.18	8.57	Weathered Formation	Aquifer 1	2-8	Potable
				3	232	39.2	47.8	Fractured Granite	Aquifer 2	8-48	Potable
				4	5205			Gondwana Formation			
7	Saletigra	21.83429	83.97105	1	41.2	1.2	1.2	Top Soil			

				2	10	1.42	2.62	Top Soil			
				3	44	58	60.7	Weathered Formation			
				4	14.2						
8	Pandripathar	21.84213	83.99439	1	425.6	1.2	1.2	Top Soil			
				2	143.8	4.2	5.4	Hard Top soil			
				3	73	47.8	54.2	Weathered Formation	Aquifer 1	6-54	Potable
				4	7969			Granite Formation			
9	Gauntipada	21.83687	84.01624	1	198	2	2	Top Soil			
				2	69	3	5	Weathered Formation			
				3	202	61	66	Fractured Formation	Aquifer 2	7-66	Potable
				4	3003			Granite Formation			
10	Brundamal	21.80645	84.02145	1	313	2	2	Top Soil			
				2	91.1	6	8	Weathered Formation	Aquifer 1	2-8	Potable
				3	217	70	78	Fractured Formation	Aquifer 2	9-78	Potable

				4	1825			Granite Formation			
11	Mundapada	21.80929	83.99161	1	336	2	2	Top Soil			
				2	253	4	6	Top Soil			
				3	458	7	13	Fractured Formation	Aquifer 2	13-38	Potable
				4	253	25	38	Highly Fractured Formation			
				5	1737			Granite Formation			
12	Badheimunda	21.86676	84.03354	1	106	2	2	Top Soil			
				2	42	5	6	Weathered Formation	Aquifer 1	6-12	Potable
				3	10	5	12	Highly Weathered Formation			
				4	VH			Granite Formation			
13	Purna	21.84824	84.04955	1	220	1	1	Top Soil			
				2	1596	1	2	Top Soil			
				3	373	27	28	Fractured Formation	Aquifer 2	28-49	Potable
				4	62	22	49	Highly Fractured Formation			

				5	17715			Granite Formation			
14	Siriapali	21.83024	84.08303	1	120	1	1	Top Soil			
				2	228	2	3	Hard Soil			
				3	69	13	16	Weathered Formation	Aquifer 1	3-15	Potable
				4	249	42	58	Fractured Formation	Aquifer 2	17-58	Potable
				5	966			Granite Formation			
15	Paramanpur	21.79456	84.10708	1	281	2	2	Top Soil			
				2	95	15	18	Weathered Formation	Aquifer 1	2-18	Potable
				3	916			Granite Formation			
16	Gudigaon	21.85276	84.1015	1	1292	2	2	Top Soil			
				2	49	17	19	Weathered Formation	Aquifer 1	2-19	Potable
				3	1970			Granite Formation			
17	Katikela	21.78972	84.06608	1	217	1	1	Top Soil			

				2	993	1	2	Hard Soil			
				3	455	19	21	Fractured Granite	Aquifer 2	2-92	Potable
				4	776	70	92	Fractured Granite			
				5	11441			Granite Formation			
18	Katikela 2	21.78335	84.08449	1	528	2	2	Top Soil			
				2	67	14	15	Weathered Formation	Aquifer 1	2-15	Potable
				3	405	39	55	Fractured Granite	Aquifer 2	15-55	Potable
				4	10805			Granite Formation			
19	Ainalamal	21.8242	84.12181	1	89	1	1	Top Soil			
				2	256	1	2	Hard Soil			
				3	46	16	18	Weathered Formation	Aquifer 1	2-18	Potable
				4	244	55	73	Fractured Granite	Aquifer 2	18-73	Potable
				5	1035			Granite Formation			
20	Hirma	21.78828	83.98223	1	603	2	2	Top Soil			

				2	136	4	6	Hard Soil			
				3	59	8	14	Weathered Formation	Aquifer 1	6-14	Potable
				4	194	37	51	Fractured Granite	Aquifer 2	14-51	Potable
				5	2402			Granite Formation			
21	Thumbekela	21.78249	83.9995	1	379	1	1	Top Soil			
				2	191	1	2	Top Soil			
				3	676	3	5	Hard Soil			
				4	99	5	10	Weathered Formation	Aquifer 1	5-10	Potable
				5	565	11	21	Fractured Granite	Aquifer 2	10-90	Potable
				6	184	69	90	Highly Fractured Granite			
				7	1227			Granite Formation			
22	Sripura	21.77516	84.04176	1	132	3	3	Top Soil			
				2	93	16	19	Weathered Formation	Aquifer 1	3-19	Potable
				3	170	54	73	Fractured Granite	Aquifer 2	20-73	Potable
				4	1825			Granite Formation			

23	Mantulu Camp	21.73365	83.99381	1	1340	2	2	Top Soil			
				2	364	4	6	Compact/Hard Soil			
				3	182	128	136	Fractured Granite	Aquifer 2	6-136	Potable
				4	2281			Granite Formation			
24	Budhiapali	21.75157	83.96402	1	216	1.2	1.2	Top Soil			
				2	91	1.506	2.706	Weathered Formation			
				3	435	28.41	31.12	Fractured Formation	Aquifer 2	3-71	Potable
				4	199	38.96	71	Fractured Formation			
				5	6194			Granite Formation			
25	Rampur	21.77603	83.94269	1	2575	1.5	1.5	Top Soil			
				2	1180	4	5.5	Compact Formation			
				3	193	11	16.5	Partial weathered Formation	Aquifer 1	6-37	Potable
				4	21	21	37.5	Weathered Formation			
				5	10187			Granite Formation			

26	Derba	21.75027	84.03774	1	76	1	1	Top Soil			
				2	167	18	19	Compact Formation			
				3	55	23	42	Weathered Formation	Aquifer 1	19-42	Potable
				4	1646			Granite Formation			
27	Tilemal	21.72308	84.06551	1	741	0.955	0.955	Top Soil			
				2	179	5.33	6.29	Hard Soil			
				3	115	87.1	93.4	Fractured Granite	Aquifer 2	7-93	Potable
				4	1955			Massive Granite			
28	Gurupali	21.70438	84.03819	1	129	2	2	Top Soil			
				2	7.31	5	7	Clay	Aquifer 1	2-53	Potable
				3	33.4	46	53	Highly Weathered Formation			
				4	1102			Granite Formation			
29	R R Colony	21.69403	84.03978	1	532	2.836	2.836	Top Soil			

				2	238	6.061	8.897	Hard Soil			
				3	690	75.05	83.95	Fractured Granite	Aquifer 2	9-82	Potable
				4	VH			Granite Formation			
30	Binjipali	21.68595	84.07398	1	278	2.49	2.49	Top Soil			
				2	25.6	8.36	11	Weathered Formation	Aquifer 1	3-11	Potable
				3	1760			Granite Formation			
31	Bausen	21.68453	84.00462	1	265	1.32	1.32	Top Soil			
				2	32	4.87	6.19	Weathered Formation	Aquifer 1	2-6	Potable
				3	154	33.9	40	Fractured Granite	Aquifer 2	7-40	Potable
				4	VH			Granite Formation			
32	Jambahal	21.65046	84.07083	1	114	2.99	2.99	Top Soil			
				2	38	7.743	10.73	Weathered Formation	Aquifer 1	3-11	Potable
				3	VH			Granite Formation			

33	Badmal	21.66763	84.11117	1	135	0.473	0.473	Top Soil			
				2	48.4	2.66	3.13	Weathered Formation	Aquifer 1	3-8	Potable
				3	19.91	4.26	7.4	Weathered Formation			
				4	VH			Granite Formation			
34	Laumal	21.65122	84.14222	1	18	0.937	0.937	Top Soil			
				2	73	1.45	2.38	Top Soil			
				3	3.24	5.34	7.73	clay			
				4	15	18.1	25.8	Sand stone			
				5	9	23.5	49.4	clay			
				6	188						
35	Lakshamanpada	21.65775	84.04334	1	16.5	2.17	2.17	Top Soil			
				2	10.5	3.04	5.21	Weathered Formation			
				3	VH			Granite Formation			
36	Salad	21.64459	84.02669	1	252	0.773	0.773	Top Soil			

				2	82	3.16	3.93	Top Soil	Aquifer 1	3-8	Potable
				3	33	4.31	8.24	Clay			
				4	879	40.2	48.4	Fractured Granite	Aquifer 2	9-48	Potable
				5	VH			Granite Formation			
37	Jharmunda	21.66851	84.02008	1	253	1.11	1.11	Top Soil			
				2	59	11	12.1	Weathered Formation	Aquifer 1	2-12	Potable
				3	VH			Granite Formation			
38	Rengali Basti	21.63853	84.06029	1	837	1	1	Top Soil			
				2	360	12	13	Fractured Granite	Aquifer 1	1-13	Potable
				3	1900	13	26	Granite Formation			
				4	258	28	54	Fractured Granite	Aquifer 2	27-54	Potable
				5	VH			Granite Formation			
39	Kaoalipita	21.62275	84.08562	1	95	2.34	2.34	Top Soil			
				2	32	14	16.4	Weathered Formation	Aquifer 1	3-16	Potable

				3	VH			Granite Formation			
40	Thurupali	21.62793	84.12245	1	174	0.7	0.7	Top Soil			
				2	391	1	1.7	Top Soil	Aquifer 1	2-10	Potable
				3	52	8.8	10.5	Weathered Formation			
				4	3056			Granite Formation			

ANNEXURE-3

Water quality analysis (only basic) of samples collected during premonsoon

Sl No	Sample Code	Village	Source	pH	EC	TDS	TH	TA	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F	U
						in mg/l													
1	1	Jharsuguda	Dug well	7.33	667	368	200	90	36	26.73	51	10	0	109.8	159.525	16	15	0	BDL
2	2	Beherapat	Dug well	6.42	915	524	265	50	74	19.44	75	24	0	61	262.33	21	18	0.24	BDL
3	3	Lahanabud	Dug well	7.45	720	401	255	85	50	31.59	43	4	0	103.7	152.435	47	22	0.61	BDL
4	5	Budhipadar	Dug well	7.36	1060	588	375	100	78	43.74	53	17	0	122	276.51	42	18	0.56	BDL
5	6	Marakuta	Dug well	7.48	493	275	190	75	46	18.225	25	4	0	91.5	77.99	45	14	0.61	BDL
6	7	Pandripathar	Dug well	7.46	730	410	215	110	40	27.945	54	31	0	134.2	141.8	36	13	0.42	BDL
7	9	Singhabaga	Dug well	7.74	622	322	230	180	58	20.655	36	6	0	219.6	81.535	6	6	0.77	BDL
8	11	Brundamal	Dug well	7.43	488	283	125	60	36	8.505	47	6	0	73.2	106.35	37	6	0.26	BDL
9	12	Kukurjhanga	Dug well	7.09	324	182	100	60	24	9.72	24	7	0	73.2	53.175	22	6	0.43	BDL
10	13	Hirma	Dug well	6.87	602	329	215	45	36	30.375	33	9	0	54.9	155.98	36	2	0.45	BDL
11	14	Dhuben Chhapal	Dug well	7.6	565	303	240	115	56	24.3	19	3	0	140.3	92.17	11	29	0.13	BDL
12	15	Ramchandrapur	Dug well	6.75	407	238	100	55	24	9.72	42	4	0	67.1	70.9	46	9	0.41	BDL
13	16	Tumbeikala	Dug well	6.6	227	122	90	55	18	10.935	8	5	0	67.1	31.905	5	10	0.22	BDL
14	17	Khinda	Dug well	6.56	137	75	50	45	16	2.43	7	2	0	54.9	10.635	3	7	0.34	BDL
15	18	Khodupada	Dug well	6.64	192	102	80	45	20	7.29	8	2	0	54.9	28.36	1	8	0.37	BDL
16	19	Malda	Dug well	6.69	154	79	65	50	16	6.075	4	3	0	61	17.725	1	1	0.21	BDL
17	20	Dumramunda	Dug well	7.72	404	203	160	175	50	8.505	19	1	0	213.5	17.725	1	1	0.63	BDL
18	21	Patrapali	Dug well	7.7	744	391	250	175	48	31.59	52	4	0	213.5	120.53	27	3	0.71	BDL
19	22	Brundamal 2	Dug well	7.51	954	513	320	215	50	47.385	51	19	0	262.3	159.525	51	7	1.33	BDL
20	23	Bhagipali	Dug well	6.85	358	207	105	40	30	7.29	32	5	0	48.8	70.9	27	11	0.68	BDL
21	24	Katikela	Dug well	7.39	345	192	125	85	36	8.505	19	7	0	103.7	35.45	26	9	0.05	BDL
22	25	Dabka	Dug well	7.56	798	439	320	135	70	35.235	33	7	0	164.7	134.71	41	37	0.98	BDL
23	26	Paramanpur	Dug well	7.53	627	379	180	100	50	13.365	54	3	0	122	95.715	31	72	0.49	BDL
24	27	Tharkimal	Dug well	7.72	278	159	95	55	28	6.075	16	7	0	67.1	42.54	12	15	0.18	BDL
25	28	Siriapali	Dug well	7.18	178	96	70	55	26	1.215	7	3	0	67.1	21.27	1	4	0.42	BDL

26	29	Siriapali 2	Dug well	7.15	359	183	130	145	34	10.935	19	6	0	176.9	21.27	4	1	1.23	BDL
27	30	Dalki	Dug well	7.24	514	298	125	75	28	13.365	48	19	0	91.5	106.35	20	18	0.29	BDL
28	31	Badheimunda	Dug well	7.23	656	392	185	75	36	23.085	61	8	0	91.5	109.895	45	64	0.12	BDL
29	32	Phulchanger	Dug well	6.6	396	232	145	55	32	15.795	20	7	0	67.1	63.81	19	42	0.23	BDL
30	33	Bamaloi	Dug well	6.69	655	400	200	50	40	24.3	46	13	0	61	145.345	9	92	0.23	BDL
31	34	Kaliapada	Dug well	6.99	463	265	135	65	28	15.795	39	9	0	79.3	77.99	50	6	0	BDL
32	35	Charupada	Dug well	7.62	565	299	200	140	32	29.16	36	5	0	170.8	60.265	52	1	0.6	BDL
33	36	Binjipali	Dug well	7.01	152	81	50	45	8	7.29	8	6	0	54.9	17.725	4	3	0.26	BDL
34	37	Baragarh	Dug well	7.36	368	213	120	85	38	6.075	24	4	0	103.7	53.175	2	35	0.54	BDL
35	38	Tileimal	Dug well	7.1	1349	747	435	120	84	54.675	100	6	0	146.4	343.865	57	30	0.24	BDL
36	39	Bomlai 2	Dug well	7.34	892	495	280	95	44	41.31	65	18	0	115.9	205.61	45	19	0.35	BDL
37	40	Banjiberna	Dug well	6.92	286	153	110	90	34	6.075	11	6	0	109.8	28.36	11	3	0.66	BDL
38	41	Gumkarma	Dug well	7.48	496	257	175	125	40	18.225	32	4	0	152.5	81.535	3	4	0.43	BDL
39	42	Derba	Dug well	6.43	454	282	170	65	32	21.87	17	15	0	79.3	56.72	5	96	0.18	BDL
40	43	Lapanga	Dug well	7.23	273	150	95	80	30	4.86	16	4	0	97.6	24.815	20	3	0.99	BDL
41	44	Jharmunda	Dug well	7.71	747	416	195	245	40	23.085	47	58	0	298.9	67.355	32	2	1.39	BDL
42	45	Rengali	Dug well	7.33	922	484	325	265	68	37.665	53	13	0	323.3	113.44	35	5	0.73	BDL
43	46	Rampela	Dug well	7.14	361	201	75	75	14	9.72	46	2	0	91.5	63.81	8	13	0.37	BDL
44	47	Bagmunda	Dug well	7.63	873	451	300	230	50	42.525	62	2	0	280.6	116.985	34	6	1.11	BDL
45	48	Kadalipita	Dug well	7.9	828	454	225	255	30	36.45	52	54	0	311.1	88.625	37	3	0.59	BDL
46	49	Brahmanpalli	Dug well	7.85	875	502	240	190	40	34.02	58	49	0	231.8	124.075	59	24	0.56	BDL
47	50	Thuropali	Dug well	7.86	1019	573	290	225	34	49.815	53	70	0	274.5	159.525	67	5	0.52	8.51
48	51	Katarbaga	Dug well	7.49	865	474	340	110	72	38.88	41	4	0	134.2	177.25	44	31	0.63	BDL
49	52	Parmitila	Dug well	7.84	841	435	320	200	50	47.385	43	4.7	0	244	120.53	46.61	3.5	0.09	BDL
50	53	Industrial JSM	Dug well	7.91	323	175	125	85	34	9.72	16	5.9	0	103.7	28.36	24.62	5.9	0.16	BDL
51	54	Panchapada JSM	Dug well	7.5	256	152	80	60	24	4.86	15	10	0	73.2	28.36	14.37	19.9	0.22	BDL
52	55	Malimunda	Dug well	7.72	184	103	65	50	24	1.215	9	8.1	0	61	21.27	6.58	2.7	0.11	BDL
53	56	Jharmunda 2	Dug well	7.65	717	396	280	155	56	34.02	32	1.9	0	189.1	95.715	31.28	52.5	0.35	BDL
54	57	Kallopatra	Dug well	7.57	558	306	190	85	46	18.225	29	11.3	0	103.7	138.255	1.55	10.9	0.12	BDL

55	58	Gauntiapada	Dug well	7.4	276	158	90	50	20	9.72	19	6.1	0	61	46.085	1.76	25.4	0.31	BDL
56	59	Kurebaga	Dug well	7.7	628	376	185	65	46	17.01	54	7.3	0	79.3	124.075	22.3	66	0.89	BDL
57	61	Beherapat	H/P	7.75	374	213	145	50	34	14.58	18	1.9	0	61	74.445	0	40	0.46	BDL
58	62	Lahanabud	H/P	8.29	760	403	285	150	50	38.88	40	5	0	183	131.165	31.32	16.8	0.65	BDL
59	63	Budhipadar	H/P	7.83	495	288	175	65	44	15.795	29	3.5	0	79.3	95.715	12.9	48.7	0.09	BDL
60	64	Marakuta	H/P	7.8	753	432	280	70	64	29.16	36	4.9	0	85.4	170.16	41.72	43.8	0.91	BDL
61	65	Pandripathar	H/P	7.59	233	133	75	60	26	2.43	17	1.2	0	73.2	31.905	1.21	16.9	0.1	BDL
62	66	Singhabaga	H/P	7.84	589	302	215	195	46	24.3	34	0.8	0	237.9	60.265	10.97	8.9	0.69	BDL
63	67	Brundamal	H/P	7.77	335	190	120	65	40	4.86	19	1.7	0	79.3	60.265	5.01	20.4	0.04	BDL
64	68	Kukurjhanga	H/P	7.74	319	165	115	90	28	10.935	21	1.7	0	109.8	42.54	0.35	7.1	0.16	BDL
65	69	Hirma	H/P	7.17	408	214	160	60	32	19.44	13	6.3	0	73.2	106.35	0.37	1	0.36	BDL
66	70	Dhuben Chhapal	H/P	7.84	951	504	160	370	32	19.44	147	2	0	451.4	35.45	45.87	1	0.58	BDL
67	71	Ramchandrapur	H/P	7.51	217	116	75	80	28	1.215	12	2.5	0	97.6	21.27	1.77	1	0.04	BDL
68	72	Tumbeikala	H/P	7.86	435	217	170	180	42	15.795	18	1.6	0	219.6	28.36	3.03	1	0.31	BDL
69	73	Khodupada	H/P	7.56	201	103	80	75	26	3.645	8	1.1	0	91.5	17.725	0.87	1	0.37	BDL
70	74	Malda	H/P	6.91	219	103	100	85	14	15.795	3.5	5	0	103.7	14.18	-0.82	1	0.48	BDL
71	75	Dumramunda	H/P	8.06	1515	834	390	110	64	55.89	167	1.4	0	134.2	407.675	72.58	0	0.06	BDL
72	76	Patrapali	H/P	8.15	1016	579	160	120	26	23.085	156	1	0	146.4	223.335	77.61	0	2.02	BDL
73	77	Brundamal 2	H/P	7.78	926	520	370	170	66	49.815	36	6	0	207.4	131.165	45.04	84	0.11	BDL
74	78	Bhagipali	H/P	7.85	818	467	290	145	52	38.88	50	5.2	0	176.9	116.985	33.01	84	0.03	BDL
75	79	Katikela	H/P	7.7	199	110	65	60	20	3.645	15	2.3	0	73.2	17.725	3.28	12	0.28	BDL
76	80	Dabka	H/P	7.75	1013	577	320	170	68	36.45	83	3.7	0	207.4	159.525	55.22	69	0.92	BDL
77	81	Paramanpur	H/P	7.76	512	288	170	100	42	15.795	41	1.5	0	122	70.9	23.49	33.4	0.24	BDL
78	82	Kaputikra	H/P	7.41	273	163	90	70	22	8.505	17	2.6	0	85.4	24.815	3.65	42.4	0.04	BDL
79	83	Tharkimal	H/P	7.5	181	98	70	50	18	6.075	10	1.9	0	61	17.725	0	14.4	0.47	BDL
80	84	Siriapali	H/P	7.58	602	312	255	155	44	35.235	18	3.7	0	189.1	77.99	20.29	20.6	0.25	BDL
81	85	Dalki	H/P	7.94	312	159	115	105	22	14.58	17	1.5	0	128.1	31.905	2.97	6.4	0.1	BDL
82	86	Phulchanger	H/P	7.85	626	323	240	165	34	37.665	27	1.2	0	201.3	92.17	18.33	14.4	0.06	BDL
83	87	Bamaloi	H/P	8.57	261	141	100	75	20	12.15	12	1.7	0	91.5	28.36	-0.23	22.26	0.18	BDL

84	88	Kaliapada	H/P	7.33	290	153	110	65	28	9.72	17	1.7	0	79.3	42.54	11.72	3.9	0.5	BDL
85	89	Charupada	H/P	8.06	328	168	130	110	32	12.15	12	1.3	0	134.2	38.995	4.64	1	0.08	BDL
86	90	Binjipali	H/P	7.43	378	200	145	105	32	15.795	14	8.6	0	128.1	53.175	3.95	9.7	0.17	BDL
87	91	Tileimal	H/P	7.39	443	241	170	100	44	14.58	19	1.6	0	122	74.445	11.07	16.7	0.12	BDL
88	92	Bomlai 2	H/P	7.29	280	150	95	80	20	10.935	18	1.9	0	97.6	35.45	1.72	14.33	0.61	BDL
89	93	Banjiberna	H/P	7.65	806	413	360	155	70	44.955	19	1.7	0	189.1	159.525	8.95	15.8	0.07	BDL
90	94	Gumkarma	H/P	7.69	427	224	160	90	40	14.58	23	2.4	0	109.8	81.535	4.95	4	0.02	BDL
91	95	Derba	H/P	7.79	463	255	150	120	30	18.225	32	1.8	0	146.4	63.81	2.83	34.4	0.5	BDL
92	96	Ramchandranagar	H/P	7.61	617	319	240	155	44	31.59	29	3	0	189.1	85.08	32	1.6	0.3	BDL
93	97	Ganesh Nagar	H/P	7.55	873	450	400	185	76	51.03	20	4.2	0	225.7	131.165	35.95	20.8	0.21	BDL
94	99	Rengali	H/P	7.95	1747	974	405	410	68	57.105	201	6.2	0	500.2	251.695	63.14	81.6	2.24	BDL
95	100	Rengali 2	H/P	7.84	2082	1153	640	245	136	72.9	178	7	0	298.9	482.12	66.46	64	0.32	BDL
96	101	Rampela	H/P	7.7	1310	640	620	320	70	108.135	14	5.4	0	390.4	198.52	43	9.15	0.15	BDL
97	102	Bagmunda	H/P	7.91	1014	539	345	285	44	57.105	73	5	0	347.7	92.17	44.3	53	0.94	0.018
98	103	Kadalipita	H/P	7.62	1444	776	455	310	46	82.62	108	7.8	0	378.2	226.88	76.98	42	0.65	0.026
99	104	Brahmanpalli	H/P	7.85	233	123	80	85	24	4.86	16	1	0	103.7	14.18	7.47	5	0.29	BDL
100	105	Thuropali	H/P	7.66	861	440	380	180	66	52.245	22	2	0	219.6	155.98	13.65	20.8	0.18	BDL
101	106	Katarbaga	H/P	7.69	742	396	295	100	68	30.375	32	1.9	0	122	180.795	5.49	17.6	0.07	0.0057
102	107	Lubhapali	H/P	7.57	350	188	130	115	36	9.72	17	1.6	0	140.3	31.905	13.4	9.2	0.36	BDL
103	108	Parmitila	H/P	7.78	426	230	100	110	14	15.795	48	5.7	0	134.2	56.72	21.92	2.2	0.24	BDL

104	109	OMP JSM	H/P	7.81	525	272	220	160	44	26.73	17	1.5	0	195.2	53.175	13.26	20.9	0.43	BDL
105	110	Industrial JSM	H/P	7.68	667	342	265	90	40	40.095	31	1.7	0	109.8	163.07	10.4	1.8	0.22	BDL
106	111	Bidyanagar JSM	H/P	7.54	472	251	160	80	32	19.44	33	1.9	0	97.6	99.26	15.56	2.3	0.52	BDL
107	112	Panchapada JSM	H/P	7.52	845	463	325	150	40	54.675	37	11.5	0	183	127.62	48.74	54.2	0.37	BDL
108	113	Malimunda	H/P	7.17	193	105	70	35	12	9.72	12	1.7	0	42.7	31.905	5.13	11.58	0.22	BDL
109	114	Jharmunda 2	H/P	6.99	290	147	110	100	24	12.15	15	1.7	0	122	28.36	4.02	1.8	0.25	BDL
110	115	Dalki 2	H/P	7.57	289	145	100	110	22	10.935	20	1.7	0	134.2	21.27	2.6	1	0.38	BDL
111	116	Kallopatra	H/P	7.42	269	144	110	40	22	13.365	9.6	2.4	0	48.8	60.265	1	11.3	0.13	BDL
112	117	Gauntiapada	H/P	7.6	277	156	100	60	22	10.935	17	2.2	0	73.2	35.45	3.56	29	0.4	BDL
113	118	Kurebaga	H/P	6.9	246	123	95	90	22	9.72	12	2.1	0	109.8	21.27	0.08	2	0.31	BDL
114	119	Siria Bagicha	B/W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
115	120	H. Katapali	B/W	7.68	1920	1077	815	125	160	100.845	63	5	0	152.5	464.395	57.54	151	0.29	BDL
116	121	Dipaparha	B/W	7.54	255	147	80	45	20	7.29	18	3.6	0	54.9	46.085	4.3	21	0.18	BDL
117	122	Badmal	B/W	7.6	188	108	65	25	12	8.505	12	2.7	0	30.5	35.45	1	21	0.13	BDL
118	123	Kukurjhanga	B/W	7.59	258	143	105	45	28	8.505	11	1.9	0	54.9	46.085	0	21	0.31	BDL
119	124	Dhubenchappal Steel Plant Supply Water	B/W	7.79	599	352	250	75	54	27.945	23	9.8	0	91.5	31.905	158	2.9	0.44	BDL
120	125	Baragarh	B/W	7.65	381	207	140	105	36	12.15	19	3.5	0	128.1	49.63	3.02	21.4	0.49	BDL
121	126	Lapanga	B/W	7.76	1274	734	165	40	26	24.3	216	1.3	0	48.8	372.225	68.74	1.3	0.05	BDL
122	127	Jharmunda	B/W	7.86	1242	658	390	210	50	64.395	98.7	9.5	0	256.2	255.24	48.84	5.8	0.72	BDL
123	128	Jharmunda	B/W	7.92	480	246	150	195	38	13.365	36	4.4	0	237.9	31.905	4.82	1	0.7	BDL
124	129	Jharmunda	B/W	7.77	555	295	205	100	40	25.515	31	5.6	0	122	99.26	33.27	1	0.48	BDL
125	130	Rengali 2	B/W	7.91	788	429	190	220	40	21.87	90	2.9	0	268.4	81.535	59.88	1	1	BDL
126	131	Tewararidham	B/W	7.74	428	224	135	125	30	14.58	35	3.5	0	152.5	49.63	14.7	2.3	0.54	BDL
127	73PS	Bhagipali Safai Nalla 1	NALA-3	8.21	1305	769	415	100	80	52.245	104	12.7	0	122	191.43	260.5	8.3	1.58	BDL

128	74PS	Bheden and Safainalla confluence	NALA-5	8.17	1469	863	485	100	80	69.255	107	12.3	0	122	212.7	320.1	2.3	1.4	BDL
129	75PS	Safai Nalla Upstream 2	NALA-4	8.2	1170	732	425	125	84	52.245	67	7.7	0	152.5	56.72	388.8	1	1.63	BDL
130	76PS	Effluent point near Vedanta Aluminium	NALA-2	8.18	1130	656	385	100	70	51.03	65.6	7.7	0	122	46.085	355.6	0.5	1.56	BDL
131	77PS	Bagipali Pond	POND-1	7.91	300	146	85	50	22	7.29	15	8.2	0	61	42.54	17.23	4	1.77	BDL
132	78PS	Katikela Pond	POND-2	8.18	348	191	115	100	32	8.505	26.8	6.7	0	122	42.54	11.95	3	1.5	BDL
133	79PS	Katikela Bheden upstream	VEDEN RIVER-1	8.09	254	137	100	90	30	6.075	13.7	2.2	0	109.8	21.27	9.33	1	0.39	BDL
134	80PS	Siryapali Ash pond	EFFLUENT WATER	6.46	2644	1439	875	140	216	81.405	153	57	0	170.8	670	151.6	26	1.77	BDL
135	81PS	Kurebaga II	H/P	7.45	840	339	230	60	72	12.15	39	5	0	73.2	134.71	39.44	1	1.28	BDL
136	82PS	IB river Barghat	IB RIVER-9	7.83	424	206	120	75	32	9.72	22.9	4.3	0	91.5	35.45	54.81	2.3	0.86	BDL
137	83PS	Kherual Bridge Bheden river Downstream	VEDEN RIVER-6	8.1	1006	614	305	95	72	30.375	77	9.6	0	115.9	127.62	240.1	1	1.76	BDL
138	84PS	Rampur IB river Downstream	IB RIVER-8	8.12	413	242	165	100	40	15.795	22.4	3.8	0	122	63.81	34.89	1.3	1	BDL
139	85PS	Bheden and IB confluence	IB-VEDEN RIVER-7	8	743	405	265	75	58	29.16	39	6.7	0	91.5	155.98	69.83	1	1.54	BDL
140	86PS	Drainage from BSPL	BSPL-DRAINAGE	7.47	3000	1591	810	50	228	58.32	218	31.3	0	61	567.2	431.1	26.9	1.66	BDL
141	87PS	Pondaloi Matwari Nalla b/w Viraj Steel and Shyam Metallics	MATWARI NALA AT Pondaloi	8.28	511	244	150	115	38	13.365	28.8	4.7	0	140.3	46.085	43.72	1	1.05	BDL
142	88PS	Shyam Metallics	B/W	8.07	474	250	155	65	34	17.01	33.9	2.8	0	79.3	60.265	62.11	1	0.43	BDL
143	89PS	Shyam Metallics	Shyam - WWTP	8.02	2380	1498	720	85	148	85.05	193	28.9	0	103.7	184.34	800	7.5	1.56	BDL
144	90PS	Viraj Steel	B/W	8.21	630	299	185	105	48	15.795	33.5	6.8	0	128.1	63.81	61.02	7.2	0.47	BDL
145	91PS	Viraj Steel	Viraj-WWTP	8.47	1122	684	445	25	96	49.815	42.7	18.7	54	30.5	88.625	314.2	5.3	1.41	BDL
146	92PS	Effluent point backside of BSPL	Supply Water-BSPL	8.16	336	172	115	110	28	10.935	16.9	3.04	0	134.2	10.635	31.08	5.2	0.44	BDL
147	-	Nabasanga	H/P	7.61	1027	546	235	335	42	32	119	7.13	0	409	106	36	1.4	1.63	0.0467

ANNEXURE-4

Water quality analysis (only basic) of samples collected during postmonsoon

Sl No	LAB SAMPLE ID	Village	Source	pH	EC	TDS	TH	TA	Ca	Mg	Na	K	CO3	HCO3	Cl	SO4	NO3	F	U
						in mg/l													
1	2023-24/4273	Budhipadar	HP	7.61	429	264	126	65	38	7	35	7.9	0	79	61	17	59	0.23	BDL
2	2023-24/4274	Beherapat	HP	7.83	329	189	132	65	28	15	12	3.4	0	79	45	2	45	0.36	BDL
3	2023-24/4275	Brundamal	HP	7.74	1062	619	393	210	105	32	50	26.3	0	256	124	68	88	0.13	BDL
4	2023-24/4276	Bhagipali	HP	7.95	735	433	308	125	65	35	22	11.7	0	153	82	35	107	0.37	BDL
5	2023-24/4277	Singabaga	HP	7.72	801	443	301	200	100	12	40	9.7	0	244	92	58	12	0.58	BDL
6	2023-24/4278	Kaliapada	HP	7.25	284	148	114	105	41	3	12	3.2	0	128	18	8	0	0.31	BDL
7	2023-24/4279	Malda	HP	7.1	187	97	66	85	22	2	7	10	0	104	4	1	0	0.1	BDL
8	2023-24/4280	Patrapali	HP	7.34	1285	792	152	100	58	2	220	5.2	0	122	239	187	21	1.29	BDL
9	2023-24/4281	Rengali 2	HP	7.33	1242	697	347	145	105	21	120	18.5	0	177	287	55	4	0.45	BDL
10	2023-24/4282	Talabira OCP	Mines sump	7.42	426	235	146	120	25	20	28	4.1	0	146	13	66	7	0.47	BDL
11	2023-24/4283	Rengali	HP	7.73	1514	851	400	375	85	45	158	12.7	0	458	161	83	82	2.64	BDL
12	2023-24/4284	Derba	Dug	7.41	555	349	157	140	50	8	32	44.5	0	171	38	8	85	0.11	BDL
13	2023-24/4285	Bamaloi	Dug	7.8	926	598	223	105	60	18	110	6.9	0	128	115	30	195	0.22	BDL
14	2023-24/4286	Thuropali	Dug	7.68	845	480	297	220	66	32	43	13.4	0	268	77	63	54	0.34	BDL
15	2023-24/4287	Parmitila	HP	7.86	377	205	79	110	26	3	49	3	0	134	46	10	2	0.11	BDL
16	2023-24/4288	Badhemunda	Dug	7.21	893	481	382	180	80	44	35	2.2	0	220	95	102	15	0.26	BDL

17	2023-24/4289	Nabasanga Old	HP	7.65	852	457	210	300	40	27	96	12.8	0	366	37	50	15	1.65	BDL
18	2023-24/4290	Dabca	HP	7.67	1076	588	411	240	94	43	65	6.8	0	293	112	73	51	0.55	BDL
19	2023-24/4291	Kurebaga	Dug	7.7	625	385	156	95	50	8	75	1.8	0	116	77	32	84	0.15	BDL
20	2023-24/4292	Parmanpur	Dug	7.33	1341	812	456	240	105	47	102	2.8	0	293	115	78	219	0.15	BDL
21	2023-24/4293	Nabasanga 2	HP	7.38	769	389	276	275	37	45	43	12.6	0	336	50	33	4	1.14	BDL
22	2023-24/4294	H Katapali	BW	6.96	1956	1152	673	195	185	51	132	11.4	0	238	391	88	177	0.26	BDL
23	2023-24/4295	Bagmunda	HP	7.21	1051	568	381	300	75	47	70	10.2	0	366	69	52	65	0.89	BDL
24	2023-24/4296	Jharmunda 2	Dug	7.65	851	419	360	270	70	45	30	10.1	0	329	94	6	3	0.41	BDL
25	2023-24/4297	Panchpada JSM	HP	7.72	852	493	341	190	80	34	37	3.8	0	232	62	69	94	0.25	BDL
26	2023-24/4298	Industrial JSM	HP	7.65	699	379	292	170	66	31	30	1.5	0	207	67	40	42	0.27	BDL
27	2023-24/4299	Kodapara	Pond sample	7.5	238	125	94	50	20	11	10	1.2	0	61	41	11	1	0.14	BDL
28	2023-24/4488	DALKI	BW	6.23	197	110	76	70	24	4	10	1.3	0	85	7	1	21	0.22	BDL
29	2023-24/4489	MARAKUTA	BW	6.71	425	242	190	130	60	10	10	1.8	0	159	22	9	51	0.25	BDL
30	2023-24/4490	GUDIGAON	BW	5.78	303	188	102	75	35	4	19	3	0	92	24	3	55	0.17	BDL
31	2023-24/4491	H KATAPALI	BW	6.05	271	153	109	90	32	7	9	2.4	0	110	16	1	32	0.24	BDL
32	2023-24/4492	LAHAMANI	BW	6.63	497	261	187	125	42	20	28	2.2	0	153	66	22	6	0.51	BDL
33	2023-24/4493	Bargad	BW	7.69	419	215	138	200	41	9	28	4.2	0	244	5	6	2	0.53	BDL
34	2023-24/4669	Ghichamoha	BW	7.17	752	390	293	210	68	30	37	2	0	256	101	3	24	0.47	BDL

35	2023-24/4670	Nishanbhanga	BW	7.21	383	195	91	185	20	10	41	9.5	0	226	3	1	0	0.36	BDL
36	2023-24/4671	Kendupada	BW	7.3	571	285	172	260	36	20	50	11.5	0	317	9	2	1	0.42	BDL
37	2023-24/4672	Katarbaga	BW	7.39	626	317	194	190	30	29	53	2.8	0	232	85	2	2	1	BDL
38	2023-24/4673	Khinda new	BW	7.21	542	270	219	160	40	29	23	2.1	0	195	75	3	2	0.67	BDL
39	2023-24/4674	Rampela	BW	7.53	454	220	167	210	34	20	28	1.4	0	256	8	1	2	1.34	BDL
40	2023-24/4675	Golamal	BW	7.17	752	390	293	210	68	30	37	2	0	256	101	3	24	0.47	BDL
41	79PS	Katikela Bheden upstream	Bheden River 1	7.48	455	273	180	105	42	18	26	3.9	0	128	45	73.4	1	0.82	BDL
42	73PS	Safai Nalla at Bhagipali bridge	Nalla-3	7.22	675	425	260	125	62	26	40	7.7	0	153	61	147	2	3.17	7.22
43	74PS	Bheden and Safainalla confluence	Bheden River 2	7.4	490	298	200	50	44	22	29	4.7	0	61	89	76.7	1	1.48	BDL
44	83PS	Kherual Bridge Bheden river Downstream	Bheden River 3	7.45	489	294	190	90	44	19	33	4.6	0	110	61	76	1	1.52	BDL
45	82PS	IB river Barghat	IB River 0	7.52	285	158	120	90	20	17	14	2.6	0	110	25	24	1	0.34	BDL
46	85PS	Bheden and IB confluence	IB-Bheden River 1	7.05	292	177	110	65	30	9	18	3.6	0	79	40	36	1	0.43	BDL
47	84PS	Rampur, IB river Downstream	IB River-2	7.47	304	177	120	70	26	13	19	3.1	0	85	35	38.4	1	0.16	BDL
48	77PS	Bagipali Pond	Pond-1	7.21	208	121	90	70	20	10	8	4.7	0	85	18	13	1	3.63	BDL
49	78PS	Katikela Pond	Pond-2	6.91	214	128	80	60	20	7	14	3.9	0	73	20	15.5	11	0.86	BDL
50	80PS	Siryapali Ash pond	Ash Pond	6.57	1519	1004	605	45	160	50	77	40.7	0	55	225	420	1.6	1.89	BDL
51	86PS	Drainage from BSPL	BSPL-Drainage	6.65	1206	852	390	75	102	33	113	16.6	0	92	9	510	18.7	3.54	BDL

52	87PS	Pondaloi Matwari Nalla b/w Viraj Steel and Shyam Metallics	Matwari Nala at Pondaloi	7.24	318	185	130	65	30	13	16	2.7	0	79	58	23.6	2	0.79	BDL
53	89PS	Shyam Metallics	Shyam - WWTP	6.4	1147	755	385	50	108	28	99	15.8	0	61	180	288	5	1.37	BDL
54	91PS	Viraj Steel	Viraj WWTP	7.13	79	44	40	35	12	2	1	0.2	0	43	1	5.3	1	0.06	BDL
55	92PS	WWTP-1 BSPL	Supply Water-BSPL	6.22	4571	2811	805	45	270	32	760	12	0	55	1620	83	5.6	1.3	0.0023

ANNEXURE-5

Ground Water quality analysis (only heavy) of samples collected during premonsoon

Sl.No.	Village	Source	Lat Decimal	Long Decimal	Al mg/l	Cu mg/l	Fe mg/l	Mn mg/l	Se mg/l	Zn mg/l	U mg/l	Cd mg/l	Pb mg/l	Ni mg/l	As mg/l	Cr mg/l
1	Beherapat	DW	21.865511	83.994439	0.13	0.04	0.61	0.31	0	0.05	0	0	0	0.02	0	0
2	Lahanabud	DW	21.886735	83.982151	0.03	0	0.05	0.03	0	0.05	0	0	0	0	0	0
3	Budhipadar	DW	21.858134	83.959443	0.18	0	0.12	0.1	0	0.16	0	0	0	0.02	0	0
4	Marakuta	DW	21.852182	83.973766	0.09	0	0.12	0.08	0	0.05	0	0	0	0	0	0
5	Pandripathar	DW	21.844239	83.984796	0.25	0	0.22	0.42	0	0.07	0	0	0	0.01	0	0
6	Singhabaga	DW	21.83044	83.981618	0.21	0	0.76	0.5	0	0.06	0	0	0	0	0	0
7	Brundamal	DW	21.807925	84.01107	0.47	0	0.51	0.45	0	0.07	0	0	0	0.01	0	0
8	Kukurjhanga	DW	21.81977	84.002815	0.28	0	0.72	0.1	0	0.16	0	0	0	0.01	0	0
9	Hirma	DW	21.795814	83.986409	0.13	0	0.29	0.73	0	0.04	0	0	0	0.03	0	0
10	Dhuben Chhapal	DW	21.744454	84.007844	0.03	0	0.03	0.16	0	0.03	0	0	0	0	0	0
11	Ramchandrapur	DW	21.778512	84.016923	0.24	0	0.25	0.14	0	0.03	0	0	0	0.01	0	0
12	Tumbeikala	DW	21.784281	84.001641	0.06	0	0.66	0.65	0	0.02	0	0	0	0	0	0
13	Khinda	DW	21.741733	83.98997	0.13	0	0.1	0.02	0	0.02	0	0	0	0	0	0
14	Khodupada	DW	21.739521	83.97113	0.25	0	0.24	0.05	0	0.06	0	0	0	0.01	0	0
15	Malda	DW	21.782201	83.970118	0.06	0	0.54	0.05	0	0.02	0	0	0	0	0	0
16	Dumramunda	DW	21.775403	83.939466	0.02	0	0.8	0.05	0	0.88	0	0	0	0	0	0
17	Patrapali	DW	21.761835	83.952644	0.1	0	0.08	0.18	0	0.04	0	0	0	0	0	0
18	Brundamal 2	DW	21.809571	84.022912	0.17	0	0.17	0.95	0	1.5	0	0	0	0	0	0
19	Bhagipali	DW	21.792604	84.03712	0.18	0.01	0.17	0.96	0	1.57	0	0	0	0.01	0	0
20	Katikela	DW	21.788169	84.075728	0.56	0	3.22	1.02	0	0.11	0	0	0	0.02	0	0
21	Dabka	DW	21.796438	84.094589	0.05	0	0.08	0.08	0	0.09	0	0	0	0	0	0
22	Paramanpur	DW	21.797611	84.108717	0.02	0.08	3.88	0.07	0	0.29	0	0	0.01	0	0	0
23	Tharkimal	DW	21.822426	84.075362	0.1	0	0.79	0.28	0	0.06	0	0	0	0.01	0	0
24	Siriapali	DW	21.826068	84.083942	0.12	0	0.13	0.02	0	0.05	0	0	0.01	0	0	0.01
25	Siriapali 2	DW	21.834692	84.077297	0.16	0	1.02	0.22	0	0.06	0	0	0	0	0	0
26	Dalki	DW	21.844633	84.051067	0.02	0	0.15	0.07	0	0.06	0	0	0	0.01	0	0

27	Badheimunda	DW	21.865727	84.034259	0.3	0	0.24	0.51	0	0.05	0	0	0	0.03	0	0
28	Phulchanger	DW	21.716715	84.037731	0.08	0	0.08	0.12	0	0.03	0	0	0	0.06	0	0
29	Bamaloi	DW	21.697985	84.037251	0.05	0	0.08	0.07	0	0.16	0	0	0	0	0	0
30	Kaliapada	DW	21.682368	84.04504	0.07	0	2.74	0.3	0	0.04	0	0	0	0	0	0
32	Charupada	DW	21.679242	84.054539	0.09	0	0.21	0.04	0	0.02	0	0	0	0	0	0
33	Binjipali	DW	21.69537	84.06654	0.02	0	0.49	0.01	0	1.59	0	0	0.01	0	0	0
34	Baragarh	DW	21.70759	84.071673	0.11	0	0.09	0.01	0	0.06	0	0	0	0	0	0
35	Tileimal	DW	21.720659	84.07042	0.05	0	0.58	0.02	0	0.04	0	0	0	0	0	0
36	Bomlai 2	DW	21.724977	84.059276	0.11	0	0.26	0.37	0	0.03	0	0	0	0	0	0
37	Banjiberna	DW	21.7471	84.040509	0.14	0	0.72	3.28	0	0.01	0	0	0	0	0	0
38	Gumkarma	DW	21.750482	84.0532	0.12	0	0.16	0.35	0	0.02	0	0	0	0.02	0	0
39	Derba	DW	21.745313	84.073679	0.72	0.02	5.13	0.79	0	0.03	0	0	0.01	0	0	0
40	Lapanga	DW	21.727006	84.022354	0.05	0	0.12	0.13	0	0.01	0	0	0	0	0	0
41	Jharmunda	DW	21.665009	84.026229	0.82	0	1.48	2.41	0	0.03	0	0	0	0	0	0
42	Rengali	DW	21.640998	84.040813	1.05	0	0.84	0.05	0	0.09	0	0	0	0	0	0
43	Rampela	DW	21.631055	84.054368	0.31	0	0.36	0.1	0	0.01	0	0	0	0	0	0
44	Bagmunda	DW	21.631281	84.090905	0.23	0	0.17	0.04	0	0.01	0.01	0	0.01	0	0	0.01
45	Kadalipita	DW	21.623908	84.09584	0	0	0	0	0	0.06	0	0	0	0	0	0
46	Brahmanpalli	DW	21.637181	84.101433	0	0	0	0	0	0.01	0	0	0	0	0	0
47	Thuropali	DW	21.64101	84.140287	0.04	0	0.03	0.17	0	0.05	0	0	0	0	0	0
48	Katarbaga	DW	21.645789	84.126045	0.05	0	0.03	0.02	0	0.08	0.01	0	0	0	0	0
49	Parmitila	DW	21.64927	84.088787	0.05	0	0.02	0.05	0	0.03	0	0	0	0	0	0
50	Industrial JSM	DW	21.886223	84.00798	0.04	0	0.02	0.01	0	0.01	0	0	0	0	0	0
51	Panchapada JSM	DW	21.899371	84.008323	0.02	0	0.1	0.08	0	0.01	0	0	0	0	0	0
52	Jharmunda 2	DW	21.868786	84.069923	0.11	0	3.08	1.24	0	0.05	0	0	0	0.01	0	0
53	Kallopatra	DW	21.806545	83.99848	0.02	0	0.22	0.06	0	0.01	0	0	0	0	0	0
54	Gauntiapada	DW	21.833075	84.019219	0.05	0	0.11	0.07	0	0.3	0	0	0	0	0	0
55	Kurebaga	DW	21.816012	84.057103	0.01	0.13	3.95	0.02	0	0.12	0	0	0.01	0	0	0
56	Beherapat	HP	21.865582	83.994148	0.04	0.01	3.15	0.16	0	0.09	0	0	0.01	0	0	0

57	Lahanabud	HP	21.885863	83.982527	0.02	0.02	2.92	0.02	0	0.04	0	0	0.01	0	0	0
58	Budhipadar	HP	21.858582	83.960419	0.02	0.04	11.47	0.09	0	0.05	0	0	0.01	0	0	0.01
59	Marakuta	HP	21.851851	83.97444	0.04	0.02	0.56	0.01	0	0.09	0	0	0.01	0	0	0
60	Pandripathar	HP	21.844239	83.984796	0.04	0	0.25	0.02	0	0.04	0	0	0.01	0	0	0
61	Singhabaga	HP	21.83044	83.981618	0.02	0	0.36	0.01	0	0.02	0	0	0	0	0	0
62	Brundamal	HP	21.808588	84.010383	0	0.04	3.61	0.02	0	0.36	0	0	0.01	0	0	0
63	Kukurjhanga	HP	21.819963	84.00268	0.02	0.01	36.88	0.96	0	1.63	0	0	0.02	0.01	0	0
64	Hirma	HP	21.795814	83.986409	0	0	0	0.07	0	0.12	0	0	0	0	0	0
65	Dhuben Chhapal	HP	21.747665	84.015122	0.05	0.01	31.63	0.71	0	1.5	0	0	0.01	0	0	0.01
66	Ramchandrapur	HP	21.779098	84.016974	0.12	0	0.99	0.15	0	0.06	0	0	0	0	0	0
67	Tumbeikala	HP	21.782185	84.007663	0.02	0	3.76	0.18	0	0.08	0	0	0	0.01	0	0
68	Khodupada	HP	21.740707	83.970437	0.05	0.01	10.22	0.23	0	36.45	0	0	0.07	0.02	0	0.01
69	Malda	HP	21.781165	83.970278	0.14	0.02	6.26	0.12	0	2.42	0	0	0.03	0	0	0.01
70	Dumramunda	HP	21.774127	83.93907	0.09	0	0.44	0.02	0	0.19	0	0	0.01	0	0	0.01
71	Patrapali	HP	21.761277	83.953185	0.04	0.01	0.87	0.06	0	1.72	0	0	0	0	0	0
72	Brundamal 2	HP	21.808986	84.023132	0.04	0.02	2.54	0.02	0.01	0.2	0.06	0	0.01	0	0	0.01
73	Bhagipali	HP	21.792756	84.037831	0.03	0.01	1.53	0.02	0	0.07	0	0	0	0	0	0
74	Katikela	HP	21.788105	84.07606	0.04	0.02	1.94	0.07	0	0.13	0.01	0	0.01	0	0	0
75	Dabka	HP	21.796149	84.094386	0.03	0	1.02	0.2	0	0.03	0	0	0	0	0	0
76	Paramanpur	HP	21.797611	84.108717	0.02	0.04	3.96	0.05	0	4.76	0	0	0.01	0	0	0.01
77	Kaputikra	HP	21.80974	84.090444	0.02	0.03	2.48	0.04	0	0.32	0	0	0.01	0	0	0
78	Tharkimal	HP	21.823117	84.076504	0.03	0	1.68	0.08	0	1.22	0	0	0.01	0	0	0.01
79	Siriapali	HP	21.826068	84.083942	0.06	0	0.67	0.02	0	0.06	0	0	0.01	0	0	0
80	Dalki	HP	21.844633	84.051067	0.02	0.01	1.05	0.2	0	0.51	0	0	0	0.01	0	0
81	Phulchanger	HP	21.717675	84.03719	0.05	0.01	1.25	0.02	0	0.07	0	0	0.01	0	0	0
82	Bamaloi	HP	21.697246	84.0373	0.03	0.01	3.24	0.02	0	0.02	0	0	0.01	0	0	0
83	Kaliapada	HP	21.682239	84.04502	0.03	0	5.7	0.03	0	0.08	0	0	0.01	0	0	0
84	Charupada	HP	21.679038	84.054641	0.06	0.54	105.64	0.13	0	1	0	0	0.1	0.01	0	0.04
85	Binjipali	HP	21.696388	84.064444	0.03	0.02	4.43	0.08	0	0.05	0	0	0.01	0	0	0

86	Tileimal	HP	21.720659	84.07042	0.05	0	0.18	0.01	0	0.02	0	0	0	0	0	0
87	Bomlai 2	HP	21.725106	84.059656	0.02	0	1.16	0.28	0	1.02	0	0	0	0	0	0
88	Banjiberna	HP	21.747845	84.041086	0	0	0.02	0.01	0	0.03	0	0	0	0	0	0
89	Gumkarma	HP	21.75049	84.053182	0.02	0	0.89	0.18	0	0.06	0	0	0	0	0	0
90	Derba	HP	21.744192	84.07476	0.03	0.01	7.3	0.5	0	10.9	0	0	0.02	0	0	0
91	Ramchandranagar	HP	21.658244	84.051877	0	0	0.01	0.04	0	0.4	0.01	0	0	0	0	0
92	Ganesh Nagar	HP	21.656921	84.051844	0.01	0	0.03	0.11	0	0.02	0.02	0	0	0	0	0
93	Rengali	HP	21.641545	84.040195	0	0	0.28	0.2	0	0.06	0.07	0	0	0	0	0
94	Rengali 2	HP	21.637333	84.045758	0.02	0.01	0.74	0.66	0	0.67	0.02	0	0	0	0	0
95	Rampela	HP	21.623521	84.045666	0	0	0	0.73	0	0.07	0	0	0	0	0	0
96	Bagmunda	HP	21.631281	84.090905	0	0	0.41	0.18	0	0.18	0.03	0	0	0	0	0
97	Kadalipita	HP	21.623161	84.095028	0.02	0	0.74	1.02	0	0.17	0.07	0	0	0	0	0
98	Brahmanpalli	HP	21.637181	84.101441	0.01	0.01	2.55	0.07	0	0.1	0	0	0	0	0	0
99	Thuropali	HP	21.641396	84.140238	0	0	0	0	0	0.02	0	0	0	0	0	0
100	Katarbaga	HP	21.645545	84.126517	0	0	4.2	0.04	0	0.98	0	0	0	0	0	0
101	Lubhapali	HP	21.658202	84.106424	0	0.01	1.07	0.03	0	0.07	0	0	0	0	0	0
102	Parmitila	HP	21.647267	84.089008	0	0	0	0.07	0	0.01	0	0	0	0	0	0
103	OMP JSM	HP	21.89443	84.032837	0	0	0	0.01	0	0	0	0	0	0	0	0
104	Industrial JSM	HP	21.887121	84.007995	0	0	0	0	0	0.21	0	0	0	0	0	0
105	Bidyanagar JSM	HP	21.889337	84.007176	0.05	0	0.05	0.16	0	0.12	0	0	0	0	0	0
106	Panchapada JSM	HP	21.908428	84.007156	0	0	0	0.04	0	0.42	0	0	0	0	0	0
107	Malimunda	HP	21.902222	84.059223	0.15	0	0.28	0.33	0	0.14	0	0	0	0	0	0
108	Jharmunda 2	HP	21.86631	84.067939	0.01	0.06	1.81	0.04	0	0.1	0	0	0	0	0	0
109	Dalki 2	HP	21.864883	84.051102	0	0	0	0.03	0	1.95	0	0	0	0	0	0
110	Kallopatra	HP	21.806409	83.998063	0.01	0	2.24	0.11	0	1	0	0	0	0	0	0
111	Gauntiapada	HP	21.834679	84.020276	0	0.02	0.49	0.01	0	0.08	0.01	0	0	0	0	0
112	Kurebaga	HP	21.821111	84.052574	0	0	0	0	0	24.16	0	0	0	0	0	0
113	Siria Bagicha	BW	21.8535553	84.005669	0.31	0	0.24	0.04	0	0.38	0.07	0	0	0	0	0
114	H. Katapali	BW	21.882346	83.969153	0.01	0.01	0.49	0.22	0	0.02	0	0	0	0	0	0

115	Dipaparha	BW	21.844321	84.001351	0.09	0	0.12	0.01	0	0.02	0	0	0	0	0	0
116	Badmal	BW	21.823102	84.007792	0.07	0	0.07	0.01	0	0.02	0	0	0	0	0	0
117	Kukurjhanga	BW	21.81977	84.002815	0.01	0	0	0	0	0.01	0	0	0	0	0	0
118	Dhubenchappal Steel Plant Supply Water	BW	21.747346	84.014996	0.15	0	0.25	0.03	0	0.03	0	0	0	0	0	0
119	Baragarh	BW	21.707625	84.07187	0.09	0	0.05	0.02	0	0.02	0	0	0	0	0	0
120	Lapanga	BW	21.727939	84.021444	0.07	0	0.02	0.01	0	0.01	0	0	0	0	0	0
121	Jharmunda	BW	21.665266	84.026405	0.02	0	0	0	0	0.01	0	0	0	0	0	0
122	Jharmunda	BW	21.665266	84.026405	0.01	0	0.02	0.14	0	0.01	0	0	0	0	0	0
123	Jharmunda	BW	21.663659	84.02807	0.01	0	0	0.02	0	0.01	0	0	0	0	0	0
124	Rengali 2	BW	21.634737	84.047365	0.13	0	0.15	0.84	0	0.01	0	0	0	0.01	0	0
125	Kurebaga II	HP	21.814368	84.059382	0.08	0.01	0	0.54	0.01	0.03	0	0	0	0.01	0	0
126	Shyam Metallics	BW	21.68347	84.042551	0.01	0	0	0.02	0	0.01	0	0	0	0	0	0
127	Viraj Steel	BW	21.695818	84.036685	0.01	0	1.73	0.02	0	0.39	0	0	0	0	0	0
128	Nabasanga	HP	21.6483	84.0315	0	0	0	0.04	0	0.05	0.01	0	0	0	0	0
				MIN	0	0	0	0	0	0	0	0	0	0	0	0
				MAX	1.05	0.54	105.64	3.28	0.01	36.45	0.07	0	0.1	0.06	0	0.04

ANNEXURE-6

Ground Water quality analysis (only heavy) of samples collected during postmonsoon

Season	Block	Village	Source	Lat Decimal	Long Decimal	Al	Cu	Fe	Mn	Se	Zn	U	Cd	Pb	Ni	As	Cr
						in mg/l											
Premonsoon	Jharsuguda	Effluent point near Vedanta Aluminium	Discharge point	21.798329	84.03586	0.06	0	0	0.49	0	0	0	0	0	0	0	0
Premonsoon	Jharsuguda	Safai Nalla Upstream 2	Downstream	21.795917	84.032009	0.02	0	0	0	0	0	0	0	0	0	0	0
Premonsoon	Jharsuguda	Bhagipali Safai Nalla 1	Bridge	21.794537	84.029067	0.05	0	0	0.04	0.01	0.01	0	0	0	0	0	0
Premonsoon	Jharsuguda	Bheden and Safainalla confluence	Confluence Rly Bridge	21.79143	84.020447	0.01	0	0	0.03	0	0	0	0	0	0	0	0
Premonsoon	Jharsuguda	Katikela Bheden upstream	Upstream	21.772623	84.082508	0.05	0	0.05	0.19	0	0	0	0	0	0	0	0
Premonsoon	Jharsuguda	Bheden and Safainalla confluence	Confluence Rly Bridge	21.79143	84.020447	0.01	0	0	0.03	0	0	0	0	0	0	0	0
Premonsoon	Jharsuguda	Kherual Bridge Bheden river Downstream	Downstream	21.780739	84.010377	0.33	0	0.17	0.28	0	0.01	0	0	0	0	0	0
Premonsoon	Jharsuguda	Bheden and IB confluence	Industrial	21.810449	83.947283	0.86	0	0.42	0.4	0	0.01	0	0	0	0	0	0
Premonsoon	Jharsuguda	IB river Barghat	Upstream	21.864544	83.947001	0.04	0	0	0.04	0	0.03	0	0	0	0	0	0
Premonsoon	Jharsuguda	Bheden and IB confluence	Industrial	21.810449	83.947283	0.86	0	0.42	0.4	0	0.01	0	0	0	0	0	0
Premonsoon	Jharsuguda	Rampur IB river Downstream	Industrial	21.788126	83.938946	0.28	0	0.15	0.19	0	0.01	0	0	0	0	0	0
Premonsoon	Jharsuguda	Bagipali Pond	Industrial	21.7932	84.032108	0.66	0	0.54	0.23	0	0.02	0	0	0	0	0	0
Premonsoon	Jharsuguda	Katikela Pond	Industrial	21.785309	84.078475	0.69	0	0.14	0.47	0	0.01	0	0	0	0	0	0
Premonsoon	Jharsuguda	Siryapali Ash pond	Industrial	21.817073	84.067318	11.91	0	0.49	1.61	0.29	0.1	0	0.02	0	0.11	0.01	0
Premonsoon	Rengali	Drainage from BSPL	Industrial	21.756133	84.011298	0.36	0.01	2.94	1.27	0	1.02	0	0	0	0.01	0	0

Premonsoon	Rengali	Shyam Metallics	Industrial WWTP	21.68347	84.042551	0.54	0.01	0.01	0.03	0	0.02	0	0	0	0	0	0.01
Premonsoon	Rengali	Viraj Steel	Industrial WWTP	21.695818	84.036685	0.04	0	0	0	0	0.03	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Safai Nalla at Bhagipali bridge	NALA	21.794537	84.029067	1.41	0	0.92	0.79	0.01	0.03	0	0	0	0.01	0	0
Postmonsoon	Jharsuguda	Bheden and Safainalla confluence	River	21.79143	84.020447	0.38	0	0.48	0.29	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Katikela Bheden upstream	River	21.772623	84.082508	0.56	0	0.38	0.24	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Bheden and Safainalla confluence	River	21.79143	84.020447	0.38	0	0.48	0.29	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Kherual Bridge Bheden river Downstream	RIVER	21.780739	84.010377	0.28	0	0.36	0.26	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Bheden and IB confluence	River	21.810449	83.947283	0.24	0	0.2	0.15	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	IB river Barghat	RIVER	21.864544	83.947001	0.07	0	0.09	0.03	0	0	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Bheden and IB confluence	River	21.810449	83.947283	0.24	0	0.2	0.15	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Rampur IB river Downstream	River	21.788126	83.938946	0.28	0	0.25	0.11	0	0.01	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Siryapali Ash pond	POND	21.817073	84.067318	9.45	0.02	0.08	1.13	0.3	0.19	0	0	0	0.19	0.01	0
Postmonsoon	Rengali	Drainage from BSPL	BSPL Drainage	21.756133	84.011298	0.5	0.01	5.82	2.19	0	0.53	0	0	0.01	0.01	0	0
Postmonsoon	Jharsuguda	JSW Bhushan plant	WTP	21.7682	84.014022	0.24	0	1.41	0.29	0	0.04	0	0	0	0.01	0	0
Postmonsoon	Rengali	Shyam Metallics	Industry	21.68347	84.042551	1.27	0.01	0.05	0.23	0	0.04	0	0	0	0	0	0.06
Postmonsoon	Rengali	Viraj Steel	Industry WTP	21.695818	84.036685	0.01	0.01	1.62	0.01	0	0.04	0	0	0.01	0	0	0
Postmonsoon	Jharsuguda	Bagipali Pond	POND	21.7932	84.032108	0.11	0	0.22	0.2	0	0	0	0	0	0	0	0
Postmonsoon	Jharsuguda	Katikela Pond	POND	21.785309	84.078475	0.04	0	0.11	0.22	0	0.01	0	0	0	0	0	0

ANNEXURE 7

Pumping Test in Farmer Borewell/HP/ in Badmal village Jharsuguda Under NAQUIM 2.0

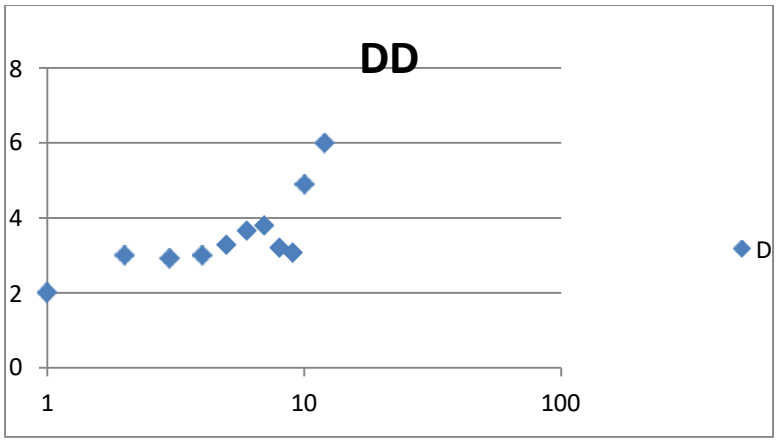
Date 22.12.23

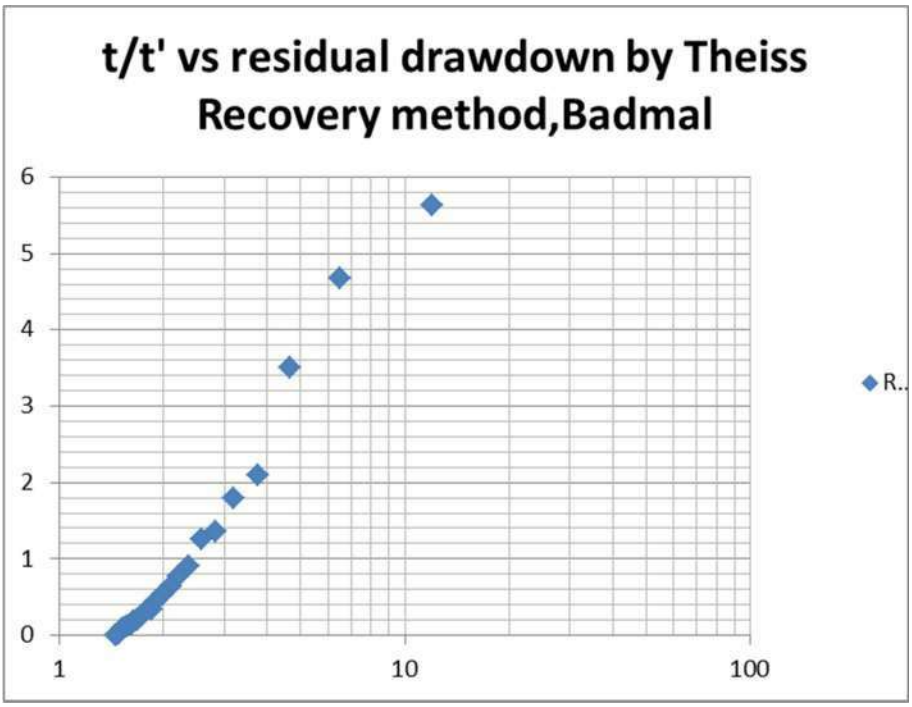
T	**4.878268**	square meter/day	ΔS	4.8 m	**lat**	**21**	**48.905**	21.81508
Depth of well		58.2 m			**long**	**83**	**59.823**	83.99705
SWL	3.00 mbmp							
MP	0.24 magl							

Pumping test data analysis	**Badmal Village,Jharsuguda**		**Discharge**	**1.48 lps**	**127.872**	**cubicmeter per day**	
Time	**DTW**	**DD**				Time	DD
1	5	2				1	2
2	6	3				2	3
3	5.92	2.92				3	2.92
4	6	3				4	3
5	6.28	3.28				5	3.28
6	6.64	3.64				6	3.64
7	6.78	3.78				7	3.78
8	6.2	3.2				8	3.2
9	6.07	3.07				9	3.07
10	7.9	4.9				10	4.9
12	9	**6**				12	6

Recovery						
t	**t0**	**t/t0**	**DTW**	**RDD**	**t/t0**	**RDD**
12	1	12	8.63	5.63	12	5.63
13	2	6.5	7.67	4.67	6.5	4.67
14	3	4.666667	6.5	3.5	4.666667	3.5
15	4	3.75	5.1	2.1	3.75	2.1
16	5	3.2	4.8	1.8	3.2	1.8
17	6	2.833333	4.35	1.35	2.833333	1.35
18	7	2.571429	4.25	1.25	2.571429	1.25
19	8	2.375	3.9	0.9	2.375	0.9
20	9	2.222222	3.77	0.77	2.222222	0.77
21	10	2.1	3.64	0.64	2.1	0.64
22	11	2	3.53	0.53	2	0.53
23	12	1.916667	3.45	0.45	1.916667	0.45
24	13	1.846154	3.34	0.34	1.846154	0.34
25	14	1.785714	3.32	0.32	1.785714	0.32
26	15	1.733333	3.26	0.26	1.733333	0.26

27	16	1.6875	3.2	0.2	1.6875	0.2
28	17	1.647059	3.18	0.18	1.647059	0.18
29	18	1.611111	3.14	0.14	1.611111	0.14
30	19	1.578947	3.12	0.12	1.578947	0.12
31	20	1.55	3.1	0.1	1.55	0.1
32	21	1.52381	3.08	0.08	1.52381	0.08
33	22	1.5	3.04	0.04	1.5	0.04
34	23	1.478261	3.02	0.02	1.478261	0.02
35	24	1.458333	3	0	1.458333	0





Pumping test data analysis Bargad Village,Rengali,Sambalpur

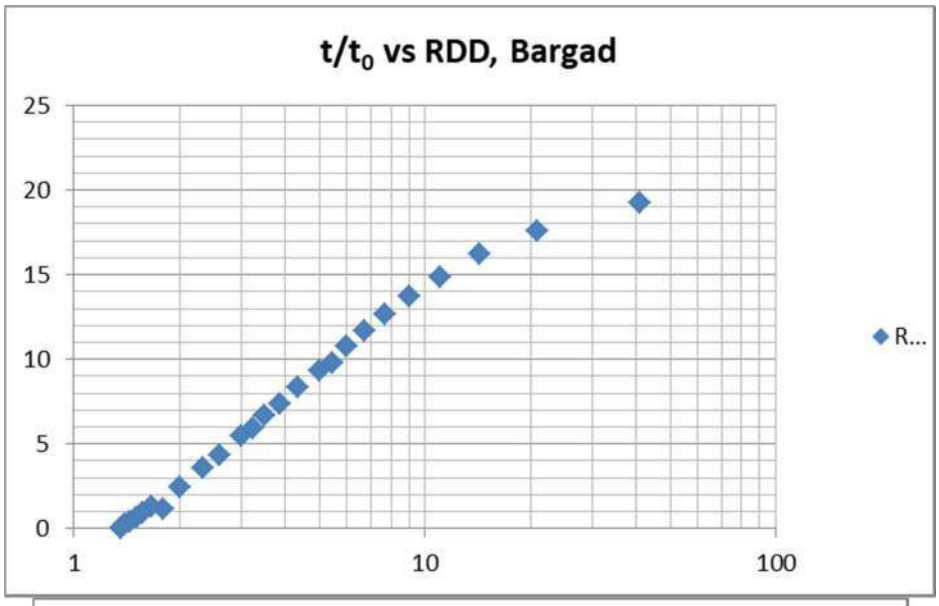
Discharge 2.0 lps 172.8 day

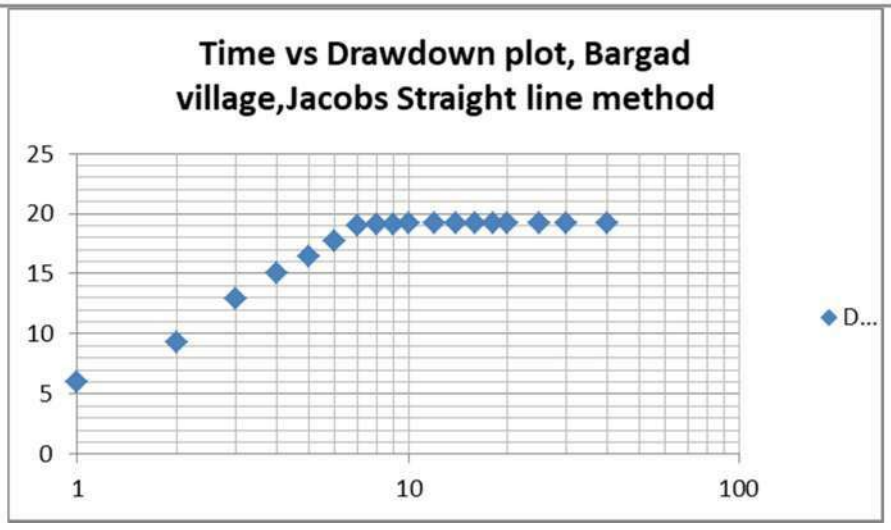
T
Pumping 2.109554 squaremeter/day ΔS 15 m
Depth of well 33 m,
SWL 4.85 mbmp
MP 0.74 magl

T
Recovery 1.861371 squaremeter/day ΔS 17 m
Depthof well 33 m **lat 21.70783**
SWL 4.85 mbmp **long 84.07184**
MP 0.74 magl

Time	DTW	DD	t	t0	t/t0	DTW	RDD
1	10.8	5.95	41	1	41	24.08	19.23
2	14.18	9.33	42	2	21	22.4	17.55
3	17.81	12.96	43	3	14.33333	21.06	16.21
4	19.94	15.09	44	4	11	19.7	14.85
5	21.28	16.43	45	5	9	18.6	13.75
6	22.58	17.73	46	6	7.666667	17.5	12.65
7	23.88	19.03	47	7	6.714286	16.5	11.65
8	24	19.15	48	8	6	15.62	10.77
9	24	19.15	49	9	5.444444	14.64	9.79
10	24.08	19.23	50	10	5	14.2	9.35
12	24.08	19.23	52	12	4.333333	13.17	8.32
14	24.08	19.23	54	14	3.857143	12.2	7.35
16	24.07	19.22	56	16	3.5	11.5	6.65
18	24.08	19.23	58	18	3.222222	10.8	5.95
20	24.07	19.22	60	20	3	10.3	5.45
25	24.08	19.23	65	25	2.6	9.17	4.32
30	24.08	19.23	70	30	2.333333	8.45	3.6
40	24.08	19.23	80	40	2	7.3	2.45
			90	50	1.8	6.03	1.18
			100	60	1.666667	6.14	1.29

			110	70	1.571429	5.76	0.91
			120	80	1.5	5.47	0.62
			130	90	1.444444	5.27	0.42
			140	100	1.4	5.08	0.23
			150	110	1.363636	4.86	0.01

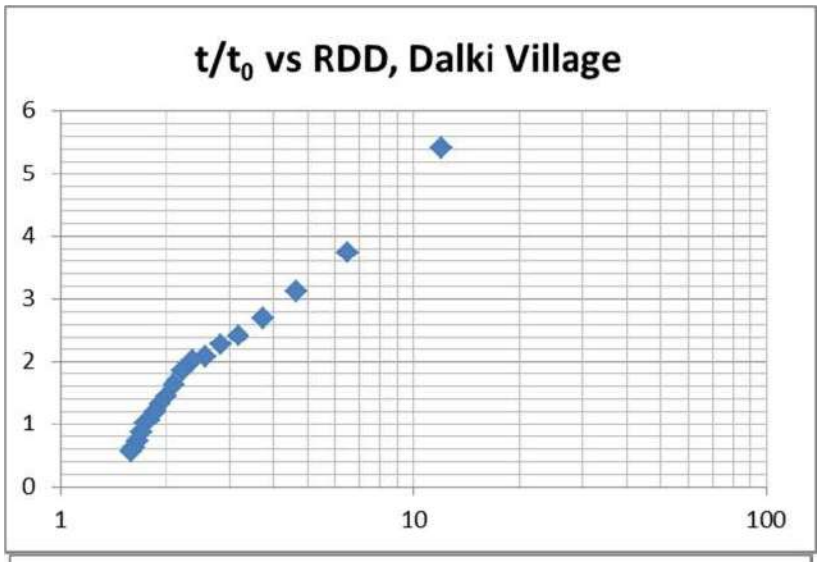


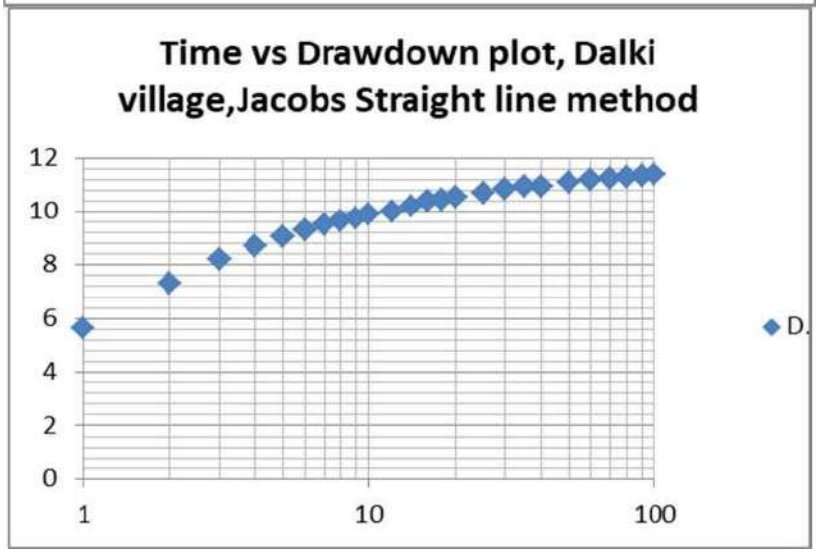


Pumping test data analysis Dalki Village, Jharsuguda

Pumping test data analysis	**Dalki Village,Jharsuguda**	**Discharge**	**2.09 lps**	**180.576**	**cubicmeter day**	**per**		
Date	**22.12.23**							
T	**17.40382**	squaremeter/day	ΔS	1.9 m	**lat**	**21**	**50.612**	21.84353
Depthof well		58.2 m			**long**	**84**	**3.031**	84.05052
SWL	1.72 mbmp							
MP	0 magl							

Time	**DTW**	**DD**	Recovery						
1	7.34	5.62	**t**	**t0**	**t/t0**	**DTW**	**RDD**	**t/t0**	**RDD**
2	9.05	7.33	101	1	101	7.14	5.42	12	5.42
3	9.92	8.2	102	2	51	5.47	3.75	6.5	3.75
4	10.45	8.73	103	3	34.33333	4.84	3.12	4.666667	3.12
5	10.8	9.08	104	4	26	4.42	2.7	3.75	2.7
6	11	9.28	105	5	21	4.14	2.42	3.2	2.42
7	11.24	9.52	106	6	17.66667	3.99	2.27	2.833333	2.27
8	11.36	9.64	107	7	15.28571	3.8	2.08	2.571429	2.08
9	11.48	9.76	108	8	13.5	3.73	2.01	2.375	2.01
10	11.6	9.88	109	9	12.11111	3.58	1.86	2.222222	1.86
12	11.7	9.98	110	10	11	3.35	1.63	2.1	1.63
14	11.93	10.21	112	11	10.18182	3.16	1.44	2	1.44
16	12.1	10.38	114	12	9.5	3.04	1.32	1.916667	1.32
18	12.17	10.45	116	13	8.923077	2.92	1.2	1.846154	1.2
20	12.25	10.53	118	14	8.428571	2.78	1.06	1.785714	1.06
25	12.4	10.68	120	15	8	2.74	1.02	1.733333	1.02
30	12.54	10.82	125	16	7.8125	2.58	0.86	1.6875	0.86
35	12.64	10.92	130	17	7.647059	2.45	0.73	1.647059	0.73
40	12.68	10.96	135	18	7.5	2.35	0.63	1.611111	0.63
50	12.8	11.08	140	19	7.368421	2.28	0.56	1.578947	0.56
60	12.91	11.19							
70	12.97	11.25							
80	13.02	11.3							
90	13.06	11.34							
100	**13.1**	11.38							


t/t0 vs RDD, Dalki Village
6
5
4
3
2
1
0
1
10
100


Time vs Drawdown plot, Dalki village,Jacobs Straight line method
12
10
8
6
4
2
0
1
10
100
D.

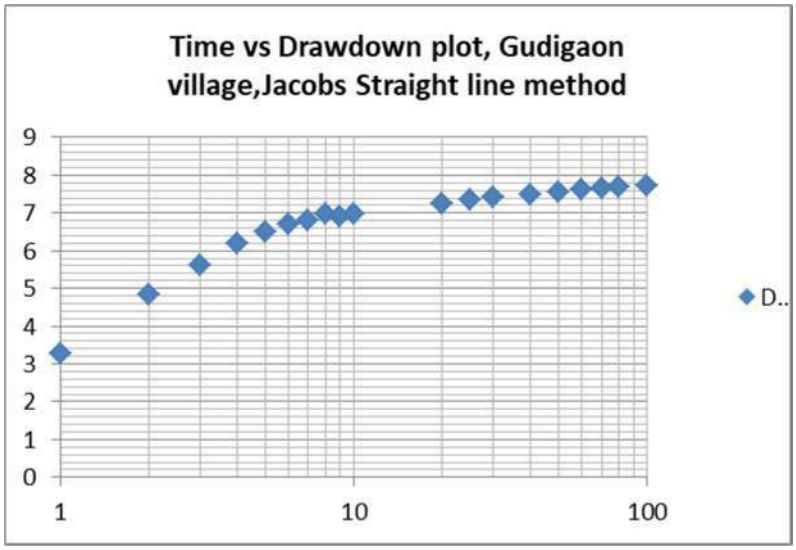
Pumping test data analysis Gudigaon Village,Jharsuguda

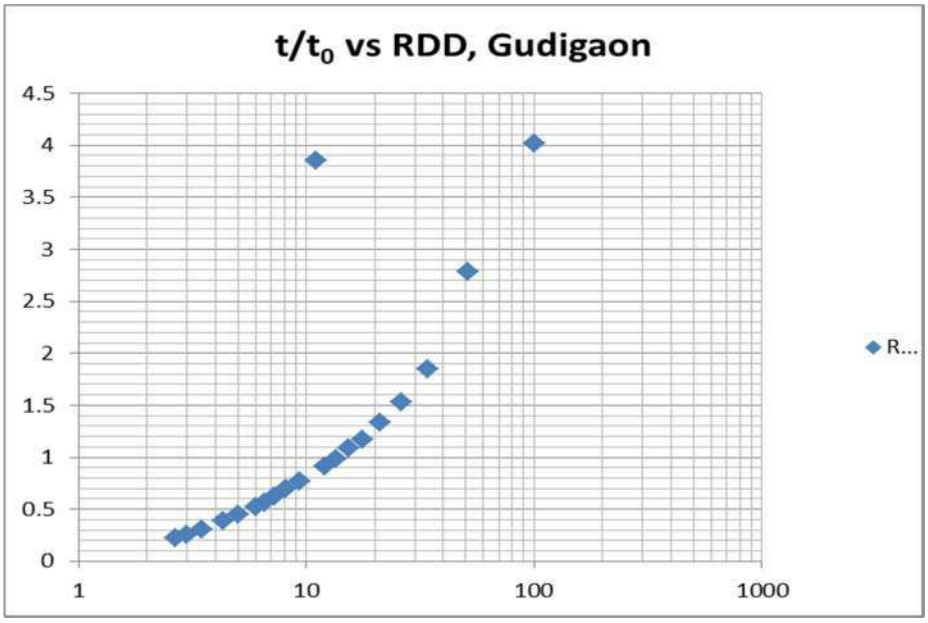
Pumping test data analysis	**Gudigaon Village,Jharsuguda**	**Discharge**	**1.02 lps**	**88.128**	**cubicmeter per day**		

Date	**24.12.23**	**T Pumping**	**20.17261**	squaremeter/day	ΔS	0.8 m
		Depthof well		50 m		
		SWL	4.08 mbmp			
		MP	0.53 magl			

T Recovery	**7.335495**	squaremeter/day	ΔS	2.2 m	
Depthof well		50 m			**lat** **21.8636**
SWL	4.08 mbmp				**long** **84.08983**
MP	0.53 magl				

Time	**DTW**	**DD**	Recovery						
1	7.35	3.27	**t**	**t0**	**t/t0**	**DTW**	**RDD**	t/t0	RDD
2	8.93	4.85	101	1	101	8.1	4.02	101	4.02
3	9.7	5.62	102	2	51	6.86	2.78	51	2.78
4	10.28	6.2	103	3	34.33333	5.93	1.85	34.33333	1.85
5	10.57	6.49	104	4	26	5.61	1.53	26	1.53
6	10.79	6.71	105	5	21	5.41	1.33	21	1.33
7	10.9	6.82	106	6	17.66667	5.25	1.17	17.66667	1.17
8	11.06	6.98	107	7	15.28571	5.17	1.09	15.28571	1.09
9	11	6.92	108	8	13.5	5.06	0.98	13.5	0.98
10	11.06	6.98	109	9	12.11111	4.99	0.91	12.11111	0.91
20	11.33	7.25	110	10	11	7.93	3.85	11	3.85
25	11.43	7.35	112	12	9.333333	4.85	0.77	9.333333	0.77
30	11.5	7.42	114	14	8.142857	4.78	0.7	8.142857	0.7
40	11.58	7.5	116	16	7.25	4.71	0.63	7.25	0.63
50	11.64	7.56	118	18	6.555556	4.64	0.56	6.555556	0.56
60	11.71	7.63	120	20	6	4.6	0.52	6	0.52
70	11.75	7.67	125	25	5	4.53	0.45	5	0.45
80	11.78	7.7	130	30	4.333333	4.47	0.39	4.333333	0.39
100	**11.8**	7.72	140	40	3.5	4.39	0.31	3.5	0.31
			150	50	3	4.33	0.25	3	0.25
			160	60	2.666667	4.3	0.22	2.666667	0.22


Time vs Drawdown plot, Gudigaon village,Jacobs Straight line method
9
8
7
6
5
4
3
2
1
0
1
10
100
D..


t/t0 vs RDD, Gudigaon
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1
10
100
1000
R...

Pumping test data analysis	**H Katapali Village,Jharsuguda**	**Discharge**	**1.0 lps**	**86.4**	**cubicmeter per day**

T

Pumping **39.55414** squaremeter/day ΔS 0.4 m

Depthof well 80 m

6.2

Mbmp MP 0.69

T Recovery **31.64331** squaremeter/day

ΔS 0.5 m

Depthof well 95 m

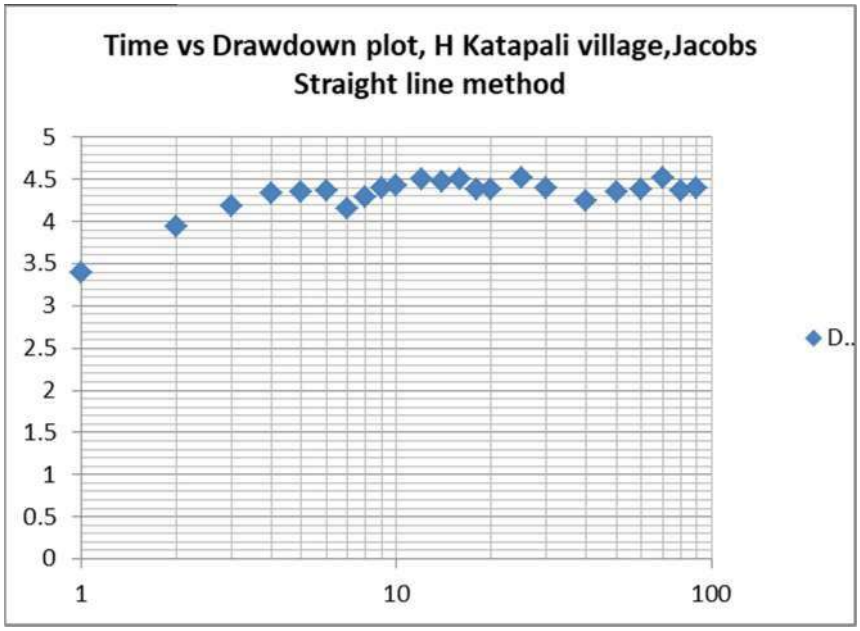
SWL 3.75 mbmp

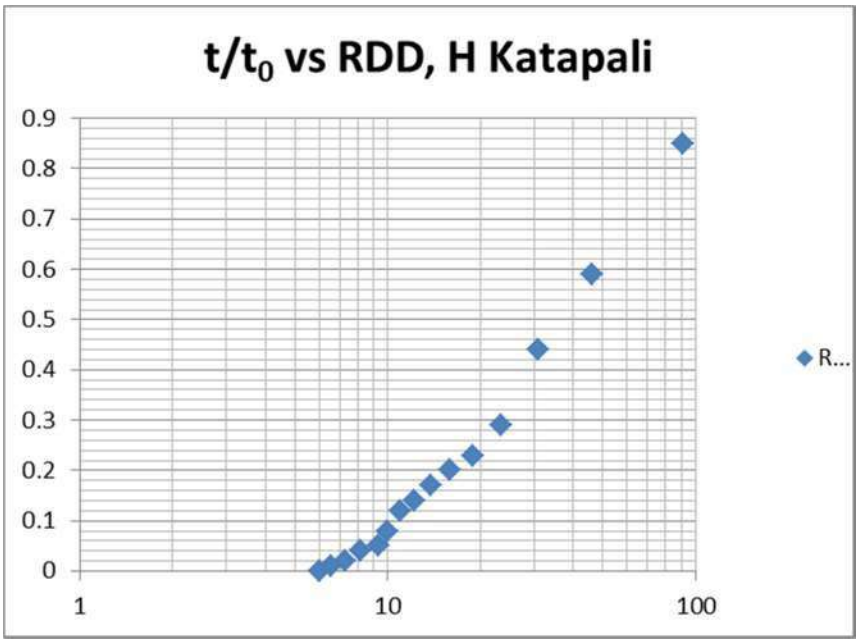
MP 0.5 magl

lat **21.87033**

long **83.96671**

Time	DTW	DD	t	t0	t/t0	DTW	RDD
1	9.6	3.4	91	1	91	7.05	0.85
2	10.14	3.94	92	2	46	6.79	0.59
3	10.38	4.18	93	3	31	6.64	0.44
4	10.53	4.33	94	4	23.5	6.49	0.29
5	10.55	4.35	95	5	19	6.43	0.23
6	10.57	4.37	96	6	16	6.4	0.2
7	10.36	4.16	97	7	13.85714	6.37	0.17
8	10.49	4.29	98	8	12.25	6.34	0.14
9	10.6	4.4	99	9	11	6.32	0.12
10	10.63	4.43	100	10	10	6.28	0.08
12	10.7	4.5	112	12	9.333333	6.25	0.05
14	10.67	4.47	114	14	8.142857	6.24	0.04
16	10.7	4.5	116	16	7.25	6.22	0.02
18	10.59	4.39	118	18	6.555556	6.21	0.01
20	10.58	4.38	120	20	6	6.2	0
25	10.72	4.52					
30	10.6	4.4					
40	10.45	4.25					
50	10.55	4.35					
60	10.59	4.39					
70	10.72	**4.52**					
80	10.56	4.36					
90	10.6	4.4					


Time vs Drawdown plot, H Katapali village,Jacobs Straight line method
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1
10
100
D..


t/t0 vs RDD, H Katapali
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
10
100
R...

Pumping test data analysis Kherual Village, Jharsuguda

Pumping test data analysis	**Kherual Village,Jharsuguda**	**Discharge**	**1.0 lps**	**86.4**	**cubicmeter per day**

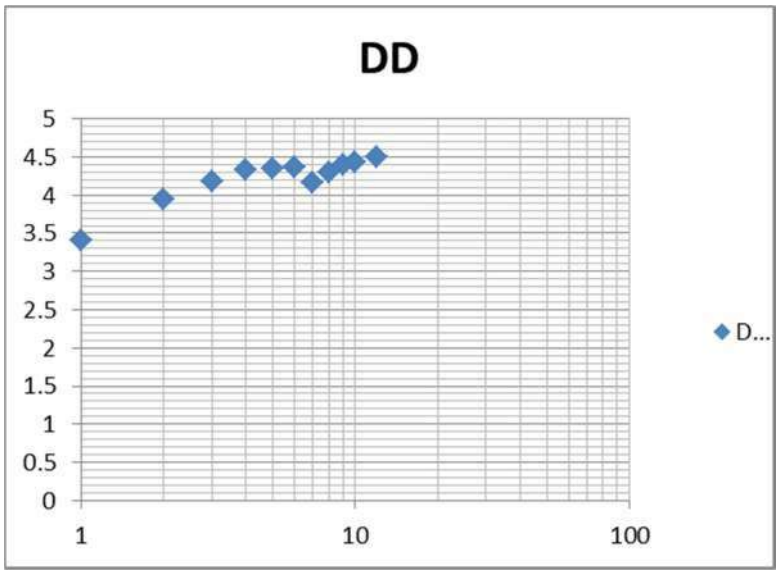
T

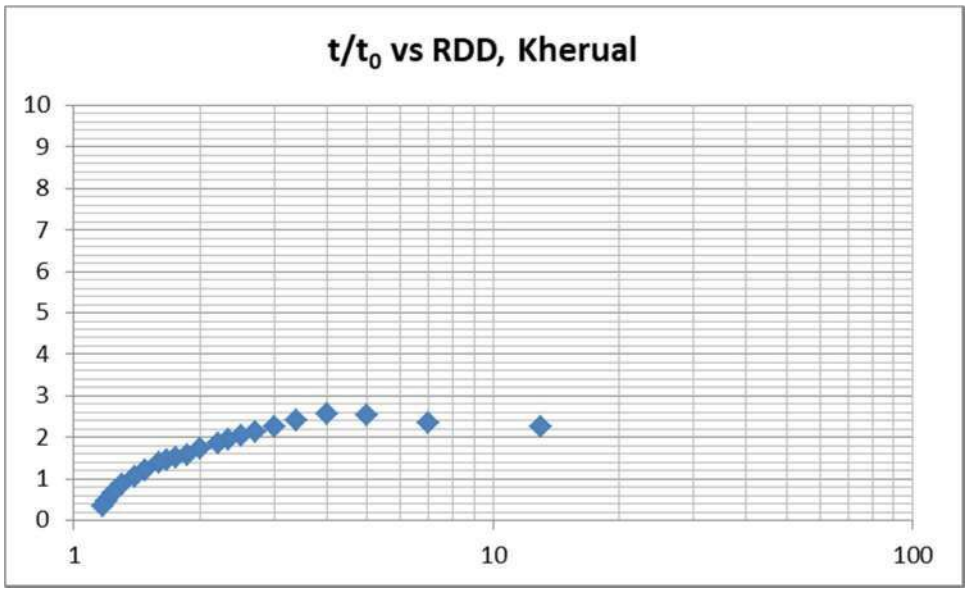
Pumping	**26.36943**	square meter/day	ΔS	0.6 m
Depth of well		80 m		
SWL	4.66 mbmp			
MP	0.5 magl			

T

Recovery	**5.273885**	squaremeter/day	ΔS	3 m		
Depthof well		95 m			**lat**	**21.79449**
SWL	4.66 mbmp				**long**	**84.00604**
MP	0.5 magl					

Time	DTW	DD	t	t0	t/t0	DTW	RDD
1	5.97	1.31	13	1	13	6.92	2.26
2	6.6	1.94	14	2	7	7	2.34
3	6.98	2.32	15	3	5	7.18	2.52
4	7.38	2.72	16	4	4	7.23	2.57
5	7.69	3.03	17	5	3.4	7.06	2.4
6	8	3.34	18	6	3	6.91	2.25
7	8.06	3.4	19	7	2.714286	6.78	2.12
8	8.1	3.44	20	8	2.5	6.7	2.04
9	8.67	4.01	21	9	2.333333	6.6	1.94
10	8.89	4.23	22	10	2.2	6.52	1.86
12	8.99	4.33	24	12	2	6.39	1.73
			26	14	1.857143	6.25	1.59
			28	16	1.75	6.16	1.5
			30	18	1.666667	6.1	1.44
			32	20	1.6	6.04	1.38
			37	25	1.48	5.86	1.2
			42	30	1.4	5.7	1.04
			52	40	1.3	5.53	0.87
			62	50	1.24	5.32	0.66
			72	60	1.2	5.13	0.47
			82	70	1.171429	5	0.34


DD
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1
10
100
D...


t/t0 vs RDD, Kherual
10
9
8
7
6
5
4
3
2
1
0
1
10
100

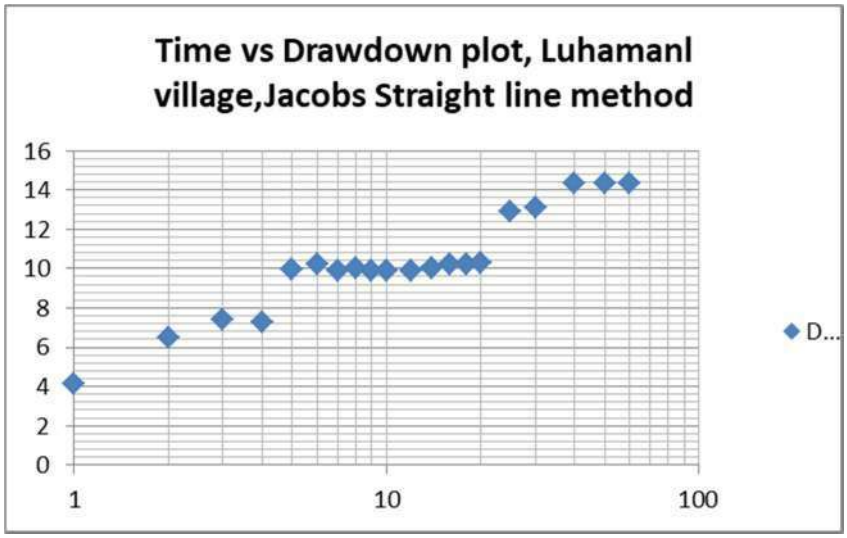
Pumping test data analysis Lohamanl Village,Rengali,Sambalpur

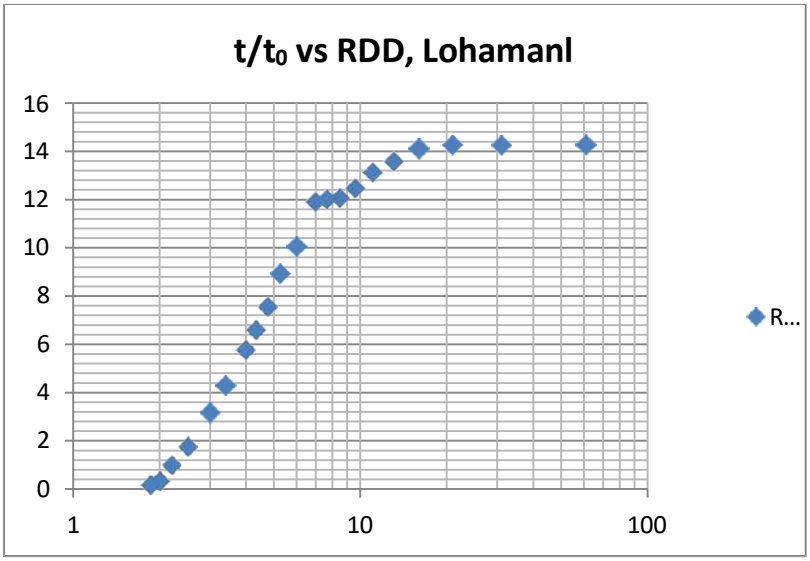
Pumping test data analysis	**Lohamanl Village,Rengali,Sambalpur**	**Discharge**	**1.66 lps**	**143.424**	**cubicmeter per day**

T
Pumping **3.053862** squaremeter/day ΔS 8.6 m
Depthof well 100 m
SWL 3.69 mbmp
MP 0.6 magl

T
Recovery **2.918217** squaremeter/day ΔS 9 m
Depthof well 100 m **lat** **21.70783**
SWL 3.69 mbmp **long** **84.07184**
MP 0.6 magl

Time	DTW	DD	t	t0	t/t0	DTW	RDD
1	7.8	4.11	61	1	61	17.97	14.28
2	10.2	6.51	62	2	31	17.96	14.27
3	11.13	7.44	63	3	21	17.96	14.27
4	11	7.31	64	4	16	17.8	14.11
5	13.63	9.94	65	5	13	17.25	13.56
6	13.92	10.23	66	6	11	16.8	13.11
7	13.6	9.91	67	7	9.571429	16.15	12.46
8	13.7	10.01	68	8	8.5	15.75	12.06
9	13.6	9.91	69	9	7.666667	15.7	12.01
10	13.6	9.91	70	10	7	15.6	11.91
12	13.61	9.92	72	12	6	13.73	10.04
14	13.7	10.01	74	14	5.285714	12.6	8.91
16	13.93	10.24	76	16	4.75	11.25	7.56
18	13.93	10.24	78	18	4.333333	10.3	6.61
20	13.96	10.27	80	20	4	9.49	5.8
25	16.62	12.93	85	25	3.4	8	4.31
30	16.8	13.11	90	30	3	6.85	3.16
40	18	14.31	100	40	2.5	5.45	1.76
50	18	14.31	110	50	2.2	4.7	1.01
60	18	14.31	120	60	2	4.05	0.36
			130	70	1.857143	3.88	0.19


Time vs Drawdown plot, Luhamanl village,Jacobs Straight line method
16
14
12
10
8
6
4
2
0
1
10
100
D...

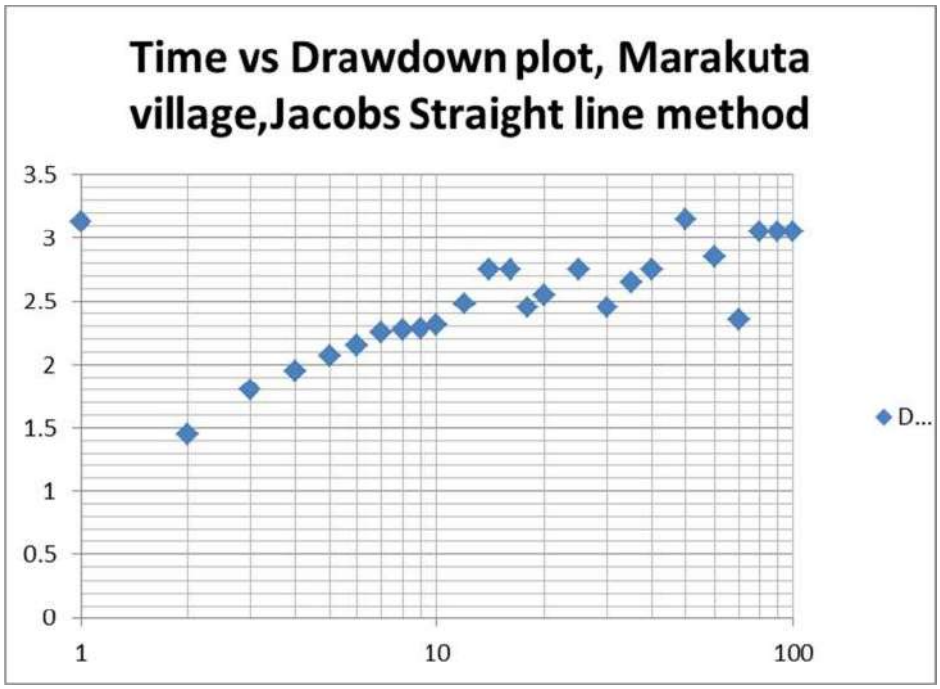

t/t0 vs RDD, Lohamanl
16
14
12
10
8
6
4
2
0
1
10
100
R...

Pumping test data analysis Marakuta Village,Jharsuguda

Pumping test data analysis	**Marakuta Village,Jharsuguda**	**Discharge**	**3.46 lps**	**298.944**	**cubicmeter per day**	

Date	**23.12.23**	**T**	**68.31925**	squaremeter/day	ΔS	0.8 m	
		Depthof well		80 m		**lat**	**21.84237**
		SWL	4.75 mbmp			**long**	**83.97996**
		MP	0.6 magl				

Time	**DTW**	**DD**	Recovery				
1	7.88	3.13	**t**	**t0**	**t/t0**	**DTW**	**RDD**
2	6.2	1.45	101	1	101	6.7	4.98
3	6.55	1.8	102	2	51	7.12	5.4
4	6.7	1.95	103	3	34.33333	4.4	2.68
5	6.82	2.07	104	4	26	5.3	3.58
6	6.9	2.15	105	5	21	5.4	3.68
7	7	2.25	106	6	17.66667	2.11	0.39
8	7.02	2.27	107	7	15.28571	2.13	0.41
9	7.03	2.28	108	8	13.5	2.5	0.78
10	7.06	2.31	109	9	12.11111	2.51	0.79
12	7.23	2.48	110	10	11	2.55	0.83
14	7.5	2.75	112	11	10.18182	2.6	0.88
16	7.5	2.75	114	12	9.5	2.8	0.93
18	7.2	2.45	116	13	8.923077	2.92	1.2
20	7.3	2.55	118	14	8.428571	2.78	1.06
25	7.5	2.75	120	15	8	2.74	1.02
30	7.2	2.45	125	16	7.8125	2.58	0.86
35	7.4	2.65	130	17	7.647059	2.45	0.73
40	7.5	2.75					
50	7.9	3.15					
60	7.6	2.85					
70	7.1	2.35					
80	7.8	3.05					
90	7.8	3.05					
100	**7.8**	3.05					


Time vs Drawdown plot, Marakuta village,Jacobs Straight line method
3.5
3
2.5
2
1.5
1
0.5
0
1
10
100
D...

Pumping test data analysis Nishanbhanga Village,Rengali,Sambalpur

Pumping test data analysis

Nishanbhanga Village,Rengali,Sambalpur Discharge 2 lps 172.8 cubicmeter perday

T

Pumping 13.18471 squaremeter/day ΔS 2.4 m

Depthof well 80 m

SWL 7.00 mbmp

0.45

MP magl

T

Recovery 18.61371 squaremeter/day ΔS 1.7 m

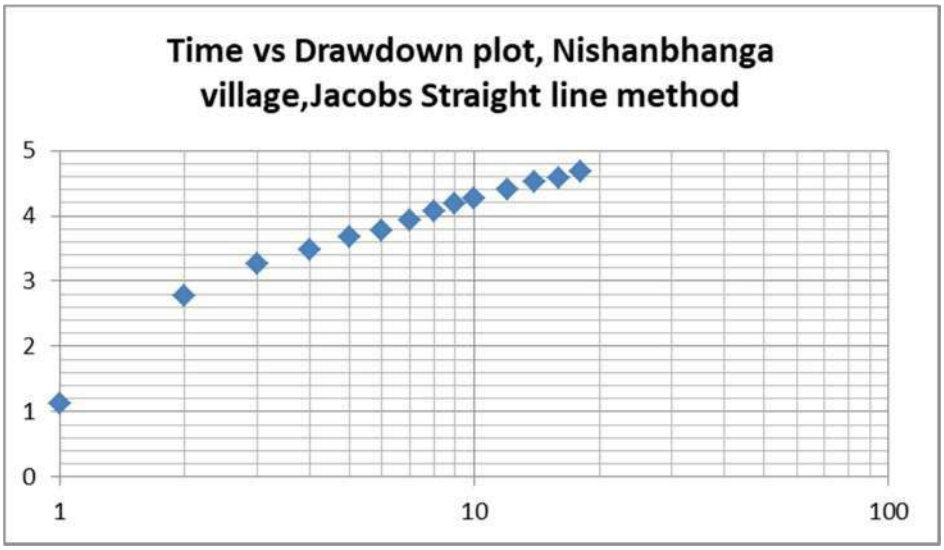
Depthof well 100 m **lat 21.76232**

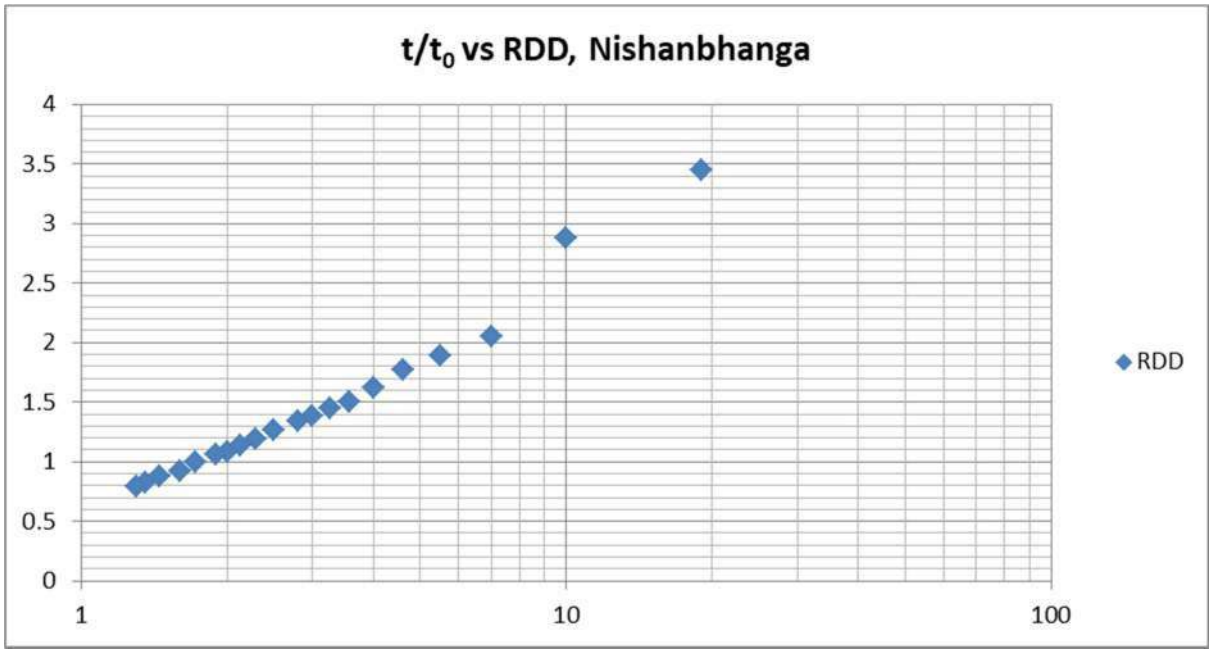
SWL 7.94 mbmp **long 84.10982**

0.45

MP magl

Time	DTW	DD	t	t0	t/t0	DTW	RDD
1	8.12	1.12	19	1	19	10.45	3.45
2	9.78	2.78	20	2	10	9.88	2.88
3	10.27	3.27	21	3	7	9.05	2.05
4	10.48	3.48	22	4	5.5	8.89	1.89
5	10.68	3.68	23	5	4.6	8.77	1.77
6	10.78	3.78	24	6	4	8.62	1.62
7	10.94	3.94	25	7	3.571429	8.5	1.5
8	11.06	4.06	26	8	3.25	8.45	1.45
9	11.18	4.18	27	9	3	8.38	1.38
10	11.26	4.26	28	10	2.8	8.34	1.34
12	11.4	4.4	30	12	2.5	8.27	1.27
14	11.52	4.52	32	14	2.285714	8.19	1.19
16	11.58	4.58	34	16	2.125	8.14	1.14
18	11.67	4.67	36	18	2	8.08	1.08
			38	20	1.9	8.06	1.06
			43	25	1.72	8	1
			48	30	1.6	7.92	0.92
			58	40	1.45	7.88	0.88
			68	50	1.36	7.82	0.82
			78	60	1.3	7.79	0.79


Time vs Drawdown plot, Nishanbhanga village,Jacobs Straight line method
5
4
3
2
1
0
1
10
100


t/t0 vs RDD, Nishanbhanga
4
3.5
3
2.5
2
1.5
1
0.5
0
1
10
100
RDD

Pumping test data analysis Parmanpur village, Jharsuguda

Discharge 1.0 lps 86.4 cubicmeter per day

Date 24.12.23

T

Pumping 3.102286 squaremeter/day ΔS 5.1 m Depthof well 95 m

SWL

MP

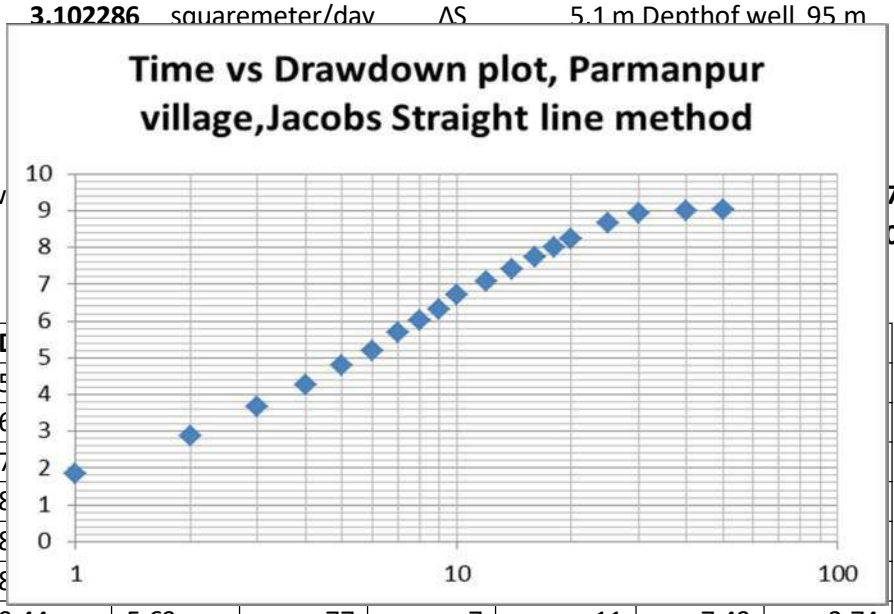
T

Recovery

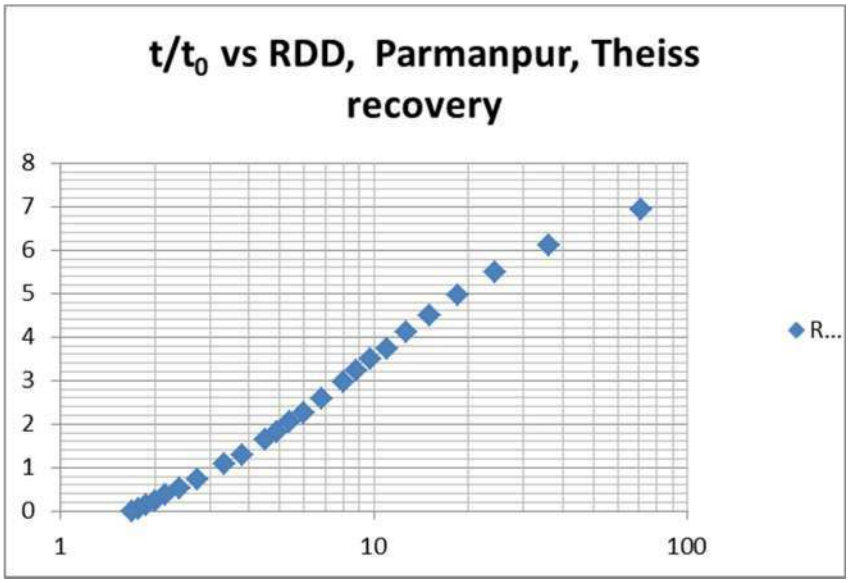
Depthof w **747**

SWL **002**

MP



Time	D						
1	5						
2	6						
3	7						
4	8						
5	8						
6	8						
7	9.44	5.69	77	7	11	7.49	3.74
8	9.78	6.03	78	8	9.75	7.23	3.48
9	10.07	6.32	79	9	8.777778	6.98	3.23
10	10.47	6.72	80	10	8	6.71	2.96
12	10.82	7.07	82	12	6.833333	6.34	2.59
14	11.16	7.41	84	14	6	6.02	2.27
16	11.49	7.74	86	16	5.375	5.79	2.04
18	11.74	7.99	88	18	4.888889	5.57	1.82
20	11.99	8.24	90	20	4.5	5.39	1.64
25	12.42	8.67	95	25	3.8	5.05	1.3
30	12.68	8.93	100	30	3.333333	4.82	1.07
40	12.76	9.01	110	40	2.75	4.48	0.73
50	12.78	**9.03**	120	50	2.4	4.27	0.52
			130	60	2.166667	4.12	0.37
			140	70	2	3.98	0.23
			150	80	1.875	3.88	0.13
			160	90	1.777778	3.8	0.05
			170	100	1.7	3.75	0


t/t0 vs RDD, Parmanpur, Theiss recovery
8
7
6
5
4
3
2
1
0
1
10
100
R...

Pumping test data analysis Turitikra Village,Rengali,Sambalpur

Pumping test data analysis	**Turitikra Village,Rengali,Sambalpur**	**Discharge**	**0.33 lps**	**28.512**	**cubicmeter per day**

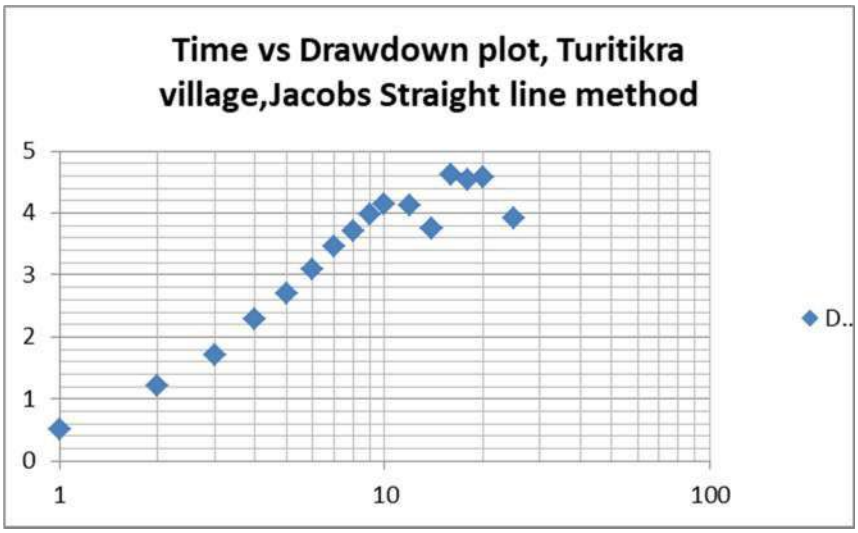
T

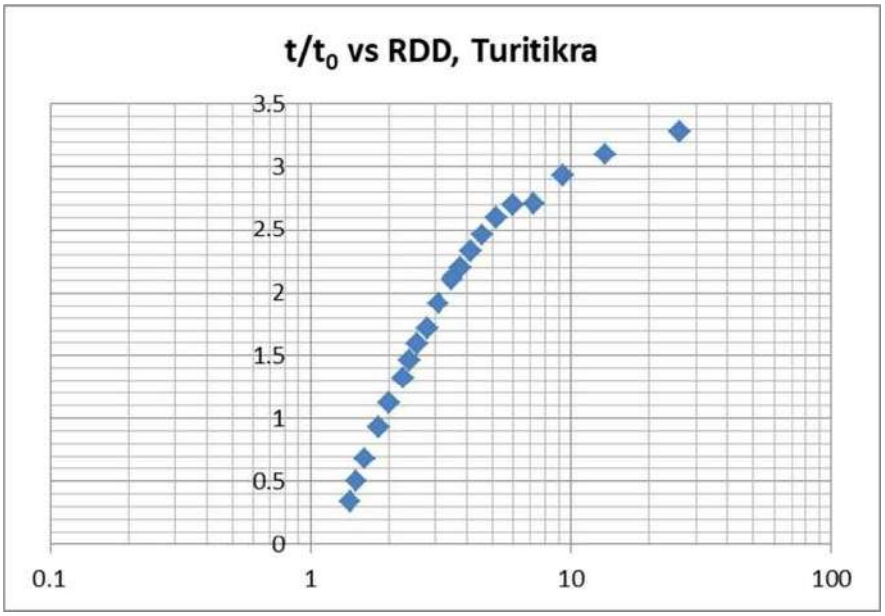
Pumping	**1.631608**	squaremeter/day	ΔS	3.2 m
Depthof well		80 m		
	2.4			
SWL	mbmp			
MP	0.7 magl			

T

Recovery	**1.684241**	squaremeter/day	ΔS	3.1 m		
Depthof well		100 m			**lat**	**21.62963**
	2.4					
SWL	mbmp				**long**	**84.01548**
MP	0.7 magl					

Time	DTW	DD	t	t0	t/t0	DTW	RDD
1	2.92	0.52	26	1	26	5.68	3.28
2	3.61	1.21	27	2	13.5	5.5	3.1
3	4.11	1.71	28	3	9.333333	5.33	2.93
4	4.69	2.29	29	4	7.25	5.11	2.71
5	5.1	2.7	30	5	6	5.1	2.7
6	5.5	3.1	31	6	5.166667	5	2.6
7	5.87	3.47	32	7	4.571429	4.86	2.46
8	6.11	3.71	33	8	4.125	4.73	2.33
9	6.37	3.97	34	9	3.777778	4.6	2.2
10	6.54	4.14	35	10	3.5	4.51	2.11
12	6.53	4.13	37	12	3.083333	4.32	1.92
14	6.15	3.75	39	14	2.785714	4.12	1.72
16	7.02	4.62	41	16	2.5625	3.99	1.59
18	6.93	4.53	43	18	2.388889	3.86	1.46
20	6.97	4.57	45	20	2.25	3.72	1.32
25	6.32	3.92	50	25	2	3.52	1.12
			55	30	1.833333	3.33	0.93
			65	40	1.625	3.08	0.68
			75	50	1.5	2.9	0.5
			85	60	1.416667	2.74	0.34


Time vs Drawdown plot, Turitikra village,Jacobs Straight line method
5
4
3
2
1
0
1
10
100
D..


t/t0 vs RDD, Turitikra
3.5
3
2.5
2
1.5
1
0.5
0
0.1
1
10
100

Tentative Location of Rainwater Harvesting Structure in Jharsuguda, NAQUIM 2.0 Study

Id	Latitude	Longitude
1	21.87080	84.02490
2	21.87320	84.02440
3	21.87510	84.02530
4	21.87640	84.02550
5	21.87740	84.02630
6	21.87830	84.02720
7	21.88000	84.02840
8	21.88290	84.02850
9	21.88660	84.02850
10	21.89100	84.02600
11	21.88510	84.02310
12	21.88200	84.02430
13	21.88080	84.01910
14	21.87880	84.02360
15	21.87780	84.01740
16	21.87690	84.02150
17	21.87580	84.02380
18	21.87440	84.02390
19	21.87370	84.02150
20	21.88660	84.02040

Tentative Location of Farm Pond in Jharsuguda, NAQUIM 2.0 Study

Id	Latitude	Longitude
1	21.91990	84.00870
2	21.91680	84.00560
3	21.91690	84.01030
4	21.91130	84.00420
5	21.90600	84.00540
6	21.91420	84.00960
7	21.90210	84.00510
8	21.90220	84.00860
9	21.91070	84.01800
10	21.91210	84.01160
11	21.89690	84.00700
12	21.89260	84.00790
13	21.90470	84.01700
14	21.90170	84.01590
15	21.89700	84.01910
16	21.90280	84.02290

17	21.89280	84.02290
18	21.90080	84.02020
19	21.89760	84.02280
20	21.89650	84.01170
21	21.89220	84.01190
22	21.89560	84.02490
23	21.89460	84.02900
24	21.89830	84.02880
25	21.89020	84.03470
26	21.89920	84.04280
27	21.89840	84.04560
28	21.90120	84.01310
29	21.91480	84.00440
30	21.91200	84.00770
31	21.92000	84.00680
32	21.91720	84.00780
33	21.90980	84.00330
34	21.90700	84.00880
35	21.90660	84.00740
36	21.90490	84.00660
37	21.90400	84.00520
38	21.89940	84.00600
39	21.90120	84.00720
40	21.88820	84.01190
41	21.89580	84.02120
42	21.90430	84.01050
43	21.90010	84.00990
44	21.89850	84.02070
45	21.89740	84.02840
46	21.89620	84.02860
47	21.89650	84.02630
48	21.87360	84.02820
49	21.87560	84.02700
50	21.87740	84.02850
51	21.88030	84.02970
52	21.87310	84.03600
53	21.87670	84.03530
54	21.87520	84.03180
55	21.87410	84.03440
56	21.88150	84.03530
57	21.88140	84.03190
58	21.87440	84.04470
59	21.87570	84.04830
60	21.87980	84.03950
61	21.88150	84.04600

62	21.87010	84.03880
63	21.86650	84.04110
64	21.86510	84.04010
65	21.87710	84.04450
66	21.87600	84.05240
67	21.87360	84.04750
68	21.88060	84.05280
69	21.88160	84.05150
70	21.88320	84.04920
71	21.88630	84.05430
72	21.88810	84.05430
73	21.88260	84.05470
74	21.89100	84.06210
75	21.89230	84.06050
76	21.89410	84.05950
77	21.89740	84.05960
78	21.89580	84.05730
79	21.89690	84.05520
80	21.89800	84.05030
81	21.90210	84.06450
82	21.90280	84.06340
83	21.90360	84.06170
84	21.90470	84.06030
85	21.90660	84.06250
86	21.90540	84.06370
87	21.90660	84.06720
88	21.90550	84.06950
89	21.90430	84.07020
90	21.90610	84.06830
91	21.90400	84.06300
92	21.90450	84.05850
93	21.90430	84.05690
94	21.90430	84.05370
95	21.90360	84.05160
96	21.90360	84.04830
97	21.90420	84.04480
98	21.90660	84.04780
99	21.90710	84.04950
100	21.90730	84.05130
101	21.90830	84.05330
102	21.90950	84.05480
103	21.90950	84.05670
104	21.91120	84.05580
105	21.91190	84.05800
106	21.91110	84.06030

107	21.91070	84.06220
108	21.91070	84.05910
109	21.87490	84.02620
110	21.87340	84.02660
111	21.87460	84.02800
112	21.87570	84.02940
113	21.87930	84.02940
114	21.87400	84.03160
115	21.87540	84.03540
116	21.88340	84.03420
117	21.87830	84.04060
118	21.87820	84.03570
119	21.87090	84.03800
120	21.87430	84.03580
121	21.88080	84.04330
122	21.88030	84.04480
123	21.88220	84.04660
124	21.88140	84.04710
125	21.88340	84.05030
126	21.88410	84.05170
127	21.88140	84.05370
128	21.88100	84.05500
129	21.88020	84.05440
130	21.88340	84.05160
131	21.87090	84.03420
132	21.87230	84.03430
133	21.87610	84.03360
134	21.87790	84.03380
135	21.87230	84.03780
136	21.87190	84.03640
137	21.86780	84.03940
138	21.86800	84.04550
139	21.86930	84.04720
140	21.87040	84.04100
141	21.91290	84.04450
142	21.89330	84.05220
143	21.89020	84.05350
144	21.90410	84.06500
145	21.90030	84.06700
146	21.88880	84.04520
147	21.89270	84.02050
148	21.89760	84.01660
149	21.88690	84.00970
150	21.88300	84.01580

Farmers Feedback

village / GP - katikela - 1 (Mega Oil Project is there)
Thorupada

Annexu

Farmer Feedback Form

Name	NARENDRA NAIK
Village	KATIKELA
Block	JHARSUGUDA
District	JHARSUGUDA
Address	katikela
Mobile Number (optional)	9937910062

Type and number of structures	
Type	Dugwell (30 feet)
Number	1 nos.
(coordinates of the structures are to be obtained by the field officer)	Lat - 21° 46' 57" Longi - 84° 4' 43"
Drill time discharge (lps)	
Depth of installation of pump	
Casing depth (Bore wells) HR	
Fracture encountered depth-HR	
Slotted pipe depths (TW) SR	
Average water levels – pre-monsoon	24 feet
Average water levels – post-monsoon	1 feet
The well is used for	Agriculture + Domestic
Is water available throughoutthe year	Yes.
If not for how many monthswater is available	

Pumping Duration	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	3-4 days interval	2hrs	
Kharif (no of months to be specified)			
Others (no of months to be specified)	Daily	3Hrs.	

Area Irrigated	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	0.50 Ac	Vegetable	
Khariff (no of months to be specified)	0.50 Ac + 1.80 Ac.	Vegetable + Maize + millets - paddy	
Others (no of months to be specified)	0.5 Ac	Vegetables	

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	paddy Til	Mustard	
Area under crop	410 15	10	
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	paddy Til	Must	
Area under crop	310 5	2	
Reasons for change in cropping pattern in last 20years.	Area decreases day by day due to Industrialization		
If the cropping pattern is to be changed, which are the suitable crops that can be grown	Ragi Til		
Available Market for the crop	yes		
Average unit cost of production			
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected	paddy Rs-2300/q Ragi 3500/q	
Other subsidies, facilities, restrictions.	farm meehanised 40 to 50% Subsidy		
Source of Energy			
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif-250/— ○ During Rabi---350/—		
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif ○ During Rabi		
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)		
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		
- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.			

* Desl effected Area
decreases day by day due to Indus

(2)

Farmer Feedback Form

Name	SHIVSHANKAR SAHU		
Village	JAMUAPALI		
Block	JSG		
District	JSG		
Address	Near Pani Tanki		
Mobile Number (optional)	8018421428		
Type and number of structures			
Type	BW (450ft)	DW (27ft)	Pond (10ft)
Number	1	2	1
(coordinates of the structures are to be obtained by the field officer)			
Drill time discharge (lps)			
Depth of installation of pump	200ft		
Casing depth (Bore wells) HR			
Fracture encountered depth-HR	250ft		
Slotted pipe depths (TW) SR			
Average water levels – pre-monsoon		29ft	10ft
Average water levels – post-monsoon		12ft	7ft
The well is used for	Irrigation	Domestic + Irrigation	Irrigation
Is water available throughoutthe year	Shortage	Shortage	Shortage
If not for how many monthswater is available	April - June 10/30 min → Entire year		

Pumping Duration			
	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	2 days interval	3-4 hrs	
Kharif (no of months to be specified)	———		
Others (no of months to be specified)			

Area Irrigated			
	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1 Acre	Sarso, Moong No vegetable	
Khariff (no of months to be specified)	1½ Acre	Paddy	Rainfed
Others (no of months to be specified)	~~1 Acre~~		

(1)

Annexure -III

Farmer Feedback Form

Photograph		
Name	SAHADEV MEHER	
Village	Kelendo	
Block		
District		
Address	Meherpada	
Mobile Number (optional)	7873752409	
Type and number of structures	BW (personal), DW, Pond (other do), Rainfed	
Type	BW (~~250 ft~~ 300 ft)	DW (25 ft)
Number	1	1
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)		
Depth of installation of pump	270 ft	
Casing depth (Bore wells) HR	80 ft	
Fracture encountered depth-HR	100 ft	
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		25 ft
Average water levels – post-monsoon		10 ft
The well is used for	Irrigation, Domestic	Irrigation, Domestic
Is water available throughoutthe year	No	No
If not for how many monthswater is available	May → 1/2 hr pump then 1 to 2 hr to recover	

Pumping Duration	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	3-4 days interval	2-3 hrs	1.01 lps (1.5 HP)
Kharif (no of months to be specified)			
Others (no of months to be specified)			

Area Irrigated	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	0.5 Acre	~~Mixed~~,	
Khariff (no of months to be specified)	5 Acre	Paddy, Muli (Kuratu, Vegetable (September)	
Others (no of months to be specified)	~~0.5~~		

Crops - Paddy, Gobi, Bhindi, Muli, Kuratu, Kal, Til

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	Sugarcane	Mirch, Baigan (Vegetables destroyed due to pollution)	
Area under crop			
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	Paddy		
Area under crop	400 hectare		
Reasons for change in cropping pattern in last 20years.	- ↓ water - ↑ Air pollution; Dust on crops destroys it.		
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop			
Average unit cost of production	15000/acre		
Average unit cost of selling	22000/acre		
Existing MSP and other related information	Crop wise details are to be collected		
Other subsidies, facilities, restrictions.			
Source of Energy			
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---- 800-900 / Month ○ During Rabi----- 1500-1800 / Month		
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif ○ During Rabi		
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)		
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		

- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.

Problems - Not much paddy ∵ water is less. Paddy is more in Sambalpur area due to Dam
- 7 Star Steel industry takes water from Nala & has 600-700

(1)

Annexure -III

Farmer Feedback Form

Photograph		
Name	BEBRYAS PRADHAN	
Village	Jammal	
Block	Keldamal	
District		
Address	Near Kirtan Mandap	
Mobile Number (optional)	9937280120	
Type and number of structures	Pond, DW, Nala	
Type		DW
Number		1 (30 ft)
(coordinates of the structures are to be obtained by the field officer)		✓
Drill time discharge (lps)		
Depth of installation of pump		
Casing depth (Bore wells) HR		
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		30 ft (June)
Average water levels – post-monsoon		4-5 ft (Oct)
The well is used for		Domestic
Is water available throughoutthe year		
If not for how many monthswater is available		

Pumping Duration

	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	Weekly 3 pumps per 4-5 days	5-6 hrs	
Kharif (no of months to be specified)			
Others (no of months to be specified)			

Area Irrigated

	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1 Acre	Moong Dal	
Khariff (no of months to be specified)	10 Acre (June - Sept.)	Paddy, Urad & Vegetables	
Others (no of months to be specified)		Kurtath (September)	Used to be done ~~before~~ 10-15 yrs earlier Now water is not

Crops - Moong Dal, Biri (Urad Dal)

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop			Vegetable, Sunflower
Area under crop			Mustard
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	Paddy + vegetable	Vegetable	None
Area under crop	150 hectare	4 hectare	
Reasons for change in cropping pattern in last 20years.	Same as	Khunapali	
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop			
Average unit cost of production	15000/acre	20000/acre ↑Due to diesel & pesticides	
Average unit cost of selling	40000/acre	Market Dependent	
Existing MSP and other related information	Crop wise details are to be collected Paddy - 2140/Quintal; Kurthi - 6000 Biri, Dal - 8500/Quintal; Moong - 9000/Quintal		
Other subsidies, facilities, restrictions.			
Source of Energy			
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---- ○ During Rabi-----		
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif No. ○ During Rabi 25 L/month; sunny day 30L/month		
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)		
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		
- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.			

Problems - Subsidy from block received after on-season (Eg:- Seeds, Pesticides, Fertilizer)
- Water Supply & Lift irrigation problem.
- Lift point should be placed near Nala; Check Dam has been made at various points.

(2)

Annexure -III

Farmer Feedback Form

		Photograph
Name	JAYANAND HARIDAS	
Village	Gudigaon	
Block		
District		
Address		
Mobile Number (optional)	(personal) 9777337434	
Type and number of structures	4 BW (2+2 OLIC), 1 DW, Pond (Personal)	
Type	BW (350 ft)	DW (32 ft)
Number	4 (only 2 working)	
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)	200 L / 25 sec	
Depth of installation of pump	250, 200	
Casing depth (Bore wells) HR	60, 40	
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		32 ft
Average water levels – post-monsoon		2 ft
The well is used for	Irrigation	Irrigation
Is water available throughoutthe year	Yes	NO
If not for how many monthswater is available		

Pumping Duration			
	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	Every day	3 hrs	1.5 lps
Kharif (no of months to be specified)			
Others (no of months to be specified)	Every day	3 hrs	1.5 lps

(1) BW (2) BW → pond → Irrigation

Area Irrigated			
	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	13 Acre	Green Vegetable	
Khariff (no of months to be specified)	17 Acre		
Others (no of months to be specified)	13 Acre	Green veg.	

Paddy - [illegible], Parbati (1.5), khira 1 (acre) — kharrif

(2)

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop			
Area under crop			
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	Paddy	~~Other Millets~~	
Area under crop	500 hectare	100 hectare	
Reasons for change in cropping pattern in last 20years.			
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop			
Average unit cost of production	Gobi-> 50000 (100000) Paddy-> 15000-20000 (40000)	15000 (35000)	
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected 2140 / Quintal ← Paddy (Earlier 1440)		
Other subsidies, facilities, restrictions.			
Source of Energy			
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---- ₹500 / Month ○ During Rabi----- 3500 / Month		
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif ○ During Rabi		
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)		
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		
- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.			

Problem - Give LI expert.

(1)

Annexure -III

Farmer Feedback Form

Photograph		
Name	YUDISHTHIR SAHOO	
Village	Khunapali	
Block	Keldamal	
District		
Address		
Mobile Number (optional)	9178264009	
Type and number of structures	Pond (Major), ~~Tank~~ (shared) DW	
Type	Pond	DW (only domestic)
Number	1	1 (25 ft)
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)		
Depth of installation of pump		
Casing depth (Bore wells) HR		
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		25 ft
Average water levels – post-monsoon		18 ft
The well is used for	Irrigation	Domestic
Is water available throughoutthe year		No
If not for how many monthswater is available		March - May

Pumping Duration

	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)			
Kharif (no of months to be specified)			
Others (no of months to be specified)			

Area Irrigated

	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1-1.5 Acre (No water)	Vegetable	Summer Plan for next 2 months
Khariff (no of months to be specified)	10 Acre (Depends on Rain)	Paddy	
Others (no of months to be specified)	0.5 Acre	Bhindi, Barbatti	

Crops - Paddy, Tomato, Bhindi, Baigan, Lauki, Gobi, Dhaniya Pat

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	Sugarcane	Vegetables	Stopped due to less water & Elephant
Area under crop			
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	Paddy	Vegetables	Vegetables
Area under crop	>300 hectare	1 hectare (v. less water)	
Reasons for change in cropping pattern in last 20years.	- Less water - Elephant	- Small factory taking water	(Sponge Iron Jai Hanuman Cable plant, Sobha Kasal Chem, Chem.) Bricks, 7 Star Sponge iron
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop	Parmanpur Society	Local market Jharsuguda	
Average unit cost of production	15000/Acre		
Average unit cost of selling	15000/Acre		
Existing MSP and other related information	Crop wise details are to be collected 2140/Quintal Paddy		
Other subsidies, facilities, restrictions.			
Source of Energy			
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---- ○ During Rabi-----		
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif No ○ During Rabi 20-25L		
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)		
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		

- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.

Problems - Elephant & Pig eat farm produce. Pig eats rooted plants (potato, saru, mash, etc.) ∴ farmer doesn't produce there.
- No input subsidy (insurance)

(1)

Annexure -III

Farmer Feedback Form

Photograph		
Name	KSHYAMASHILA NAIK	
Village	Jiriapali	
Block	Parlakhemundi	
District		
Address	Near Mandap	
Mobile Number (optional)	9348319612	
Type and number of structures	3 (BW, DW, Stream) ← Pump from OWC	
Type	BW (2018)	DW
Number	1 (500 ft)	1 (30 ft)
(coordinates of the structures are to be obtained by the field officer)	1.5 km far Inaccessible	
Drill time discharge (lps)		
Depth of installation of pump	70 m (210 ft)	
Casing depth (Bore wells) HR	80-90 ft	
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		30 ft
Average water levels – post-monsoon		10 ft
The well is used for	Irrigation	Irrigation
Is water available throughoutthe year	Gets dry after 30 min of pumping	NO
If not for how many monthswater is available		(Mar - Apr - May) 9 months

Pumping Duration

	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	30 days (10-12 days/Month)	2 hrs	
Kharif (no of months to be specified)	10 days (Rainfed)	1-2 hrs	
Others (no of months to be specified)	45 days (Rain for other days)	2 hrs	

Area Irrigated

	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	~~3 acre (3×1)~~ 1 acre	Vegetable	
Khariff (no of months to be specified)	3 acre + 1 acre	Paddy, Til, Vegetables	
Others (no of months to be specified)	1 acre	Vegetables	

Crops - Paddy, Muli, Bhindi, Tamatar, Lauki, Cauliflower

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	Mostly paddy		
Area under crop			
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	Paddy	Dhaniya, Patta, Gai bhadi, Mudi	Vegetable
Area under crop			
Reasons for change in cropping pattern in last 20years.	Dhania Patta, Mudi, etc. are sold in market in every 20-30 days (Except March - Sept.) (∴ Adopted with market demand ∴ need change)		period due to market demand near to Town)
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop	Jharsuguda & Society	Jharsuguda	Jharsuguda (Daily Market)
Average unit cost of production	~~30~~ 13000/acre	22000/acre	22000/acre
Average unit cost of selling	30000/acre	45000/acre	45000/acre
Existing MSP and other related information	Crop wise details are to be collected 1940		
Other subsidies, facilities, restrictions.	Fertilizer, Seed, Medicine (Pesticide), Machine RW (OLIC)		

Source of Energy	
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)
Electric	○ Do you get free electricity for irrigation? NO ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---- 300-500/monthly ○ During Rabi----- 400-500/monthly
Diesel	○ Average consumption of diesel (liters) per month ~~100~~ 15L ○ During Kharif 10L ○ During Rabi 20L
Water Market*	○ Do you share the pumped water with other farmers ○ If yes Pumped water from stream (OLIC) is shared by farmers (50 acre) ○ For how many days do you share pumped water in Kharif 20 hours ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc Low water level, No health issue

- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.

Kshyamashila Naik

(2)

Annexure -III

Farmer Feedback Form

Name	DILESHWAR MEHER	
Village	KHERUAL	
Block	JSG	
District	JSG	
Address	NEAR SAMLESWARI TEMPLE	
Mobile Number (optional)	8917344386	
Type and number of structures		
Type	DW (30 ft)	
Number	1	
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)		
Depth of installation of pump		
Casing depth (Bore wells) HR		
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon	28 ft (June)	
Average water levels – post-monsoon	3 ft	
The well is used for	Irrigation + Domestic	
Is water available throughoutthe year	No	
If not for how many monthswater is available	Shortage during Summer	

Pumping Duration	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	Daily	3-4 hrs	
Kharif (no of months to be specified)			
Others (no of months to be specified)			

Area Irrigated	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	0.5 Acre		
Khariff (no of months to be specified)	2.5 Acre		
Others (no of months to be specified)	0.5 Acre		

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop			
Area under crop			
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop			
Area under crop			
Reasons for change in cropping pattern in last 20years.	LI point near Khenual Bridge is defunct since 30years		
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop	Tripura Society		
Average unit cost of production			
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected		
Other subsidies, facilities, restrictions.			
Source of Energy			
Solar	o Is it connected to grid o If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric	o Do you get free electricity for irrigation? o Do you pay a fixed charge o If a fixed charge is paid, what is the per month charge o If unit-based charges are paid what is the average monthlycharges in rupees o During kharif---- o During Rabi-----		
Diesel	o Average consumption of diesel (liters) per month o During Kharif o During Rabi 1000/month		
Water Market*	o Do you share the pumped water with other farmers o If yes o For how many days do you share pumped water in Kharif o For how many days do you share pumped water in RabiPeriod o On an average how much do you charge per annum (in Rs)		
	o Do you receive additional water from boreholes of nearbyfarmers o If yes o For how many days do you receive pumped water in Kharif o For how many days do you receive pumped water in RabiPeriod o On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		
- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.			

Problems - Cauliflower production affected due to dust.

(1) village/GP Dalki

Jharsuguda

Annexure -III

Farmer Feedback Form

Name	LOKESWAR PATEL
Village	DALKI
Block	JHARSUGUDA
District	JHARSUGUDA
Address	NEAR UGME SCHOOL
Mobile Number (optional)	9556688804

Type and number of structures		
Type	DUGWELL (30ft)	POND
Number	1nos	1nos
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)		
Depth of installation of pump		
Casing depth (Bore wells) HR		
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon	9 feet	3 feet
Average water levels – post-monsoon	25 feet	10 feet
The well is used for	Agriculture & Domestic	Agriculture
Is water available throughoutthe year	Yes	Yes
If not for how many monthswater is available		

Pumping Duration	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)			
Kharif (no of months to be specified)			
Others (no of months to be specified)			

Area Irrigated	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	0.6 Acre	Vegetables	
Khariff (no of months to be specified)	0.2.6 Acre	Paddy + Vegetable	
Others (no of months to be specified)	0.6 Acre	Vegetable	

(Kharif) Rabi Summer

Sugarcane
Paddy
Sweet Potato

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	Paddy + Vegetable	Vegetable, Mw	Vegetable, Sugarcane
Area under crop	6 Acre	8 Acre	6 Acre
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	Paddy, Ragi	vegetab	vegetab
Area under crop	54 5	6	3
Reasons for change in cropping pattern in last 20years.	Due to effected area		
If the cropping pattern is to be changed, which are the suitable crops that can be grown	Ragi		
Available Market for the crop	yes		
Average unit cost of production			
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected	paddy Rs2300/Q Ragi Rs3500/Q	
Other subsidies, facilities, restrictions.	DBT Input Farm mechanism	40 to 50% subsidy	

Source of Energy	
Solar	o Is it connected to grid o If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)
Electric	o Do you get free electricity for irrigation? o Do you pay a fixed charge o If a fixed charge is paid, what is the per month charge o If unit-based charges are paid what is the average monthlycharges in rupees o During kharif-200/- o During Rabi---300/-
Diesel	o Average consumption of diesel (liters) per month o During Kharif o During Rabi
Water Market*	o Do you share the pumped water with other farmers o If yes o For how many days do you share pumped water in Kharif o For how many days do you share pumped water in RabiPeriod o On an average how much do you charge per annum (in Rs)
	o Do you receive additional water from boreholes of nearbyfarmers o If yes o For how many days do you receive pumped water in Kharif o For how many days do you receive pumped water in RabiPeriod o On an average how much do you pay per annum (in Rs)
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc

- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.

20-30 years ago, the entire village was covered by 3 major crops crops like Paddy, Sugarcane & Sweet potato, But Now these crops are decreasing day by day due to shortage of water, elephant & monkey

Dalki GP. village - ~~Pooma~~ Kumudapali

1

Annexure

Farmer Feedback Form

Phot

Name	Hemraj Sandha
Village	KUMUDA PALI
Block	JHARSUGUDA
District	JHARSUGUDA
Address	KUMUDAPALI
Mobile Number (optional)	7008042424
Type and number of structures	
Type	Dugwell (3ofi)
Number	1
(coordinates of the structures are to be obtained by the field officer)	21.835019° 84.062643°
Drill time discharge (lps)	
Depth of installation of pump	
Casing depth (Bore wells) HR	
Fracture encountered depth-HR	
Slotted pipe depths (TW) SR	
Average water levels – pre-monsoon	28 ft
Average water levels – post-monsoon	12 ft
The well is used for	Irrigation + Domestic
Is water available throughoutthe year	Shortage
If not for how many monthswater is available	

Pumping Duration	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	3-4 days per week	2-3 hrs	
Kharif (no of months to be specified)			
Others (no of months to be specified)			

Area Irrigated	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1 Acre	Vegetable	
Khariff (no of months to be specified)	2 Acre	Paddy Vegetable	Rainfed
Others (no of months to be specified)	0.30 Acre	Bhindi,	

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	Paddy, Sugar	Turmeric, Sunflower	
Area under crop	70	2 10	
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	paddy,	Maize	
Area under crop	60	2	
Reasons for change in cropping pattern in last 20years.	wild animal attack	Industrial Dust	
If the cropping pattern is to be changed, which are the suitable crops that can be grown	Ragi		
Available Market for the crop	yes		
Average unit cost of production			
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected		paddy Rs 2300/Q Ragi 3500/Q
Other subsidies, facilities, restrictions.	Farm Mechanised 40 to 50% subsidy		

Source of Energy	
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---- ○ During Rabi----- 300–400 / month
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif ○ During Rabi
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc
- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.	

Problems - Industrial Dust, Wild life problem

village - Purna - 1

GP Dalki

Annext

Farmer Feedback Form Tharsuguda

Ph

Name	Sreepriya Pandey		
Village	Purna		
Block	Tharsuguda		
District	Tharsuguda		
Address	Purna		
Mobile Number (optional)	8249988650		
Type and number of structures			
Type	Deepwell 35 Feet		
Number	1		
(coordinates of the structures are to be obtained by the field officer)	Lat - 21° 50' 39" Long - 84° 3' 15"		
Drill time discharge (lps)			
Depth of installation of pump			
Casing depth (Bore wells) HR			
Fracture encountered depth-HR			
Slotted pipe depths (TW) SR			
Average water levels – pre-monsoon	30 Feet		
Average water levels – post-monsoon	15 Feet		
The well is used for	Agriculture + Domestic		
Is water available throughoutthe year	yes		
If not for how many monthswater is available			

Pumping Duration			
	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	3-4 days	2 hrs	
Kharif (no of months to be specified)			
Others (no of months to be specified)	Daily	3 hrs	

Area Irrigated			
	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	0.50	vegetable	
Khariff (no of months to be specified)	0.50+0.84	vegetable + paddy	
Others (no of months to be specified)	0.50	vegetable	

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop	paddy, Til	Mustard, veg	
Area under crop	4B ha 10	5 3	
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop	paddy, Ragi	vegetable	
Area under crop	41 5	5	
Reasons for change in cropping pattern in last 20years.	wild animal attack		
If the cropping pattern is to be changed, which are the suitable crops that can be grown	Ragi		
Available Market for the crop	yes	yes	
Average unit cost of production			
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected	paddy - Unit cost R>2300/Q Ragi - 3500Q	
Other subsidies, facilities, restrictions.	Farm mechanisms 40%50% Subsidy DBT		

Source of Energy	
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)
Electric	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif---200 ○ During Rabi-----250
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif ○ During Rabi
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc

- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.

* Dust effected Area
* Area decreases day by day due to Industrialization

Talmal-2

Farmer Feedback Form

Name	Dolagobind Naik		
Village	Talmal		
Block	JSG		
District	JSG		
Address	Near Post office		
Mobile Number (optional)			
Type and number of structures			
Type	Dugwell (30 feet)	Dugwell	
Number	1 nos.	1	
(coordinates of the structures are to be obtained by the field officer)	Lat - 21.918811 Longi - 84.078573		
Drill time discharge (lps)			
Depth of installation of pump			
Casing depth (Bore wells) HR			
Fracture encountered depth-HR			
Slotted pipe depths (TW) SR			
Average water levels – pre-monsoon	10 ft	depth 25 ft is ft = 8961 25	
Average water levels – post-monsoon	2 ft	33	
The well is used for	Agriculture.	Agriculture	
Is water available throughoutthe year	Yes.	Yes	
If not for how many monthswater is available			

Pumping Duration			
	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	2-3 days Intervel (3 hrs).	3hrs	
Kharif (no of months to be specified)			
Others (no of months to be specified)	Daily (1 hrs)	1 hrs	

Area Irrigated			
	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1	Veg + Mustard	
Khariff (no of months to be specified)	0.5 Acre	Chilly.	
Others (no of months to be specified)	0.1 Acre	Vegetables	

Cropping patterns (past and present) in the village			
Traditional Cropping patternin the village	Kharif	Rabi	Other
Type of Crop			
Area under crop			
Prevailing Cropping pattern inthe village	Kharif	Rabi	Other
Type of Crop			
Area under crop			
Reasons for change in cropping pattern in last 20years.			
If the cropping pattern is to be changed, which are the suitable crops that can be grown			
Available Market for the crop			
Average unit cost of production			
Average unit cost of selling			
Existing MSP and other related information	Crop wise details are to be collected		
Other subsidies, facilities, restrictions.			
Source of Energy			
Solar	○ Is it connected to grid ○ If yes how much incentive do you get per month on an average for feeding electricity to the grid (Rs per month)		
Electric ✓	○ Do you get free electricity for irrigation? ○ Do you pay a fixed charge ○ If a fixed charge is paid, what is the per month charge ○ ✓ If unit-based charges are paid what is the average monthlycharges in rupees ○ During kharif-250/- ○ During Rabi---400/-		
Diesel	○ Average consumption of diesel (liters) per month ○ During Kharif ○ During Rabi		
Water Market*	○ Do you share the pumped water with other farmers ○ If yes ○ For how many days do you share pumped water in Kharif ○ For how many days do you share pumped water in RabiPeriod ○ On an average how much do you charge per annum (in Rs)		
	○ Do you receive additional water from boreholes of nearbyfarmers ○ If yes ○ For how many days do you receive pumped water in Kharif ○ For how many days do you receive pumped water in RabiPeriod ○ On an average how much do you pay per annum (in Rs)		
Other issues/Remarks	e.g. common problems in drilling of wells, common health issuesin the area etc		
- Feedback of the local users will form an important input for problem identification andcharacterization. Feedbacks are to be obtained in case of Urban areas, Industrial clusters also. Feedbacks on drinking water availability, dependence on ground water etc are also to be obtained. The above feedback form can be customized to the type of priority area and objectiveof the study.			

Dolagobinda Naik

Annex

Farmer Feedback Form

P

Name	Purna Ch. Mehere	
Village	Kherval	
Block	Jharsuguda	
District	Jharsuguda	
Address	Samalai mandir.	
Mobile Number (optional)	9938159485	
Type and number of structures		
Type	~~Dug well~~ BORE	Dug well
Number	1	1 (36 foot)
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)		
Depth of installation of pump	90 foot.	36 foot.
Casing depth (Bore wells) HR	30 ft.	
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		
Average water levels – post-monsoon		
The well is used for	Irrigation + Domestic.	Agriculture + Domestic.
Is water available throughoutthe year	yes.	yes.
If not for how many monthswater is available	shortage of water Daily. may to jun	shortage of water may to jun.

Pumping Duration			
	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	2-3 days of in a week	1 to 2 hour.	
Kharif (no of months to be specified)	–	–	
Others (no of months to be specified)	Daily.	1 to 2 hour.	

Area Irrigated			
	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1 AC.	Vegetable + Sugarcane	
Khariff (no of months to be specified)	3 Ac.	Paddy + vegetable + pulse	
Others (no of months to be specified)	1 AC.	Vegetable.	

Annex

Farmer Feedback Form

Name	Rebati Rabari	
Village	Kandaripathar	C/P Baabaal
Block	Tharsuguda	
District	Tharsuguda	
Address	Near Axon Plant.	
Mobile Number (optional)	9861918871	
Type and number of structures		
Type	Borewell (2 nos)	Dug well 30 Foot
Number	1	1
(coordinates of the structures are to be obtained by the field officer)		
Drill time discharge (lps)		
Depth of installation of pump	180 Foot.	14 Foot.
Casing depth (Bore wells) HR	50 Foot.	7½ Foot
Fracture encountered depth-HR		
Slotted pipe depths (TW) SR		
Average water levels – pre-monsoon		
Average water levels – post-monsoon		
The well is used for	Agriculture + Domestic.	Agriculture + Domestic.
Is water available throughoutthe year	Yes	Yes.
If not for how many monthswater is available	whole months available (minimum shortage may to jun)	whole months available. (minimum shortage of water may to jun)

Pumping Duration	Number of days pump is operated (days) of each well	What is the average pumping duration (in hours)of each well	Instantaneous Discharge Measurement (to be carried out by the field officer) in lps
Rabi (no of months to be specified)	2 to 3 day interval of time.	1 to 2 hour	
Kharif (no of months to be specified)	–	–	
Others (no of months to be specified)	1 to 2 Days interval of time.	1 to 2 hour.	

Area Irrigated	Area Irrigated	Type of crop taken	Remarks
Rabi (no of months to be specified)	1 Ac.	Vegetable + Plantation.	
Khariff (no of months to be specified)	4 Ac.	Paddy + Puse	
Others (no of months to be specified)	1 Ac.	Vegetable + Plantation.	

Central Ground Water Board
South Eastern Region
Bhujal Bhawan
Khandagiri
Bhubaneswar
Odisha - 751030.
Email: rdser-cgwb@nic.in