SOUMYA SHREE SAHOO

ASSESSMENT OF SOIL DEGRADATION AND ITS IMPACTS ON AGRICULTURAL PRODUCTION: A CASE OF SAMBALPUR DISTRICT, ODISHA

May, 2021

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Master of Planning (Environmental Planning)

SOUMYA SHREE SAHOO

2019MEP006

SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD, BHAURI, BHOPAL (MP)-462 030

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Thesis submitted in partial fulfilment of the requirements for the award of the degree of

Master of Planning (Environmental Planning)

By

Soumya Shree Sahoo

Scholar No. 2019MEP006

Under the Guidance of

Mr. Govind M.P.

SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL

NEELBAD ROAD, BHAURI BHOPAL (MP)-462030

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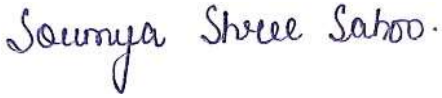
Declaration

I **Soumya Shree Sahoo**, Scholar No. **2019MEP006** hereby declare that the thesis titled "**ASSESSMENT OF SOIL DEGRADATION AND ITS IMPACTS ON AGRICULTURAL PRODUCTION - A CASE OF SAMBALPURDISTRICT, ODISHA"** submitted by me in partial fulfilment for the award of Master of Planning (Environmental Planning), at School of Planning and Architecture, Bhopal, India, is a record of bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.



Signature of the Student

Date: 20th May 2021

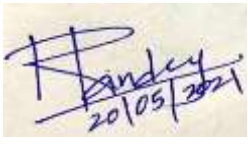
Certificate

This is to certify that the declaration of **Soumya Shree Sahoo** is true to the best of my knowledge and that the student has worked under my guidance for one semester in preparing this thesis.

RECOMMENDED

Signature of the Guide

ACCEPTED



Signature of Head,

Department of Environmental Planning

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Executive Summary

Soil is the most vital resource for providing food to the ever increasing population, it is mandatory that widespread soil degradation is brought to a halt. Soil degradation is a global problem that negatively affects environmental quality and effects the agricultural production. Soil degradation is defined as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries. Degraded soils have a health status such, that they do not provide the normal goods and services of the particular soil in its ecosystem. Soil degradation can result in a partial or complete loss of current and/or future productive potential of the soil. Natural disasters and unsuitable land use can also cause soil degradation. Soil degradation is aggravated by soil salinity and acidity, which have a detrimental effect on agricultural productivity. These are a significant impediment to the most efficient use of land resources in semi-arid, arid, and coastal areas.

Soil depletion leads to a decrease in soil fertility, a decrease in vegetative cover, and a decrease in soil quality and quantity. There are various impacts of Soil Degradation on Agricultural Production. Impact refers to the effects of soil degradation on the various soil functions. Changes in soil and terrain properties (e.g., loss of topsoil, development of rills and gullies, exposure of hardpans in the case of erosion) may reflect the occurrence and intensity of soil degradation but not necessarily the seriousness of its impact. Removal of a 5-cm layer of soil may have a greater impact on a poor shallow soil than on a deep fertile soil. The impact depends on the function and/or use of the soil: a heavily compacted soil is unsuitable for agriculture. The major impact of soil degradation can affect crop growth and yield by decreasing root depth and available water and nutrient reserves and soil erosion can lead to yield loss by affecting soil organic carbon, nitrogen, phosphorus, and potassium contents and soil ph. Soil degradation is a major environmental concern and needs attention through planning interventions and policies. Soil should be used rationally and conserved properly for realizing agricultural productivity on a sustainable basis. The main cause of soil degradation can be natural or human intervention which needs attention. Natural causes include earthquakes, tsunamis, droughts, avalanches, landslides, volcanic eruptions, floods, tornadoes, and wildfires.

Human-induced soil degradation results from land clearing and deforestation, inappropriate agricultural practices, improper management of industrial effluents and wastes, over-grazing, careless management of forests, urban sprawl, and commercial/industrial development. Inappropriate agricultural practices include excessive tillage and use of heavy machinery, excessive and unbalanced use of inorganic fertilizers, poor irrigation and water management techniques, pesticide overuse, inadequate crop residue and/or organic carbon inputs, removal of crop residues and excessive tillage and poor crop cycle planning. Sambalpur district is prone to soil degradation due to various factors. Soil erosion and surface runoff normally occurs due to rainfall and its intensity. It creates four main types of soil erosion, i.e., splash erosion, sheet erosion, rill erosion, and gully erosion. Rill and gully erosion is observed in some parts of the district where topography is undulating and hilly.

This thesis will focus on the assessment of soil quality degradation which is a major environmental concern and its impacts and implications on agricultural production. The aim of the study is Formulation of Planning interventions by assessing status of soil degradation and its impacts on agricultural production. There are four objectives to achieve the aim of the study. The first objective is to analyse the factors contributing to soil degradation. Then the second objective is to identify the study area and assess the agricultural losses due to soil degradation. Then the third objective is to document/explore the perceptions of various stakeholders regarding the issue of soil degradation. And the fourth objective is to propose the planning and policy-level interventions to address the issue of soil degradation. The scope of the study is to provide of proper land use planning. There will be provision of policies and planning interventions for agricultural practices, water management and to combat the issue of soil degradation. Planning interventions will be formulated at the watershed scale for the identified micro study area (villages) and policy-level interventions will be for the identified macro study area (Sambalpur district).

The limitations of the study are the study will be limited to providing planning interventions and policies. The policies will not be dealing with types of crops to be grown. There are various farmer's suicide cases in India due to loss of soil fertility and lack of crop productivity which is needed to be tackled through planning strategies and interventions. Thereby the seriousness of the problem of Soil Degradation must be taken into consideration and its impacts on agriculture as well. The methodology of the study begins

with problem identification followed by the literature review where both conceptual and empirical literature has been covered in the study. The literature study helped to find the need of the study which is then followed by the formulation of aim and objectives. This will be further carried with the secondary data collection followed by the identification of the problematic areas with the help of mapping and qualitative analysis using GIS tools and techniques. Soil degradation is a growing problem especially in areas of agricultural activity where soil erosion not only leads to decreased agricultural productivity but also reduces water availability. Remote sensing and GIS techniques have become valuable tools specially when assessing erosion and degradation at larger scales due to the amount of data needed and the greater area coverage. There will be interviews with various stakeholders, authorities and departments. There will be documentation of the perception study of the various stakeholders regarding the issue of soil degradation. And finally, the strategies and measures will be suggested for the proposing site in the form of spatial and policy interventions. Planning interventions will be formulated at the watershed scale for the identified micro study area (villages) and policy-level interventions will be for the identified macro study area (Sambalpur district). The expected outcome of the study will be a set of planning and policy-level interventions related to land-use and land-cover management.

This study will concentrate on the evaluation of deterioration of soil quality, which is a major environmental issue and Its effects on agricultural production and its consequences. There is a lack of knowledge about the effectiveness and efficiency of soil conservation policies and planning interventions in agriculture and there is

a little understanding of how policy measures should be designed to encourage farmers to adopt soil conservation practices. The severity of the issue of soil quality deterioration and its effects on agriculture must therefore also be taken into account. Some agricultural practices such as continuous cropping with limited supply of organic amendments, using high analysis chemical fertilizers, removal of crop residues and excessive tillage are the reasons for soil degradation. The negative effects of faulty agricultural practices on soils of the concerned areas are: decline in soil organic carbon, loss of soil fertility and contamination of soil with arsenic. Improper crop rotation coupled with lack of proper soil and water conservation measures are important reasons contributing to soil degradation.

Agricultural production in marginal areas with low Soil Organic Matter due to unsuitable cropping patterns has been the major cause of accelerated wind and leads to limited soil life and the poor soil structure. Puddling of soil for paddy rice water erosion. Urgent measures are required to arrest the degradation process and to restore productivity of degraded soils so that more food could be produced to provide livelihood and environmental security to the increasing population.

कार्यकारी सारांश

लगातार बढ़ती आबादी को भोजन उपलब्ध कराने के लिए मिट्टी सबसे महत्वपूर्ण संसाधन है, यह अनिवार्य है कि व्यापक मिट्टी के क्षरण को रोका जाए। मृदा क्षरण एक वैश्विक समस्या है जो पर्यावरण की गुणवत्ता को नकारात्मक रूप से प्रभावित करती है और कृषि उत्पादन को प्रभावित करती है। मृदा निम्नीकरण को मृदा स्वास्थ्य की स्थिति में परिवर्तन के रूप में परिभाषित किया जाता है जिसके परिणामस्वरूप पारिस्थितिकी तंत्र की अपने लाभार्थियों के लिए सामान और सेवाएं प्रदान करने की क्षमता कम हो जाती है। अवक्रमित मिट्टी की स्वास्थ्य स्थिति ऐसी होती है, कि वे अपने पारिस्थितिकी तंत्र में विशेष मिट्टी की सामान्य वस्तुओं और सेवाओं को प्रदान नहीं करती हैं। मृदा क्षरण के परिणामस्वरूप मिट्टी की वर्तमान और/या भविष्य की उत्पादक क्षमता का आंशिक या पूर्ण नुकसान हो सकता है। प्राकृतिक आपदाएं और अनुपयुक्त भूमि उपयोग भी मिट्टी के क्षरण का कारण बन सकते हैं। मिट्टी की लवणता और अम्लता से मिट्टी का क्षरण बढ़ जाता है, जिसका कृषि उत्पादकता पर हानिकारक प्रभाव पड़ता है। अर्ध-शुष्क, शुष्क और तटीय क्षेत्रों में भूमि संसाधनों के सबसे कुशल उपयोग के लिए ये एक महत्वपूर्ण बाधा हैं।

मिट्टी की कमी से मिट्टी की उर्वरता में कमी आती है, वानस्पतिक आवरण में कमी आती है और मिट्टी की गुणवत्ता और मात्रा में कमी आती है। कृषि उत्पादन पर मृदा निम्नीकरण के विभिन्न प्रभाव हैं। प्रभाव विभिन्न मृदा कार्यों पर मृदा निम्नीकरण के प्रभावों को संदर्भित करता है। मिट्टी और भूभाग के गुणों में परिवर्तन (उदाहरण के लिए, ऊपरी मिट्टी की हानि, नालियों और नालियों का विकास, कटाव के मामले में कठोर पैन का जोखिम) मिट्टी के क्षरण की घटना और तीव्रता को प्रतिबिंबित कर सकता है लेकिन जरूरी नहीं कि इसके प्रभाव की गंभीरता हो। मिट्टी की 5 सेमी परत को हटाने से गहरी उपजाऊ मिट्टी की तुलना में खराब उथली मिट्टी पर अधिक प्रभाव पड़ सकता है। प्रभाव मिट्टी के प्रकार्य और/या उपयोग पर निर्भर करता है: भारी सघन मिट्टी कृषि के लिए अनुपयुक्त होती है। मिट्टी के क्षरण का प्रमुख प्रभाव जड़ की गहराई और उपलब्ध पानी और पोषक तत्वों के भंडार को कम करके फसल की वृद्धि और उपज को प्रभावित कर सकता है और मिट्टी के क्षरण से मिट्टी के कार्बनिक कार्बन, नाइट्रोजन, फास्फोरस और पोटेशियम की मात्रा और मिट्टी के पीएच को प्रभावित करके उपज में कमी हो सकती है। मृदा निम्नीकरण एक प्रमुख पर्यावरणीय चिंता है और योजना हस्तक्षेपों और नीतियों के माध्यम से इस पर ध्यान देने की आवश्यकता है। स्थायी आधार पर कृषि उत्पादकता को साकार करने के लिए मिट्टी का तर्कसंगत रूप से उपयोग किया जाना चाहिए और उचित रूप से संरक्षित किया जाना चाहिए। मृदा निम्नीकरण का मुख्य कारण प्राकृतिक या मानवीय

हस्तक्षेप हो सकता है जिस पर ध्यान देने की आवश्यकता है। प्राकृतिक कारणों में भूकंप, सुनामी, सूखा, हिमस्खलन, भूस्खलन, ज्वालामुखी विस्फोट, बाढ़, बवंडर और जंगल की आग शामिल हैं।

भूमि की सफाई और वनों की कटाई, अनुचित कृषि पद्धतियों, औद्योगिक अपशिष्टों और कचरे के अनुचित प्रबंधन, अधिक चराई, जंगलों के लापरवाह प्रबंधन, शहरी फैलाव और वाणिज्यिक / औद्योगिक विकास के कारण मानव-प्रेरित मिट्टी का क्षरण होता है। अनुपयुक्त कृषि पद्धतियों में अत्यधिक जुताई और भारी मशीनरी का उपयोग, अकार्बनिक उर्वरकों का अत्यधिक और असंतुलित उपयोग, खराब सिंचाई और जल प्रबंधन तकनीक, कीटनाशकों का अति प्रयोग, अपर्याप्त फसल अवशेष और/या कार्बनिक कार्बन इनपुट, फसल अवशेषों को हटाना और अत्यधिक जुताई और खराब फसल शामिल हैं। चक्र योजना। संबलपुर जिला विभिन्न कारकों के कारण मिट्टी के क्षरण का खतरा है। मृदा अपरदन और सतही अपवाह सामान्यतः वर्षा और इसकी तीव्रता के कारण होता है। यह चार मुख्य प्रकार के मृदा अपरदन का निर्माण करता है, अर्थात्, स्प्लैश अपरदन, शीट अपरदन, रिल अपरदन और गली अपरदन। जिले के कुछ हिस्सों में जहां स्थलाकृति लहरदार और पहाड़ी है, वहां नाले और नाले का कटाव देखा जाता है।

यह थीसिस मिट्टी की गुणवत्ता में गिरावट के आकलन पर ध्यान केंद्रित करेगी जो एक प्रमुख पर्यावरणीय चिंता है और कृषि उत्पादन पर इसके प्रभाव और प्रभाव। अध्ययन का उद्देश्य मिट्टी के क्षरण की स्थिति और कृषि उत्पादन पर इसके प्रभावों का आकलन करके योजना हस्तक्षेप तैयार करना है। अध्ययन के उद्देश्य को प्राप्त करने के लिए चार उद्देश्य हैं। पहला उद्देश्य मृदा निम्नीकरण में योगदान करने वाले कारकों का विश्लेषण करना है। फिर दूसरा उद्देश्य अध्ययन क्षेत्र की पहचान करना और मिट्टी के क्षरण के कारण होने वाले कृषि नुकसान का आकलन करना है। फिर तीसरा उद्देश्य मृदा निम्नीकरण के मुद्दे के संबंध में विभिन्न हितधारकों की धारणाओं का दस्तावेजीकरण/अन्वेषण करना है। और चौथा उद्देश्य मृदा निम्नीकरण के मुद्दे को संबोधित करने के लिए योजना और नीति-स्तरीय हस्तक्षेपों का प्रस्ताव करना है। अध्ययन का दायरा उचित भूमि उपयोग योजना प्रदान करना है। कृषि पद्धतियों, जल प्रबंधन और मिट्टी के क्षरण के मुद्दे से निपटने के लिए नीतियों और नियोजन हस्तक्षेपों का प्रावधान होगा। चिन्हित सूक्ष्म अध्ययन क्षेत्र (गांवों) के लिए वाटरशेड पैमाने पर योजनागत हस्तक्षेप तैयार किया जाएगा और नीति-स्तरीय हस्तक्षेप चिन्हित मैक्रो अध्ययन क्षेत्र (संबलपुर जिला) के लिए होगा।

अध्ययन की सीमाएं हैं अध्ययन योजना हस्तक्षेप और नीतियां प्रदान करने तक सीमित होगा। नीतियां उगाई जाने वाली फसलों के प्रकारों से संबंधित नहीं होंगी। नुकसान के कारण भारत में विभिन्न किसान आत्महत्या के मामले हैं o

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Abbreviations

AESs- Agro-Ecosystems

BOD - Biological Oxygen Demand

CA- Conservation Agriculture

COD - Chemical Oxygen Demand

DO - Dissolved Oxygen

DSM- Digital Soil Mapping

EC- Electrical Conductivity

GHG- Green House Gas

HYV- High Yield Variety

NGO- Non-Governmental Organisation

NNL- No Net Loss

NRSA- National Remote Sensing Agency

SDI- Soil Degradation Index

SOM- Soil Organic Matter

SQI- Soil Quality Index

CHAPTER 1 INTRODUCTION

The first chapter consists of the importance of the Research Topic, Contextual Background, Need of the Study, Research Gap, Problem Statement, Problem Identification, Aim and Objectives, Scope and Limitations, Methodology, Expected Outcome and Report Structure.

1.1 IMPORTANCE OF THE RESEARCH TOPIC

In India, Soil Degradation is a major problem which has also created negative impacts to the agricultural production. There are number of places present in India including districts, urban areas and villages which are facing this issue. This is ultimately decreasing the crop production and the fertility present in the soil. This has become worse in the case of India as it supports 18% of the total population in the world.

Soil Degradation may occur due to natural activities as well as anthropogenic or man-made activities. There are several number of natural activities including droughts, floods, earthquakes and landslides. While the man-made activities such as overgrazing, over-irrigation, deforestation, different agricultural practices, improper management of the land and also forests and mining activities are the various reasons responsible for the removal of soil nutrients leading the soil towards degradation. These are the various activities which are needed to be taken into account by proper land use management.

Due to excessive tillage it has been observed that soil nutrients are getting destroyed or degraded which is also a major factor of soil degradation and this further leads in the reduction in crop productivity. Over-utilization of pesticides and chemical fertilisers causes harm to the crop growth and eliminates the essential nutrients present in the soil. This is also a major reason for the decreasing crop yield or soil nutrients in the present land or the agricultural field.

There is a need to enhance sustainable agriculture and introduce various cropping patterns as well as Conservation Agriculture which will bring the soil degradation to a halt and save the essential soil nutrients and this phenomenon will ultimately help in increasing the crop production. The watershed approach is an also an important measure which provides various facilities to the fragile areas by eliminating or reducing the environmental problems. There is an urgent requirement to bring this problem into halt as India is facing major loss due to the

soil degradation and farmers are facing many agricultural losses due to the same. They are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management.

This has become a demand to protect the soil from getting degraded because it is not only harming the land but also effecting the agricultural production. This is creating negative effect in the lives of the farmers as well. They are feeling helpless due to less productivity. Somewhere the are dependent on rain for agriculture production. Due to the scanty rainfall the land becomes barren and this also leads towards the poor quality of soil. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management.

With the help of various planning or policy level interventions this can be brought to a halt. This is urgent need to make the people aware about the importance of soil and the prevention of soil because this will provide the farmers with better crop productivity. They are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures.

1.2 CONTEXTUAL BACKGROUND

The degradation of the soil is defined as “a process which lowers the current and/or the potential capacity of soil to produce goods or services”. One type of land degradation is soil degradation; other aspects include degradation of vegetation and water supplies.

TYPES OF SOIL DEGRADATION

PHYSICAL DEGRADATION- Soil degradation is caused by a variety of physical causes, each of which is defined by how they modify the normal of natural disasters all contribute in the depletion of the fertile topsoil, which leads towards deterioration of soil fertility. These physical factors contribute to soil erosion in different ways. Weathering processes cause soil fertility to decrease over time, adverse effects in the composition and nutrient content of the soil. Wind erosion, for example, and water erosion.

CHEMICAL DEGRADATION- Alkalinity causes nutrient loss in the soil, acidity, or waterlogging are chemical components of soil degradation. The chemical compounds cause salinization and alkalinisation. Salt accumulation and nutrient leaching are the primary causes, all of which damage soil quality by causing undesirable changes. These chemical compounds causes, such as salinization and alkalization, cause Hardpan formation in iron and aluminium-rich clay soils is an example of permanent depletion of soil nutrients and production ability.

BIOLOGICAL DEGRADATION- Biological influences are human and plant behaviours that have a negative effect on the nutrient content of the land. Overgrowth in bacteria and fungi in a given area can have a same effect on soil microbial activity from biochemical reactions, reducing crop growth and productivity ability. Poor farming practises, for example, can deplete soil nutrients, resulting in a reduction in soil fertility. The biological factors have a significant impact on the soil's microbial activity. Degradation of vegetation, for example.

CAUSES OF SOIL DEGRADATION

NATURAL ACTIVITIES-

- Climate Change: Extreme Droughts and Flooding
- Natural Hazards: Earthquakes and Landslides

HUMAN ACTIVITIES-

- Deforestation
- Overuse of vegetation for domestic purposes
- Unsustainable agricultural practices: Over cultivation and Overgrazing
- Overexploitation of natural water resources
- Industrial activities

Removal of soil nutrient content is one of the biggest issue faced in today’s world. It is needed to be make awareness among the people in India and around the world for the negative impacts caused due to the soil degradation. This is degrading the land for an extended period of time, leaving the land barren or removing soil fertility for agricultural production. They can only be brought into halt if we take that into account and work hand in hand together towards the same and will be able to reduce the harmful effects of soil degradation. India's most serious environmental problem is erosion, which causes topsoil loss degrading performance. In the rain fed and irrigated areas, soil erosion has become a serious issue. India is losing a

lot of revenue because of polluted lands. Crop production is decreasing, land use intensity is increasing, cropping patterns are changing, and input use is high benefit are all evidence of this cost.

1.3 NEED OF THE STUDY

Soil is the most vital resource for providing food to the ever increasing population, it is mandatory that widespread soil degradation is brought to a halt.

Soil degradation is a major environmental concern and needs attention through planning interventions and policies. Soil should be used rationally and conserved properly for realizing agricultural productivity on a sustainable basis.

Soil degradation, which results in a decrease in soil fertility, deterioration of vegetative cover, and a decrease in soil quality and quantity. This has major impact on agricultural production.

1.4 RESEARCH GAP

Studies have been done to diagnose the qualitative aspects of soil through the formulation of SQI (Soil Quality Index), such studies are limited in the context of Western Odisha.

Perception analysis of the stakeholders and the application of spatial planning interventions are not covered.

There is a lack of awareness about how policy initiatives can be designed to enable farmers to implement soil conservation practises, as well as a lack of information about the efficacy and efficiency of soil conservation policies and planning interventions in agriculture practices.

1.5 PROBLEM STATEMENT

Soil degradation is a worldwide problem that has a negative impact affects environmental quality and also effects the agricultural production. The negative impacts of soil degradation may lead to partial or complete loss of the soil’s current and/or future productive capacity. Natural disasters and inappropriate land use can also cause soil depletion.

1.6 PROBLEM IDENTIFICATION

Land degradation is exacerbated by soil salinity and acidity, which have a detrimental effect on agricultural productivity. These factors obstruct the most efficient use of land for agricultural productivity.

Soil depletion is caused by agricultural practises such as continuous cropping with a small supply of organic amendments, the use of high-analysis chemical fertilisers, the removal of crop residues, and unnecessary tillage.

1.7 AIM AND OBJECTIVES

AIM

Formulation of Planning interventions by assessing status of soil degradation and its impacts on agricultural production.

OBJECTIVES

1.To analyse the factors contributing to soil degradation.

2.To identify the study area and assess the agricultural productivity losses due to soil degradation.

3.To document/explore the perceptions of various stakeholders regarding the issue of soil degradation.

4.To propose the planning and policy-level interventions to address the issue of soil degradation.

1.8 SCOPE

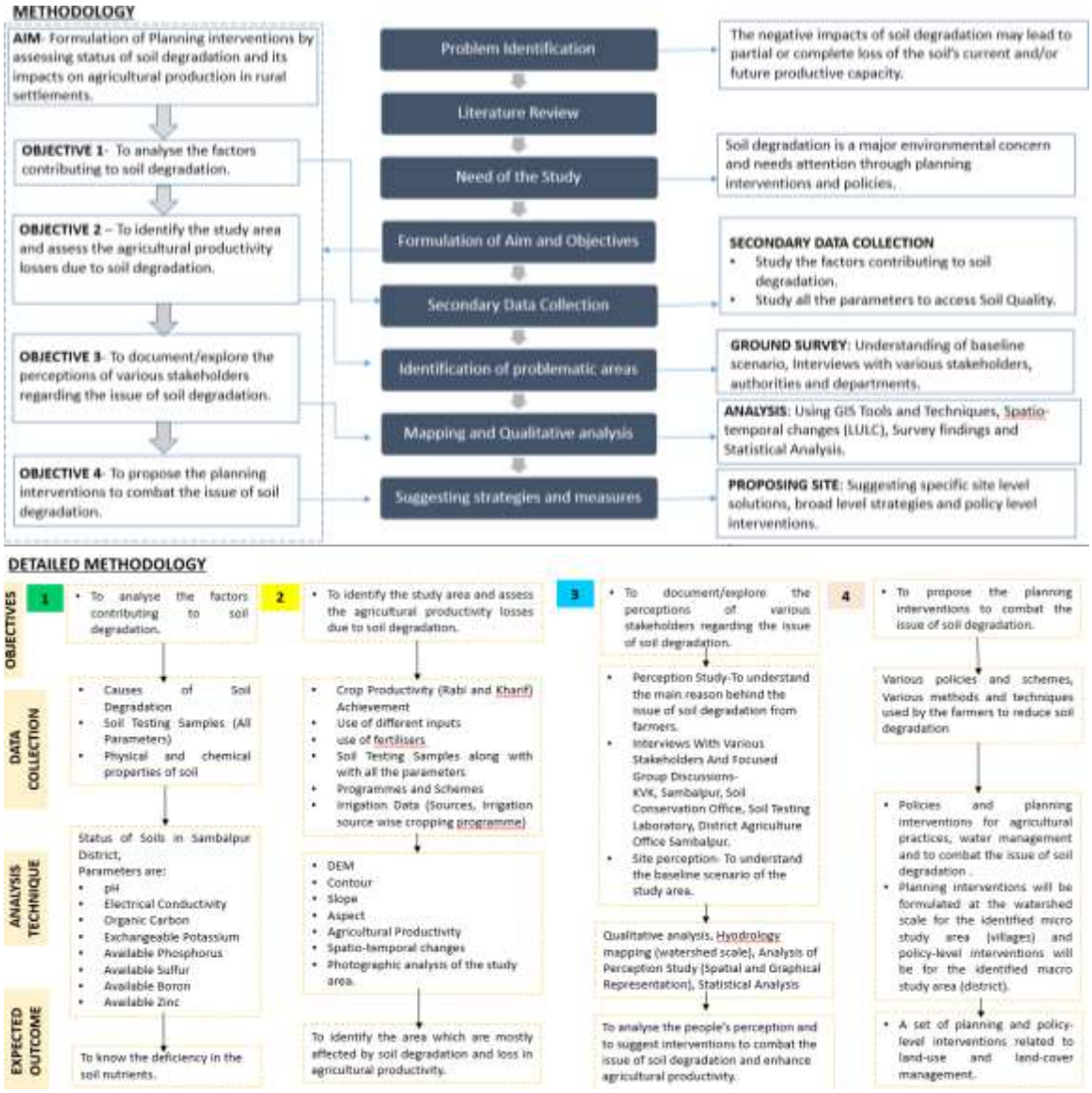
- Provision of proper land use planning.
- Policies and planning interventions for agricultural practices, water management and to combat the issue of soil degradation.
- Planning interventions will be formulated at the watershed scale for the identified micro study area (villages) and policy-level interventions will be for the identified macro study area (district).

1.9 LIMITATIONS

- The study will be limited to providing planning interventions and policies.
- Policies will not be dealing with types of crops to be grown.

1.10 METHODOLOGY

Figure 1: Methodology



Source- Author

The above methodology begins with problem identification followed by the literature review where both conceptual and empirical literature has been covered in the study. The literature study helped to find the need of the study which is then followed by the formulation of aim and objectives. This will be further carried with the secondary data collection followed by the identification of the problematic areas with the help of mapping and qualitative analysis using GIS tools and techniques. And finally, the strategies and measures will be suggested for the proposing site in the form of spatial and policy interventions.

1.11 EXPECTED OUTCOME

This study will be a set of planning and policy-level interventions related to land-use and land-cover management.

1.12 REPORT STRUCTURE

The study focuses on understanding of the basic concepts related to soil degradation and its impacts on agricultural production. The structure of the report is detailed out below.

Chapter 1 It details out the background of the study and explains the need to address the problem as mentioned. The aim of the study and for achieving the goal are as delineated supported with the scope of the study to proceed towards the final outcome. Moreover, the methodology of the whole study is explained along with the limitations to the approach.

Chapter 2 It focuses on the literature review related to the problem statement with focus on its detailed cause and impacts. The legislative and institutional measures related to soil degradation are also detailed out in this chapter. The causes and various reasons regarding soil degradation have been also discussed.

Chapter 3 It explains the profile of the study area Sambalpur District along with the nine blocks which are facing the issue of soil degradation in the area.

Chapter 4 It focuses on data collection and analysis of primary and secondary data collected from site. With the help of various stakeholder and interviews conducted the data has been collected from the site. This also provided with various causes responsible for soil degradation in Sambalpur District. The data collected from the site has been analysed. The interrelationship of variables and parameters is analysed and inferences are drawn to provide a way forward for recommendations

and proposals. The components of objective 1, 2 and objective 3 are critically focused upon in this chapter.

Chapter 5 It deals with the recommendations and proposals suggested for Soil degradation. The mitigating strategies and policy level interventions are elaborated in detail. These are provided after the various analysis done. The recommendations are suggested towards the protection and prevention of soil nutrient balance. This will ultimately help to heal the soil and reduce the impacts on agricultural production.

CHAPTER 2 LITERATURE REVIEW

The literature review is the subject of this chapter, which is necessary for laying groundwork towards the analysis which must be completed in order towards the thesis to be strengthened. This entails a thorough examination of different terms, meanings, methods, and contexts in which to conduct this research. It includes various acts and regulations, as well as design guidelines, to improve the report. In addition, both Indian and foreign cases are available in this chapter.

2.1 CONCEPTUAL LITERATURE

A change in soil health is described as soil degradation that causes the ecosystem's ability to provide the products and services to the people to be harmed. Damaged soils have a state of health that prevents them from providing the usual products as well as the ecosystem services that the soil offers.

These concepts, which are largely based on the LADA concept of land degradation, are critical in capturing the complexities of degradation processes and their subjective assessment by various stakeholders in the soil and land industries management.

2.1.1 DEFINITIONS

SOIL EROSION: Soil erosion is the concept which is associated with depletion, it applies to overall topsoil and nutrient elimination. While this is the most obvious result of soil depletion, it does not include all of it. In mountainous areas, soil erosion is a normal occurrence, but it is often exacerbated by improper managing practises.

LAND DEGRADATION: This encompasses all detrimental changes in the ecosystem's ability to provide goods and services.

DESERTIFICATION: Different word for (a) land loss in dry areas and (b) in permanent transition of the land to a condition where this can no longer be reclaimed for the original use is desertification.

PREVENTION: Conservation policies are used to safeguard natural resources and their environmental and economic importance is referred as prevention.

MITIGATION: Mitigation is a strategy for halting the progression of environmental deterioration. This arrives at the time which the degradation process has already been started. This is the key goal to stop the deterioration and begin towards improving resources and their functions. The effects of mitigating measures are

usually apparent in the time period which is from short to medium time period, which offers a good motivation to continue working. The term 'mitigation' is often occasionally used to explain the amelioration of degradation's effects.

REHABILITATION: Rehabilitation is needed when the land has degraded to the point that the original use is no longer feasible and the land has become largely unproductive. To demonstrate any results, longer-term, often costlier investments are needed.

2.1.2 SOURCES OF SOIL DEGRADATION

DEFORESTATION, OVERGRAZING, AND FOREST MANAGEMENT WITHOUT CONSIDERATION - Overgrazing and deforestation have wreaked havoc in eight Indian countries, leaving more than 20% of the land barren (Source: National Remote Sensing Agency's Wasteland Atlas of India; NRSA).

Overgrazing occurs in arid areas due to high livestock density, as a result, penetration is decreased, runoff is accelerated, and soil erosion occurs.

INDUSTRIALIZATION, URBAN DEVELOPMENT, AND MINING - Increased farmland, woodland, are all losing large amounts of land as a result of industrialization, urbanisation, and infrastructure development. This is a concern because it pollutes the environment. Opencast mining is particularly problematic because it changes an area's socioeconomic characteristics while also disrupting the soil's physical, chemical, and biological characteristics. And acid mine drainage are all examples of water depletion. The removal of overburden from mining areas results in a substantial loss of vegetation and topsoil richness [25]. Blasting or excavators are often used to remove overburden, resulting in a large amount of garbage (soil, debris and other material). The amount of waste generated by open-pit mines is eight to ten times that of mining's environmental impact varies by mineral, as does the local environment's ability to withstand negative effects associated with mineral deposits' geographical location and size of mining operations. Heavy amount of energy is produced by mineral extraction. Mineral extraction produces massive amounts of waste/overburden, tailings/slimes, which degrades a large area of land.

SOIL DEGRADATION RESOURCES: NATURAL AND SOCIAL - Soil erosion can be caused by natural and social factors.

SHORTAGE OF LAND, FRAGMENTATION OF LAND, AND POOR ECONOMY- In India, particularly in the rainy regions, small land holdings are common. Approximately 80% of farmers have less than 2 hectares of land, accounting for more than of agricultural production. As a result, employees are under a lot of pressure, and their consumption of alcohol is on the rise.

As a result, land management practises emerge as a direct cause of destruction when land scarcity and poverty are combined. In addition, improper crop rotation and overgrazing. Despite the Indian government's numerous initiatives, land degradation remains a serious issue.

INCREASE IN POPULATION- India's limited land resources are being strained by constant increases in human and livestock populations, as well as widespread poverty. Idle time leads to urban sprawl. The urban population is increasing. The urban population explosion has resulted in urban sprawl. As cities' populations expand, infrastructure requirements.

INDIA'S AGRICULTURAL ACTIVITIES RESULTING IN SOIL DEGRADATION

“The vast majority of India's agricultural land has been under cultivation for hundreds of years, and it had reached its maximum impoverishment several years ago. In this regard, it should be remembered that combined nitrogen deficiency is the limiting factor in much of India”. India's agricultural sector has grown dramatically over the last five decades. However, this also had additional impacts, such as the depletion of plant biodiversity and degradation of the atmosphere. Farmers' food and livelihood protection are directly impacted by Unsustainable farming practises have resulted in extensive land loss. Erosion, or the removal of the topmost soil cover as a result of the interaction of water and wind, and a flooded area, or the loss of groundwater, are also causes of degradation.

Depending upon management practises used, agricultural activities and practises may degrade land in a number of ways.

Overgrazing, excessive flooding, over-drafting (harvesting groundwater above the aquifer's safe yield), including industrialization, are all issues that need to be addressed which is also including dumping toxic waste on farmland, are all examples of agricultural depletion of soil nutrients.

FERTILIZATION IS LOW AND UNBALANCED- In India, intensive farming practises have virtually mined nutrients from the soil, especially rice (Oryza sativa L.) and wheat.

In this paper it has been explained that due to the soil acidity and salinity the soil fertility is reduced. This leads to the impacts in agricultural production. Soil salinity is one of the major reason for the soil degradation.

TILLAGE EXCESSIVE AND HEAVY MACHINERY USE-

Excessive amount of tillage, in combination with the heavy machinery is used for the obtaining and the need for adequate soil management steps, results in a slew. Crop establishment is hampered by poor soil physical quality, which contributes to waterlogging after irrigation. Over the last four decades, intensive agriculture has resulted in the doubling of irrigated cropland, from 19 percent to 38 percent of the cropped region. Most of this water has been taken from scarce groundwater supplies.

Improper canal irrigation usage and maintenance has contributed greatly to soil depletion issues such as waterlogging and salinization. Because of the heavy use of nitrogen fertilisers, the groundwater has been contaminated by excess nitrate. The key greenhouse gas (GHG) pollution sources from agriculture are unnecessary excessive tilling of land and agricultural practices, over amount fertiliser usage.

IRRIGATION AND WATER MANAGEMENT ARE INAPPROPRIATE- In most canal command areas, an increase in the water table has resulted from poor irrigation system planning and management.

ROTATIONS OF POOR CROP- Improper crop rotation, as well as a need of adequate the soil and the water management measures, are major contributors to soil erosion on cultivated lands.

OVERUSE OF PESTICIDE AND SOIL POLLUTION- Pesticides used indiscriminately, along toxic pollutants and heavy metals pollute the soil and water with sewage sludge and composted municipal waste. Heavy metal pollution is a serious problem caused by excessive industrial effluent treatment, as well as the usage of household and urban wastes and pesticides. Heavy metals, which have unintended consequences, are present in certain commercial fertilisers. Some commercial fertilisers often contain significant amounts of different types of heavy

metals, which have negative environmental consequences. Land destruction is often caused by the indiscriminate application of agrochemicals such as fertilisers and pesticides.

2.2 EMPIRICAL LITERATURE

2.2.1. SOIL DEGRADATION INDEX DEVELOPED BY MULTITEMPORAL REMOTE SENSING IMAGES, CLIMATE VARIABLES, TERRAIN AND SOIL ATRIBUTES (Claudia Maria, et al., 2021)- Protection of Environment necessitates soil erosion study. Mapping of soil degradation has become really important in today's scenario. This study has elaborated the same about the Soil Degradation Index by the collection of soil samples and analysing them. Further these data were used to perform algorithms. Since nearly 30% of the world's soils are depleted, it's critical to research and map them in order to improve their management and usage. Soil properties, such as pH, can be predicted spatially. Machine learning algorithms were used to make spatial predictions. Satellite images together with environmental data were instrumental in the creation of the SDI, which aids in land use planning and management decisions. The satellite images helped in analysing the various parts which are affected by soil degradation and were used to perform algorithms to protect the environment from getting degraded. This phenomenon is also useful in proper land use planning and should also be used in the places where the issue of soil degradation is increasing. There is an urgent need to bring the soil degradation to halt. As, we know this soil degradation takes over years to heal and also the essential nutrients in the soil which are essential for the crop production gets eliminated. (Claudia Maria, et al., 2021).

2.2.2. MOVING TOWARDS INTEGRATING SOIL INTO SPATIAL PLANNING: NO NET LOSS OF SOIL-BASED ECOSYSTEM SERVICES (Thomas, et al., 2020) - More specifically, the proposed instrument allows for the spatial heterogeneity of ecosystem service supply. Also the variety of stakeholder requirement for different soil nutrients to be taken into account. The implications of putting in place a soil-based NNL strategy for spatially development are discussed, as well as its general application for steering settlement development. It is a negative sign for the environment and demands for the protection of its important resources. This is a very critical part which deals with the soil protection as many other things like ecosystem services are interconnected. Therefore, it was required

to protect the soil from degraded with some sustainable measures. Ecosystem degradation and the resulting loss of ecosystem resources have prompted the development of new policies.

We wrap up with a review of the implications of adopting a soil-based NNL strategy for spatial growth, as well as its general application for guiding settlement development (Thomas, et al., 2020).

2.2.3. INNOVATIVE PRO-SMALLHOLDER FARMERS' PERMANENT MULCH FOR BETTER SOIL QUALITY AND FOOD SECURITY UNDER CONSERVATION AGRICULTURE (Sibongiseni, et al., 2020) - Globally, soil erosion is the most serious obstacle to agricultural development. To avoid soil erosion, preserve soil quality, and increase crop productivity, crop residues must be applied or retained in the field as mulch. This research aims to promote agrimat as a ground-breaking technology that benefits smallholder farmers and improves soil quality for better food security. This study has been conducted to improve the soil cover by using the agrimats which will not only improve the quality of the soil by increasing the soil quality but will also improve the agricultural productivity. This requires less amount of chemicals and fertilisers which will be applied on the crops. So, this protects the essential nutrients of the soil as well. This has become quite important to protect the soil. Agricultural productivity will also enhance with good amount of nourishment provided. There will be proper security of crops for further use in future. These sustainable measures are required to bring change in the world. This will also tackle the greatest threat which is degraded quality of soil and nourish the soil with all the essential amount of nutrients for the better growth of crops and production (Sibongiseni, et al., 2020).

2.2.4. APPLICATION OF DIFFERENT GEOTEXTILE IN SOIL TO IMPROVE THE SOIL HEALTH IN HUMID AND HOT SUB HUMID REGION OF WEST BENGAL, INDIA (Arunabha, et al., 2020)- It is a commodity that is both eco-friendly and biodegradable, will help to alleviate soil-related crop production constraints. Bio deterioration of cellulose fibre occurs when die polymerization is reduced, resulting in a loss of textile power. As a result, the use of appropriate amelioratives is needed to improve various soil conditions in order to increase crop productivity. T1 - non woven jute geotextile, T2 - non woven dry grasses geotextile, T3 - non woven coco coir geotextile, T4 - non woven banana leaf fibre geotextile, and T5 - farmers'

practises were the five treatment combinations used in the experiment (i.e. control). Different Geotextile treatments improve the physical and chemical environments in soil, resulting in better soil conditions and nutrient availability, resulting in improved vegetable growth and yield.

As a result of the findings of this analysis, it can be concluded that using each of the geotextiles increased vegetable growth and yield. It also aids in the especially the structural status, as increased crop water use efficiency and growth rate. Furthermore, each geotextile encourages the increase of soil organic carbon and soil fertility. Jute geotextile was found to be more efficient for improving soil properties and the soil fertility than the other geotextiles used in the analysis (Arunabha, et al., 2020).

2.2.5. SOIL DEGRADATION RISKS ASSESSED BY THE SOTE MODEL FOR SALINITY AND SODICITY (Isaac & Yair, 2020)- The problem is particularly acute where agriculture is often supported. As a consequence, SOTE has the potential to make well-informed decisions. Based on irrigation techniques, soil characteristics, and environment conditions, assess the probability of long-term soil degradation (Isaac & Yair, 2020).

2.2.6. SOIL HEALTH AND ARTHROPODS: FROM COMPLEX SYSTEM TO WORTHWHILE INVESTIGATION (Cristina & Sara, 2020) – Soil degradation has increased over the period of time. This paper focuses on Soil Health by assessing the micro anthropods. At the end of the discussion micro-anthropods are suggested. Furthermore, different species within the same taxonomic community may react differently. The subject is especially complicated as a result of this complex situation, as shown by the large number of papers written on the subject. (Cristina & Sara, 2020).

2.2.7. SOIL QUALITY ASSESSMENT OF COASTAL SALT-AFFECTED ACID SOILS OF INDIA (Gopal, et al., 2020) - Land degradation is exacerbated by soil salinity and acidity, which have a detrimental effect on the productivity of agriculture Soil salinity and acidity have an effect on soil quality (SQ) must be assessed in order for them to be used for agricultural production in the long run. The aim of this study was to use additive and weighted soil quality indices. (MD) were used to build the SQIs (MDS). As a result, determining the on a wide scale could be time-consuming and costly. The study recommends that such soils be restored using

corrective steps such as land use managing to mitigate or eliminate salinization (Gopal, et al., 2020).

2.2.8. ASSESSMENT OF SOIL QUALITY AND IDENTIFICATION OF PARAMETERS INFLUENCING SYSTEM YIELD UNDER LONG-TERM FERTILIZER TRIAL (Rajiv , et al., 2018) - Soil quality is often linked to yield sustainability problems, and its evaluation is critical. System productivity was determined to achieve the goal. The responsive parameters were used to evaluate the soil qualities under each of the treatments. It has been established as main soil factors harming rice-wheat cropping system yield under long-term fertilisation. Soil quality research has gained traction in India over the last decade, owing to the study's uniqueness; however, the inconsistency of the soil environment present in the rice-wheat method, owing to differences in management practises in India, necessitates identifying the main soil properties driving system productivity. Recommended fertiliser doses were found to be viable options for maintaining soil quality and ensuring long-term efficiency, but with the assurance that these residues will be available in particular locations. In addition, using this site-specific index will assist planners and decision-makers in determining which management activity is the most sustainable and vice versa in a given situation (Rajiv , et al., 2018).

2.2.9. CROPPING SYSTEM EFFECTS ON SOIL QUALITY FOR THREE AGRO-ECOSYSTEMS IN INDIA (Nishant, et al., 2013) - Soil quality takes into account the physical characteristics. In India, there are three different AESs. SQI was developed using thirteen indicators based on parameters from surface soil cover. This study demonstrated that it can be used to accurately measure soil nutrients. Variability in soil indicators will reveal a lot about the changing behaviour. parameters on crop production under a variety of conditions, the proposed indices could be refined further (Nishant, et al., 2013).

2.2.10. EFFECT OF 25 YEARS OLD AGROFORESTRY PRACTICES ON SOIL QUALITY ATTRIBUTES IN THE NORTH EASTERN HIMALAYAN REGION OF INDIA (Thounaojam Thomas, et al., 2019) - According to the findings, alder-based agroforestry activities not only reduced. However, there has been an improvement in soil quality and environmental protection. Land regeneration should be considered when moving planting is unavoidable achieved using alder-based

agroforestry practises to ensure that production and ecological functions are maintained. The study concluded that alder-based agroforestry activities increased soil quality and environmental protection in addition to preventing land degradation. When shifting planting is inevitable, land restoration should be achieved using alder-based agroforestry practises to ensure that production and ecological functions are maintained (Thounaojam Thomas, et al., 2019).

2.2.11. BIOFERTILIZER AS PROSPECTIVE INPUT FOR SUSTAINABLE AGRICULTURE IN INDIA (Manashi, et al., 2017) -The ever-increasing population of India puts enormous strain on agricultural lands and other natural resources in order to produce more food. Increasing the use of chemical fertilisers in agriculture could make the country food self-sufficient, but it also degrades the environment and has harmful effects on living things. Chemical fertiliser reliance for potential agricultural growth will result in more soil degradation and the risk of water pollution. The word "bio fertilizer" refers to a formulation that contains live microbes that aid in soil fertility enhancement by fixing atmospheric nitrogen, solubilizing phosphorus and other nutrients, and enhancing plant growth by generating growth hormone. Due to the fact that the idea is not new, bio fertilizer has a wide range of applications in sustainable agriculture. Despite being cost-effective and environmentally friendly, many restrictions such as inadequate supplies and a lack of adequate quality control hinder the technology's application or implementation. Bio fertilisers have the ability to play an important role in sustainable agriculture, since they can be used in conjunction with chemical fertilisers to improve soil fertility and crop yield. Farmers in India, especially marginal farmers, can make more money from the same amount of land by using bio fertilisers rather than chemical fertilisers alone. For bio fertilizer to be widely commercialised, more research is needed to identify more suitable strains, develop better production technologies, and implement quality control measures. The synthesis of bio fertilizers with multi-crop growth-promoting activities is critical for global agriculture's long-term viability. Bio fertilizers can be used in conjunction with chemical fertilisers in sustainable agriculture. Farmers in India, especially marginal farmers, can make more money from the same amount of land by using bio fertilizers rather than chemical fertilisers alone (Manashi, et al., 2017).

2.2.12. DESIGNING A SOIL QUALITY ASSESSMENT TOOL FOR SUSTAINABLE AGROECOSYSTEM MANAGEMENT (Susan S. & Ronald, 2001) - Increased management capacity and feedback are generally needed for sustainable agroecosystem management. Tools that integrate and synthesise goals, and issues may help with sustainable management decision-making. Soil quality indices (SQIs) based on science can provide the ecologically sound approach that Land administrators must make long-term decisions we devised a method. This results tends for a reliable indicator of long-term success. The SQI method worked well in our case studies (Susan S. & Ronald, 2001).

2.2.13. SOIL QUALITY OF DIFFERENT RICE-BASED CROPPING SYSTEMS IN A DROUGHT AFFECTED BLOCK OF ODISHA, INDIA (Dharmendra, et al., 2019)- This is a case of Jagannathprasad, in Ganjam district, using five rice-based cropping systems: Rice-Rice (RR), Rice-Vegetable (RV), Rice-Pulse (RP), Rice-Oilseed (RO), and Rice-Fallow (RF) (RF). The soils were mostly red and black in colour, according to the findings. Crop rotations should be done as part of management activities, not just to preserve soil fertility. It is not only to increase soil productivity, but also to improve the socio-economic situation of farmers in drought-prone areas. As a result, crop rotations should be implemented as part of management practises, not just to restore soil fertility but also to boost the socioeconomic status of farmers in drought-prone areas. Soil quality research has gained traction in India over the last decade, owing to the study's uniqueness; however, the inconsistency of the soil environment present in the rice-wheat method, owing to differences in management practises in India, necessitates identifying the main soil properties driving system productivity (Dharmendra, et al., 2019).

2.2.14. SOIL DEGRADATION: STATUS AND MANAGEMENT OPTIONS IN WEST BENGAL (K. & D., 2016) - Soil depletion caused by a variety of natural and human-made factors poses a major threat to food and environmental protection. As a major global problem, its negative consequences are felt most acutely in developing countries, where large proportions of the population depend on the soil for survival. The aim of this article is to identify various causes of soil degradation, as well as their degree and severity, and to focus on suggested soil management strategies to protect West Bengal's fragile soil resources. Soil depletion is caused

by agricultural practises such as continuous cropping with a small supply of organic amendments, the use of high-analysis chemical fertilisers, the removal of crop residues, and unnecessary tillage. The following are some of the detrimental effects of poor agricultural practises on the soils of the affected areas: a decline organic carbon of soil fertility, and soil pollution. The most promising strategies for restoring the state's depleted soils are to implement effective site-specific management practises that increase soil organic carbon, improve soil fertility, and minimise all types of erosion. This will enable us to meet our population's rapidly growing food, feed, fibre, and fuel needs while still preserving our precious soil resources. The most promising strategies for restoring the state's depleted soils are to implement effective site-specific management practises that increase soil organic carbon, improve soil fertility, and minimise all types of erosion. This will enable us to meet our population's rapidly growing food, feed, fibre, and fuel needs while still preserving our precious soil resources (K. & D., 2016).

2.2.15. REFINING PHYSICAL ASPECTS OF SOIL QUALITY AND SOIL HEALTH WHEN EXPLORING THE EFFECTS OF SOIL DEGRADATION AND CLIMATE CHANGE ON BIOMASS PRODUCTION: AN ITALIAN CASE STUDY

(Antonello, et al., 2019) - The aim of the research is to define procedures that can be used globally rather than just in specific regions, reflecting recent changes in soil physical and agronomic science, as well as critical questions about the Soils, cannot be defined by a generally agreed quality specification, despite extensive study. It refers to the ability to survive. Biomass production is a primary feature that can be modelled, and uniform crop behaviour are used to calculate yield, assuming sufficient water and nutrient availability (Antonello, et al., 2019). The aim of the research was focussed upon the various aspects of soil quality and the various effects of soil degradation. There are many critical questions which were raised during the research work. This has to be kept in mind and needed to be understood the importance of soil in our life. This was maintained by the uniform crop behaviour which acted towards the protection of it.

2.3 METHODS AND TOOLS RELATED TO SOIL DEGRADATION

Soil erosion is becoming more of a problem, especially in agricultural areas, where erosion reduces both agricultural productivity and water availability. There are various methods and tools present which and quantity degradation. The soil degradation can be measured spatially using the GIS tools and techniques. This is very useful to map the soil degradation. Through the help of these techniques we can easily locate and understand the place which are highly affected by the harmful effects of soil degradation.

Mapping of Soil Degradation has become very important. As, we can come across many reasons which are responsible for the soil degradation and the causes of soil degradation as well.

Around the world, the is the most commonly followed empirically based technique for erosion prediction and control. This has become a requirement to understand how to stop the soil being degraded or eroded. And through these tools and techniques we can also understand which parts of the city or the district or the blocks are facing this problem. Most of the parts of the district or blocks faces this issue due to various anthropogenic causes. There are some natural causes which leads to the degradation of the soil as well. There are many problems occurring due to the effects of soil degradation. There are several number of natural activities including droughts, floods, earthquakes and landslides. While the man-made activities such as overgrazing, over-irrigation, deforestation, different agricultural practices, improper management of the land and also forests and mining activities are the various reasons responsible for the removal of soil nutrients leading the soil towards degradation.

The soil degradation can be measured spatially using the GIS tools and techniques. This is very useful to map the soil degradation. It is important to map them and analyse them. There is a need to enhance sustainable agriculture and introduce various cropping patterns as well as Conservation Agriculture which will bring the soil degradation to a halt and save the essential soil nutrients and this phenomenon will ultimately help in increasing the crop production. Soil nutrients are needed to be restored for better crop production. These all tools and techniques will help towards achieving the results.

CHAPTER 3 STUDY AREA PROFILE

This chapter describes the characteristics of the Sambalpur District, including its basic demographic profile and the reasons for its existence of soil degradation in different blocks. A detailed overview of the Sambalpur District comprising with the nine blocks have been also discussed.

This chapter consists the detailed overview of the study area comprising of the nine blocks.

3.1 INTRODUCTION TO THE SITE

The Sambalpur District is located in Odisha's western region. The district is surrounded by the districts of Deogarh in the east, Bargarh in the west, Jharsuguda in the north, and Sonepur and Angul in the south.

The District is located between 20 degrees 40' and 22 degrees 11' north latitude and 82 degrees 39' and 85 degrees 15' east longitude, covering 6702 square kilometres.

According to the 2011 census, the total population of the District is 10,41,099. The male population of the District is 5,26,877, while the female population is 5,14,222. A total of 1,91,827 SCs and 3,55,261 STs live in the District.

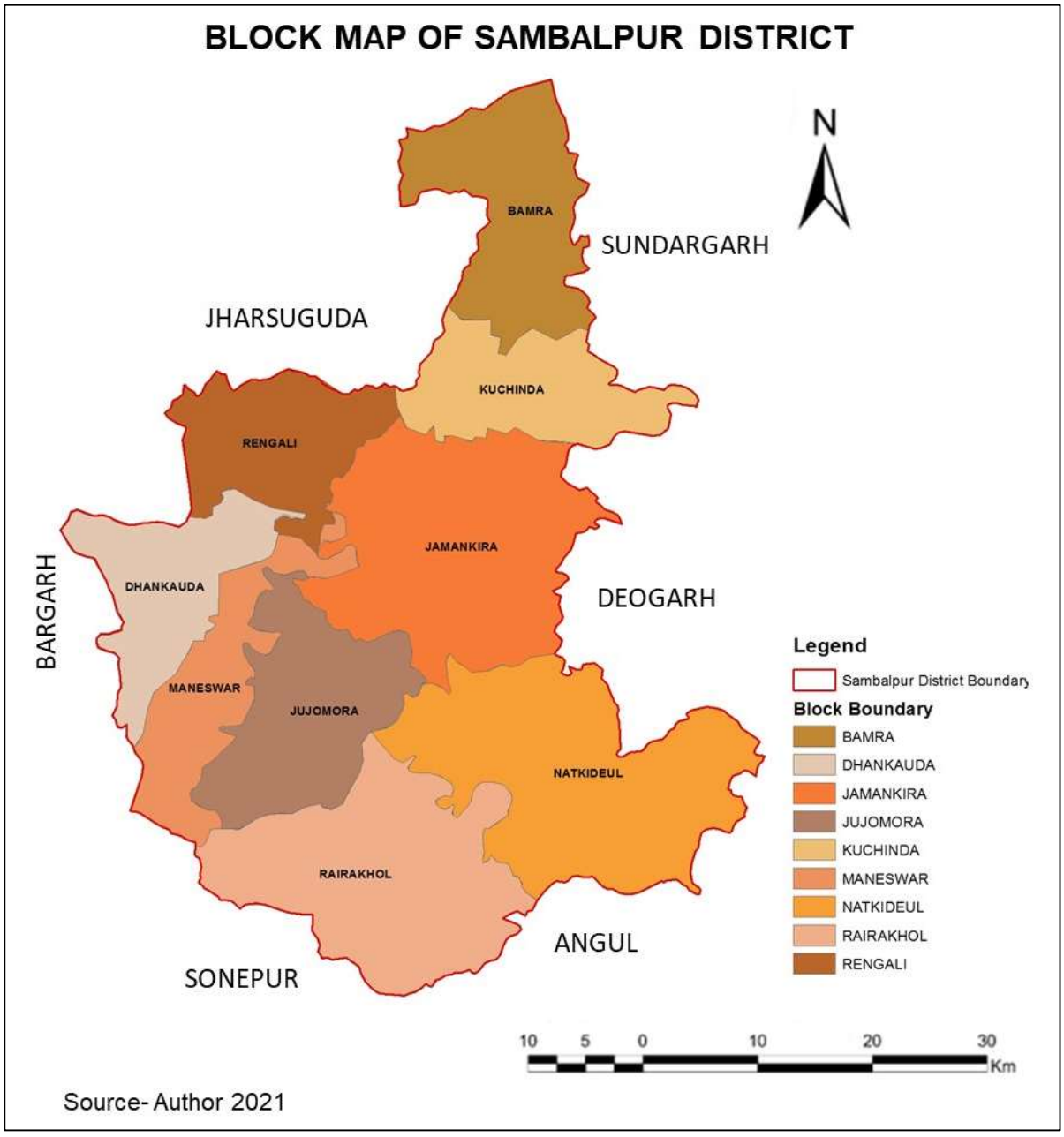
Agriculture is the primary source of income in Sambalpur District, with forests coming in second.

Sambalpur District has a severe climate, with an average of 66 rainy days and 153 centimetres of rainfall per year. Rainfall is extremely uneven and unpredictable. Due to the unpredictable rainfall or scanty rainfall the crop productivity gets effected. Most of the farmers in Sambalpur District depends on rainfall for good crop production but due to the scanty rainfall there is many consequences faced by the farmers as well.

Sambalpur district comprises of nine blocks which consists of Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. Most of the blocks like Most of the blocks (Jujumora, Jamankira, Kuchinda,Naktideul, Rairakhol) are dependent on rain fed agriculture.

Inappropriate managed or excessive irrigation in the blocks like Dhankauda and Maneswar leads to salinization, soil degradation. These are the blocks which are facing the issue of soil degradation.

Figure 2: Block Map of Sambalpur District



Source- Author 2021

The above map represents the Block Map of Sambalpur District which comprises of nine blocks namely Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. Most of the blocks in the district are affected by the soil degradation which ultimately leads to the impacts on the agricultural production. Most of the blocks (Jujumora, Jamankira, Kuchinda, Naktideul, Rairakhol) are dependent on rain fed agriculture. Over-irrigation is also a problem which is faced by most of the blocks in the Sambalpur District.

Inappropriate managed or excessive irrigation in the blocks like Dhankauda and Maneswar leads to salinization, soil degradation.

Table 1: Basic Information about Sambalpur District

1	Geographical Area (in Ha)	6,66,293	
2	Cultivated Area (in Ha)	1,93,674	
	a. High Land	96,535	
	b. Medium Land	60,759	
	c. Low Land	36,380	
3	Paddy Area (in Ha)	1,04,970	(54%)
	a. High Land	8,716	(8%)
	b. Medium Land	59,874	(57.0%)
	c. Low Land	36,380	(35.0%)
4	a. Irrigated Area (in Ha) (in Kharif)	96,413	(50%)
	b. Irrigated Area (in Ha) (in Rabi)	51166	(26%)
5	Non-Irrigated Area (in Ha)	97261	(50%)
6	Farm families (in nos)	1,20,851	
	a. Small Farmers	60185	(49%)
	b. Marginal Farmers	46,514	(38%)
	c. Big Farmers	14,152	(13%)
7	Agriculture Labourers (in nos)	1,33,943	
8	No. of Blocks	9	
9	No. of GPs/ULB	138+3ULB	
10	No. of villages	1263	
11	No of wards	85	
12.	No of ADO Circle	3	Sambalpur Rairakhol Kuchinda
13	No of PACS	46	
14	No of Fertilizer dealer	215	

15	No of Seed dealer	151 (Pvt-105+PACs-46)	
16	No of Pesticide dealer	82	

3.2 SITE JUSTIFICATION

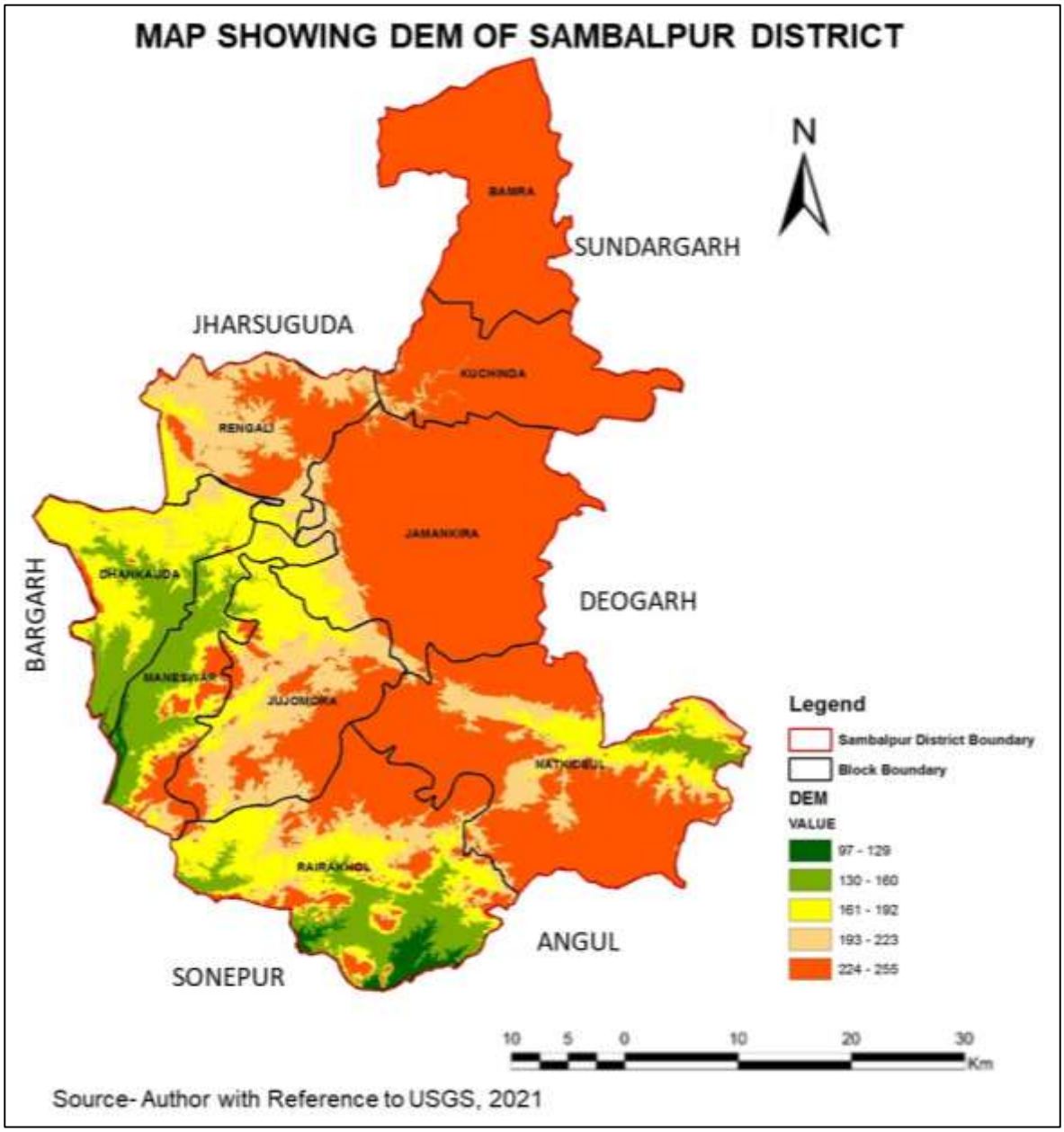
Owing to a variety of factors, the district is vulnerable to soil depletion. Rainfall and its severity usually cause soil erosion and surface runoff. There are the four major forms of soil erosion caused by it which consists of Splash erosion, sheet, rill erosion, and gully.

Rill and gully erosion can be seen in areas of the district where the topography is undulating and hilly. There are no valid data on the state of soil erosion and runoff in the blocks or districts for review. However, based on the district's degraded forest / vegetative cover, it's safe to say that top soil erosion is a problem. In some parts of the district, soil erosion (bank erosion) is occurring as a result of the current river and stream / Nala. Over-irrigation is also one of the biggest reason for the displacement of soil nutrients in the blocks of Sambalpur district. Some of the blocks are dependent on rain for agriculture production. Due to the scanty rainfall the land becomes barren and this also leads towards the poor quality of soil. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management.

Furthermore, since the district is in the semi-arid region, wind erosion is a problem. Top soil erosion has been exacerbated by various infrastructure construction projects, as well as industry and mining activities. Soils are dominantly acidic in nature in all the blocks of Sambalpur District. Boron is the most deficient nutrient amongst all the soil nutrients. Zinc deficiency is also found in Sambalpur District. Most of the blocks (Jujumora, Jamankira, Kuchinda,Naktideul, Rairakhol) are dependent on rain fed agriculture.

Inappropriate managed or excessive irrigation in the blocks like Dhankauda and Maneswar leads to salinization. These are the various blocks which are affected by the negative effects of soil degradation and this is ultimately harming the crop production of the district as well.

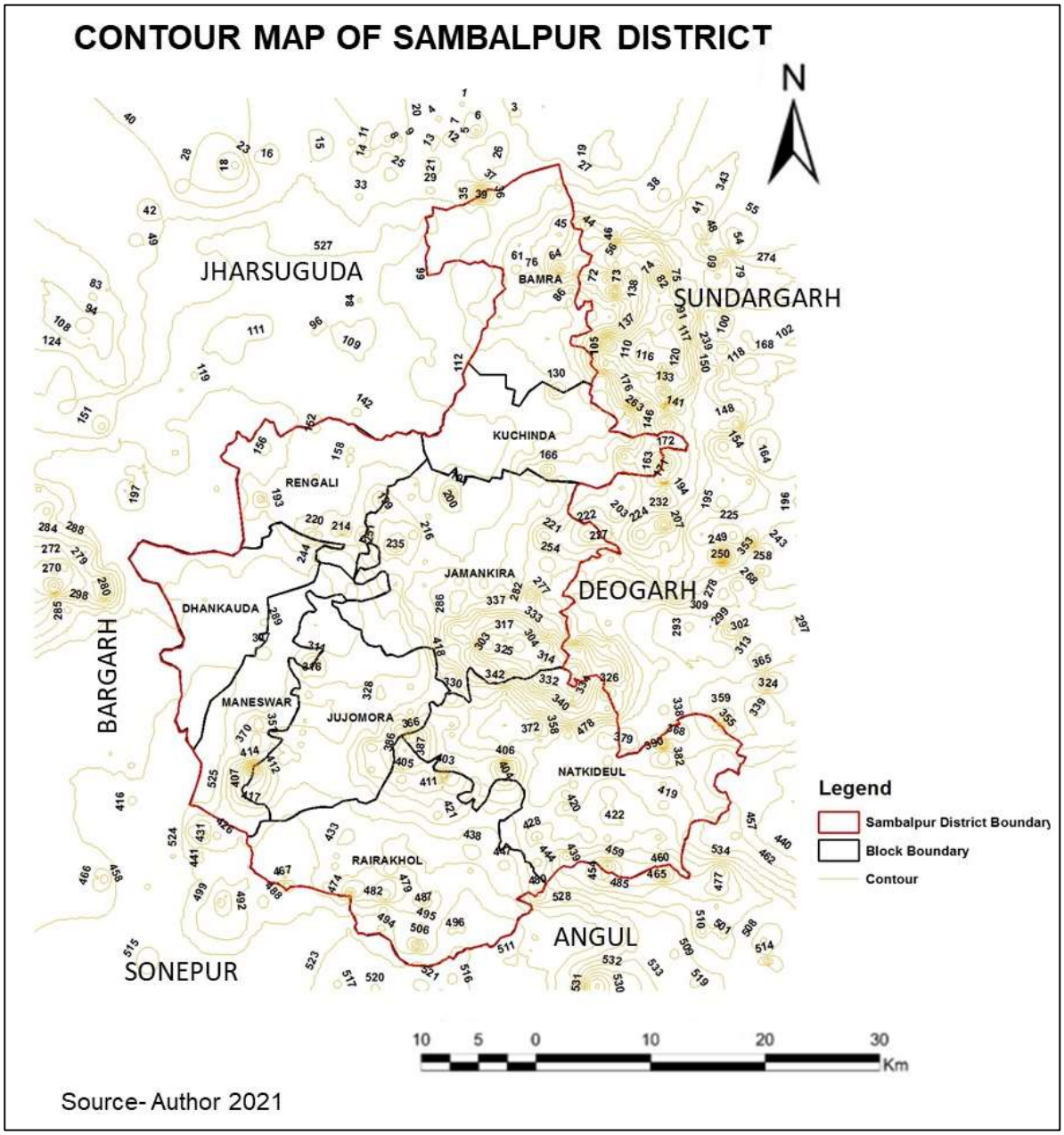
Figure 3: DEM Map of Sambalpur District



Source- Author with Reference to USGS, 2021

The above map represents the DEM Map of the Sambalpur District where we can clearly see the value ranges from 97 to 255. The Digital Elevation Model (DEM) are used in Geographic Information Systems. These are further used to generate the Slope and Aspect Map of Sambalpur District. The above map represents the DEM Map of Sambalpur District. As we can see clearly in the map this has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

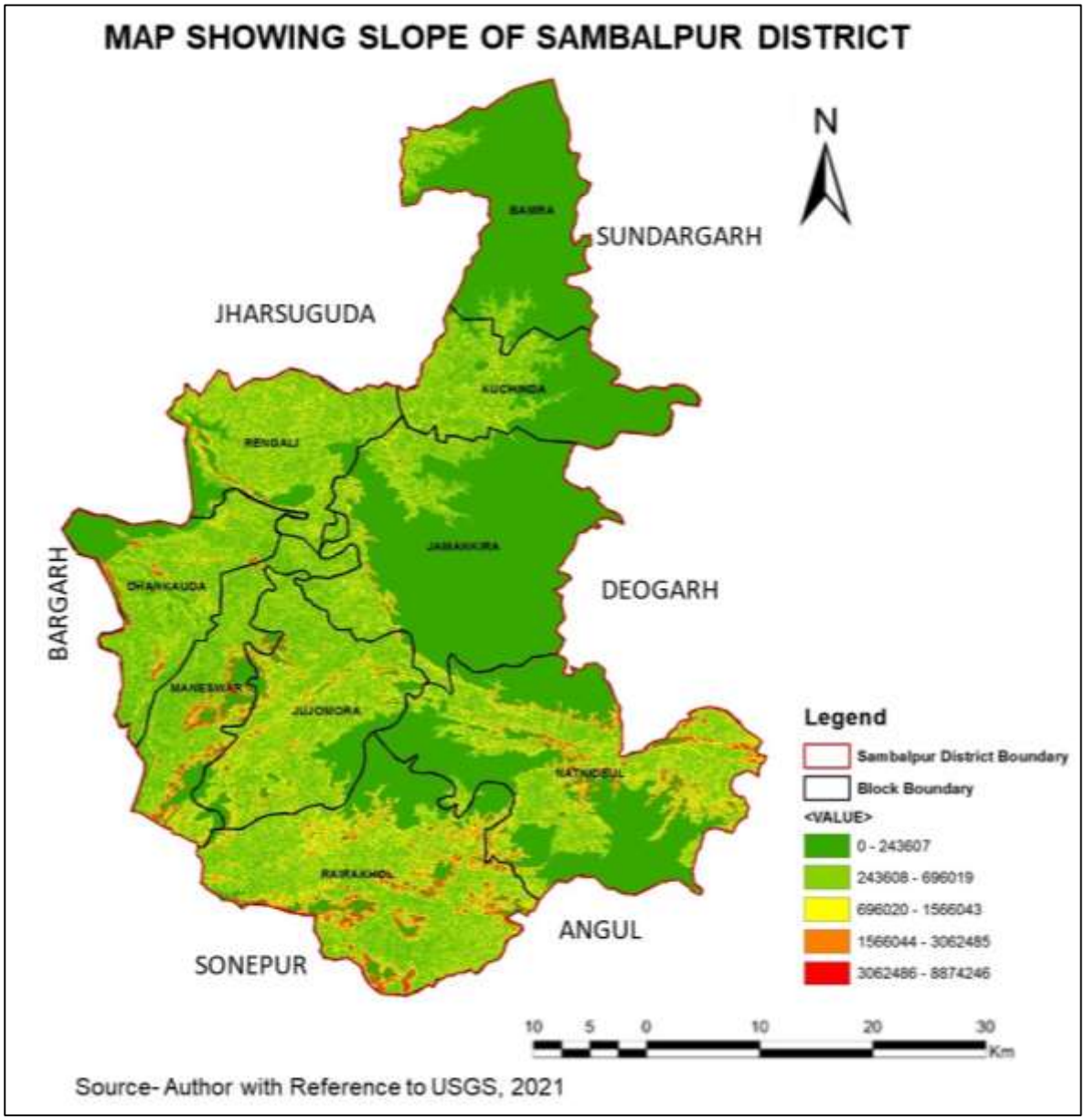
Figure 4: Contour Map of Sambalpur District



Source- Author 2021

The above map represents the contour map of Sambalpur District. The above map represents the Contour Map of Sambalpur District. As we can see clearly in the map this has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. In certain parts sections of the district with undulating and hilly topography, rill and gully erosion can be seen. In the blocks / area, there has been evidence of soil erosion and runoff.

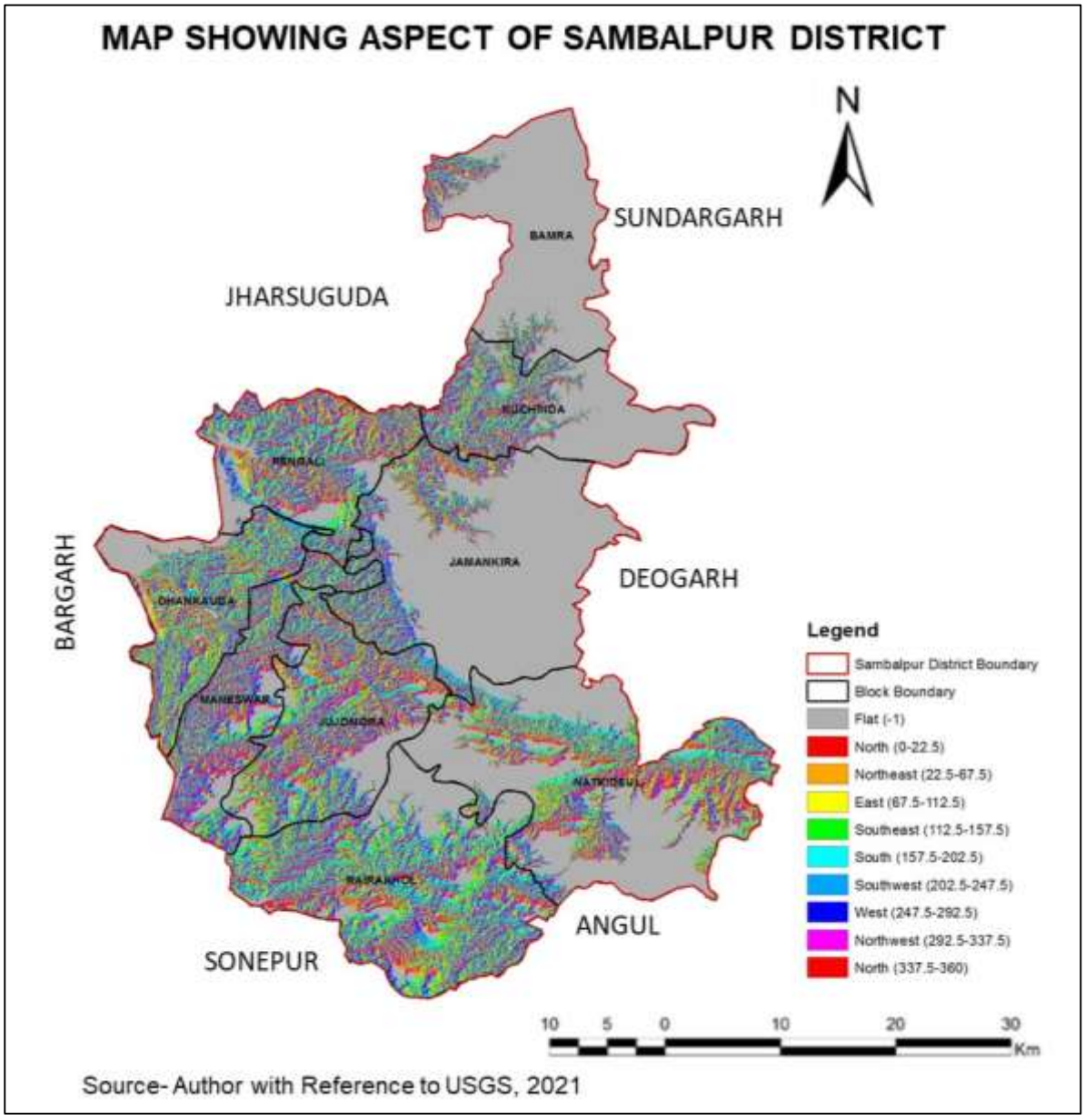
Figure 5: Slope Map of Sambalpur District



Source- Author with Reference to USGS, 2021

The above map represents the slope map of Sambalpur District. The above map represents the Slope Map of Sambalpur District. As we can see clearly in the map this has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. In certain parts sections of the district with undulating and hilly topography, rill and gully erosion can be seen. In the blocks / area, there has been evidence of soil erosion and runoff. Most of the blocks in the district are facing the problem of soil degradation.

Figure 6: Aspect Map of Sambalpur District



Source- Author with Reference to USGS, 2021

The above map represents the Aspect map of Sambalpur District. The above map represents the Aspect Map of Sambalpur District. As we can see clearly in the map this has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. In certain parts sections of the district with undulating and hilly topography, rill and gully erosion can be seen. In the blocks / area, there has been evidence of soil erosion and runoff. Most of the blocks in the district are facing the problem of soil degradation.

CHAPTER 4 DATA COLLECTION AND ANALYSIS

This chapter presents the application of data collected towards the data analysis methods for collected data in depth and draws a research conclusion.

4.1 DATA COLLECTION METHODS

4.1.1 PERCEPTION STUDY

Perception Study of the farmers to understand the main reason behind the issue of soil degradation. And how the farmers are taking various steps to reduce the effect of soil degradation.

4.1.2 INTERVIEWS WITH VARIOUS STAKEHOLDERS AND FOCUSED GROUP DISCUSSIONS

Interviews had been conducted with Soil Conservation Officer, Sambalpur, Agricultural Officer and other officials as well at Krishi Vigyan Kendra, Sambalpur, Soil Conservation Office, Soil Testing Laboratory, District Agriculture Office Sambalpur.

4.1.3 SITE PERCEPTION

Site Perception was conducted to understand the baseline scenario of the study area.

4.2 QUESTIONNAIRE

1.What are the various causes of Soil Degradation? (In Sambalpur District)

2.What is the current status of Soil Degradation in Sambalpur District?

3.What are the various methods and techniques used by Farmers to reduce the Soil Degradation?

4. What is the impact on Agricultural Production?

5.Which blocks are majorly Soil degraded and has a detrimental impact on the environment?

6.Which villages are mostly degraded by the impacts of Soil Degradation?

7.What are the physical and chemical properties of soil in Sambalpur District? (considering all the soil parameters)

8.What are the various schemes and policies to combat the issue of soil degradation?

9. What is the status of the ongoing schemes and policies to combat soil degradation?

10.What measures should be introduced to reduce the issue of soil degradation?

4.3 DATA CHECKLIST

Table 2: Data Checklist

DATA REQUIRED	SOURCES	STATUS
Causes of Soil Degradation in the Study area	Secondary Data Collection, Krishi Vigyan Kendra, Sambalpur	Partially Collected
Soil Degradation Status	ULB, Block Office, KVK Sambalpur	To be Collected
Perception of Various Stakeholders	Interviews, Visual Surveys	To be Collected
Various techniques or methods used by farmers to reduce soil degradation	Secondary Data Collection, Interviews	To be collected
Impacts on Agricultural Production	Ground Survey (Site Visit)	To be Collected

Source- Author

4.4 DATA SCHEME WITH REASONING

Table 3: Data Scheme with Reasoning

DATA REQUIRED	REASON
Causes of Soil Degradation in the Study area	Land use and Land cover management
Soil Degradation Status	Preparation of SQI (Soil Quality Index)
Perception of Various Stakeholders	Qualitative analysis
Various techniques or methods used by farmers to reduce soil degradation	For proposing Policy level interventions
Impacts on Agricultural Production	For showing the temporal changes in vegetative cover and how it has impacted the crop growth.
Physical and Chemical Properties of the Soil	To analyse the soil has degraded to what extent for further analysis.
Policies and Schemes	To know the current status of the Policies and Schemes and Benefits.

Source- Author

4.4 ANALYSIS METHODS

Table 4: Analysis Methods

ANALYSIS	SOURCES
Mapping	Using GIS Tools and Techniques, Spatio-temporal changes (LULC), Preparation of SQI (Soil Quality Index) Map, Map showing Changes in vegetative cover, Contour, Slope and Aspect
Qualitative Analysis	Survey findings and Statistical Analysis (Site Visit)

Source- Author

4.5 VISUAL PERCEPTION SURVEY

Figure 7: Images showing Soil Degradation in Sambalpur District

The above images represent the soil degradation in the different blocks of the Sambalpur District. As it is clear from the figure different types of soil degradation is taking place and due to which there is loss in crop production or agricultural productivity.

Source- Author,2021

The above figures represent the soil degradation on the site. These are the various types of degradation which can be seen in the figures.

4.6 SOIL FERTILITY STATUS OF SAMBALPUR DISTRICT

Table 5: Block-wise Initial Soils Data Range and Mean Value

BLOCK	pH	EC (dS/m)	OC (%)	Av.P (kg/ha)	Av.K (kg/ha)	Av.S (ppm)	Av.Zn (ppm)	Av.B (ppm)	Av.Fe (ppm)	Av.Cu (ppm)	Av.Mn (ppm)	NO. OF SAMPLES
BAMRA	4.01--8.12 (5.41)	0.03--7.86 (0.50)	0.09--2.37 (0.50)	0.15--72.54 (11.55)	19.9--462.95 (244.64)	1.84--725.7 (33.87)	0.09--12.6 (1.49)	0.08--1.26 (0.35)	2.96--308.98 (62.37)	0.3--4.76 (1.73)	0.84--172.16 (44.52)	150
DHANKAUDA	4.03--7.36 (5.13)	0.03--0.68 (0.30)	0.1--1.92 (0.67)	1.09--39.34 (11.26)	16--345.85 (80.00)	1.52--105.87 (18.05)	0.1--1.72 (0.92)	0.09--0.72 (0.27)	5.5--199.96 (99.07)	0.34--3.86 (1.42)	1.14--88.28 (20.15)	100
JAMANKIRA	3.89--7.93 (5.20)	0.03--5.31 (0.25)	0.07--1.41 (0.55)	0.74--72.36 (9.92)	11.7--493.8 (122.49)	0.9--661.54 (23.91)	0.1--3.21 (0.77)	0.05--3.15 (0.28)	3.02--386.2 (78.81)	0.24--5.58 (1.95)	1.54--134.88 (43.47)	250
JUJUMURA	4.33--8.17 (5.65)	0.03--0.78 (0.15)	0.22--1.41 (0.60)	1.3--61.17 (11.24)	12.35--346.14 (108.97)	1.38--147.58 (16.90)	0.18--3.48 (0.82)	0.13--2.75 (0.36)	5.18--298.24 (73.17)	0.44--4.78 (1.88)	2.38--160.52 (39.71)	100
KUCHINDA	4.01--7.78 (4.87)	0.02--1.32 (0.13)	0.1--1.33 (0.52)	1.99--72.33 (17.41)	51.11--371.47 (116.26)	1.07--125.56 (12.05)	0.08--3.54 (0.83)	0.08--2.69 (0.35)	4.54--281.88 (88.08)	0.26--4.54 (1.62)	3.54--170.28 (35.91)	100
MANESWAR	4.27--8.32 (5.56)	0.03--1.08 (0.15)	0.11-1.68 (0.54)	1.73--72.16 (17.96)	30--399.02 (121.43)	1.9--179.43 (16.92)	0.1--2.62 (0.65)	0.06--1.3 (0.26)	7.34--313.76 (69.83)	0.32--3.02 (1.38)	3.94--136.08 (47.02)	100
NAKATIDEUL	4.17--7.98 (5.36)	0.02--0.65 (0.13)	0.18--1.16 (0.65)	0.97--53.69 (10.47)	18.65--496.15 (127.12)	1.7--73.59 (15.16)	0.08--3.9 (0.97)	0.12--0.97 (0.31)	9.66--296.7 (74.43)	0.42--5.58 (2.16)	3.16--136.06 (36.72)	150
RAIRAKHOL	4.32--8.11 (5.76)	0.02--2.96 (0.15)	0.18--1.4 (0.72)	1.24--72.41 (11.39)	14.25--483.55 (125.27)	1.26--251.86 (16.37)	0.14--3.94 (1.18)	0.07--0.93 (0.27)	4.22--211.1 (60.96)	0.22--6.02 92.15)	2.92--205.06 (48.77)	150
RENGALI	4.25--7.61 (5.28)	0.03--0.67 (0.13)	0.16--1 (0.50)	1.07--52.82 (10.87)	12.7--356.5 (103.59)	0.97--78.61 (12.24)	0.12--3.42 (1.08)	0.05--0.73 (0.27)	7.08--133.18 (59.94)	0.16--3.44 (1.67)	3.34--148.42 (34.56)	70

Source- Soil Testing Laboratory, Sambalpur and Odisha Bhoochetna

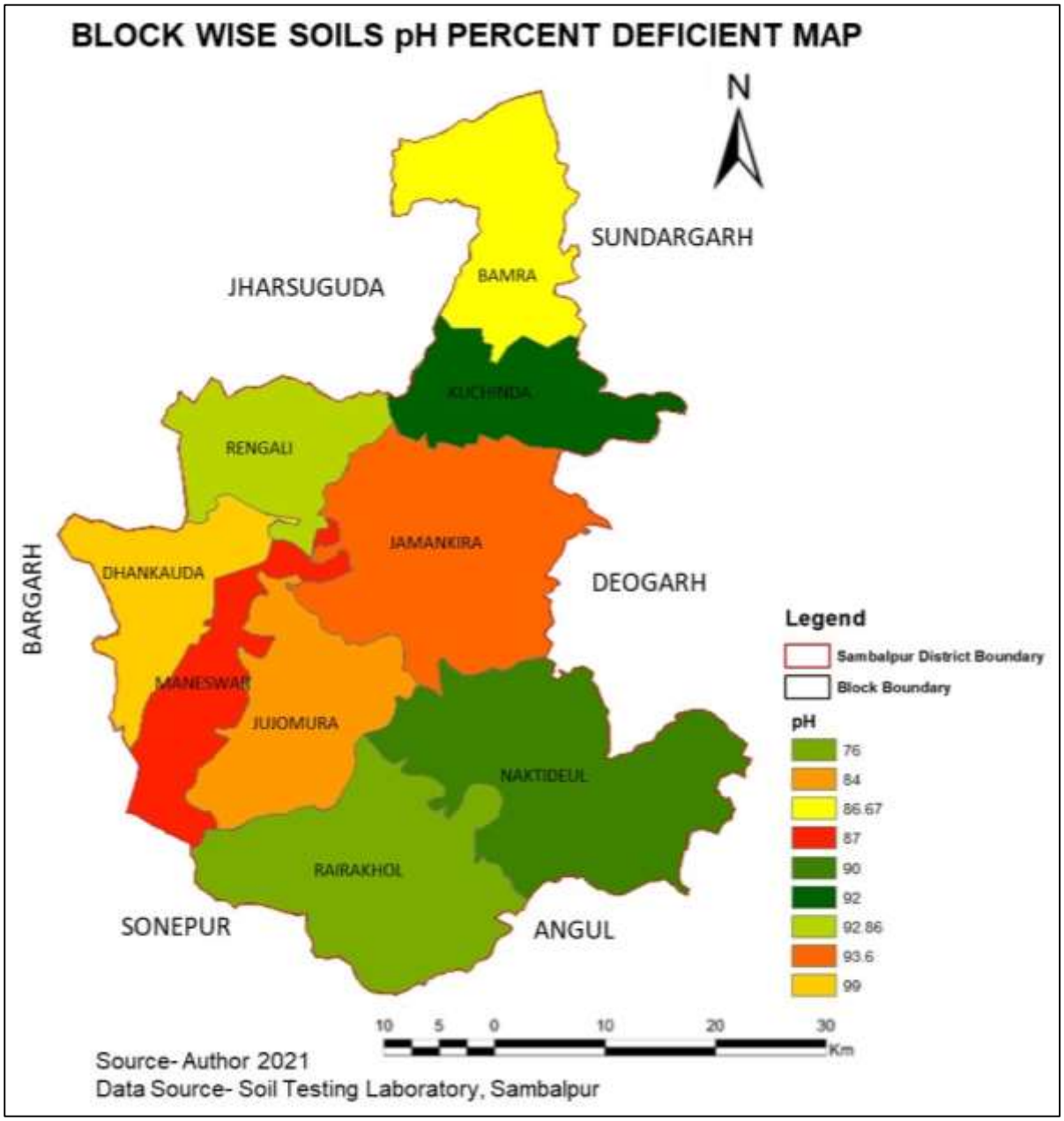
Table 6: Block-wise Initial Soil Nutrient Percent Data

BLOCK	pH	EC	OC	Av.P	Av.K	Av.S	Av.Zn	Av.B	Av.Fe	Av.Cu	Av.Mn	NO. OF SAMPLES
	ACIDIC	NORMAL										
BAMRA	86.67	97	57.33	56	15.33	40	40.67	84	6.67	2.67	2.67	150
DHANKAUDA	99	100	33	44	68	27	31	96	1	1	9	100
JAMANKIRA	93.6	99	42	62.4	13.6	47.6	44.8	96	3.2	1.6	0.8	250
JUJUMURA	84	100	3500%	59	17	43	46	89	7	0	12	100
KUCHINDA	92	100	5300%	32	0	61	58	91	2	1	1	100
MANESWAR	87	100	4900.00%	43	9	38	56	98	0	1	1	100
NAKATIDEUL	90	100	2533.00%	52.67	22.67	47.33	31.33	93.33	0	0	0.67	150
RAIRAKHOL	76	100	1667%	61.33	14.67	40.67	25.33	94.67	0.67	2.67	0.67	150
RENGALI	92.86	100	5571%	55.71	25.71	60	40	84.29	0	2.86	1.43	70

Source- Soil Testing Laboratory, Sambalpur and Odisha Bhoochetna

The above table represents the Soil Fertility Status of Sambalpur district. The table denotes the Block-wise Initial Soils Data Range and Mean Value and the Block-wise Initial Soil Nutrient Percent Data. These data are for all the nine blocks of the Sambalpur District. The first table represents the Block-wise Initial Soils Data Range and Mean Value while the second table represents the Block-wise Initial Soil Nutrient Percent Data.

Figure 8: Block Wise Soils pH Percent Deficient Map

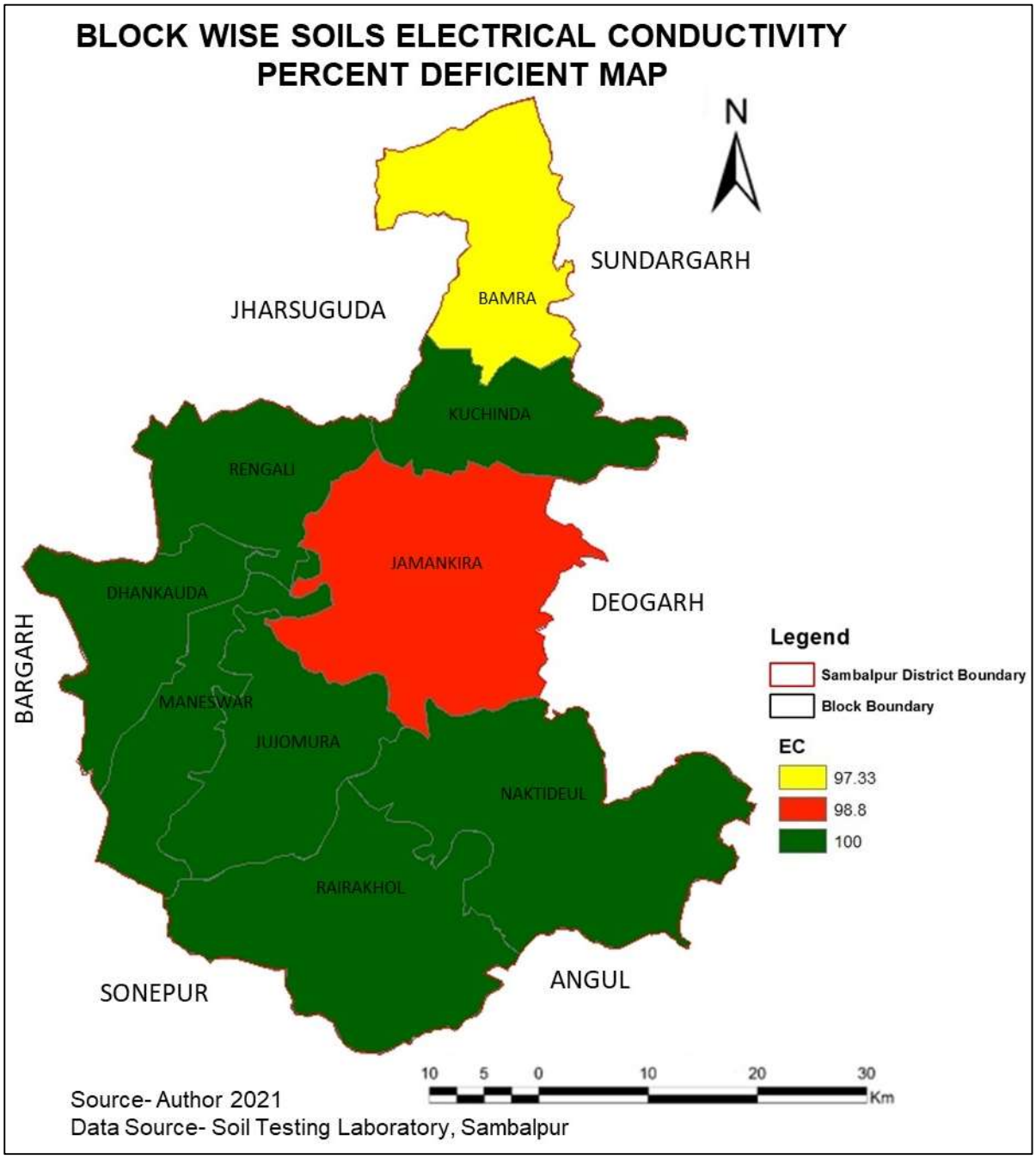


Source- Author 2021
Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Ph Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

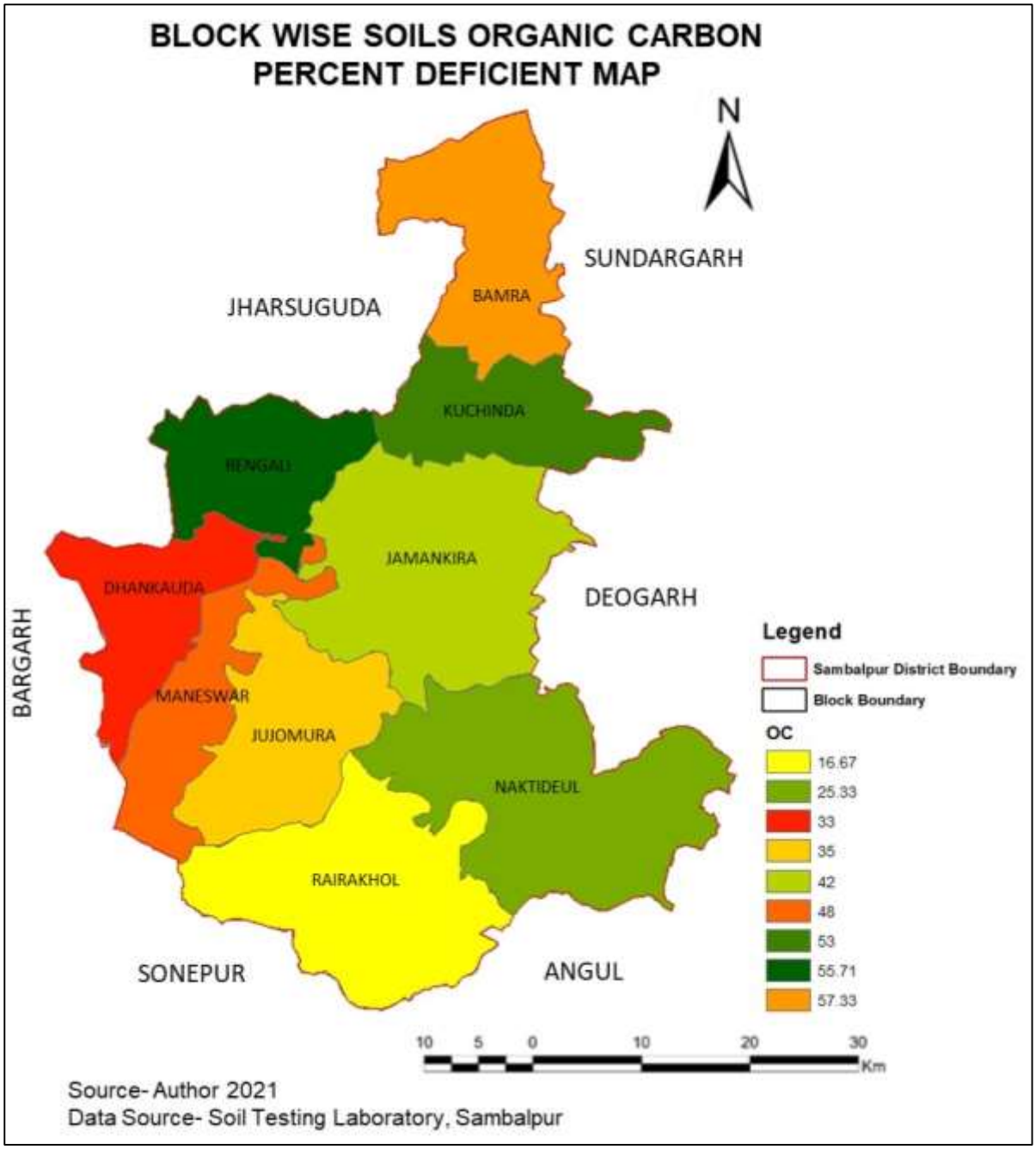
Figure 9: Block Wise Soils Electrical Conductivity Percent Deficient Map



Source- Author 2021
Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Electrical Conductivity Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

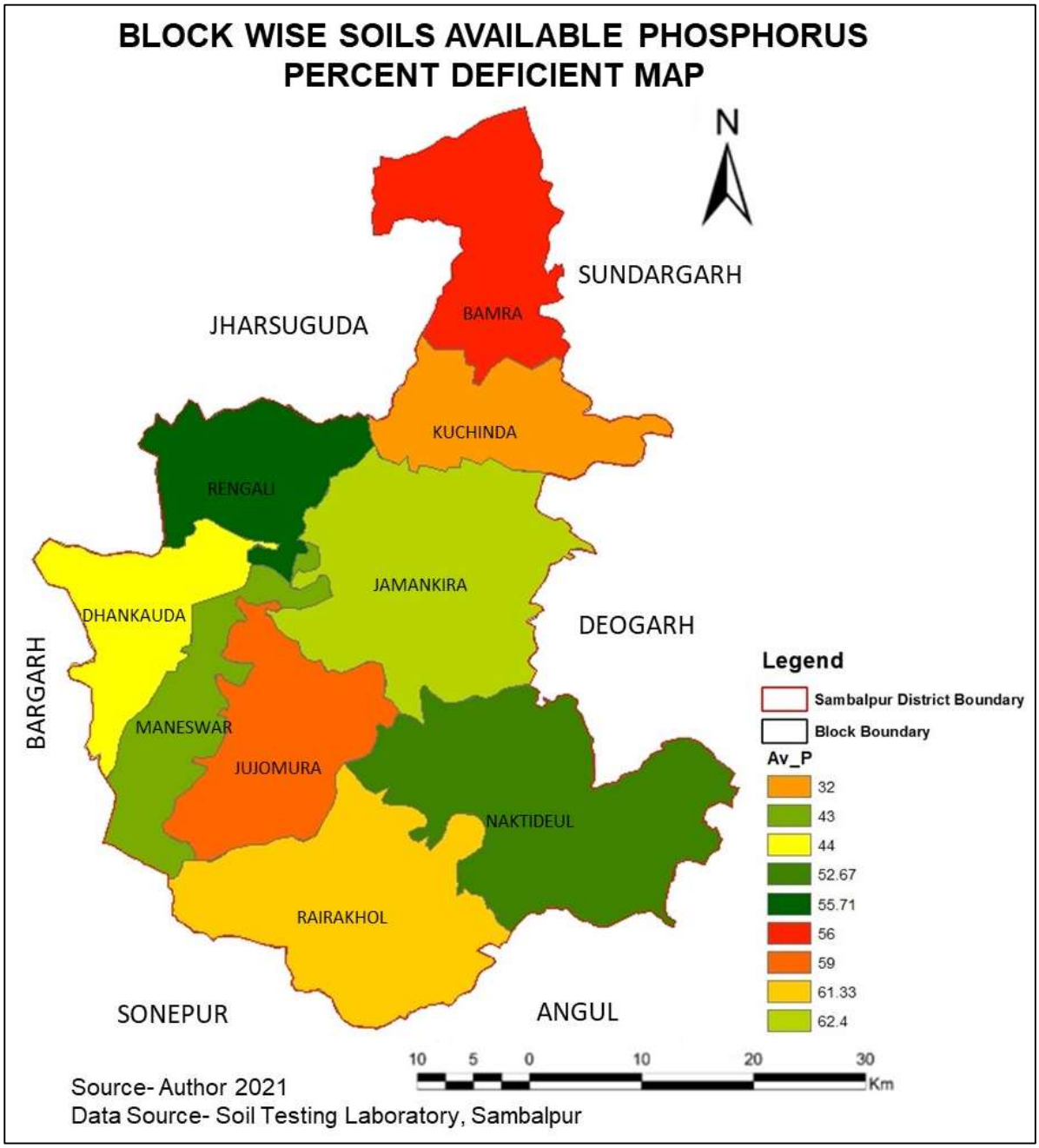


Source- Author 2021
Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Organic Carbon Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

Figure 10: Block Wise Soils Available Phosphorus Percent Deficient Map



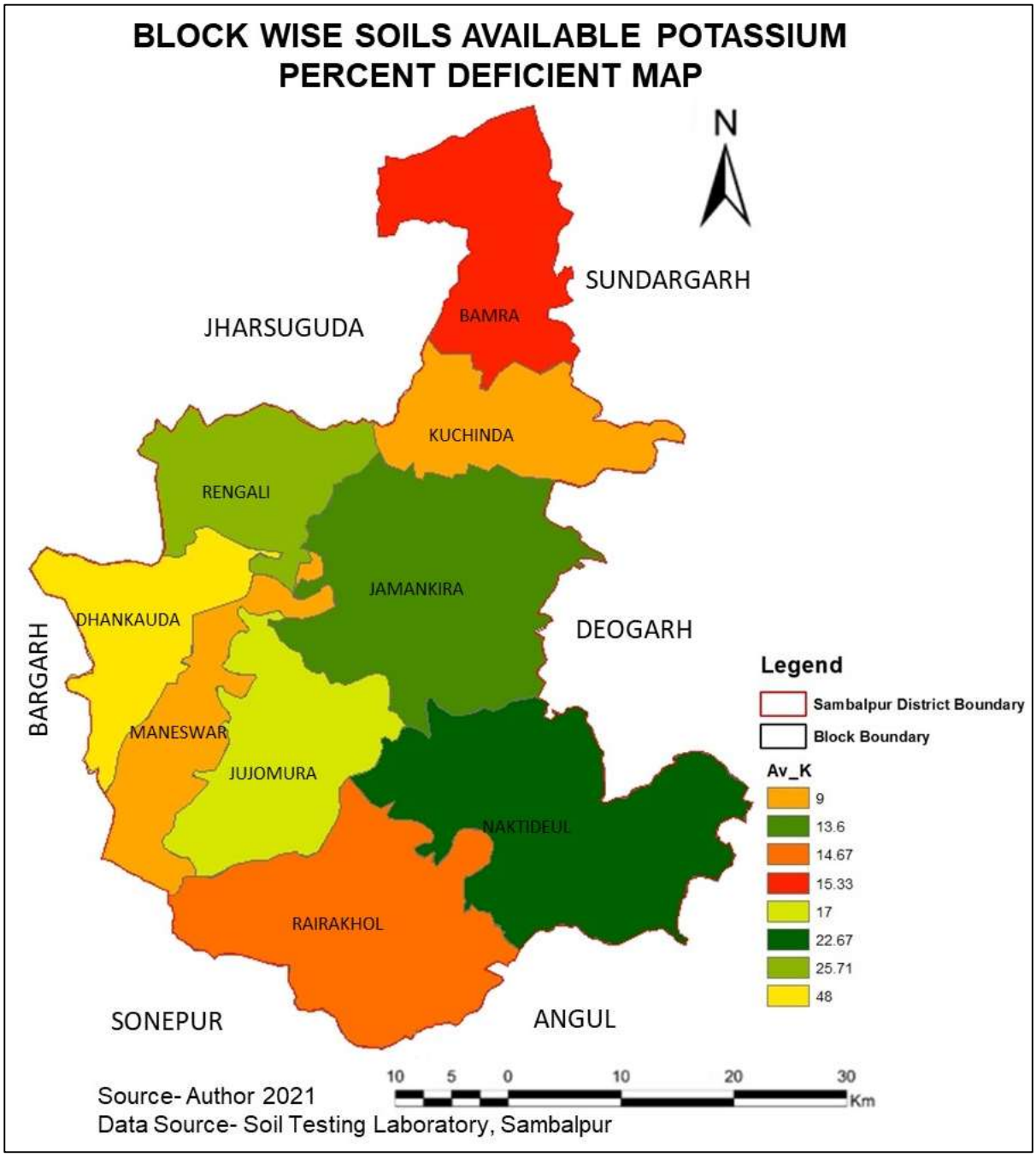
Source- Author 2021

Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Available Phosphorus Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

Figure 11: Block Wise Soils Available Potassium Percent Deficient Map

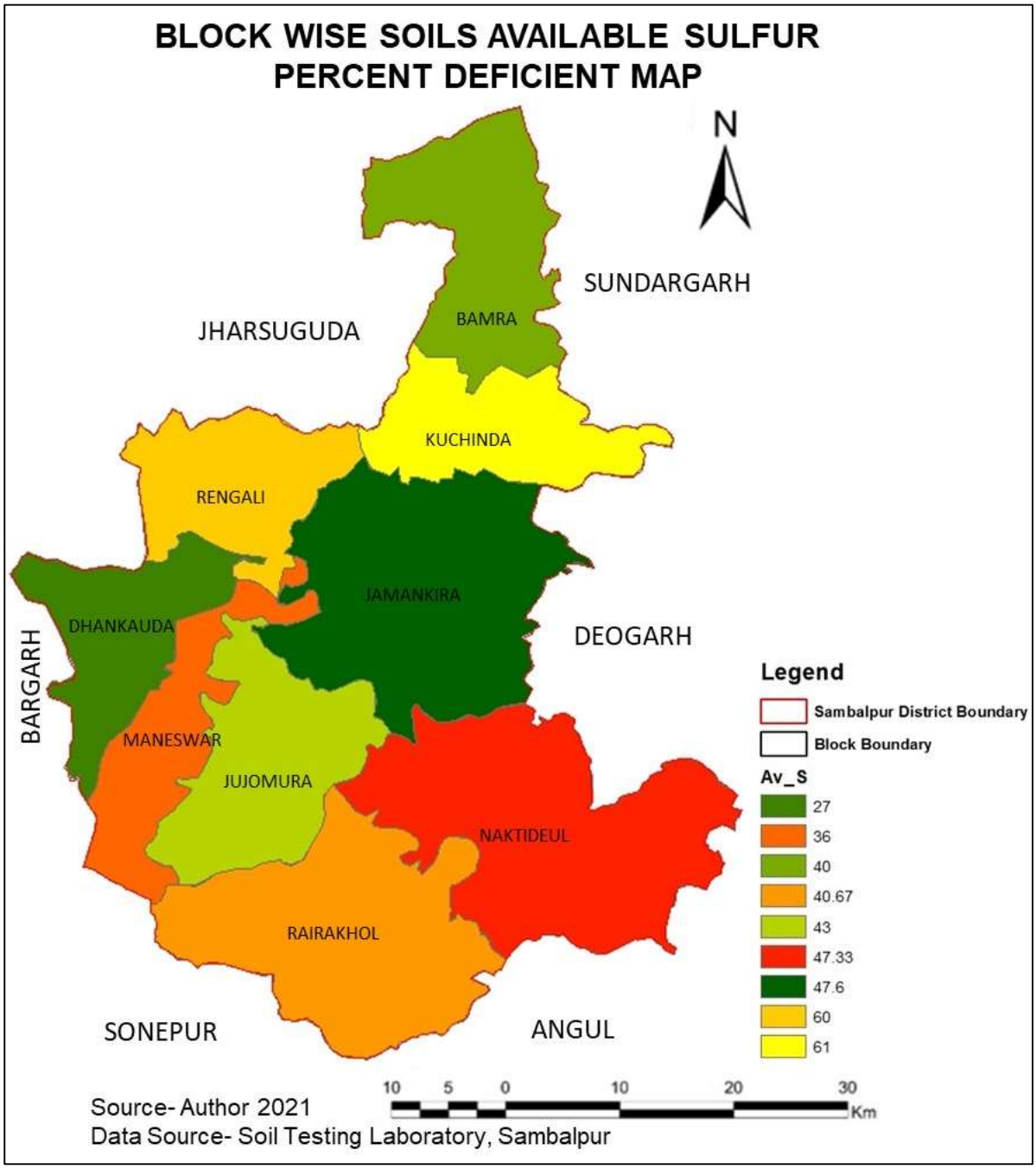


Source- Author 2021
Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Available Potassium Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

Figure 12: Block Wise Soils Available Sulfur Percent Deficient Map



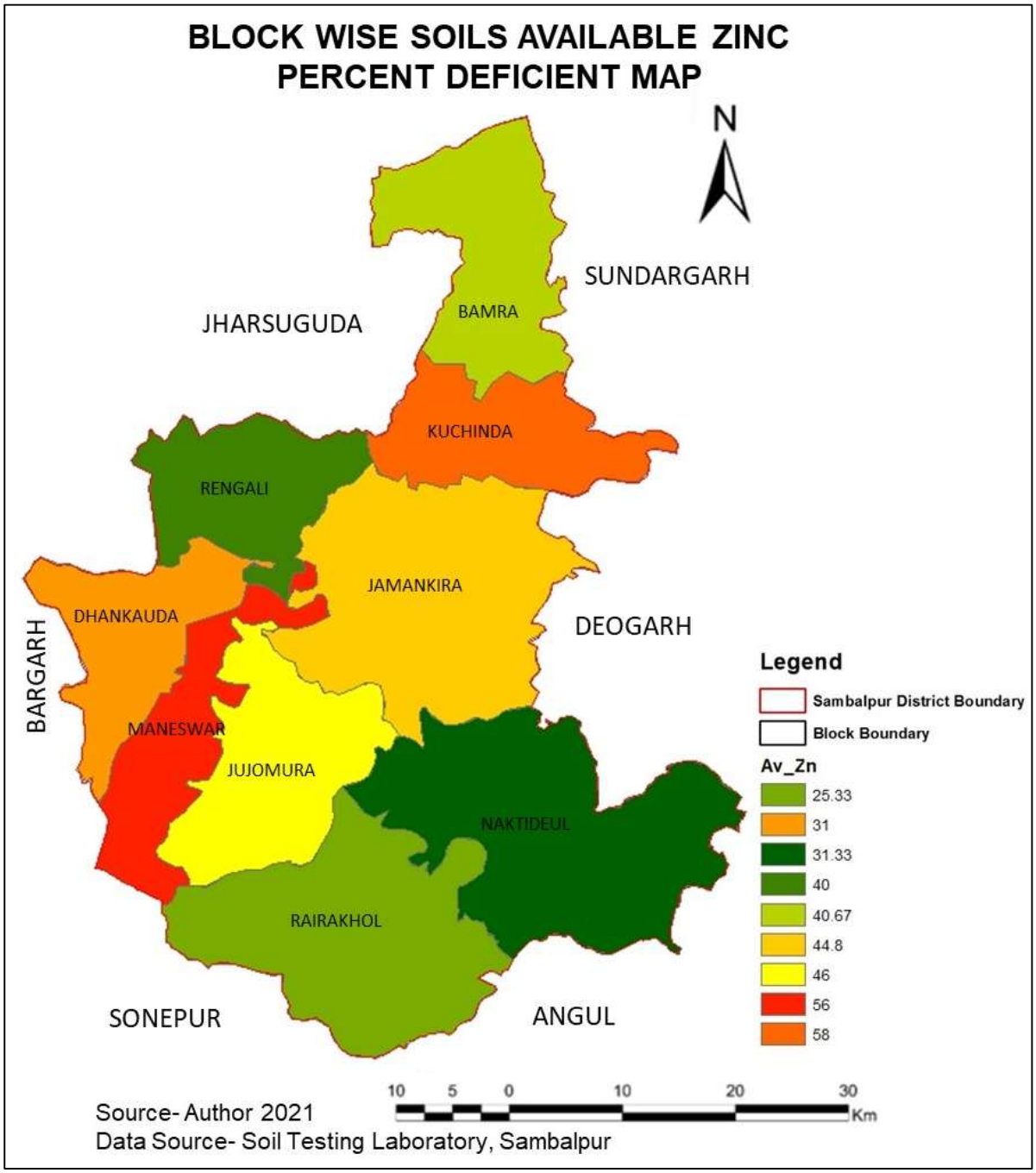
Source- Author 2021

Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Available Sulfur Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

Figure 13: Block Wise Soils Available Zinc Percent Deficient Map

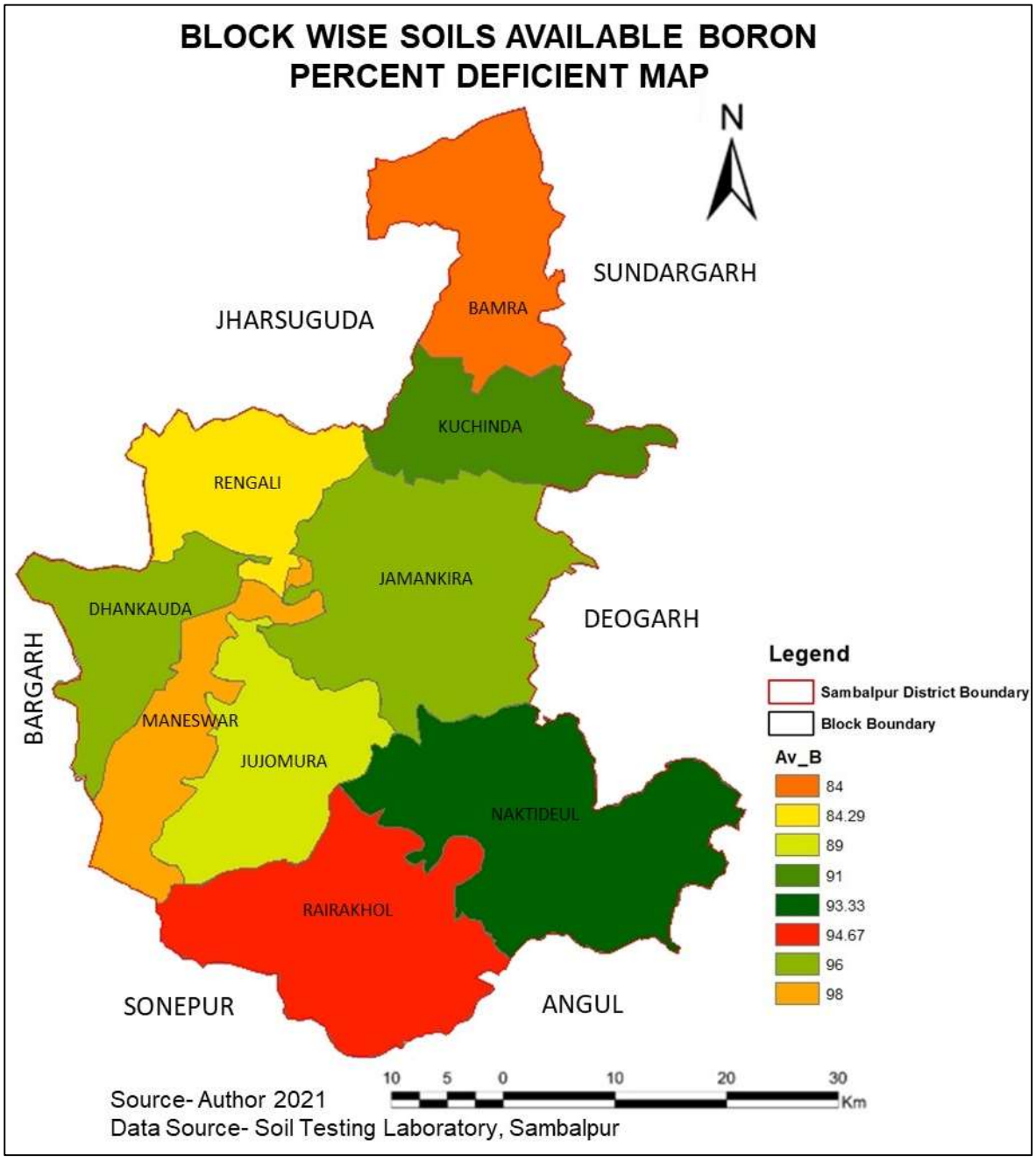


Source- Author 2021
Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Available Zinc Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

Figure 14: Block Wise Soils Available Boron Percent Deficient Map



Source- Author 2021
Data Source- Soil Testing Laboratory, Sambalpur

INFERENCE

The above map represents the Block-wise Soils Available Boron Percent Deficient Map of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

4.7 MAPPING OF SOIL STATUS AND DEGRADATION

Table 7: Soil Parameter, Value Range and Classification

PARAMETER	VALUE RANGE	CLASSIFICATION
Ph	<4.4	Extreme to ultra-acidic
	4.5-5.5	Strong to very strong acidic
	5.6-6.5	Slight to moderately acidic
	6.6-7.3	Neutral
	7.4-8.4	Slight to moderately alkaline
	>8.4	Strong to very strong alkaline
Electrical conductivity (dS/m)	<0.8	Normal
	0.8-1.6	Critical to salt sensitive crops
	1.6-2.5	Critical to salt tolerant crops
	>2.5	Injurious to crop
Organic carbon (%)	<0.5	Low
	0.5-0.75	Medium
	>0.75	High
Exchangeable potassium (mg/kg)	<50	Low
	50-100	Medium
	>100	High
Available sulfur (mg/kg)	<10	Deficient
	>=10	Sufficient
Available boron (mg/kg)	<0.58	Deficient
	>=0.58	Sufficient
Available zinc (mg/kg)	<0.75	Deficient
	>=0.75	Sufficient

DIGITAL SOIL MAPPING

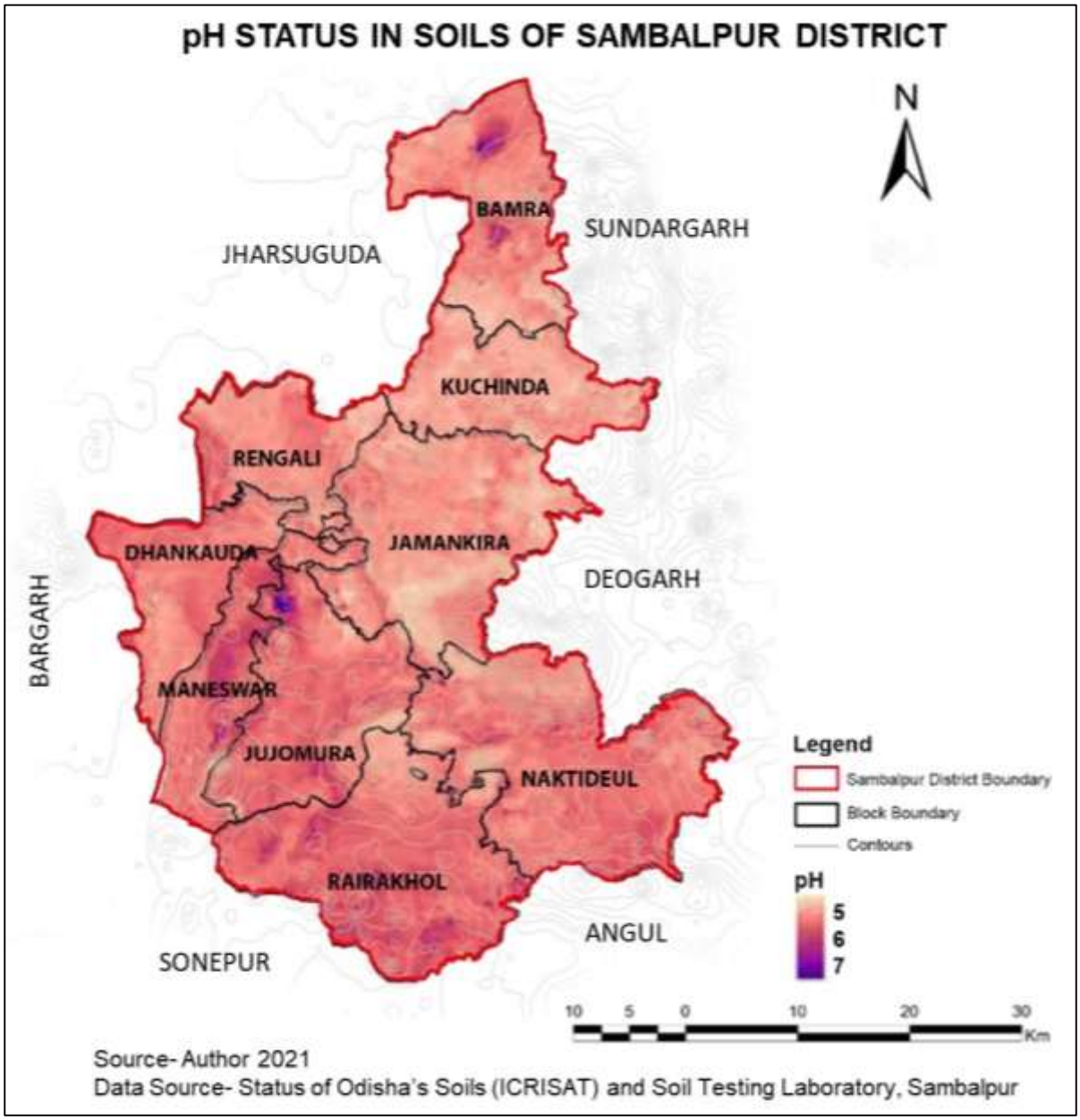
Digital Soil Mapping (DSM), also known as predictive soil mapping, is a technique for generating high-resolution data on soil surface assets. The process of creating digital soil maps is divided into three steps:

(1) Collection of legacy soil data or field and laboratory measurements of soil properties, as well as the development of base maps from available data, such as climate data, land cover, and technology;

(2) Soil property estimation based on the quantitative relationship between pointwise measured data and the spatial maps generated in phase one

(3) Derivation of estimated soil properties are used to quantify soil properties that are more difficult to quantify, such as soil water storage, carbon density, and phosphorus fixation.

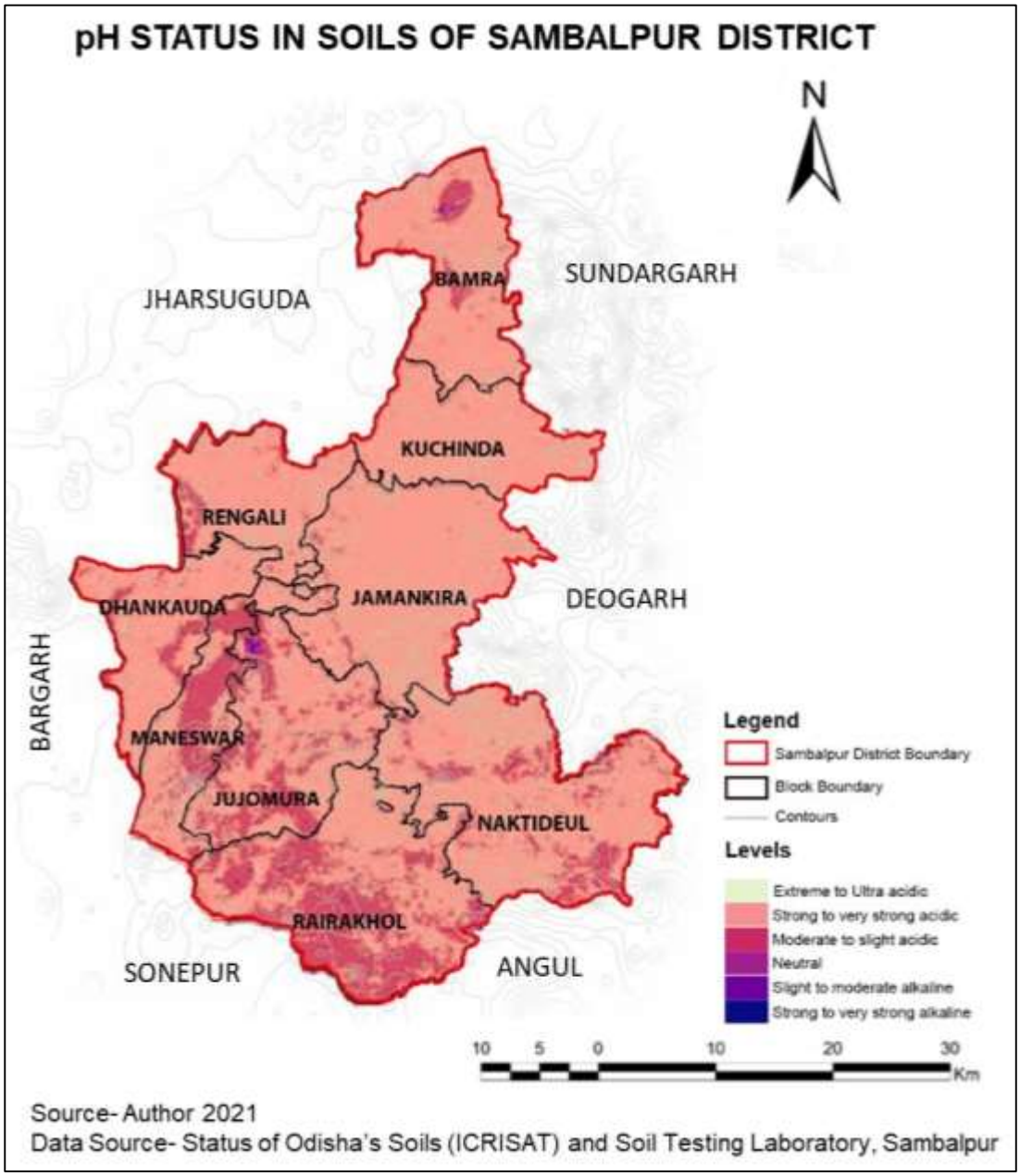
Figure 15: pH Status in Soils of Sambalpur District



INFERENCE:

The pH value is ranging from 5 to 7. Soils are dominantly acidic in nature in all the blocks of Sambalpur District. Most of the blocks has the pH level strong to very strong acidic. As we can see clearly in some parts of the district like in the block of Maneswar, Jujomora and Bamra the Ph value is 7 in some parts. While most of the blocks ranges between 5 to 6. Since the soil nature is acidic in all the nine blocks of the Sambalpur District. The blocks have the pH level strong to very strong acidic which can be easily seen in the map. This is an important soil parameter which is needed to be focussed upon and taken proper steps to maintain the value.

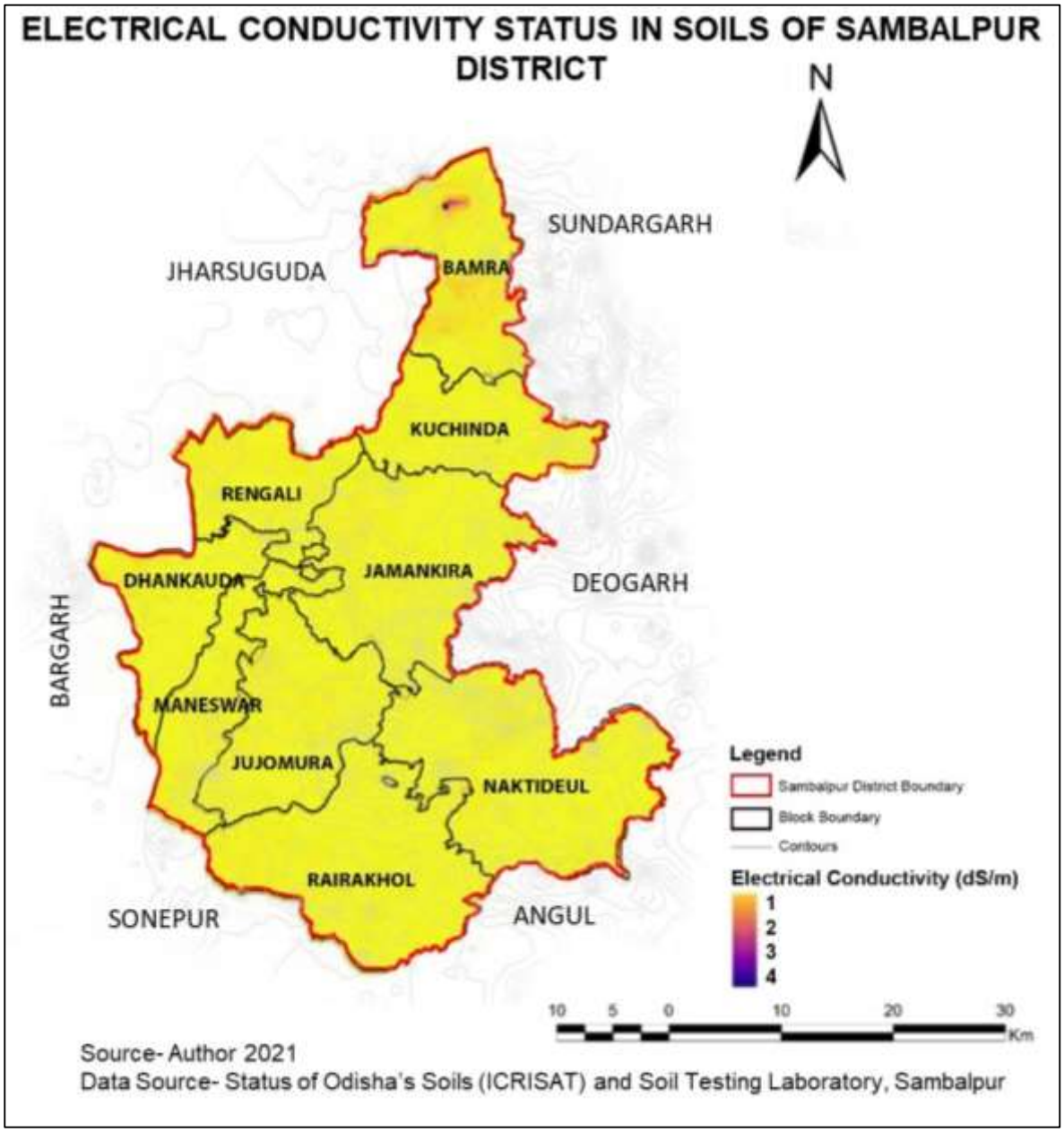
Figure 16: pH Status in Soils of Sambalpur District



INFERENCE:

The pH value is ranging from 5 to 7. Soils are dominantly acidic in nature in all the blocks of Sambalpur District. This is an important soil parameter which is needed to be focussed upon and taken proper steps to maintain the value. Most of the blocks has the pH level strong to very strong acidic. While most of the blocks ranges between 5 to 6. Since the soil nature is acidic in all the nine blocks of the Sambalpur District. The blocks have the pH level strong to very strong acidic which can be easily seen in the map. This is an important soil parameter which is needed to be focussed upon and taken proper steps to maintain the value.

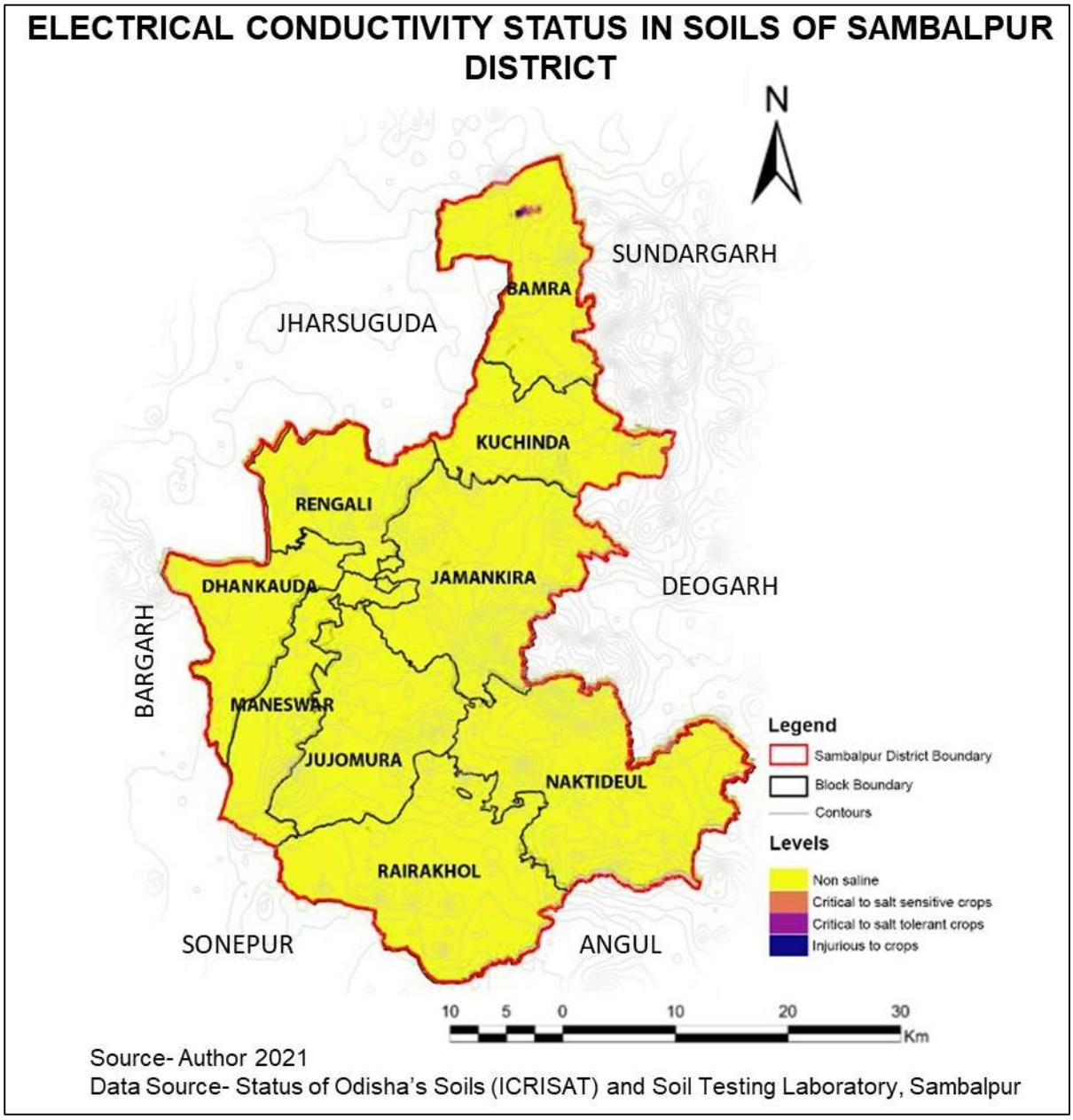
Figure 17: Electrical Conductivity Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Electrical Conductivity Status in Soils of Sambalpur District. Soil Electrical Conductivity is an important parameter to measure the amount of salts in the soil. The Electricity Conductivity is ranging from 1 to 4. This is also required to maintain for the soil nutrient balance. This is one of the important aspect which is also needed to maintain. This will also essential for the proper soil nutrients balance for better crop production. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

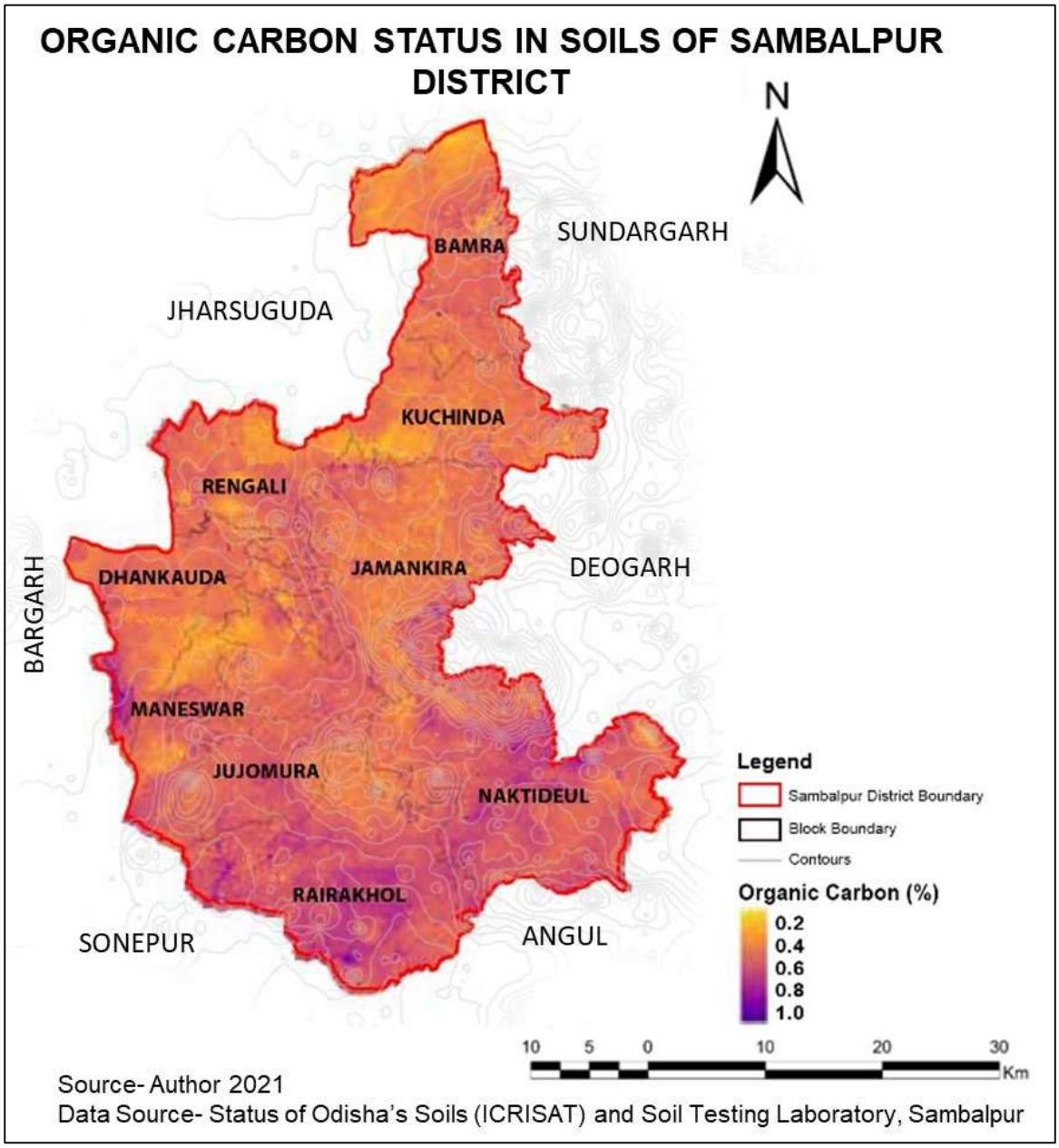
Figure 18: Electrical Conductivity Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Electrical Conductivity Status in Soils of Sambalpur District. This has been shown in different levels in the map, i.e., Non-Saline, Critical to salt sensitive crops, critical to salt tolerant crops and injurious to crops. These are the various levels in which the Electrical Conductivity Status of the Sambalpur District has been shown in the map. In some parts of the Bamra block the Electrical Conductivity Status is ranging from critical to salt tolerant crops and injurious to crops Soil Electrical Conductivity is an important parameter to measure the amount of salts in the soil. This is also required to maintain for the soil nutrient balance.

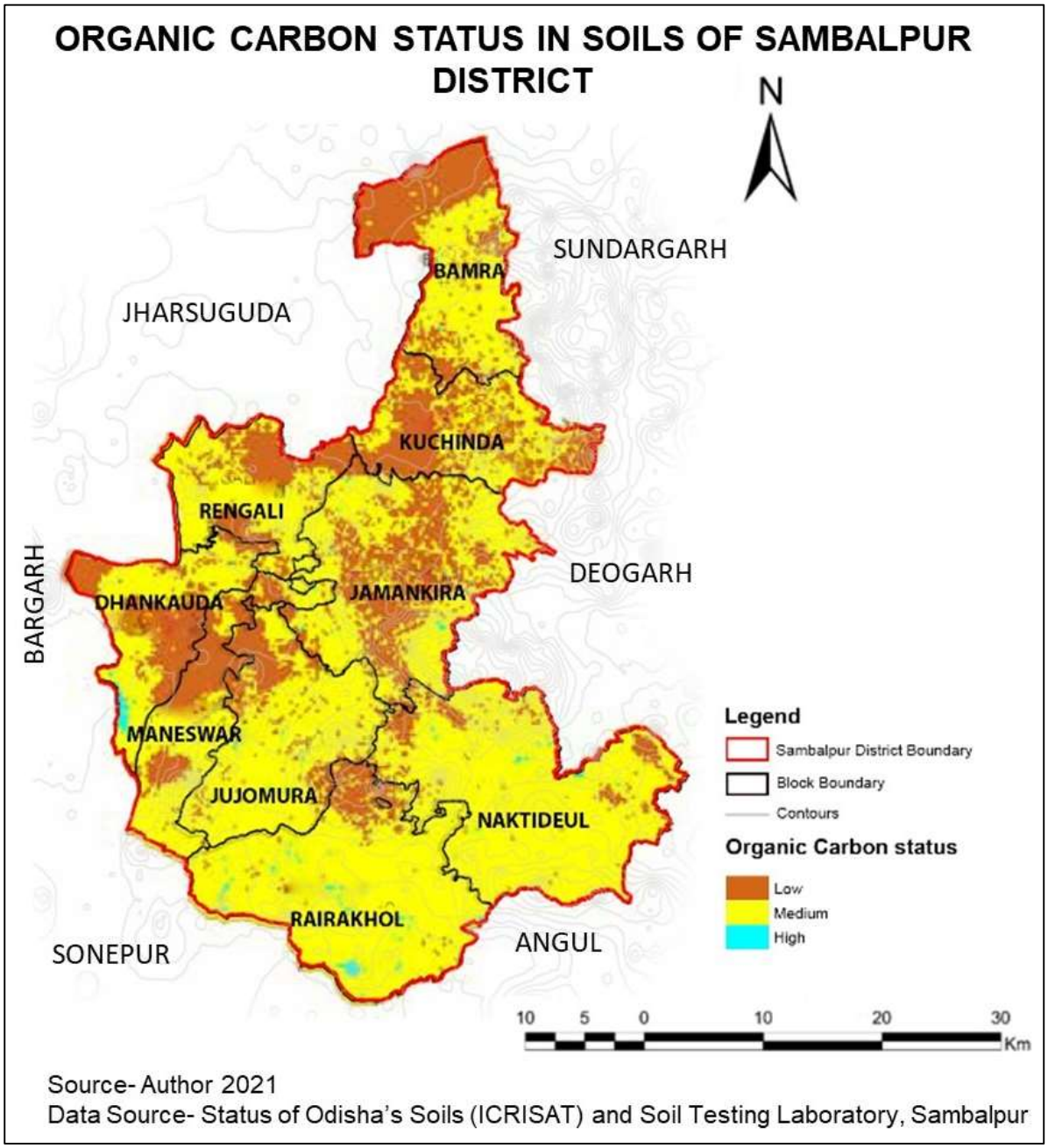
Figure 19: Organic Carbon Status in Soils of Sambalpur District



INFERENCE:

To determine the amount of organic content in soils, total organic carbon estimates are used. Higher levels of soil organic carbon foster soil structure, implying greater physical stability. As we can clearly see the above map is representing the Organ Carbon Status in Soils of Sambalpur District. The percentage of Organic Carbon Status is ranging from 0.2% to 1.0%. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. The Higher levels of soil organic carbon foster soil structure and stability.

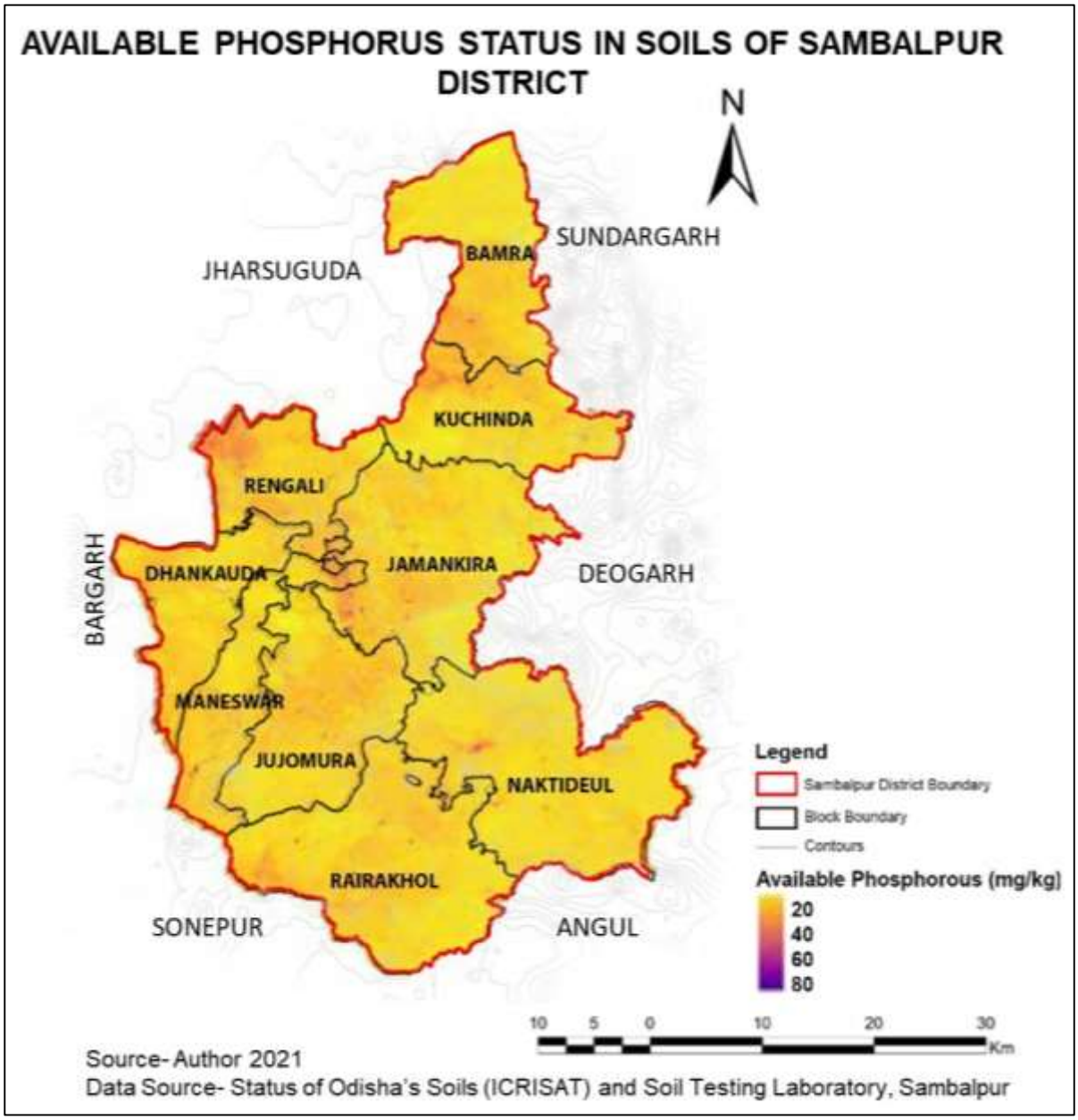
Figure 20: Organic Carbon Status in Soils of Sambalpur District



INFERENCE:

To determine the amount of organic content in soils, total organic carbon estimates are used. Higher levels of soil organic carbon foster soil structure, implying greater physical stability. As we can clearly see in some parts of the blocks like Maneswar, Rairakhol, Naktideul and Jamankira the organic carbon status is higher as compared to other parts of the blocks. While in some parts of the Dhankauda, Rengali, Kuchinda, Bamra, Jamankira and Rairakhol the organic carbon status is low. The Higher levels of soil organic carbon foster soil structure and stability.

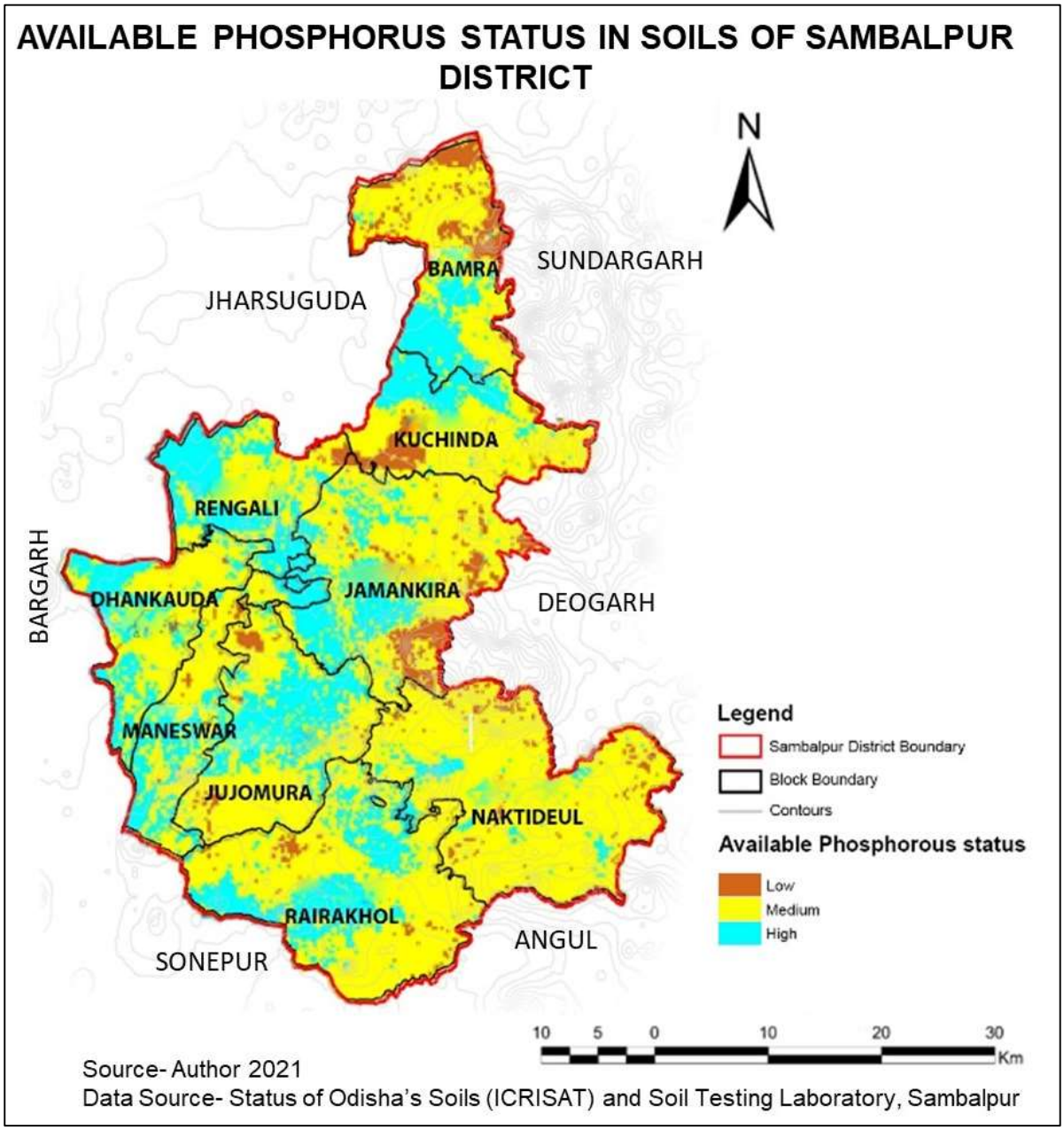
Figure 21: Available Phosphorus Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Phosphorus Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. As we can see clearly the Available Phosphorus (mg/kg) is ranging from 20 to 80. The available Phosphorus content is also one of the important Soil Parameter which is needed to be maintained. The displacement of soil nutrients has been observed mainly through water run-off and from bio-physical and chemical deterioration.

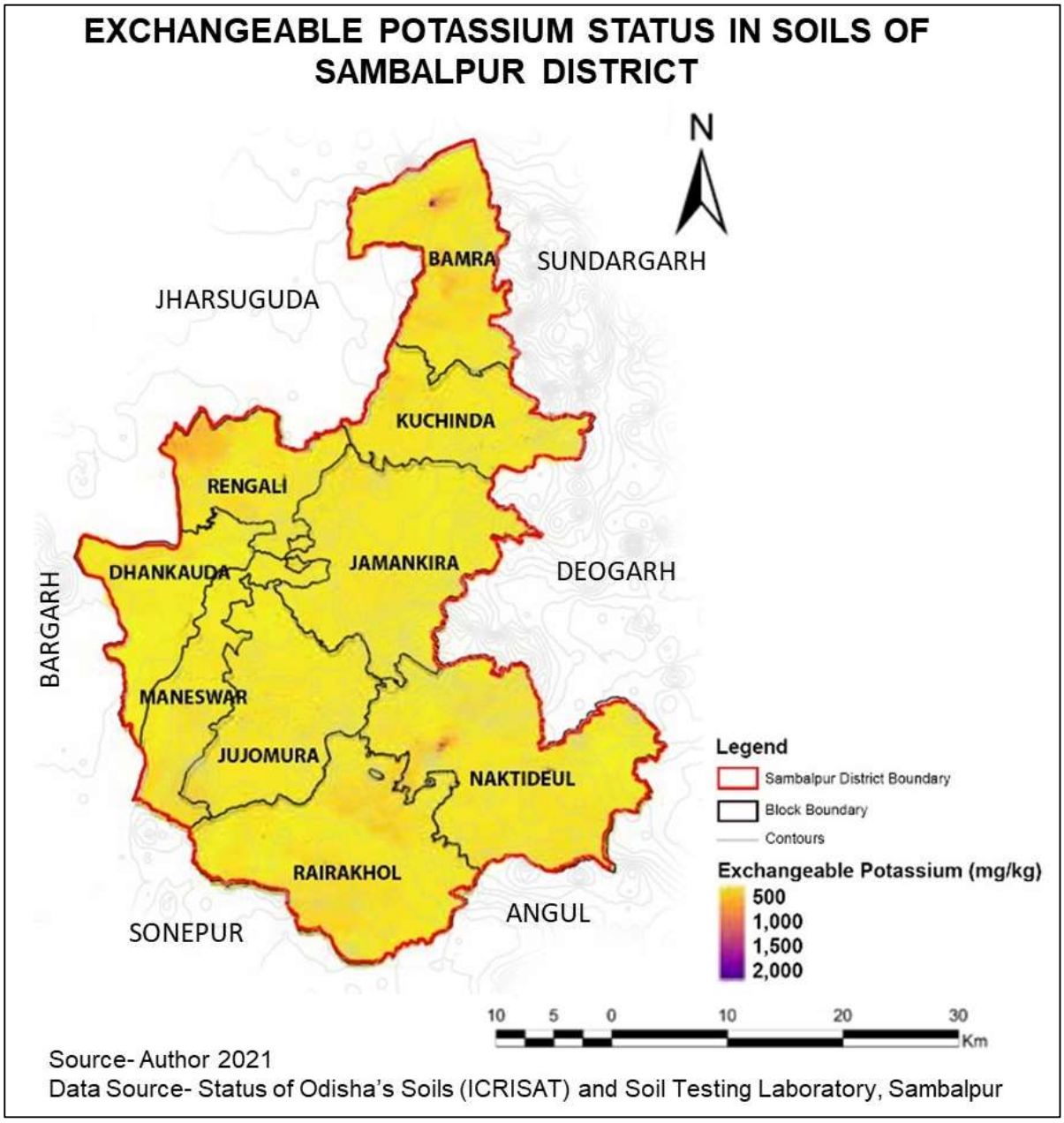
Figure 22: Available Phosphorus Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Phosphorus Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. The above map shows the available Phosphorus Status in three classifications that is low, medium and high. The displacement of soil nutrients has been observed mainly through water run-off and from bio-physical and chemical deterioration. The available Phosphorus content is also one of the important Soil Parameter which is needed to be maintained.

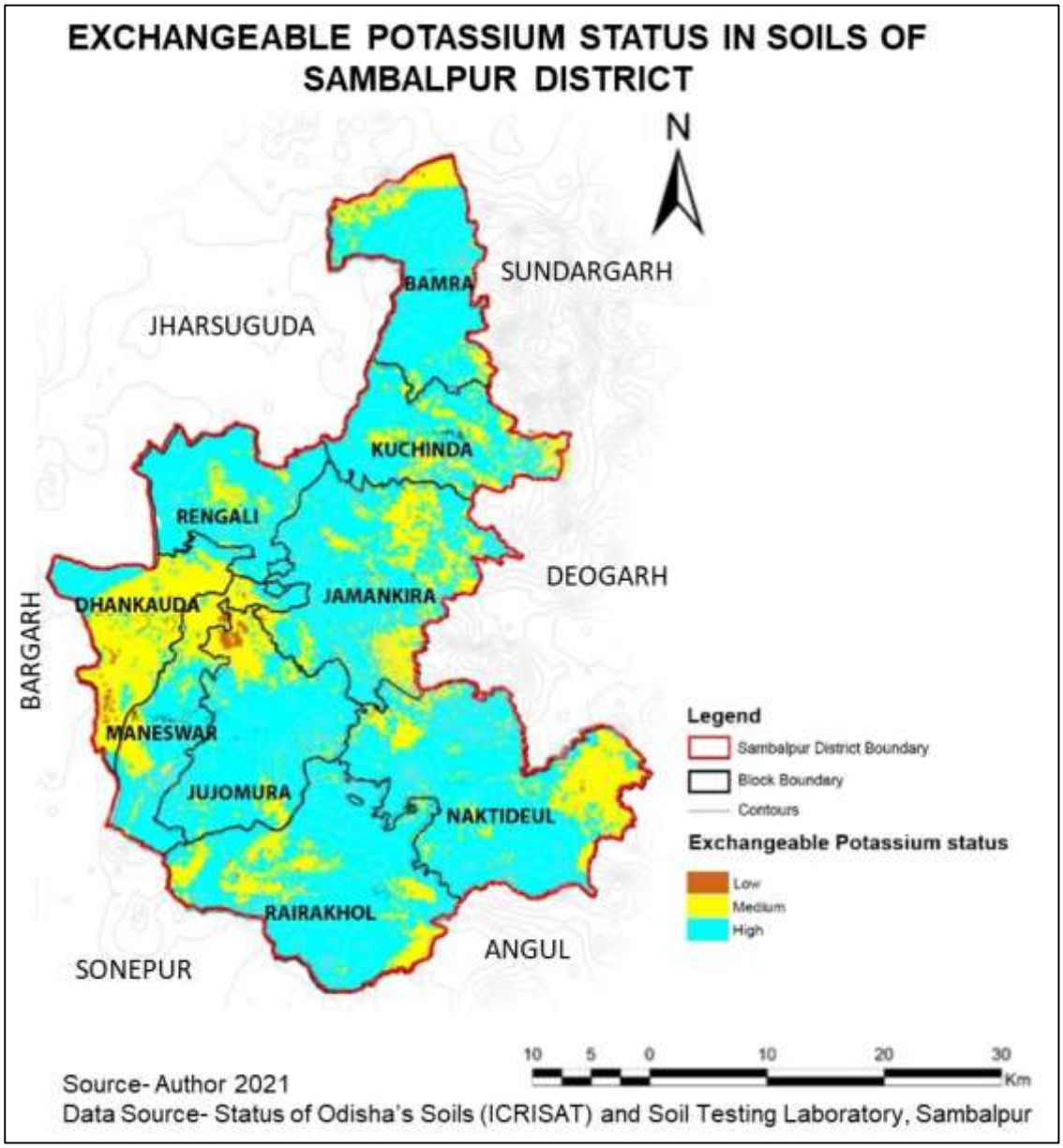
Figure 23: Exchangeable Potassium Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Exchangeable Potassium Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. The exchangeable Potassium (mg/kg) which is ranging from 500 to 2000. Potassium is one of the important parameter of the soil nutrients. Farmers depend on potassium for healthy crop production. This is one of the important soil nutrient which helps in better and healthier crop production. This is needed to be maintained for better crop production.

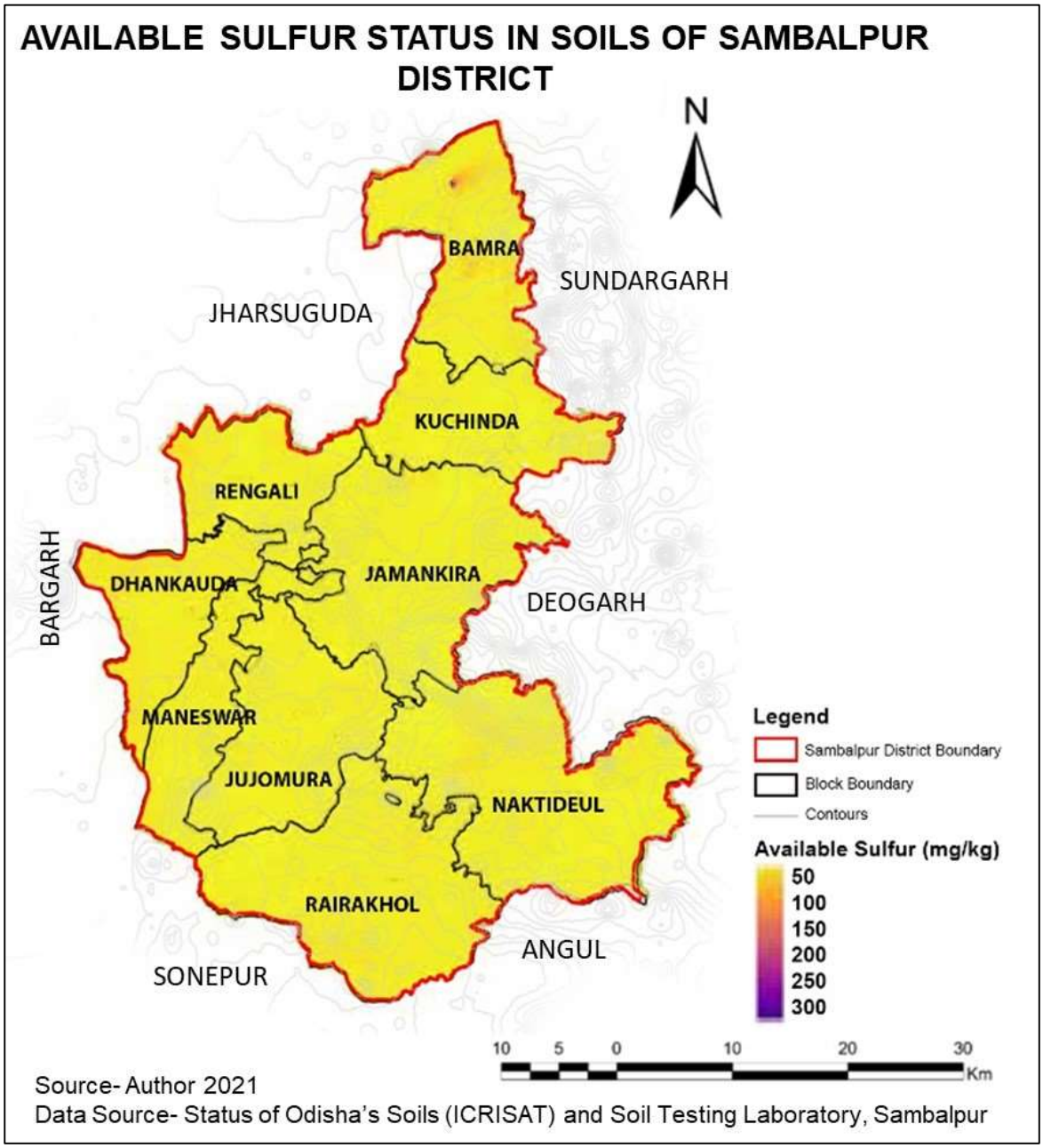
Figure 24: Exchangeable Potassium Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Exchangeable Potassium Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. The exchangeable Potassium Status is ranging from low, medium and high as per the classifications. Potassium is one of the important parameter of the soil nutrient. Farmers depend on potassium for healthy crop production. This is one of the important soil nutrient which helps in better and healthier crop production. This is needed to be maintained for better crop production.

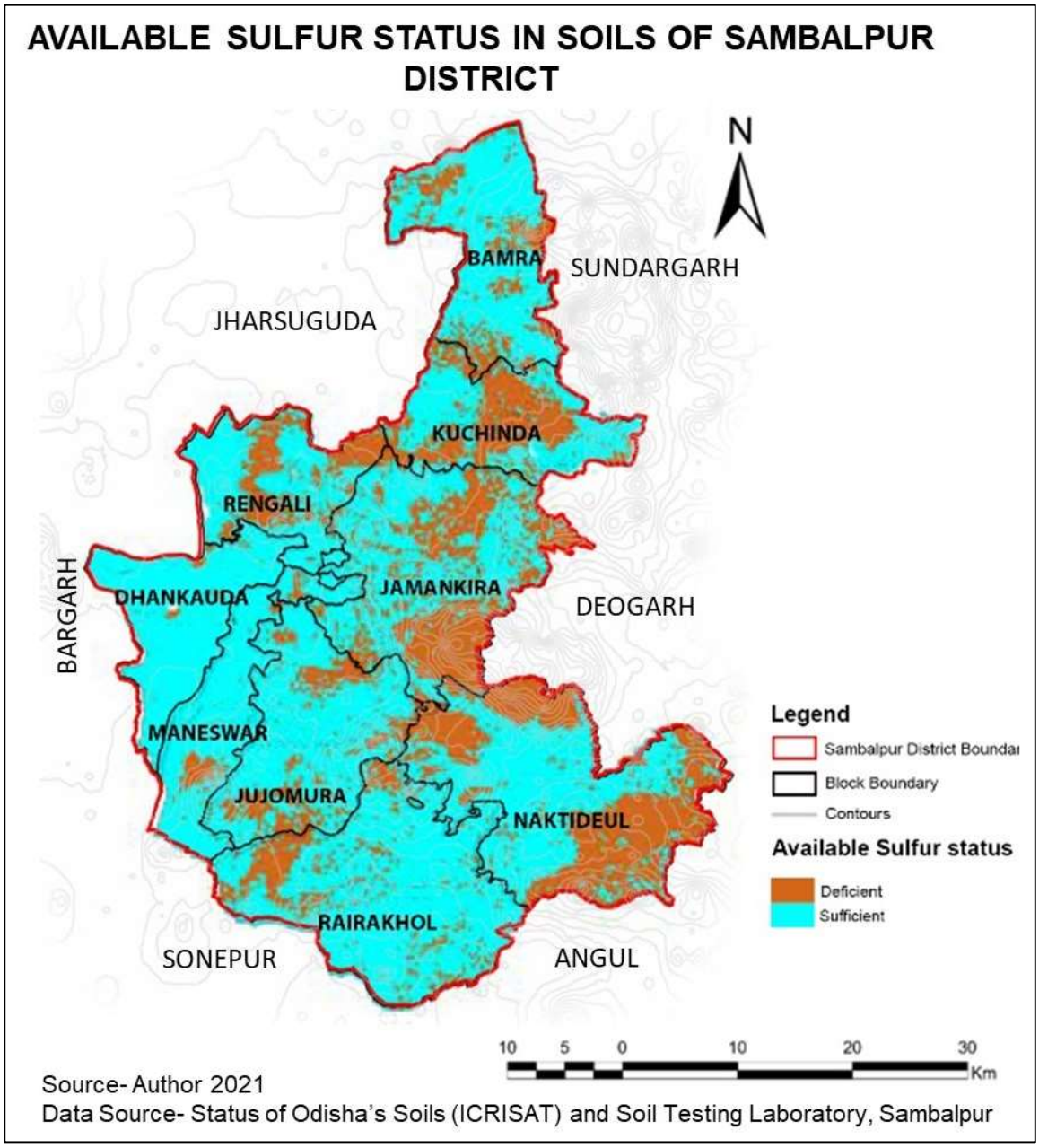
Figure 25: Available Sulfur Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Sulfur Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. The Available Sulfur Status (mg/kg) is ranging from 50 to 300. Sulfur is a soil conditioner that helps to lower sodium levels in soils. Excess sulphur produces excessive salts, which reduce crop productivity. The amount of Sulfur is needed to be maintained as excessive amount of it may harm the crop production.

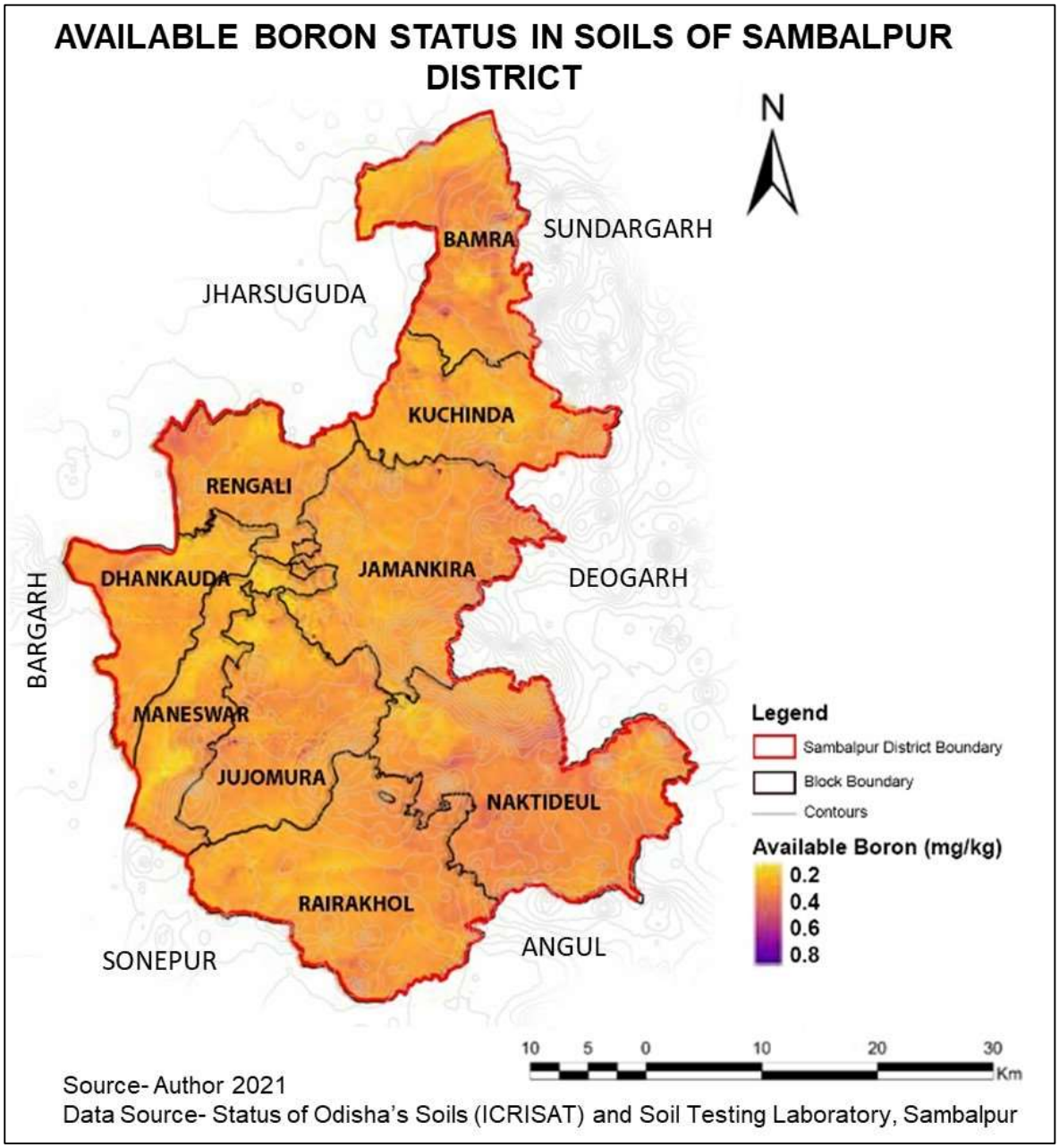
Figure 26: Available Sulfur Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Sulfur Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. Sulfur is a soil conditioner that helps to lower sodium levels in soils. As we can see clearly in the map the Available Sulfur Status is classified as Deficient and sufficient. Excess sulphur produces excessive salts, which reduce crop productivity. The amount of Sulfur is needed to be maintained as excessive amount of it may harm the crop production.

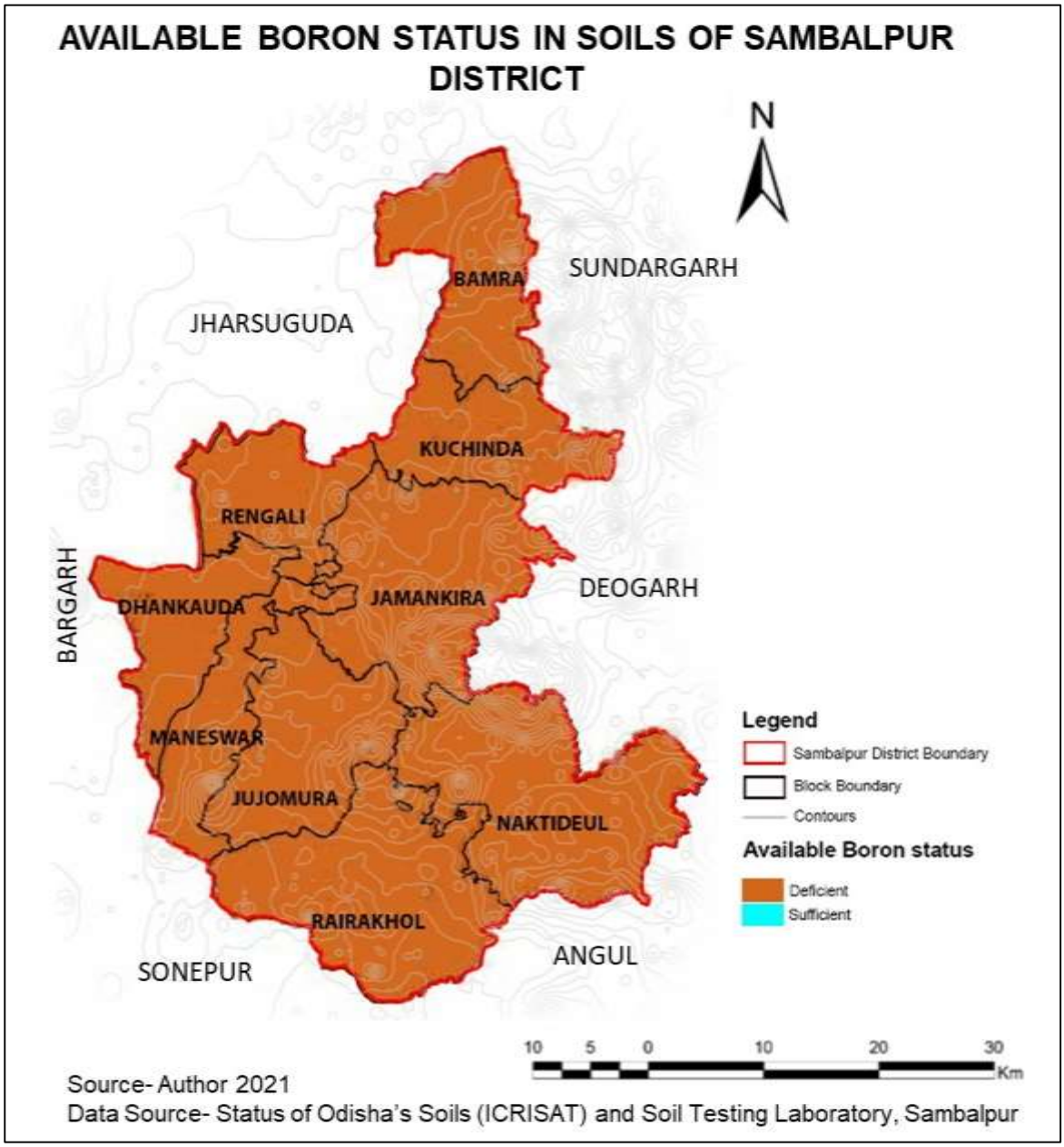
Figure 27: Available Boron Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Boron Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. The Available Boron (mg/kg) is ranging from 0.2 to 0.8 as we can see clearly in the above map. Boron is the most deficient nutrient amongst all the soil nutrients. Boron aids in the development of cell walls in rapidly developing tissue. Calcium deficiency decreases calcium uptake and prevents the plant's ability to use it.

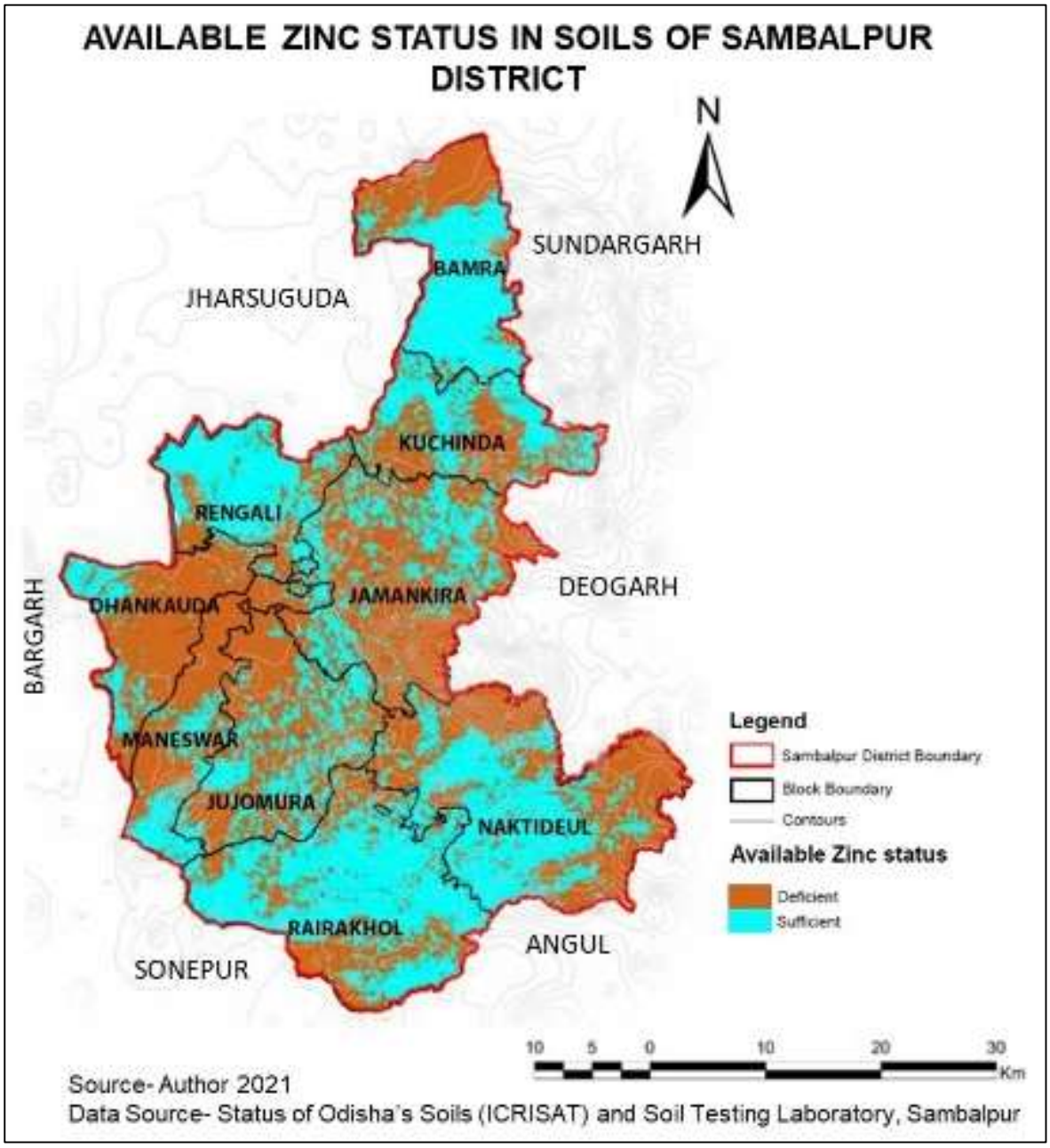
Figure 28: Available Boron Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Boron Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. As we can see clearly in the map the Available Boron Status is classified as Deficient and sufficient. Boron is the most deficient nutrient amongst all the soil nutrients. Boron aids in the development of cell walls in rapidly developing tissue. Calcium deficiency decreases calcium uptake and prevents the plant's ability to use it. It is also one of the important soil parameter.

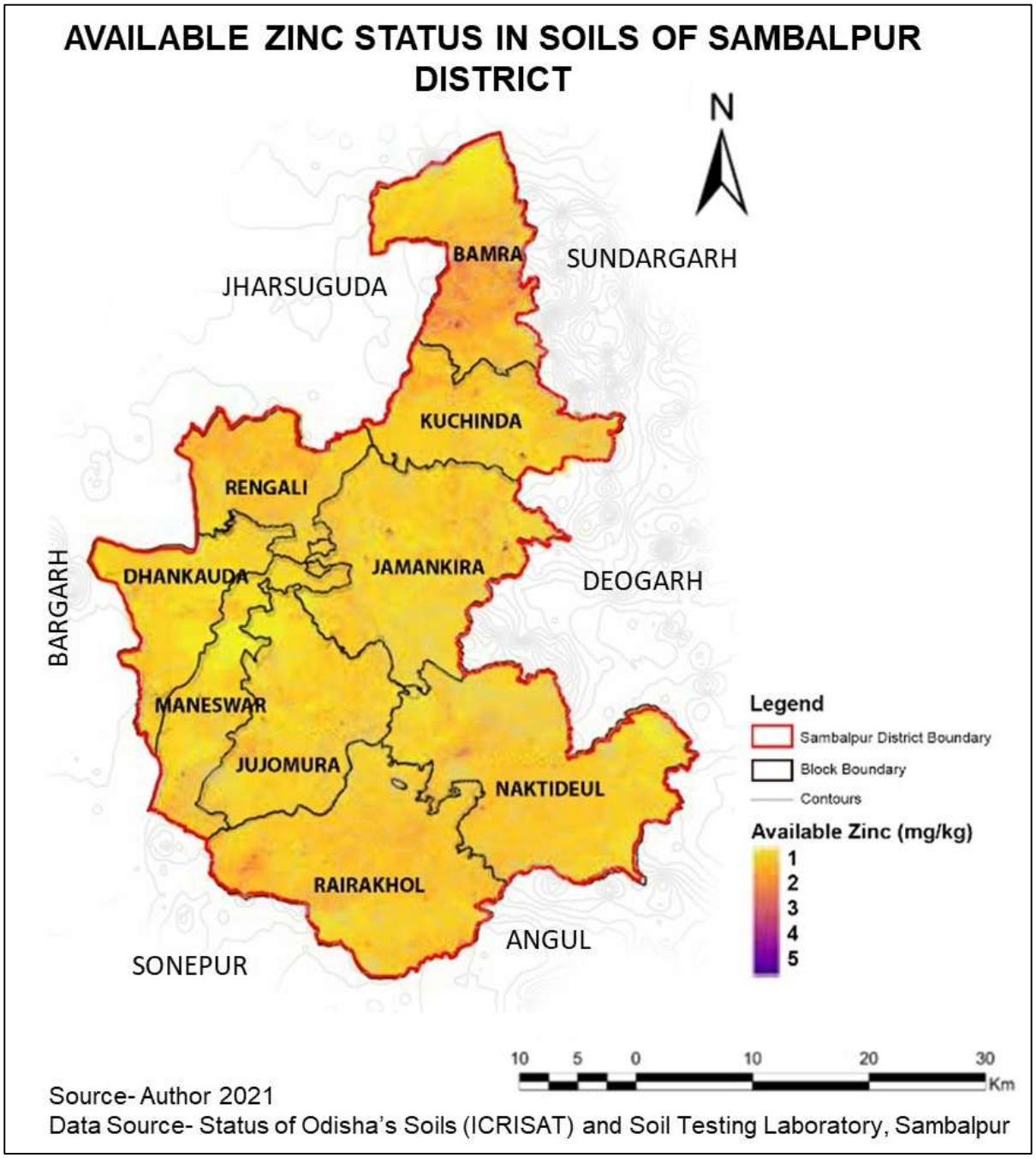
Figure 29: Available Zinc Status in Soils of Sambalpur District



INFERENCE:

The above map represents the Available Zinc Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. As we can see clearly in the map the Available Zinc Status is classified as Deficient and sufficient. Zinc deficiency is also found in Sambalpur District. Most of the blocks like Dhankauda, Jamankira, Bamra some parts of Rairakhol and Naktideul are found to be Zinc deficient. This is required to be maintained using some preventive measures to maintain the balance

Figure 30: Available Zinc Status in Soils of Sambalpur District

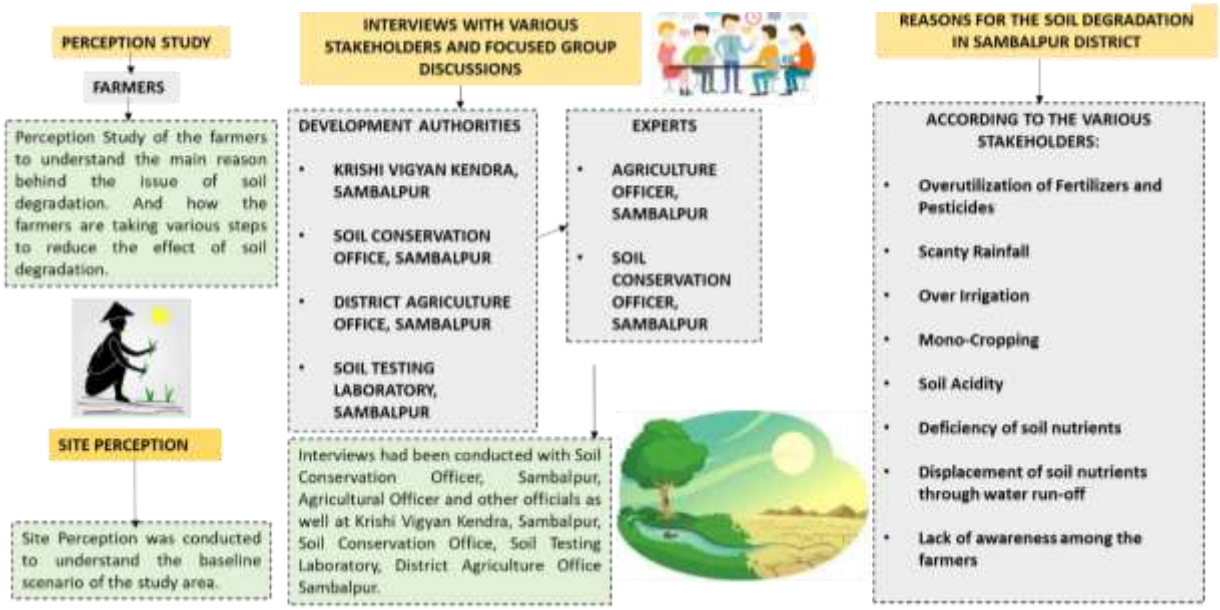


INFERENCE:

The above map represents the Available Zinc Status in Soils of Sambalpur District. This has been shown for all the nine blocks of the Sambalpur district, namely, Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul. It is ranging from 1 to 5. Zinc deficiency is also found in Sambalpur District. Most of the blocks like Dhankauda, Jamankira, Bamra some parts of Rairakhol and Naktideul are found to be Zinc deficient.

4.8 PERCEPTION STUDY

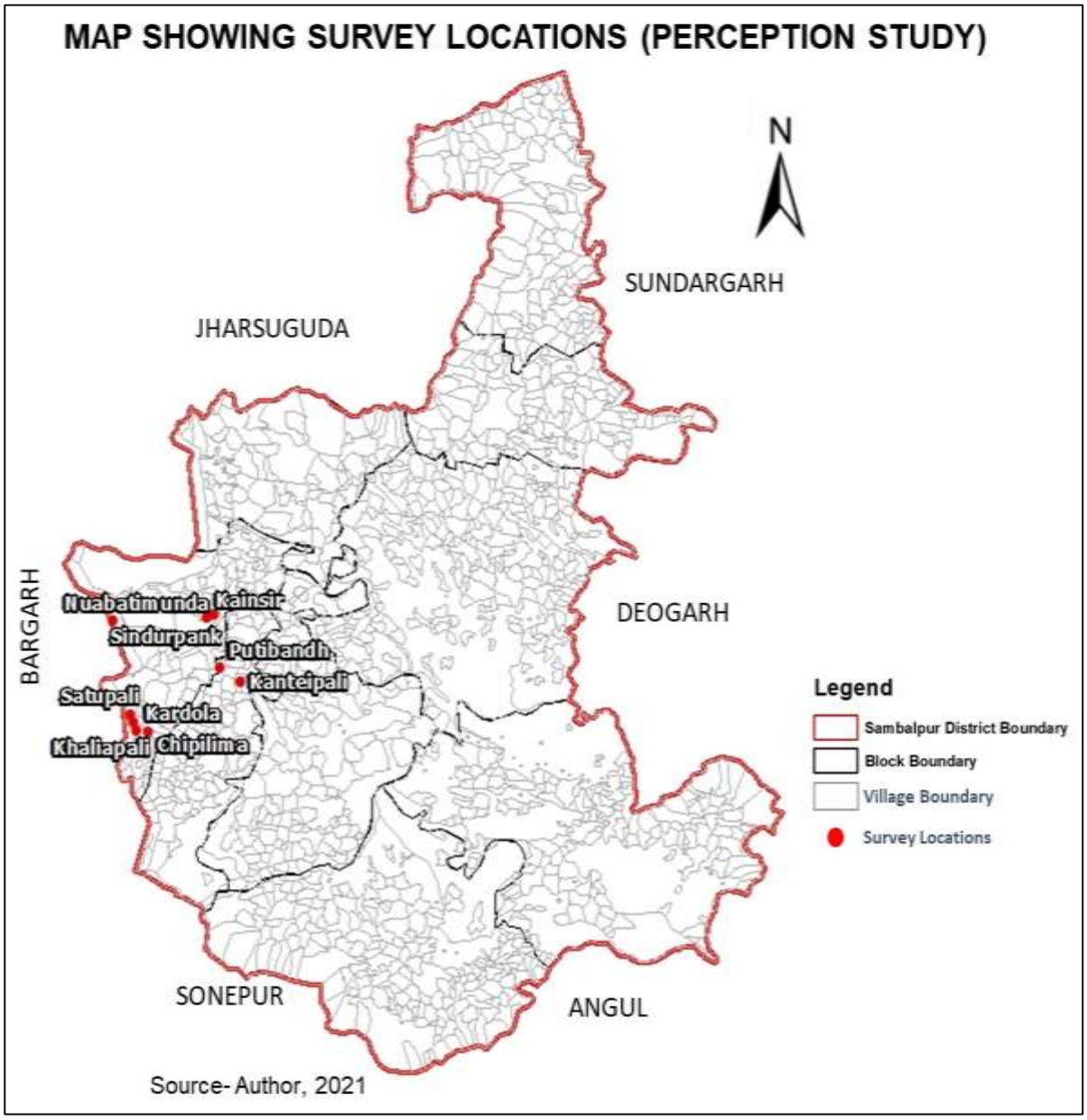
Figure 31: Perception Study



The above figure represents the Perception Study of various stakeholders which has been conducted on the site. Perception Study of the farmers was conducted to understand the main reason behind the issue of soil degradation. And how the farmers are taking various steps to reduce or combat the issue of soil degradation. Site Perception study was also conducted to understand the baseline scenario of the study area. Interviews had been conducted with the experts such as Soil Conservation Officer Sambalpur, Agricultural Officer and other officials as well at Krishi Vigyan Kendra Sambalpur, Soil Conservation Office Sambalpur, Soil Testing Laboratory Sambalpur, District Agriculture Office Sambalpur.

According to the various stakeholders the reason for the soil degradation in Sambalpur District Are Overutilization of Fertilizers and Pesticides, Scanty Rainfall, Over Irrigation, Mono-Cropping, Soil Acidity, Deficiency of soil nutrients, Displacement of soil nutrients through water run-off and Lack of awareness among the farmers. These are the various reasons for the soil degradation in Sambalpur District which is needed to be taken care of. Rainfall is sporadic and unevenly distributed, resulting in unpredictably poor agricultural results. Due to the unpredictable rainfall or scanty rainfall the crop productivity gets effected. Most of the farmers in Sambalpur District depends on rainfall for good crop production but due to the scanty rainfall there is many consequences faced by the farmers as well.

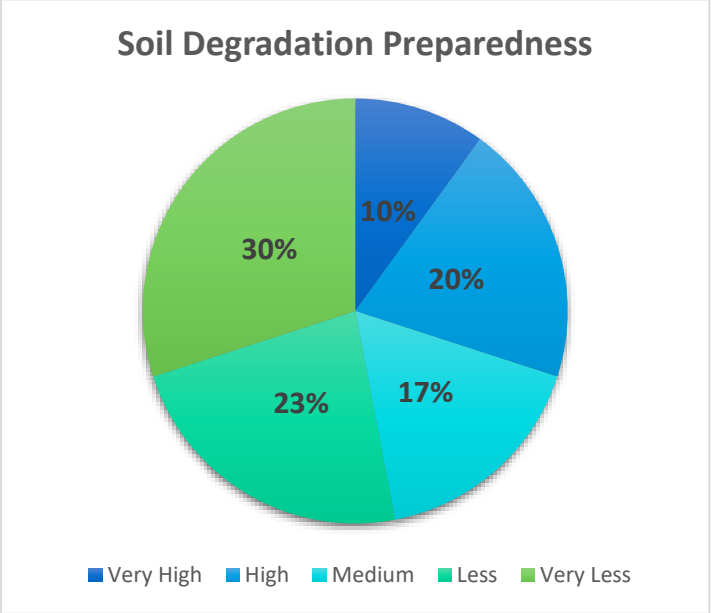
Figure 32: Map showing Survey Locations (Perception Study)



Source- Author, 2021

The above map represents the survey Locations for the Perception Study. The Perception Study was conducted in the villages namely, Nuabatimunda, Sindurpank, Kainsir, Putibandh, Satupali, Kanteipali, Kardola, Khaliapali and Chiplima. The Perception Study was conducted of the farmers was conducted to understand the main reason behind the issue of soil degradation. And how the farmers are taking various steps to reduce or combat the issue of soil degradation. Site Perception study was also conducted to understand the baseline scenario of the study area.

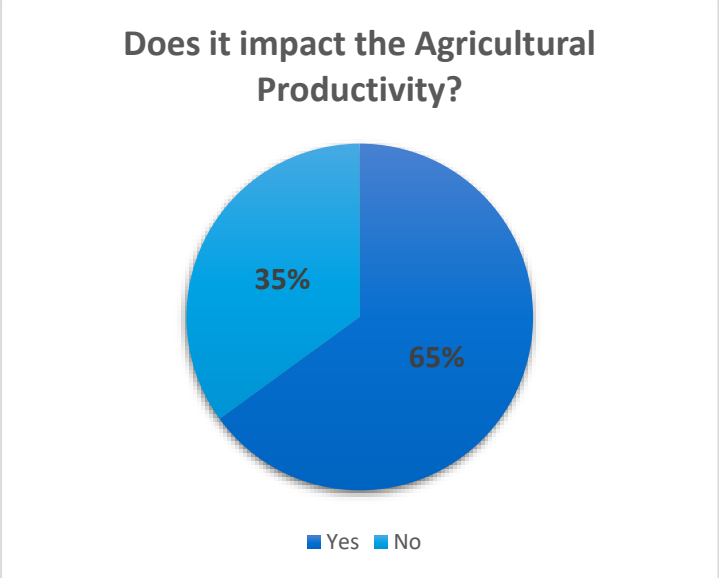
Figure 33: Soil Degradation Preparedness



Source- Primary Survey

The above figure represents the respondents on the Soil Degradation Preparedness in the Sambalpur District.

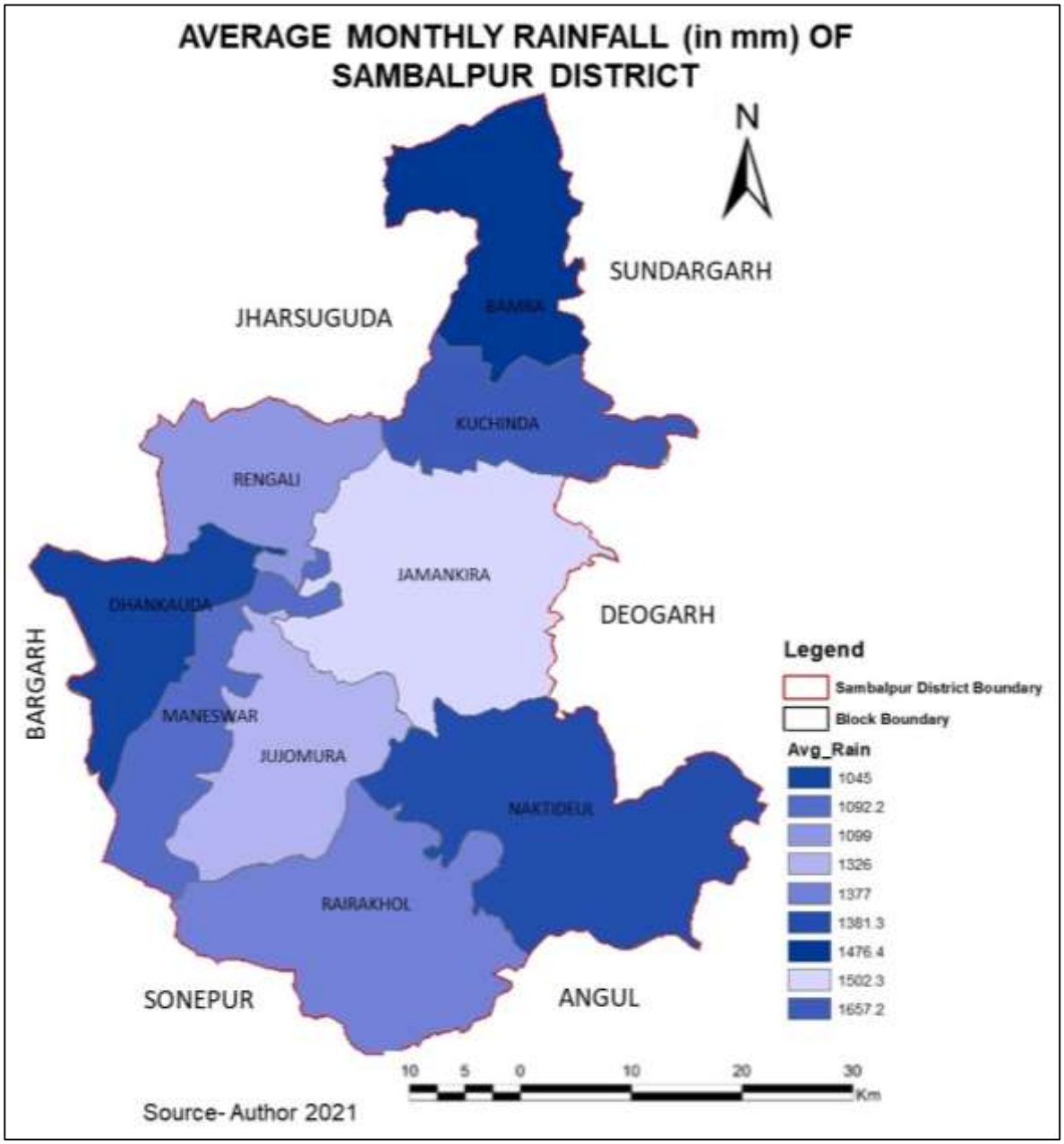
Figure 34: Does it Impact the Agricultural Productivity



Source- Primary Survey

The above figure represents the respondents on the impact on Agricultural Production due to Soil Degradation. in the Sambalpur District. Soil degradation is adversely affecting the agricultural production in Sambalpur district.

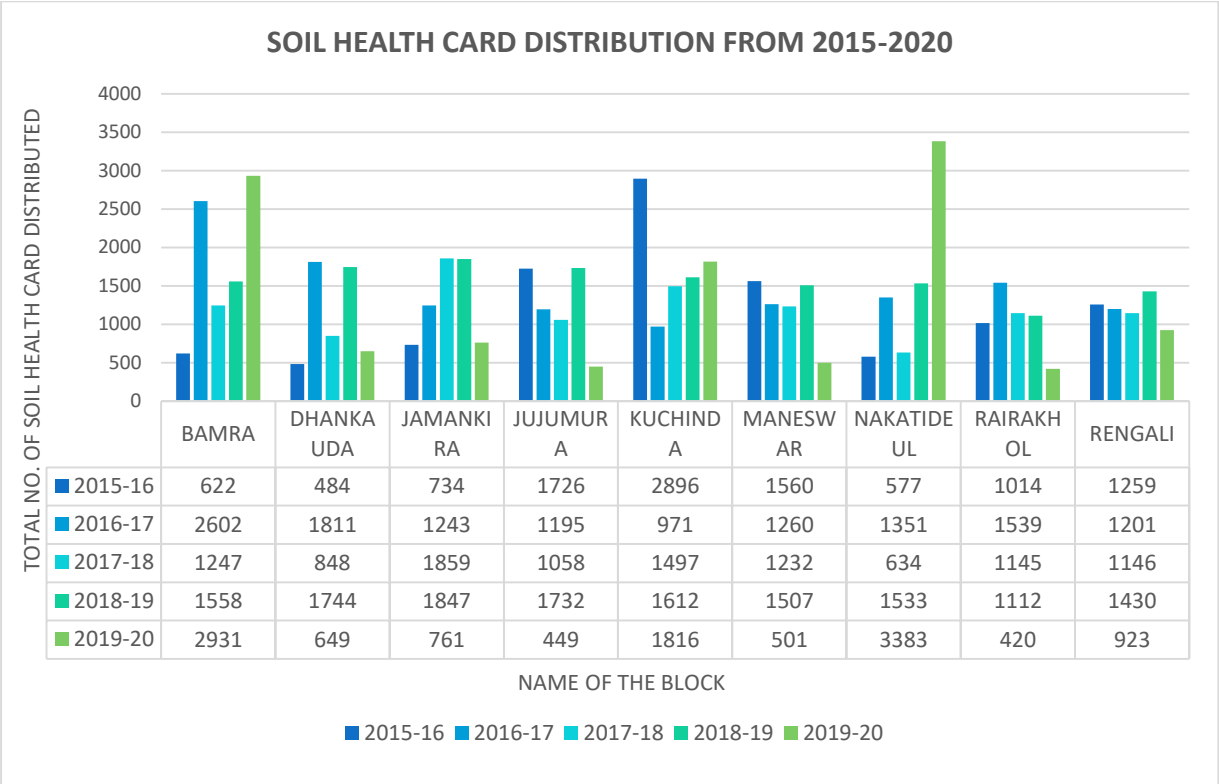
Figure 35: Average Monthly Rainfall (in mm) of Sambalpur District



INFERENCE- It is mostly rained on by the South-West monsoons seasons. It has an average annual rainfall of 1495.7 mm and 68.2 rainy days, with the majority of rain falling between June and September. Rainfall is sporadic and unevenly distributed, resulting in unpredictably poor agricultural results. Due to the unpredictable rainfall or scanty rainfall the crop productivity gets effected. Most of the farmers in Sambalpur District depends on rainfall for good crop production but due to the scanty rainfall there is many consequences faced by the farmers as well.

This above average monthly rainfall is for all the nine blocks, i.e., Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

Figure 36: Soil Health Card Distribution from 2015-2020



	BAMRA	DHANKAUDA	JAMANKIRA	JUJUMURA	KUCHINDA	MANESWAR	NAKATIDEUL	RAIRAKHOL	RENGALI
2015-16	622	484	734	1726	2896	1560	577	1014	1259
2016-17	2602	1811	1243	1195	971	1260	1351	1539	1201
2017-18	1247	848	1859	1058	1497	1232	634	1145	1146
2018-19	1558	1744	1847	1732	1612	1507	1533	1112	1430
2019-20	2931	649	761	449	1816	501	3383	420	923

Source- Author 2021

Data Source- Soil Testing Laboratory, Sambalpur

The above graph represents the Soil Health Card Distribution from 2015-2020. This above graph is for all the nine blocks, i.e., Bamra, Kuchinda, Rengali, Dhankauda, Jamankira, Maneswar, Jujomora, Rairakhol and Naktideul.

4.9 ON-GOING SCHEMES OF SAMBALPUR DISTRICT (2019-2020)

Paramparagat Krishi Vikash Yojana(Organic farming):-

In Sambalpur district an area of 1000 acres in 20 clusters @ 50acres/cluster under the above scheme is being implemented through the Resource Organisation, High Land Agriventure Ltd, Bhubaneswar. For rest 250 acres the Support Agency has been finalized through the DLEC held on dt25.6.2019 Chaired by the Collector & District Magistrate, Sambalpur. The project period for implementation of PKVY both in Jujomura & Naktideul block is 3 years (2018-19 to 2020-21).Besides, the above scheme is in operation in Jamankira block for a period of 3 years(2019-20 to 2021-22) by Agranee Jana Kalyan Anusthan (AJKA),Bargarh.

Programme on Soil Health Card Scheme:-

The programme for 2020-21 is 18929 (Both STL/MSTL) . All the farmers of the district will be covered to develop and promote soil test based nutrient management to enhance nutrient use efficiency.

Analysis of Fertiliser & pesticide sample: -

Programme has been made to collect Fertilizer samples from fertilizer dealers & rake point of Sambalpur district during Kharif'2020 to ensure sale of quality fertilizer in the district. In order to detect the spurious fertilizer 300.nos of samples will be collected by fertilizer Inspector to analyse at the Quality Control Laboratory, Sambalpur. Pesticide sample target is 65 nos for analysis & to ensure availability of quality pesticides in the market.

4.10 KHARIF AND RABI AGRICULTURAL PRODUCTIVITY IN SAMBALPUR DISTRICT

Table 8: Kharif Agricultural Production in Sambalpur District

Area production and productivity of different crops during last two year& Programme for Kharif 2020 of Sambalpur District										
(Area in Ha. ,Prodn.in M.T. & Yield in Qtl.)										
SlNo	Crop	Achievement during Kharif'2018			Achievement Kharif2019			Programme for Kharif'2020		
		A	P	Y	A	P	Y	A	P	Y
1	HYV. Paddy	103197	135482	13.12	103233	385612	37.35	100870	403480	40
2	Hybrid Paddy	4660	20201	43.35	3645	20302	55.7	4000	24000	60
2	Local Paddy	87	80	9.24	92	251	27.29	100	280	28
Total Paddy		107944	155763	14.43	106970	406165	37.97	104970	427760	40.75
3	Maize	3897	7307	18.75	3900	7898	20.25	4000	8800	22
4	Jowar	5	3	6.2	14	9	6.15	5	4	7
5	Ragi	68	37	5.42	45	25	5.65	45	27	6
6	S.Millets		0	0	0	0	0	0	0	0
Total Millet		3970	7347	18.5	3959	7932	20	4050	8830.5	21.80
7	Arhar	2874	2115	7.36	2788	2152	7.72	3000	3000	10
8	Mung	17503	7806	4.46	17608	8188	4.65	18800	11280	6
9	Biri	13144	6020	4.58	13185	6026	4.57	13500	6750	5
10	Kulthi	0	0	0	0	0	0	0	0	5
11	Other pulses	1005	384	3.82	2339	924	3.95	1400	700	5
Total Pulses		34526	16325	4.72	35920	17290	4.81	36700	21730	5.92
12	G.Nut	544	623	11.45	572	672	11.75	600	780	13
13	Til	12110	5231	4.32	12405	5657	4.56	12500	6875	5.5
14	Castor	9	4	4.25	6	3	4.38	5	2.5	5
15	Niger	0	0		0	0	0	0	0	0
16	S.flower	0	0		0	0	0	0	0	0
Total Oilseeds		12663	5858	4.62	12983	6331	4.87	13105	7657.5	5.84
17	Mesta	6	4	6.87	11	8	6.97	5	1	7
18	Sunhemp	0			0	0	0	0	0	0

Total Fibre		6	4	6.87	11	8	6.97	5	1	7
20	Sweet Potato	392	4259	108.65	389	4250	109.25	400	4400	110
21	Oth. Veg.	26945	324552	120.45	26193	320733	122.45	26870	335875	125
Total Vegetable		27337	328811	120.28	26582	324983	122.25	27270	340275	124.78
22	Chilli	5879	8024	13.65	5988	8216	13.72	6500	9750	15
23	Ginger	1185	18575	156.75	1129	17866	158.25	1250	20000	160
24	Turmeric	119	263	22.17	97	218	22.45	110	440	40
Total condiment		7183	26862	37.39	7214	26300	36.45	7860	30190	38.41
25	S.Cane	35	2643	755.25	35	2647	756.25	40	3200	800
	G.Total	193664			193674			194000		

Source- District Agriculture Office, Sambalpur

Table 9: Rabi Agricultural Production in Sambalpur District

Sl. No.	Crop	Achievement Rabi 2019-20			Programme Rabi 2019-20		
		A	P	Y	A	P	Y
1	HYV Rice	14844	70791.04	47.69	146300	87780	60
2	Wheat	72	109.44	15.2	70	105	15
3	Maize	386	880.08	22.8	392	902	23
	Total Cereals	15302	0		15092	88787	58.65
4	Gram	189		3.4	200	100	5
5	Mung	7537	4936.735	6.55	7600	3800	5
6	Biri	3084	2359.26	7.65	3000	1500	5
7	Kulthi	1124	395.648	3.52	1200	540	4.5
8	Fieldpea	498	273.9	5.5	550	440	8
9	Cowpea	1510	921.1	6.1	1500	1200	8
10	Other Pulses	1248	638.976	5.12	1250	625	5
	Total Pulses	15190	9525.619		15300	8205	5.36
11	Groundnut	574	875.35	15.25	600	1080	18
12	Sesamum	4141	1490.76	3.6	4121	2061	5
13	Mustard	6495	3539.775	5.45	6500	3575	5.5
14	Castor	0	0		0	0	0
15	Niger	0	0		0	0	0
16	Sunflower	217		6.32	200	140	7
Total Oilseeds		11427	5905.885		11421	6856	5.95
18	Potato	1895	1752.875	9.25	1900	18050	95
19	Sweet Potato	242	2745.49	113.45	250	3000	120
20	Onion	2945	29184.95	99.1	3000	28500	95
21	Other Vegetables.	13023	163699.1	125.7	13005	166464	128
Total Vegetables		18105	0		18155	216016	119.28
22	Chilli	4750	6080	12.8	4740	6162	13
23	Garllic	767	3271.255	42.65	750	3000	40
24	Coriander	2260	1288.2	5.7	2250	1237.5	5.5
Total Condiments.		7777	0		7740	10400	14.45
25	Sugarcane	15			50		
	G.Total	67816			67758		

Source- District Agriculture Office, Sambalpur

The above table represents the Kharif and Rabi Agricultural Productivity in Sambalpur District. The first table represents the Kharif Crop Production while the second table represents the Rabi Crop Production. These are the various types of crops that has been represented in the table which consists of various rice, pulses, vegetables, oilseeds, condiments, fibres, paddy crops. So, all of the record has been shown in the above table for the Kharif and Rabi Crop Production in Sambalpur District. The crop products include HYV Rice, wheat, maize, total cereals, gram, mung, biri, kulthi, fieldpea, sugarcane, etc

There is a need to enhance sustainable agriculture and introduce various cropping patterns as well as Conservation Agriculture which will bring the soil degradation to a halt and save the essential soil nutrients and this phenomenon will ultimately help in increasing the crop production.

There is an urgent requirement to bring this problem into halt as India is facing major loss due to the soil degradation and farmers are facing many agricultural losses due to the same. They are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management.

This has become a demand to protect the soil from getting degraded because it is not only harming the land but also effecting the agricultural production. This is creating negative effect in the lives of the farmers as well.

The first table represents the Kharif Crop Production while the second table represents the Rabi Crop Production. These are the various types of crops that has been represented in the table which consists of various rice, pulses, vegetables, oilseeds, condiments, fibres, paddy crops. So, all of the record has been shown in the above table for the Kharif and Rabi Crop Production in Sambalpur District. Conservation Agriculture which will bring the soil degradation to a halt and save the essential soil nutrients. There is an urgent need to bring solution to the problem of Soil Degradation.

CHAPTER 5 PROPOSALS AND RECOMMENDATIONS

This chapter focuses on the numerous suggestions that should be made, as well as the possibilities and solutions that should be put into action in order to improve the situation in the research area.

This was previously mentioned; the following recommendations would be made with the anticipated outcomes in mind:

5.1 POLICY LEVEL INTERVENTIONS

1. Commercial farming should be avoided.

Agrochemicals, growing yields through multiple harvests and tilling has come at the cost of long-term viability Responsible land and agricultural management will aid in this effort, but we must also be honest about our eating habits. If we eat meat at all, it should be sustainably raised and grass-fed, and we should eat a lot of fruits and vegetables., according to the evidence.

2. Replant the trees

Without plant and tree cover, erosion is much more likely. The significance of long-term forest conservation and reforestation programmes cannot be overstated. Soil erosion can be reduced by increasing the number of trees planted.

3. Ploughing should be stopped or restricted.

Zero-tillage, also known as conservation agriculture, is being tried by a few farmers. Efforts are focused on ensuring that no bare soil is revealed, with ‘cover crops' planted immediately following harvest. These not only protect the soil, but they also return nutrients and plant matter. They also help to keep moisture in hot climates.

4.Goodness must be replaced.

Organic farmers who amend the soil with compost and manure replenish nutrients thus reducing flood danger and trapping carbon. Bio-waste should not be thrown away; instead, it should be used to make organic soil improvers, fertilisers, and grow in, according to advocates of the circular economy. Mineral fertilisers and peat, for example, are fossil-based goods that could be replaced with these.

5. Leave land alone

Leaving more land undeveloped, amid the demands of an increasing population, would be extremely beneficial: it takes 500 years to produce only 2.5cm of topsoil.

Land removed from cultivation will enable carbon in the soil must be rebuilt and stabilised. Experts advise that the beef and dairy industries rotate pastured land so that less is used at any given time.

5.2 PLANNING LEVEL INTERVENTIONS

1. Soil fertility can be restored by the plantation of the cover crops as this will regain the organic nutrients back to the soil which will improve the quality of the soil.

2. Increament in the soil nutrients such as Soil Carbon which will improve the soil fertility, restores landscape function, reduces anthropogenic pollution, and increases climatic variability resilience.

3. Consider planting nitrogen-rich plants such as beans and peas nearby to correct a nitrogen deficiency. To encourage nitrogen production, add used and rinsed coffee grounds to the soil.

4. Garden compost, bagged compost, or well-rotted manure may all be used. Until digging or forking it in, apply a minimum 5cm layer of organic matter to the soil. Organic fertilisers are better for soil bacteria than inorganic fertilisers.

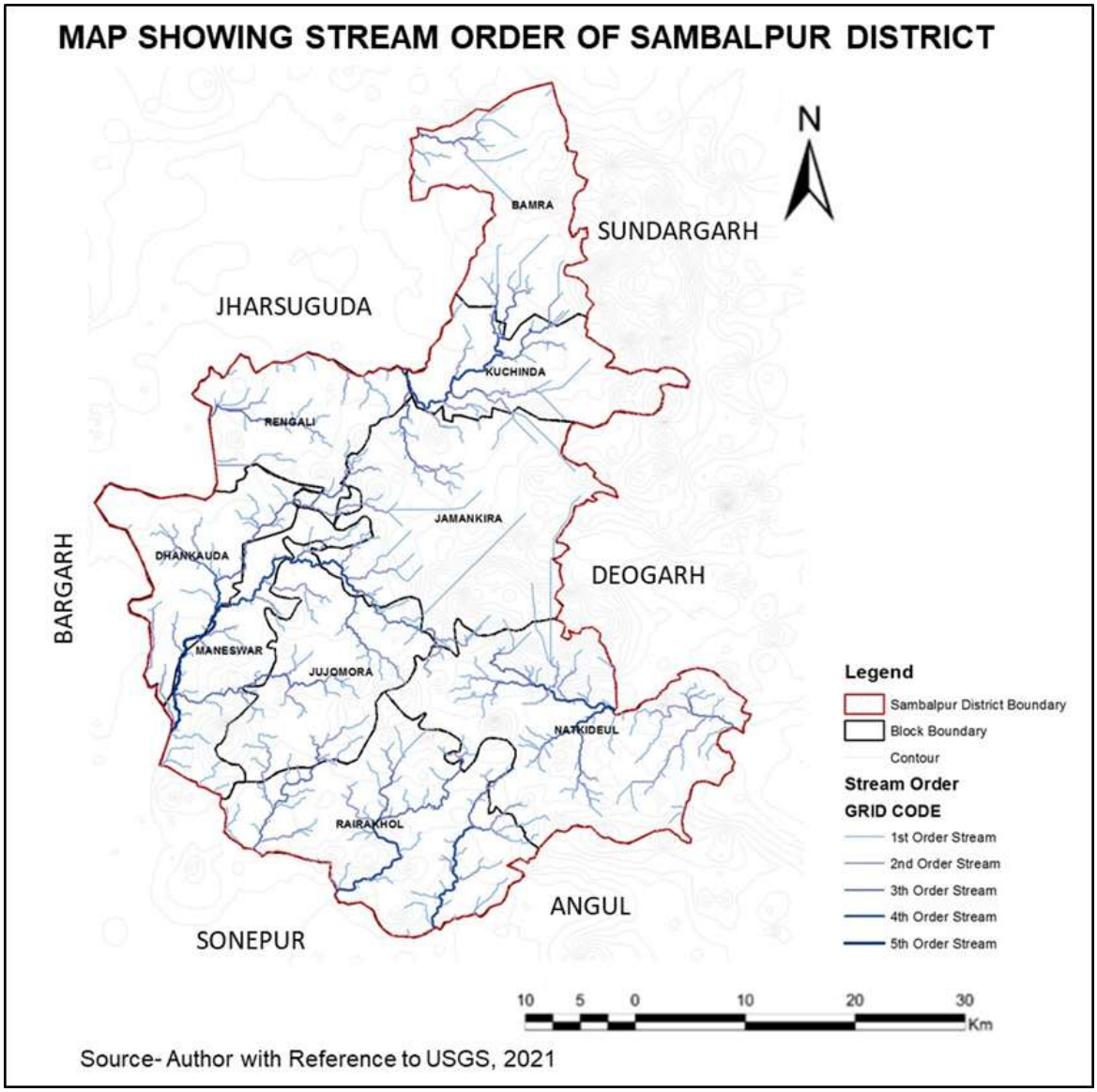
5. Green manure (uprooted or sown crop parts incorporated or left on topsoil), cover crops, crop rotation, and organic compost are all organic farming techniques that help to restore the soil.

6. Bioremediation with salt-tolerant plants (halophytes). Salts accumulate in the shoots and other aerial plant sections of halophytes.

The above planning level interventions focuses towards the restoration of the soil fertility for enhancement of the soil nutrient balance. Planning Level Interventions play a very crucial role in the protection or prevention of land from being degraded. There is a need to enhance sustainable agriculture and introduce various cropping patterns as well as Conservation Agriculture which will bring the soil degradation to a halt and save the essential soil nutrients and this phenomenon will ultimately help in increasing the crop production. They are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management. This is important to protect the soil from degradation for better crop production.

5.3 WATERSHED DEVELOPMENT

Figure 37: Map showing Stream Order of Sambalpur District



The watershed approach is an also an important measure which provides various facilities to the fragile areas by eliminating or reducing the environmental problems. There is an urgent requirement to bring this problem into halt as India is facing major loss due to the soil degradation and farmers are facing many agricultural losses due to the same. They are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management.

5.4 FARMER'S AWARENESS PROGRAMMES

- Farmer's Awareness Programmes plays an important role in educating farmers about an importance of soil and negative impacts of soil degradation.
- They must be given the knowledge about the proper usage of fertilisers and pesticides. The correct amount of it would lead to good agricultural productivity.
- Low implementation of recommended technologies was due to farmers' lack of awareness and perceptions of soil erosion and soil conservation measures.
- Farmers who believe their land is declining and yielding less than they want should practise better land use.
- Farmers who believe their land is fertile, on the other hand, are less likely to practise conservation.
- The study recommends that the government adopt successful land degradation monitoring and prevention policies to tackle land degradation and its consequences. These policies should be community-inclusive/participatory, and should be focused on indigenous and long-standing experience and practise of preventing the degradation of land.

5.5 STAKEHOLDER'S PARTICIPATION

Stakeholder engagement may be seen as a "preventive measure" if it is enlisted before a potentially adverse decision is made.

Multiple stakeholders, especially local citizens, must be involved in the planning, execution, and monitoring of environmental projects in order for them to be viable and sustainable.

Stakeholders should bring their money, expertise, and experiences to bear so that collaboration results are environmentally sustainable and superior to those of each

All major stakeholders must be organised into formal or non-formal homogeneous groups that are aware of the need for environmental protection and conservation, mobilised through education and training, and inspired and led, ideally by local non-governmental organisations, to make this possible (NGOs).

People's ability to engage in collective action for soil conservation is influenced by a variety of factors.

All partnerships must also be realised and carried out in accordance with good governance principles, especially transparency, accountability, cost effectiveness, and efficiency.

5.6 MITIGATING MEASURES TO SOIL DEGRADATION

Soil loss can be mitigated, prevented, and even reversed. The following are the details:

Windbreaks- Both artificial and natural windbreaks, such as shrubs, help to keep the wind at bay. Plants also have the advantage of “anchoring”, which reduces the impact of water degradation.

Terracing- It decreases the impact of water runoff and helps to preserve rainwater by terracing slopes.

Strip farming- Its aim is to prevent erosion by alternating strips of different kinds of crops.

Crop rotation refers to the planting of different crops in a specific order in the same region, whereas monoculture refers to the planting of only one crop. Crop rotation has been shown to increase soil nutrients while decreasing pests and crop disease.

Soil quality reduction has a direct effect on the atmosphere and our ability to feed the world's rising population. In the very least, it jeopardises one's ability to communicate.

Soil degradation can be regulated and reduced by increasing public understanding of the problem and promoting creative land management techniques.

5.7 RECOMMENDATIONS

For restoring eroded property, there are many protection strategies. The best strategy for avoiding erosion is to cover footpaths with mulch or stone. Check dams or terraces are the most effective solutions for heavy soil degradation in areas of concentrated flow.

5.7.1 REPLANT VEGETATION SUITED TO SITE CONDITIONS

In cases of light soil degradation, replanting with suitable vegetation may help to stabilise the soil. Your erosion problems will not be solved if the plants are unable to take root and grow. A non-g slope is one with a grade greater than 3:1. To prevent mowing difficulties a low-maintenance non-grass vegetation should be considered. on slopes with a grade greater than 3:1.

Until, to fill in areas affected by gully erosion, replanting and fill soil with a high clay content may be needed. Fill in the gully in the same way we would a sinkhole, then topsoil the area. Before we can build the groundcover, we'll require to construct a brief diversion to divert erosion before site is ready for planting.

Mulch or compost may be used in tree and shrub beds, as well as other places where vegetation is required grows slowly.

Plants that help to prevent erosion. These hardy native species can grow in a variety of conditions, from groundcover to shrubs.

To grow suitable vegetation, soil fertility or pH can need to be improved. Learn how to conduct a soil test to determine if a pH or nutrient level adjustment is needed.

Soil fertility can also be improved by mixing compost into the soil. Find out how to use a compost blanket or a soil amendment.

Tips for Sodding: If sodding is used, make sure the final elevation does not allow water to pool on the upslope side. With a rake, prepare the soil. Strips of sod should be fixed with sod staples and positioned perpendicular to the flow of water.

Tips for Seeding: Consider seed protection If grass seeds are used, a thin layer of topsoil (approximately 14 of an inch) is applied first, followed by a thin layer of straw. The seeds will be protected from birds by a thin layer of soil and straw, which will also aid germination. The first year is crucial, watering the grass will help it establish.

5.7.2 EXPOSED SOIL FOOTPATHS: COVER WITH MULCH OR GRAVEL

Tips required in installing stepping stones:

After the stepping stones are finished, using a rake, a robust pitchfork, or an aerator, loosen the compacted area. before spreading the grass around them.

Add to keep the stepping stones in place, a layer of sand or small gravel.

Place to make stepping easier for the average person, position your stepping stones at appropriate distances citizen.

Add mulch or plant grass seeds or any other suitable vegetation of your choosing.

Laying a gravel or mulch path: some pointers include the following:

Use landscaping spray paint, temporary flags, or other visual markers to demarcate the field signs. Area that will be included in your path. The path's width should be determined by the site's conditions.

Remove any vegetation and grade the field to drain in the desired direction, if necessary.

Landscape fabric should be used to cover the length of exposed soil. Weeds will be eradicated, unable to thrive as a result of this, preventing them from developing through the final stages.

Along the path's length, place landscape edging. To prevent ponding, any low spots in the path should have a gap in the edging to allow water to flow out. Instead of using edging, we can tuck in the length, it is buried in the earth route.

Spread a cover material such as pea gravel, bluestone, or mulch within the markers' boundaries.

5.7.3 TERRACING

Consider constructing terraces along the contour of steep slopes (intersecting the flow path).

Terraces of a shorter duration are more competitive in comparison to higher terraces in a sequence.

Terraces can be constructed from coir fibre biologs, stone, and wood are among the landscaping materials available.

It's important having a strong drainage system built behind your terrarium (gravel or gravel with perforated pipes).

5.7.4 BUILD CHECK DAMS

Arrange the stones in the pile such that the highest elevation is in the centre and the lowest elevation is on both sides.

Big stones should be used. The stones should be big enough to not be moved by strong currents. The upstream side of the check dam should have finer stones, while the downstream end should have larger stones.

Check dams to be closer together if the swale's slope is steep.

Biologs made of coir fibre are a more environmentally friendly choice. They will decompose over time, allowing plants to thrive.

5.8 CONCLUSION

There is a need to enhance sustainable agriculture and introduce various cropping patterns as well as Conservation Agriculture which will bring the soil degradation to a halt and save the essential soil nutrients and this phenomenon will ultimately help in increasing the crop production.

There is an urgent requirement to bring this problem into halt as India is facing major loss due to the soil degradation and farmers are facing many agricultural losses due to the same. They are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures. Over-utilisation of chemical fertilisers and pesticides should be prevented. Excessive tillage also harms the crop production. So, this should also be managed which will help in proper land use management.

This has become a demand to protect the soil from getting degraded because it is not only harming the land but also effecting the agricultural production. This is creating negative effect in the lives of the farmers as well.

The farmers are needed to be explained about the importance and need to protect the soil from getting degraded and increase the crop production by taking preventive measures. The planning level interventions focuses towards the restoration of the soil fertility for enhancement of the soil nutrient balance. Planning Level Interventions play a very crucial role in the protection or prevention of land from being degraded. Stakeholder engagement may be seen as a "preventive measure" if it is enlisted before a potentially adverse decision is made.

Multiple stakeholders, especially the local citizens, must be involved in the planning, execution, and monitoring of environmental projects in order for them to be viable and sustainable. The study recommends that the government adopt successful land degradation monitoring and prevention policies to tackle land degradation and its consequences. These policies should be community-inclusive/participatory, and should be focused on indigenous and long-standing experience and practise of preventing the degradation of land.

Organic farmers who amend the soil with compost and manure replenish nutrients thus reducing flood danger and trapping carbon. Bio-waste should not be thrown

away; instead, it should be used to make organic soil improvers, fertilisers, and grow in, according to advocates of the circular economy. Mineral fertilisers and peat, for example, are fossil-based goods that could be replaced with these. For restoring eroded property, there are many protection strategies. The best strategy for avoiding erosion is to cover footpaths with mulch or stone. Check dams or terraces are the most effective solutions for heavy soil degradation in areas of concentrated flow. Soil degradation can be regulated and reduced by increasing public understanding of the problem and promoting creative land management techniques.

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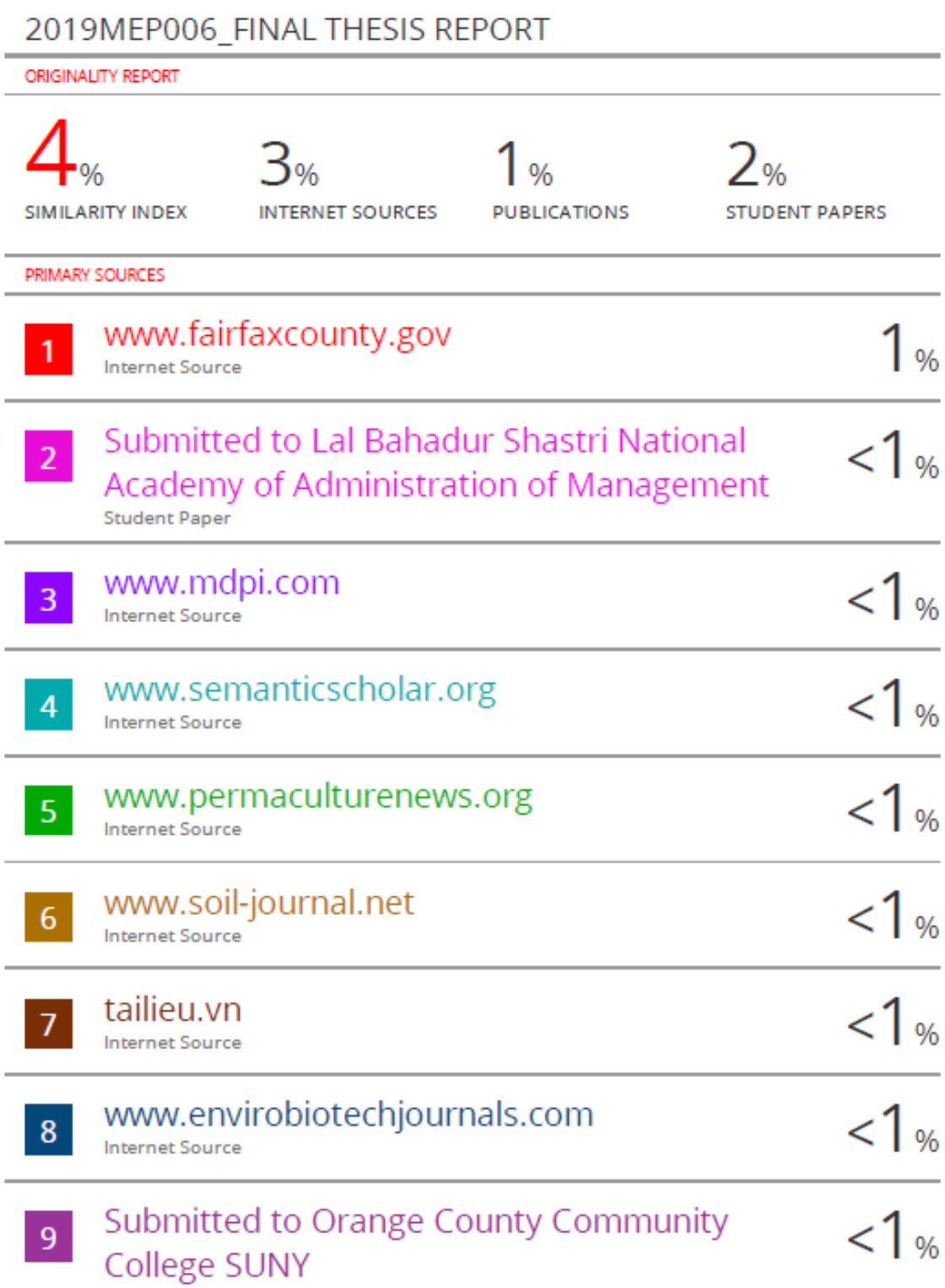
ANNEXURE

ANNEXURE
Annexure I: PLAGIARISM REPORT (SIMILARITY INDEX)



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4%	3%	1%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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Annexure II: SURVEY FORMAT

QUESTIONNAIRE	
1.What are the various causes of Soil Degradation? (In Sambalpur District)	
2.What is the current status of Soil Degradation in Sambalpur District?	
3.What are the various methods and techniques used by Farmers to reduce the Soil Degradation?	
4. What is the impact on Agricultural Production?	
5.Which blocks are majorly affected by the effects of Soil Degradation?	
6.Which villages are mostly affected by the effects of Soil Degradation?	
7.What are the physical and chemical properties of soil in Sambalpur District? (considering all the soil parameters)	
8.What are the various schemes and policies to combat the issue of soil degradation?	
9. What is the status of the ongoing schemes and policies to combat soil degradation?	
10.What measures should be introduced to reduce the issue of soil degradation?	

DATA CHECKLIST

DATA REQUIRED	SOURCES	STATUS
Causes of Soil Degradation in the Study area	Secondary Data Collection, Krishi Vigyan Kendra, Sambalpur	Partially Collected
Soil Degradation Status	ULB, Block Office, KVK Sambalpur	To be Collected
Perception of Various Stakeholders	Interviews, Visual Surveys	To be Collected
Various techniques or methods used by farmers to reduce soil degradation	Secondary Data Collection, Interviews	To be collected
Impacts on Agricultural Production	Ground Survey (Site Visit)	To be Collected

DATA SCHEME WITH REASONING

DATA REQUIRED	REASON
Causes of Soil Degradation in the Study area	Land use and Land cover management
Soil Degradation Status	Preparation of SQI (Soil Quality Index)
Perception of Various Stakeholders	Qualitative analysis
Various techniques or methods used by farmers to reduce soil degradation	For proposing Policy level interventions
Impacts on Agricultural Production	For showing the temporal changes in vegetative cover and how it has impacted the crop growth.
Physical and Chemical Properties of the Soil	To analyse the soil has degraded to what extent for further analysis.
Policies and Schemes	To know the current status of the Policies and Schemes and Benefits.

ANALYSIS METHODS

ANALYSIS	SOURCES
Mapping	Using GIS Tools and Techniques, Spatio-temporal changes (LULC), Preparation of SQI (Soil Quality Index) Map, Map showing Changes in vegetative cover, Contour, Slope and Aspect
Qualitative Analysis	Survey findings and Statistical Analysis (Site Visit)