IMPACT ASSESSMENT OF WATER TRANSFER IN THE NATIONAL RIVER LINKING PLAN: A CASE STUDY OF PROPOSED SHARDA-YAMUNA LINK

THESIS

SUBMITTED TO
BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
LUCKNOW

BABASAHEB
BHIMRAO
AMBEDKAR
UNIVERSITY

LUCKNOW
प्रज्ञा शील करूणा
ESTABLISHED 1996

FOR THE DEGREE OF

Doctor of Philosophy

IN

ENVIRONMENTAL SCIENCE

Submitted by

Anjali Verma

Enrolment No: 393/11

DEPARTMENT OF ENVIRONMENTAL SCIENCE
SCHOOL FOR ENVIRONMENTAL SCIENCES
BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
(A CENTRAL UNIVERSITY, NAAC ACCREDITATION 'A' GRADE)
LUCKNOW-226 025

2015

DEDICATION

"I Dedicate this Research Work

To my Loving Parents

Who provide me moral support and

much, more which can't be expressed

in words"

DECLARATION

I, **Anjali Verma**, hereby declare that the thesis entitled **“Impact Assessment of Water Transfer in the National River Linking Plan: A Case Study of Proposed Sharda-Yamuna Link”** is my own work conducted under the joint supervision of **Dr. Narendra Kumar** (Supervisor), Assistant Professor, Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow, U.P. and **Prof. Mohammad Yunus (**Co-supervision) (Vice-Chancellor) Mohammad Ali Jauhar University, Rampur.

I further declare that to the best of my knowledge, the thesis work does not contain any work or part of work, which has been submitted for the award of any degree either in this University or in any other University.

Anjali Verma
Department of Environmental Science,
School for Environmental Sciences,
Babasaheb Bhimrao Ambedkar University,
Lucknow-226025, (U.P), India.

बाबासाहेब भीमराव अम्बेडकर विश्वविद्यालय

(केन्द्रीय विश्वविद्यालय)

विद्या विहार, रायबरेली रोड, लखनऊ–226025

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

(A Central University)

Vidya Vihar, Raebareli Road, Lucknow-226025

CERTIFICATE

This is to certify that the work incorporated in the thesis entitled **"Impact Assessment of Water Transfer in the National River Linking Plan: A Case Study of Proposed Sharda-Yamuna Link"** is being submitted for award of the degree of Doctor of Philosophy in Environmental Science, of Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow. The present research work was entirely carried out by Ms. **Anjali Verma** under our supervision and guidance. She fulfils the terms and conditions as laid down in the Ph.D. ordinance of this University. To the best of our knowledge no part of this thesis has been submitted for the award of any degree either in this university or in any other University.

I wish her success in her career pursuit.

Dr. Narendra Kumar
(Assistant Professor)
Supervisor
School for Environmental Science
Babasaheb Bhimrao Ambedkar (A Central)
University Lucknow U.P. - India.
E-Mail: narendrakumar_lko@yahoo.co.in

Mohammad Ali Jauhar University
Jauhar Nagar, Post Singan Kheda, Rampur 244 901
TEL. (0595) 2328786, FAX : 2328787
Cell : +91-9415016633
Email : vcmajuniv@live.com, mykabdali@yahoo.co.in

Mohammad Ali Jauhar University

Prof. (Dr.) Mohammad Yunus
VICE-- CHANCELLOR

CERTIFICATE

This is to certify that the work incorporated in the thesis entitled **"Impact Assessment of Water Transfer in the National River Linking Plan: A Case Study of Proposed Sharda-Yamuna Link"** is being submitted for award of the degree of Doctor of Philosophy in Environmental Science, of Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow. The present research work was entirely carried out by **Anjali Verma** under our supervision and guidance. She fulfils the terms and conditions as laid down in the Ph.D. ordinance of this University. To the best of our knowledge no part of this thesis has been submitted for the award of any degree either in this university or in any other University.

I wish her success in her career pursuit.

Co-Supervisor

09.06.2015

Prof. Mohammad Yunus

(Vice-Chancellor)

ACKNOWLEDGEMENT

It is by the grace and will of the Almighty that I have reached the finishing stage of my doctoral work and it feels good. I would like to take this opportunity to humbly express my deepest gratitude for the innumerable gesture of help, co-operation and inspiration that I have received from my teachers, elders, friends and well-wishers during the course of this research work.

I extend my sincere gratitude and appreciation to my supervisor, ***Dr. Narendra Kumar,*** *Assistant Professor, Department of Environmental Sciences, Babasheb Bhimrao Ambedkar University, Lucknow, U.P. - India, for introducing me to the exciting field of research in Environmental Sciences. I will ever remain grateful to him for his excellent guidance, valuable suggestions, unending encouragement and constant cooperation throughout the period of my research work.*

I express my deep sense of gratitude and admiration to my Co- supervisor, ***Prof. M. Yunus,*** *Vice Chancellor, Mohammad Ali Jauhar University, Rampur for his persistent and diligent care and illustrious guidance during course of my research work and preparation of the thesis. His generosity, incessant inspiration, gracious guidance, active co-operation and affection heeled me a lot during the entire period of my Ph. D programme.*

At the outset I owe a deep sense of gratitude and reverence to ***Prof. D.P. Singh (Head),*** *Department of Environmental Sciences, Babasheb Bhimrao Ambedkar University, Lucknow, U.P. - India, for his warm support and valuable suggestion during the tough situations that served as the starting point of this research study.*

I am immensely thankful to all the teachers of Department of Environmental Sciences, B.B. Ambedkar University, ***Prof. D.P. Singh (Head), Prof. R.P. Singh, Prof. S.K. Dwivedi, Mr. N.K.S. More, Dr. Shikha, Dr. Richa Tyagi*** *and* ***Dr. Venkatesh Dutta,*** *whose useful help and suggestions enabled me proceed smoothly toward the work.*

I have no words to express my humble gratitude and profound thanks to ***my Father, my Late Mother*** *and* ***my Brother*** *for their blessings, love, encouragement and for being a source of strength and motivation over the years in every walk of my life.*

I gratefully acknowledge the University Grant Commission (UGC), New Delhi for providing financial assistance in the form of Rajiv Gandhi National Fellowship (RGNF) which buttressed me to perform my work comfortably.

My sincere thanks are extended to all the research scholars and my friends for providing a constant source of encouragement, support, and cheerful company.

I extend my profound thanks to all the office staff members for providing me necessary help in research work.

Anjali Verma

Department of Environmental Science,
School for Environmental Sciences,
Babasaheb Bhimrao Ambedkar University,
A Central University
Lucknow – 226025 (U.P.), India.

PREFACE

Indian Ministry of Water Resources formulated a National Perspective Plan (NPP) in the year 1980, by Central Water Commission (CWC) and identified about 30 major Inter-Basin Water Transfer Links are under the NPP plan in respect of both Peninsular Rivers and Himalayan Rivers of the country in order to reduce the irregularity in the availability of water in various regions and to avoid the problems of Flood and Drought in India. India is prone to natural disasters such as floods, droughts, cyclones, landslides and earthquakes on account of its geo-climatic conditions Ayalasomayajula *et al*. (2014). According to (IWMI) International Water Management Institute, Inter-Linking of Rivers is a project of linking two or more rivers by creating a network of canals and providing water to the deficit areas. It is based on the assumptions that surplus water in some rivers can be diverted to deficit rivers by creating a network of canals. Shukla and Asthana (2005) explained the history of river linking plan in India. Sir Arthur Cotton prepared a plan to link rivers in southern parts in India, then Captain Dinshaw J. Dastur given a proposal for the "Garland Canal" system consisted of two canals Himalayan Canal and Central and Southern Garland Canal. They were to be connected at two points Delhi and Patna. Then, Dr. K. L. Rao former Union, Minister for Irrigation proposed Ganga-Cauvery Link to link river Ganga and river Cauvery in 1975 (Iyer, 2012). Sivanappan (2012) analyzed the decreasing water resources in the country and the need for interlinking of rivers in India. In India the rainfall is irregular and unevenly distributed and hence, water scarcity and floods in some parts frequently occur. As more than 65%

of water flow in the rivers is not utilizable and goes to sea every year, it is necessary to interlink all the rivers to provide water to the deficit basins. Government has created a National Water Development Agency (NWDA) to study and implement the Inter-Basin Water Transfer Plan. Proposed Sharda-Yamuna link (S-Y link) project is one of the identified links of Himalayan river development component of NPP plan. It envisages for transferring of approx.11, 680 million cubic meter of surplus water available from the upper reaches of river Sharda River into the S-Y link for meeting the water demands in acute water short and drought prone areas of Uttar Pradesh, Haryana, Rajasthan and Gujarat in India. It will off take water from existing Tanakpur barrage near Tanakpur town of Champawat district of Uttarakhand and out falls into Yamuna River near Kairana village of Muzaffarnagar district of Uttar Pradesh state in India. The length of the entire link is about 384 Km, which traverses through districts Champawat, Nainital, Udham Singh Nagar and Haridwar of Uttrarakhand state and Bijnor and Muzaffarnagar districts of Uttar Pradesh. The Command areas lies in Bareilly, Rampur, Moradabad, J.P. Nagar, Badaun and Bijnor districts of Uttar Pradesh and Udham Singh Nagar district of Uttarakhand. The S-Y link will further divert water through Yamuna-Rajasthan and Rajasthan Sabarmati Link canals for providing irrigation to the drought prone areas of Haryana, Rajasthan and Gujarat states.

The key objectives of the case study were to study the description of Proposed S-Y link and its role in management of water, flood and drought. Current Baseline Environmental, Ecological and Socio-Economic Issues were discussed in details to know the Impacts of proposed S-Y Link Project. The concept of Impact Assessment is based on EIA Checklist method which was applied on Enrouted and Command areas of the S-Y link canal to know the Socio-Economic conditions. Some Environmental Management Plans are also focused for the construction work of the proposed S-Y link to manage the adverse impacts of the project.

The whole Case Study is arranged in Eight Chapters…

CHAPTER. 1 - An **Introduction** about the Proposed Sharda-Yamuna National River Linking Project and its role in management of Flood and Drought in India. It provides the concept of EIA Checklist method and outlines of Objectives.

CHAPTER . 2- A **Review of Literature** regarding National River linking Plan in India, its Impacts and EIA process.

CHAPTER. 3- It gives the brief information about the **Study Areas** of the Proposed S-Y Link.

CHAPTER. 4 - It is a **Methodological** framework of Case Study. It includes the Collection of data, Impact identification, Surveys and Investigation.

CHAPTER. 5- RESULTS AND DISSCUSION

5.1 A **Description** about the Proposed S-Y Link project regarding its size, area and location.

5.2 A study on **Baseline Environmental factors** and expected Impacts of Proposed S-Y Link Project.

5.3 A study on **Baseline Ecological Status** of the link canal, which also covers the Impact of Proposed link canal on Ecological factors.

5.4 A study on **Socio- Economic Status** of the proposed S-Y Link project on the basis of impact identification EIA Checklist method.

5.5 This section involves the study of **Other Environmental Factors** of the proposed S-Y link which may likely to exist during and after Construction phase.

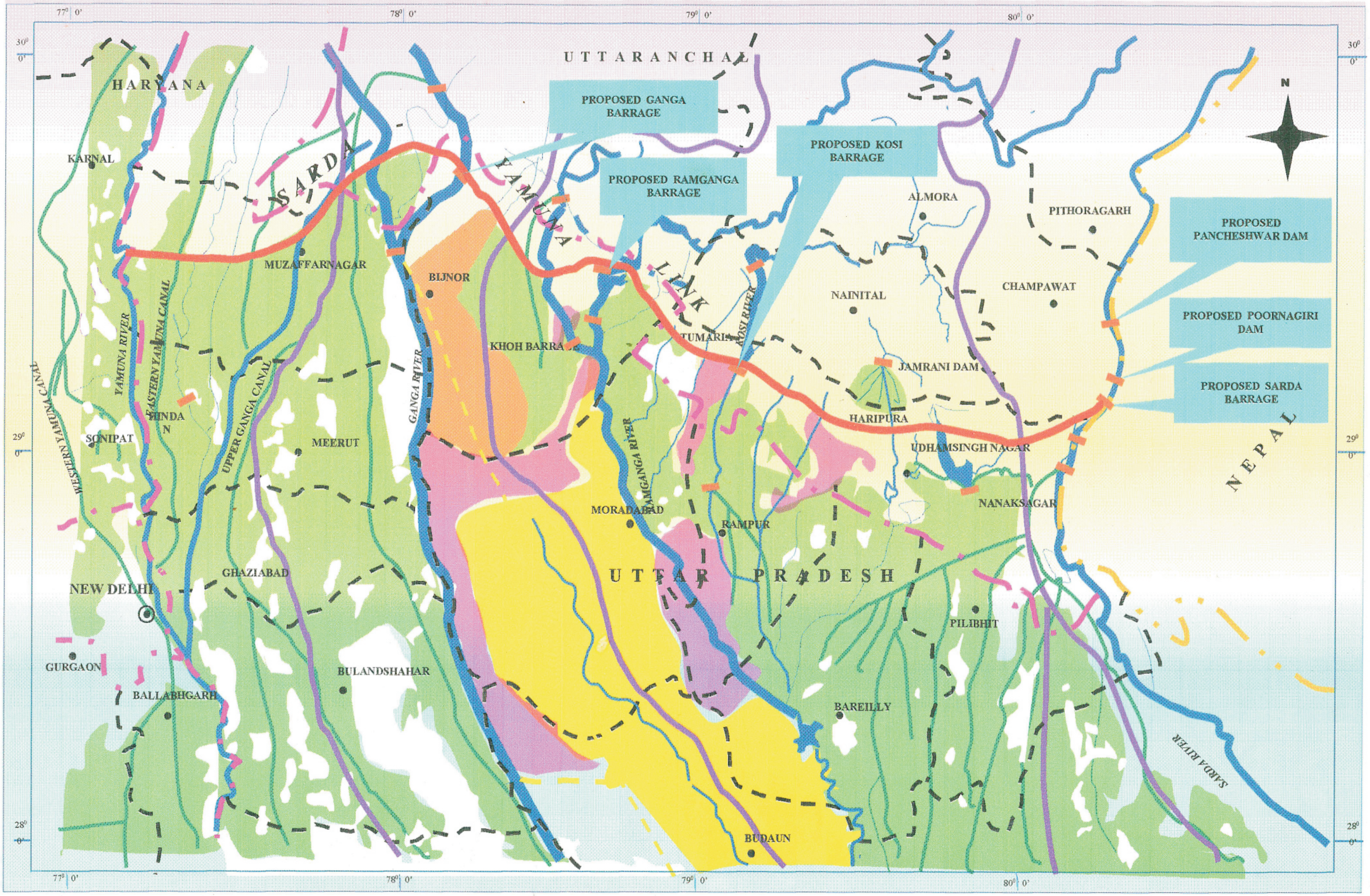
CHAPTER . 6- It provides with the **Summary and Conclusions** part of the case study which highlights the Importance of the River Linking Project and its Environment, Ecological and Socio-Economic Impacts. It also proves that an EIA is a good management tool for impact assessment.

CHAPTER . 7- It deals with the **Suggested Strategies** for Environment Management to mitigate the adverse impacts during construction and operation phase of the project.

CHAPTER. 8 - It is about **Resettlement and Rehabilitation Plan** to restore the Social and Economic standard of the project affected people.

CHAPTER. 9- It is the **References** part of the research work.

SARDA – YAMUNA LINK



CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

1. Archeological Survey of India (ASI)
2. Catchment area Management Plan (CAMP)
3. Central Ground Water Board (CGWB)
4. Central Soil and Materials Research Station (CSMRS)
5. Central Soil and Materials Research Station (CSMRS)
6. Central Water Commission (CWC)
7. Centre for Ecological Sciences (CES)
8. Density per square mile (Density/mi^2)
9. Environmental Impact Assessment (EIA)
10. Environmental Impact Statement (EIS)
11. Environmental Management Plan (EMP)
12. Environmental Management Unit (EMU)
13. Environmental Policy Act (NEPA)
14. Ganga Flood Control Commission (GFCC)
15. Geographic Information Systems (GIS)
16. Geographical Area (GA)
17. Geological Survey of India (GSI)
18. Gross Irrigated Area (GIA)
19. Hectares (Ha)
20. Indian Meteorological Department (IMD)
21. Inter Basin Water Transfer (IBWT)
22. Interlinking of Rivers (ILR)
23. International Union for Conservation of Nature (IUCN)
24. International Water Management Institute (IWMI)
25. Jyotiba Phule Nagar (J. P. Nagar)
26. Mean Sea level (MSL)
27. Megawatt (MW)
28. Millimeter (mm)

29. Million Cubic Meter (Mm^3)

30. Million kilowatt hours (MKwh)

31. Ministry of Environment and Forests (MoEF)

32. Moderate Dense Forest (MDF)

33. National Disaster Management Authority (NDMA)

34. National Perspective Plan (NPP)

35. National River Linking Project (NRLP)

36. National Water Development Agency (NWDA)

37. National Workshop on Uttarakhand Disaster (NIDM)

38. Net Irrigated Area (NIA)

39. Non Forest (NF)

40. Open Forest Area (OP)

41. Participatory Irrigation Management (PIM)

42. Policy and Advisory Technical Assistance (PATA)

43. Project Affected Persons (PAPs)

44. Regional Distance (RD)

45. Resettlement and Rehabilitation (R&R)

46. Sharda-Yamuna link (S-Y link)

47. Square kilometer (Km^2)

48. United Nations Environment Programme (UNEP)

49. Upper Ganga Canal (UGC)

50. Very Dense Forest (VDF)

INTRODUCTION

1 INTRODUCTION

1.1 WATER AVAILIBILITY AND WATER SCARCITY

Water is the most important natural resource required for sustaining life on earth, without it life cannot possible. It is required for irrigation, power generation, drinking, industrial use and other so many purposes etc. Availability of water resource is decreasing day by day. Efforts have been made to conserve precious water for future use.Water resources in the country are limited due to developmental activities, industrialization, pollution, population, dropped rainfall levels, droughts, floods and other factors. Amarasinghe *et al*. (2007) focused on the scarcity of water and its demand in river basins in India. Rapid urbanization and rising population results water demand, with rapidly expanding developmental activities. It is expected that, in India water scarcity may rise in future thus; the water should be saved through global trades (Bandyopadhyaya and Perveen, 2003). Study on significance of water saving and its sustainability at global trade was done by Chapagain *et al*. (2005). According to some researchers, maximum population of the world may be faced by water scarcity problem by 2025. The demand of water in the developing countries of the world may increase up to 50 % by global warming. Some other problems may also arise such as rise in water level in sea, global warming and climate change etc. Climate change refers to the alterations in weather patterns. Climate change is overall the change in our environment. It is affected by several things from natural processes or by human activities. The climate change in the developed countries is due to increasing pollution, population, industrialization, deforestation, urbanization and dependence of people on natural resources. Gross (2002) described the current state of epidemiological research on the health impacts of global warming, about the serious impact of climate, adaptation, vulnerability and indirect consequences of climate change on human health such as malaria, dengue, virus-related disease, cholera, meningococcal infections, and malnutrition. Considering the future water demands, conservation and its management, study on demand for water and its changing consumption patterns in India was done by Iyer (2003). Sustainable use of water is very important. Although, India is very rich in water availability, but many factors like pollution, population etc. leads to decrease the level of water table. Urbanization, growth in population and the process of economic development results in water demand (Iyer 2007). Problem and potential of water pricing are increasing day by day (Sridhar and Mathur 2011). Barbier (2004) and Jain (2014) discussed the problem of water scarcity in Indian scenario. Different states in India such as Rajasthan, Gujarat, Tamil Nadu, Orissa and Bihar etc are facing droughts and floods due to hydrological ignorance. The demand of water and its changing consumption patterns in India causes scarcity of water, which can be minimized by supplying the water towards deficit areas (Amarasinghe, 2009). Inter-Basin Water Transfer plan is to mitigate the water scarcity through the diversion of surplus amount of water to deficit areas and to meet the existing and future water demands (Bhaduri *et al*., 2007). Boroujeni and Saeedinia (2013) highlighted the importance and impacts of the diversion of water from one basin to other basin or sub basin through available natural drain from the catchment area of one reservoir to other for use of water. Hazards are natural and become disasters by affecting vulnerable land-uses, people and their infrastructure including ecosystems and resources. Gupta *et al*. (2013) studied the recent mega and complex disasters, which occur due to flash flood.

1.2 IMPROPER RAINFALL DISTRIBUTION

Rainfall is an important to maintain the ecological balance. In India, several parts have faced improper rainfall distribution, which varies from heavy to low. India has a great regional and temporal variation in the distribution of rainfall. According to Indian Meteorological Department (IMD), the maximum rainfall occurs in the months of June to September in the country. Annually average rainfall occurs in the country is approx 125 cm. The highest annual rainfall in the world has been recorded is around 1141.9 cm at Cherrapunji in Meghalaya in India. Rainfall generally increases with height towards east direction. Precipitation is increases with higher elevations of around 1,500 meters in the Himalayan Mountains. In recent years, abnormal rainfall has been reported around the world. Study on rainfall pattern with its Precipitation Concentration Index in several climatic parts in the state Andhra Pradesh was done by Valli *et al.* (2013). Jain and Kumar (2012) explained the trends of rainfall and temperature all over India. Many parts of the south, central and western regions of India showed low rainfall due to high temperature and regions in the north-eastern states showed high rainfall. Due to irregular fluctuations in rainfall and climate change during the monsoon season level, some parts of the country are facing acute drought and some are flooded.

1.3 IMPROPER RAINFALL DISTRIBUTION IN NORTH INDIA (U.P AND U.K STATES)

Irregular monsoon and unequal rainfall distribution results flood and drought in northern region of India. According to Indian Meteorological Department, rainfall in India was rise with 6.3% excess in the year 2013. Western, Central and North eastern regions were faced high rainfall in India and regions like Bihar and Jharkhand were faced drought. Several districts of Uttarakhand state including Uttarkashi, Chamoli and Rudraprayag were faced with heavy rainfall.

"Variations in rainfall cause irregular distribution of water in the country. Some parts of the country faced flood and some are drought affected".

1.4 DROUGHT

Drought condition generally occurs due to the no rainfall for a very long time. It results water scarcity in the river basins. The discussion on the variation of supply of water and its demand in the river basins in India was done by Amarasinghe *et al.* (2005). Some regions of Rajasthan, Bundelkhand, Karnataka, Orissa, Chhattisgarh, Punjab and Haryana states in India are the examples of severe drought. Gupta *et al*. (2011) described the impacts of drought, its management, data management and monitoring.

1.5 FLOOD

Flood is an overflow of surplus water in an area which is dry. It is basically, a natural hydrological phenomenon. The main cause of flooding is heavy monsoon rainfall over the region for a long time.

1.6 FLOOD AFFECTED AREAS IN NORTH INDIA (U.P AND U.K STATES)

Flood is known as hazard of U.P. state in India due to overflowing of major rivers such as Ganga, Yamuna, Gomti, Sharda, Ghaghra, Ramganga, Rapti and Gandak. In U.K state some areas received heavy rainfall near Gobindghat, Dehradun, Rambada, Badrinath, Uttarkashi, Rudraprayag, Tehri Garhwal, Kedarnath, Chamoli and Joshimath. The study on the consequences of flood was done by Nautiyal and Bhandari (2012).

1.7 FLOOD AND DROUGHT MANAGEMENT

The Government of India has developed a proposal to minimize the problems of drought and flood by proposing "Large Scale Inter Basin Water Transfer" or "Interlinking of Rivers" to provide an equal distribution of water from surplus regions to deficit regions. Pant and Pande (2012) explained different disasters and their impacts in Uttarakhand state in India and gave the concept of disaster management through disaster risk analysis and case studies.

1.8 LARGE SCALE INTER-BASIN WATER TRANSFER PROJECT OR "INTERLINKING OF RIVERS" (ILR) IN INDIA

"Interlinking of Rivers proposal is a mega Inter-basin Water Transfer Project Proposed by Indian Ministry of Water Resources for flood and drought management".

It is need to transfer the surplus water to deficit basins of the country for proper water distribution, sustainable use of water and control flood and drought (Urfi, 2004). The purpose of the large-scale project is to divert the water to the places which are water deficit through the links.

1.9 NATIONAL PERSPECTIVE PLAN IN INDIA

About 30 Interlinks of river are proposed under the NPP plan in 1980 by the Central Water Commission and Indian Ministry of Water Resources to reduce water irregularity and to increase in water availability.

1.10 PROPOSED SHARDA-YAMUNA LINK

Proposed Sharda-Yamuna link is a part of Himalayan river development component and one of the large scale Inter- basin Water Transfer Links in India, which is for transferring the surplus amount of water form Sharda river to Yamuna river which is water deficit and further towards drought western states of the country such as Uttar Pradesh, Haryana, Rajasthan and Gujarat. The purpose of S-Y link is to manage flood and drought situations in U.P and U.K states in India. Except flood and drought control, it will also help in increasing water quantity for other useful purposes in its Enrouted and Command regions.

1.11 LOCATION OF THE PROJECT

The Enrouted areas of the proposed S-Y Link canal are Champawat, Nainital, Udham Singh Nagar and Haridwar districts in Uttarakhand state and Bijnor, Muzaffarnagar districts in Uttar Pradesh state in India. Enrouted areas are the locations through which the link has been proposed to transfer. Command areas lies in Bareilly, Rampur, Moradabad, Badaun, Bijnor and Jyotiba Phule Nagar (J.P.Nagar) districts in Uttar Pradesh and Udham Singh Nagar in Uttarakhand. These are the surrounding locations of the S-Y link.

1.12 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Environmental Impact Assessment is a method for the assessment of impacts of any proposed developmental activity or a project, whether the impacts are beneficial and harmful. It is a management process to ensure the proper use of natural resources and sustainable development. EIA is identification, prediction, evaluation and mitigation of environmental, social and other potential impacts with their consequences. The process relates with Socio-Economic, Cultural and Human health aspects. EIA process can be used for any developmental activity earlier to take decisions and commitments and recommend suitable mitigation measures to decrease the possible adverse impacts Kaya and Kahraman (2011).

1.12.1 EIA Checklist Method

EIA Checklist is a well-structured list to identify the environmental parameters and a method for representing the collective knowledge judgments. On the basis of interaction, this method provides information regarding environmental components. It is a collection of data to ensure that it is efficient and targeted to answer the specific questions and to quantify the impacts. EIA Checklist is a list of environmental parameters about to be affected by any developmental activity (Poder and Lukki, 2011).

1.13 OBJECTIVES OF THE STUDY

1) To study the description of proposed Sharda -Yamuna Link Project viz. size, area and location of the project.

2) To study Baseline Environmental factors of the proposed Sharda-Yamuna Link Project viz. Physiography, Geology, Soil, Land use, Agriculture, Surface Hydrology, Groundwater Hydrology and Meteorology.

3) To study the Socio Economic conditions and Baseline Ecological status of the proposed Sharda- Yamuna Link.

4) To study the Impacts of proposed Sharda-Yamuna Link Project on air quality, water quality, Flora, Fauna, Settlements, Land use, Agricultural sectors, Soil, Groundwater, Water use etc.

REVIEW

OF

LITERATURE

2 REVIEW OF LITERATURE

2.1 RAINFALL DISTRIBUTION IN INDIA

Rainfall in India is highly uneven due to which the distribution of water is not proper. In some places heavy rainfall occurs during the normal monsoon time. The scarcity of water in river basins is increasing fast with rise in population. Many parts of the country are facing from severe frequent droughts and floods. Monsoon flood water should be conserved and utilized optimally for the various purposes **(Fig 2.1).**

2.1.1 The rainfall zones in India are:

2.1.1.1 Low Rainfall Zone

In low rainfall zone, the distribution of rainfall is about 50 to 100 cm per year. Some low rainfall zones are Western Rajasthan, Tamil Nadu, Northern Jammu and Kashmir, Kutch areas, where the rainfall occurs below 50 cm.

2.1.1.2 Medium Rainfall Zone

In medium rainfall zone, the distribution of rainfall is about 100 to 200 cm per year. Some medium rainfall zones are Eastern Ghats, Upper Ganga Valley, Gujarat, Punjab and Rajasthan states in India.

2.1.1.3 High Rainfall Zone

In high rainfall zone, the distribution of rainfall is above 200 cm per year. Distribution of rainfall in the areas of heavy zone implies rainfall above 200 cm in a year. Four rainy months in the northern part are June to September of high rainfall. July is the rainiest month. Zones of very high rainfall are North Eastern and Darjeeling district of West

Bengal state in India. Arunachal Pradesh and Tripura are also the regions of very high rainfall.

2.2 RAINFALL DISTRIBUTION IN NORTH INDIA

In north India, several damages are caused by flood including crops, agriculture, human life etc. According to Uttarakhand State Action Plan on Climate Change September 2012, Uttarakhand state is affected by the climate change. Climate change affects many factors such as melting of glaciers, loss of life, loss of natural resources, winter rains, irregular rainfall, flora and fauna diversity etc. Climate change has increased over the last three decades. Among all the parameters of climate change, temperature is an important factor to detect the change in climate due to developmental activities. The changing pattern of temperature in Dehradun city in Doon valley of Uttarakhand state in India was studied by Singh *et al*. (2013). The rise in annual maximum, minimum and mean temperature is attributed to urbanization effect. According to Uttarakhand Disaster Recovery Project 2013, heavy rains affect many regions of Uttarakhand, which is recorded of about 124.5 to 244.4 mm. This unprecedented rainfall resulted increase in water levels and raise the flood situation in the river basins such as Mandakini, Alakananda, Bhagirathi and caused extensive landslides at various locations such as Bageshwar, Chamoli, Pithoragarh, Rudraprayag. The study on heavy rainfall in the north region of India was done by Joseph *et al*. (2013)**.** The climate of Uttar Pradesh state is a humid subtropical with dry winter type and in some areas of the eastern part has semi-arid climate. The state U.P is situated in Indo-Gangetic Plain, which are a plain of River Ganga and its tributaries. With the variations in temperature, floods and droughts occurs in many areas of the north India. The summers are very hot; winters are so cold and rainy season is wet or very dry.

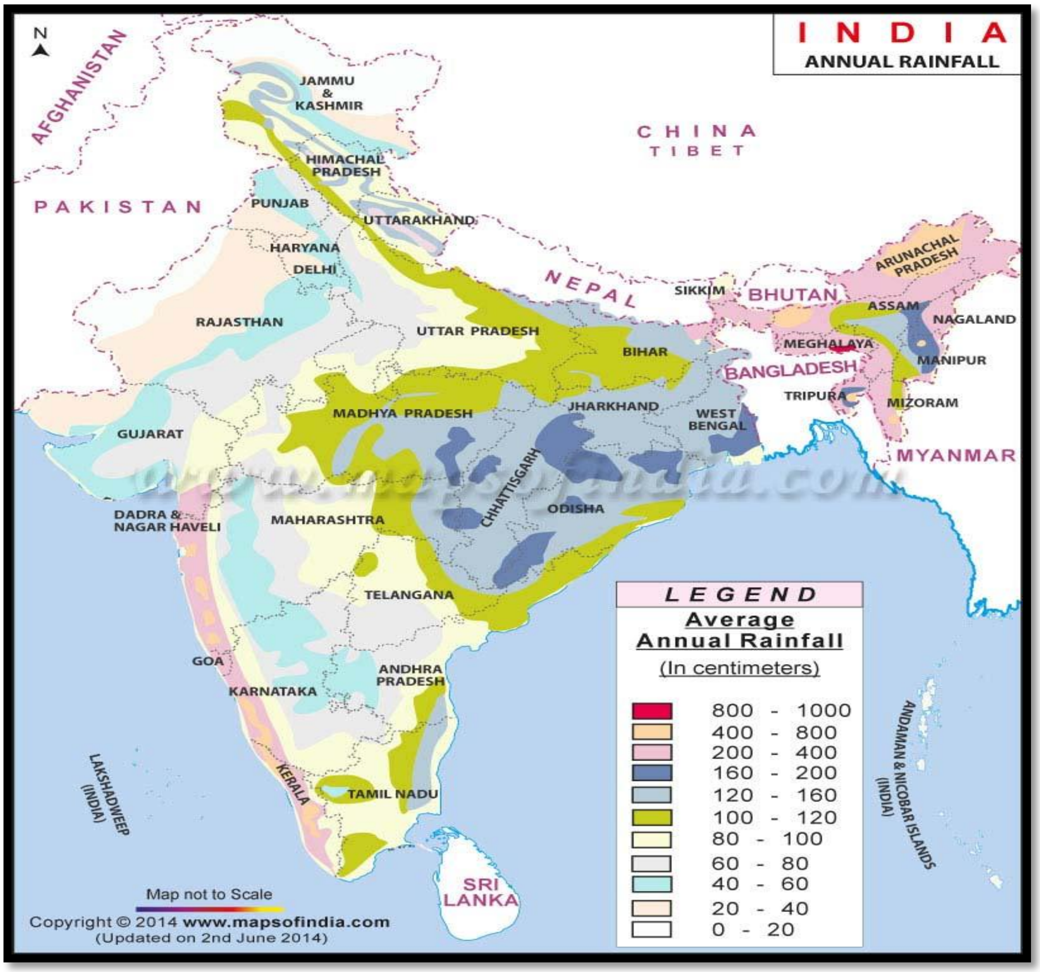


Fig: 2.1 Annual Rainfalls in India Source: Google

2.3 NATURAL HAZARDS IN INDIA

Natural hazards cause huge losses to life with property. Some natural hazards are floods, cyclones, avalanches, landslides and torrential rains etc that cause great loss to biodiversity. Some other hazards are storms, hail which is also common in several parts causes severe damage to standing crops such as rice and wheat **(Fig 2.2).**

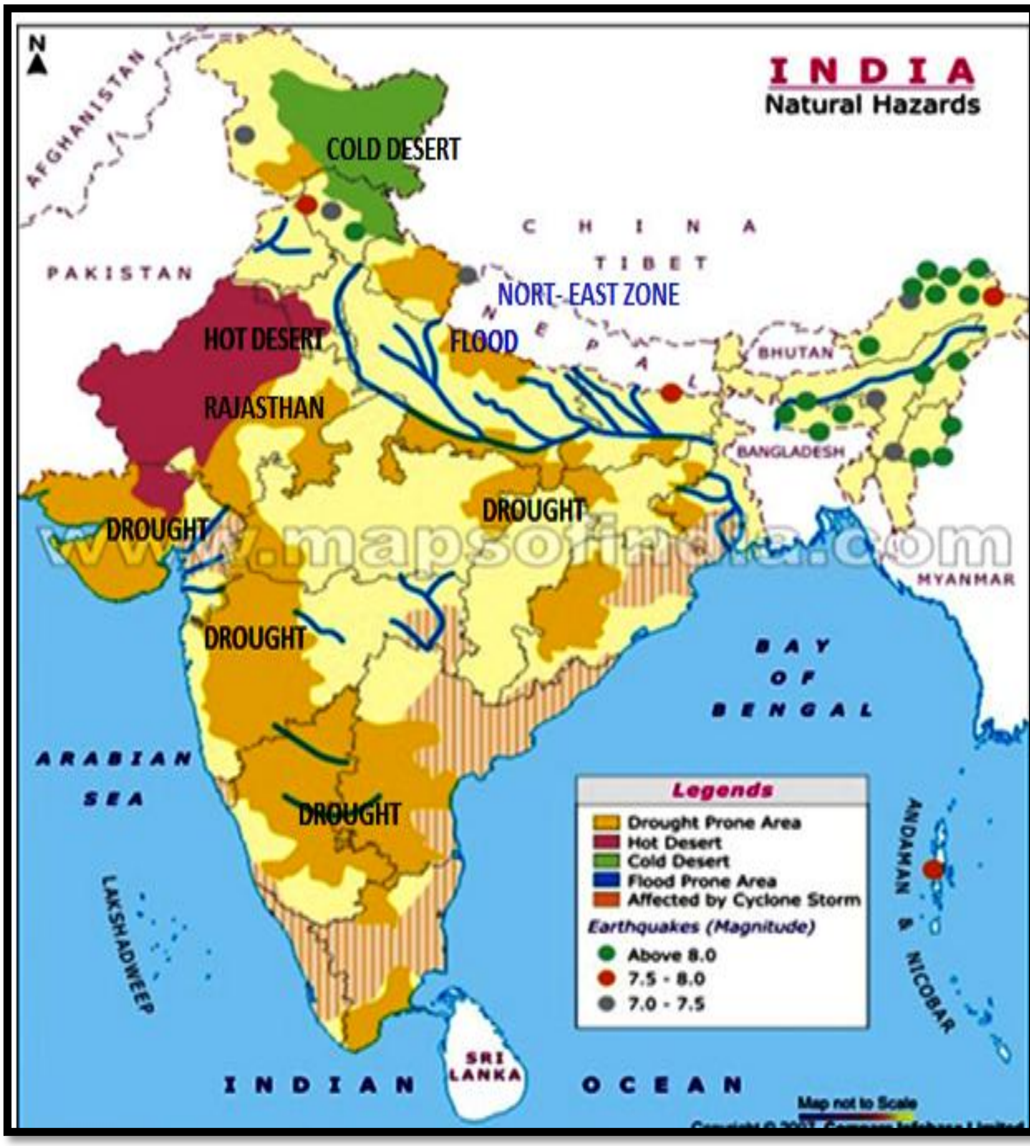


Fig: 2.2 Natural Hazards in India Source: Google

2.3.1 FLOOD AND DROUGHT

"Drought and Floods are major water concerns in India and generally happen due to improper rainfall water distribution".

2.3.1.1 DROUGHT

Drought is a condition of scarcity of water in an area, where the level of rainfall is below then average. It is a period when an area receives a deficiency in its water supply and gets less amount of rain water. It causes when a geographic area receives significantly deficient rainfall for an extended period of time. Drought results climate change, loss of biodiversity, degradation of natural resource etc. It disrupts the socio-economic conditions (Pai *et al*., 2010). Bhattacharya and Das (2007) explained vulnerability to drought, cyclones and floods in India and focused into three climate extremes such as repeatedly drought, floods and cyclones. Vulnerability "hot spots" in the three states are such as Andhra Pradesh, Uttar Pradesh and Orissa, where these hazards are prevalent. Gore *et al*. (2010) studied on the mapping of drought prone areas for developmental planning, which is one of the drought management strategies. Elliott *et al*. (2013) predicted the agricultural impacts of drought which not only affects the regions of India but other countries also. Dass *et al*. (2012) discussed the impact of drought in ground water level of Rajasthan, which is one of the severe drought affected states in India. Drought directly affects the scarcity of drinking water. Awareness and participation of people can help in management of drought **(Fig 2.3).**

Fig: 2.3 Droughts in India

2.3.1.2 Drought prone areas in India

Many parts of India faces drought every year. Drought prone state in India is Madhya Pradesh, Karnataka, Maharashtra, Odisha and Tamil Nadu, but Rajasthan, Gujarat and Haryana are severely drought affected regions. The first evidence of drought was seen due to low rainfall (Moreland, 1993) **(Fig 2.4).**

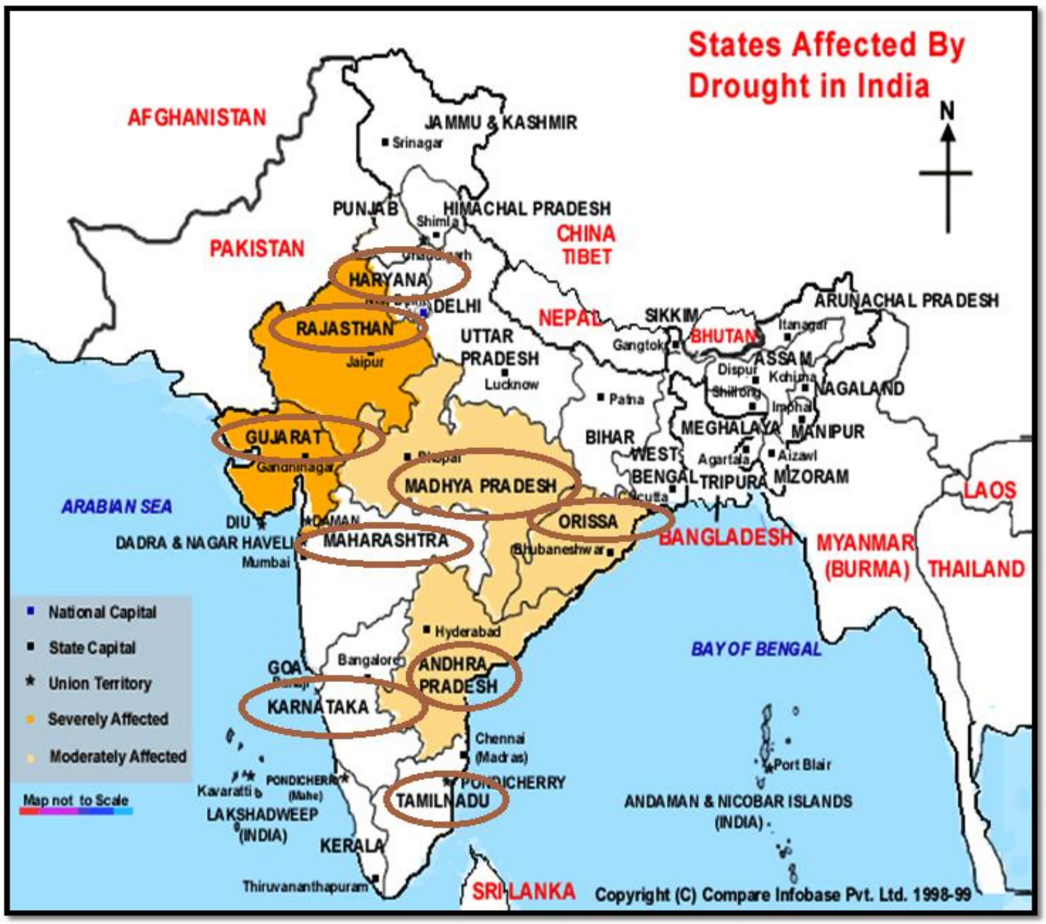


Fig: 2.4 Drought prone areas in India Source: Google

2.3.1.3 FLOOD

Flood is another most common natural hazard and one of the destructive forces in nature, which occurs mostly due to heavy rainfall. It occurs by many factors such as high rainfall, developmental activities, urbanisation, population, loss of vegetation, tsunamis or other natural disasters etc. It causes heavy damages every year. According to the Geological Survey of India (GSI), the major part of flooded area is approx. 12.5 %. In eastern regions several people are affected by flood which causes loss to many people. In recent time, heavy precipitation resulted flood that caused huge loss to economy and life (Guhathakura *et al*., 2010). Zlatanovaa *et al.* (2014) examined the activities and information needs related to flood management. The study on flood risk disaster and its management was done by Gupta *et al.* (2013). Flooding is a major problem in India, which causes lots of damage each year (PATA, 2012). Rising sea levels, development and other factors increase the flood situations (Thilagavathi *et al*., 2011). Flood management is an important fact of climate change adaptation in India to minimise the risk of flood conditions. According to National Disaster Management Authority, India is a country which is highly vulnerable to flood situations and about more than 40 million hectares of the area is flood affected **(Fig 2.5).**

Fig: 2.5 Floods in India

2.3.1.4 Flood prone areas in India

Floods are recurrent phenomena in India. Every year several parts of the country are affected by flood due to varying rainfall. Different parts of the country have different rainfall and climate patterns. About 75 % of the raining occurs from month of June to September due to the south west monsoon, which is irregular distributed. The rivers of North and Central India parts are prone to frequent floods. Some flood affected regions in the country are Orissa, Gujarat, Haryana, Bihar, Uttarakhand, Uttar Pradesh and Punjab etc (Gaurang *et al*., 2014) **(Fig 2.6).**

In India, North-Indian plains are more prone to flood which is categorized in three parts:

- **Ganga Basin:** In northern part of India, mostly flood occurs in Ganga Basin due to presence of river Ganga and its tributaries such as Sharda, Rapti, Gandak and Ghagra. States affected by flood in Ganga basin are West Bengal, Bihar and Uttar Pradesh.
- **Brahmaputra Basin:** The flood occurs in Brahmaputra Basin due to surplus amount of water in the north eastern states like West Bengal, Assam and Sikkim. The study on the devastation caused by the flood in the Brahmaputra basin was done by Pal *et al. (*2012).
- **Central India and Deccan Rivers Basin:** Southern and Central part of India are affected by heavy rainfall and due to presence of rivers like Mahanadi, Godavari, Tapti, Krishna and Narmada and in some coastal regions, such as Kerala, Andhra Pradesh, West Bengal and Odisha flood occurs occasionally.

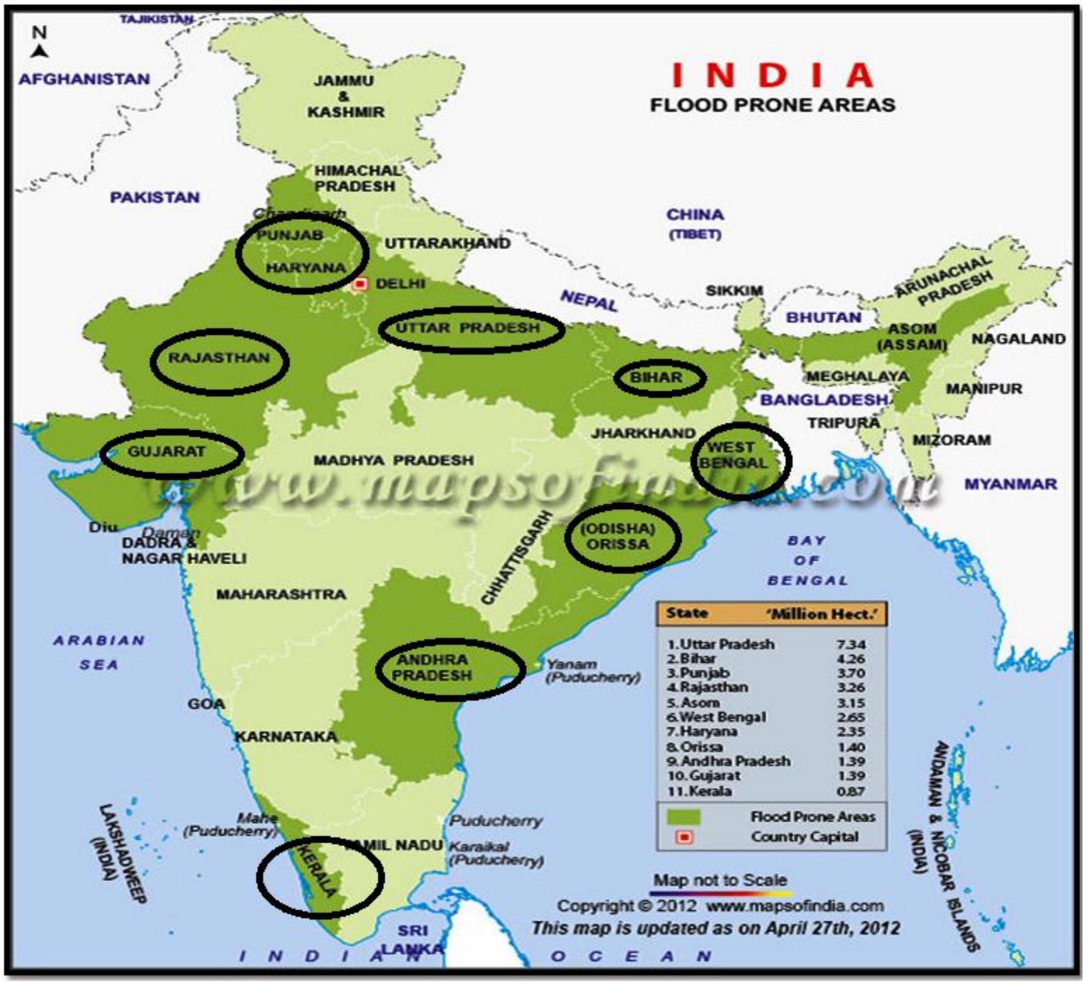


Fig: 2.6 Flood prone areas in India Source: Map of India

2.4 FLOOD AFFECTED AREAS IN NORTH INDIA (U.P AND U.K)

In eastern part of Uttar Pradesh, flood affects Behraiach, Kheri, Sitapur, Barabanki, Faizabad, Gonda, Balrampur, Azamgarh, Sravasti and Lakhimpur **(Fig 2.7)** due to the presence of rivers like Rapti, Sharda, Ghagara and Gomti. Sharma *et al*. (2013) studied flood happened in Kedarnath valley in Uttarakhand due to heavy rainfall. De *et al*. (2005) describes the effect of extreme weather in India in last 100 years and socio-economic impacts due to increasing population and climate change. Many others issues related with great disaster flood in Uttarakhand flood and the geographical causes with possible mitigation plans were focused by Das (2013). In the month of June 2013 year, the whole region of Kedarnath faced heavy rainfall and flood. Some districts of Uttarakhand state such as Uttarkashi, Chamoli and Rudraprayag were badly affected **(Fig 2.8).** The death count was reached up to 10, 000, about more than 3000 people were missing and injured. The flash flood was named as 'The Himalayan Tsunami'.

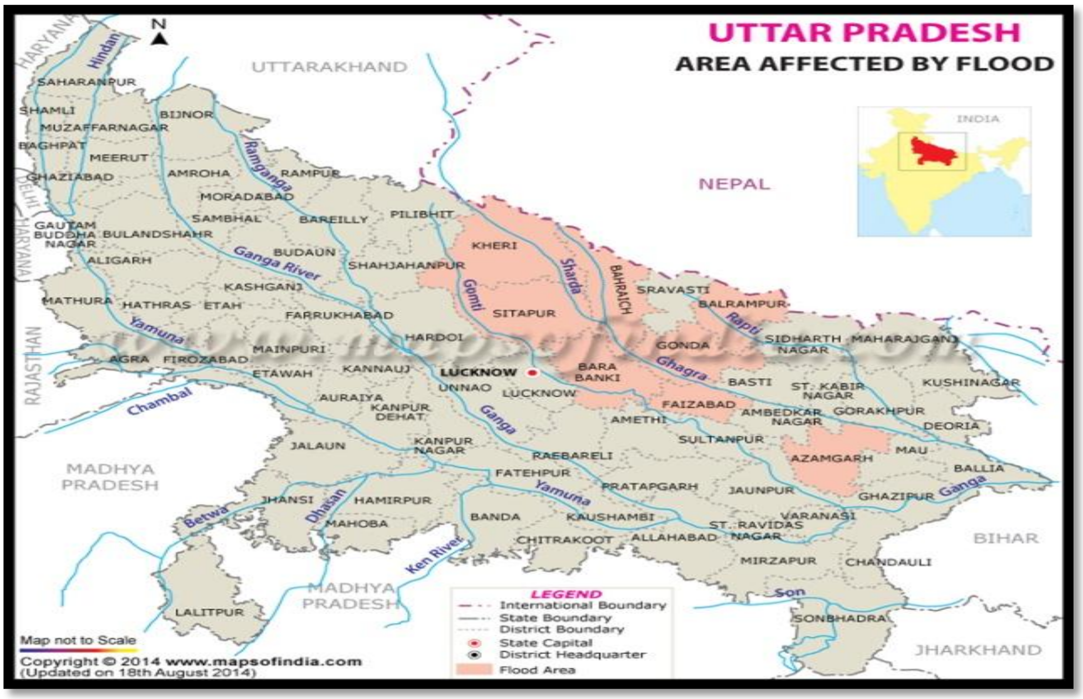


Fig: 2.7 Flood Affected Areas in U.P Source: Map of India

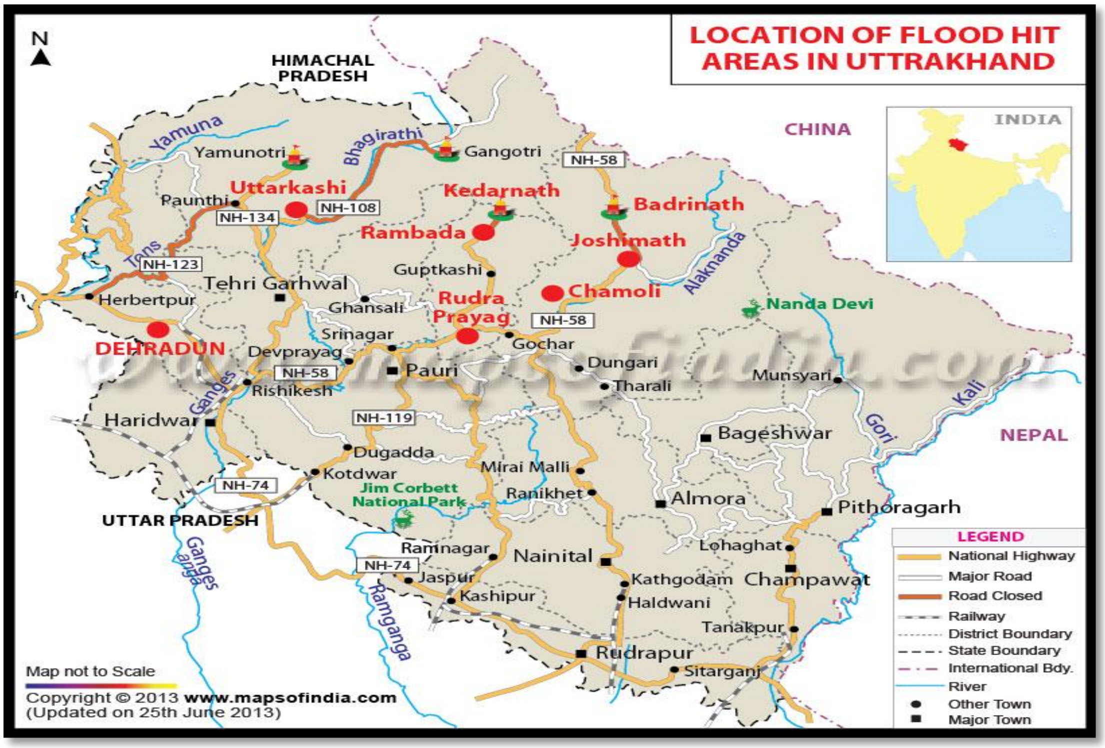


Fig: 2.8 Flood Affected Areas in U.K Source: Map of India

2.4.1 Destruction caused by Flood and Drought and Some Environmental Issues are:

- Huge loss of life and property
- Chances of landslides disaster
- More flooding
- Damaged several houses and structures
- Limited food.
- Road damages, vehicles, traffic jams mary arise.

2.5 FLOOD AND DROUGHT MANAGEMENT

"Efforts have been undertaken in management to mitigate the risk of Flood and Drought".

Practices should be needed for the water resource management. Mann (2012) carried out studies on disaster management of Uttarakashi district, which is the most sensitive zone of the Himalaya. In the district earthquake, flood and landslides are always occurs. On the basis of NIDM, in June 2013, the state Uttarakhand was affected by heavy rainfall resulted great loss to life and properties of the people. The study on management of drought, its prevention, mitigation and preparedness was done by Rahore *et al.* (2014). Gupta *et al*. (2011) suggested the drought management methods with impacts, strategies and symptoms of drought. The river interlinking proposals is to carry out studies for water resource management. George *et al*. (2014) highlighted the concept of interlinking of rivers, its issues and concern of economic and ecological benefits for the sustainable development as well as adverse impacts due to Inter-basin water transfer. Interlinking of project is aimed to modifying the acute spatial inequity in the availability of water resources in India and making more water available to the western and southern regions. Singh and Chauhan (2005) stressed on the need for economic and environmental feasibility study of the proposed project.

2.5.1 Some Methods of Flood Management

2.5.1.1 Dams

Many small and large dams with their reservoirs to manage the flood situations.

2.5.1.2 Diversion of Canals

The control of flood by transfer the amount of water to the ponds and other water bodies.

2.5.1.3 Flood barrier

It is a management of flood during the heavy rainfall or rapid melting of snow to protect the life of people and property self-closing flood barrier.

2.5.1.4 River defences

Other defence methods of flood management are such as reservoirs, bunds and weirs to protect the rivers from bursting their banks.

2.5.1.5 Coastal defences

Some coastal defences are sea walls, barrier islands and beach nourishment for the sea and rivers.

2.5.1.6 Temporary perimeter barrier

Temporary perimeter barrier is a method of water to control flood.

2.5.2 Some existing Mechanism for Flood management in India

Some flood management mechanisms are exists as follows:

2.5.2.1 State Level Mechanism

The mechanisms at the State level are State Technical Advisory Committee, Flood Control Board, Irrigation Departments, Water Resources Departments and Public Work Departments.

2.5.2.2 Central Level Mechanism

Various organisations are set up and many expert committees of the central level to manage the problem of flood in India.

2.5.2.3 Central Water Commission (CWC)

In 1945, the Government of India set CWC to control the flood, conserve the water and proper use of water resources.

2.5.2.4 Brahmaputra Board

The Brahmaputra board was set up in 1980, by the Ministry of Irrigation to control the soil erosion process and water drainage system.

2.5.2.5 Ganga Flood Control Commission

Ganga Flood Control Commission (GFCC) was set in 1972, for the preparation of plan to control the flood in Ganga Basin.

2.5.2.6 Farakka Barrage Project Authority

Farakka Barrage Project Authority to control the soil-erosion and river bank protection.

2.5.2.7 National Disaster Management Authority (NDMA)

In 2005, the Govt of India set National Disaster Management Authority for the management of flood and issued guidelines in January 2008. Various ministries of State and Central Govt. suggested policies or plans to manage the flood in India.

2.5.3 Drought Management

Many of the Drought Management methods are such as:

- Awareness programmes
- Emergency plans for the conservation
- Sustainable use of water.
- Development and Urbanisation
- Improvement in systems of water such as leak detection, canal etc.

2.6 LARGE SCALE INTER-BASIN WATER TRANSFER PLAN OR "INTERLINKING OF RIVER"

Surplus water should be transferred to the needy areas to increase water availability and water requirements in the various river basins **(Fig 2.9).** Interlinking of Rivers is one of the ways to achieve regular distribution of surface water and to providing solution to floods and droughts in India (Shah *et al*., 2006). Based on the availability criteria of water in river basins, it is assumed that by 2025, many of the basins would be water scarce due to growing population. Some river basins may affect such as Krishna, Tapti, Ganga, Pennar, Mahi, Cauvery, Brahmputra, Narmada, Godavari, Mahanadi, Sabarmati and Indus. The placement of National Water Development Department was to study pre feasibility about need, significance and information's of the River Linking plan in India. The suggestion of Interlinking of India plan is one of the ways in the talk from the past few years to cure all of the country's future water problems. Inter basin transfer will help in increasing water availability in different river basins in India (Bandyopadhyay, 2005). Rao *et al*. (2010) explained the management of surplus water by transferring towards drought areas. In 1970s, Interlinking of river plan was focused by Rao and Dastur and President of India, Abdul Kalam who discussed issue of river linking project in India. Later NWDA found surplus water of Himalayan component towards peninsular region and proposed about 30 links over 37 rivers in India. Jain *et al*. (2008) stated some issues on Interlinking of rivers in India including hydrological analysis of data. Study on the Interlinking in management of flood and drought in India was done by Singh and Srivastava (2006). Snaddon *et al*. (1999) discussed the global overview of water transfer project; the flow of surplus amount of water would be by gravity. The possible way for equally distribution of water across a geographical region and fresh water demand due to increasing population, developmental activities and urbanization (GOI, 1999). The National Water Policy is for the management of water resources and appropriate ways to proper utilization of water resource not only for the benefit of the people living in the basin, but also to meet the requirements of areas which are water deficit. Water should be transfer to water deficit regions on the basis of National Perspective (GOI, 2002). Water resource management is necessary for providing water to biodiversity, ecological balance, economic activities and increasing water quantity. Study on proposed Interlinking of River project has done by several researchers including Rijsberman (2006); Sharma (2006); Saleth (2009); Radhakrishna (2003) and Thatte and Pandit (2006). In consultation with State Governments, Central Water Commission is responsible for control, conservation, development and utilization of water for other useful ways such as agriculture, industrial, power generation etc (Central Water Commission, 1997). National River linking Plan is for the flood and drought management by transfer of surplus water (Amarasinghe *et al*., 2009). Mehta and Mehta (2013) focused on the environmental impacts, issues and challenges of Inter- Linking of Rivers in India. It will help in increase in water resource, irrigation, potable water, electricity and source of livelihood. The surplus water transfer of the region of north east part towards the drought affected areas of west and southern part is based on river linking plan in India (Joshi, 2013). In the Himalayan region, about 16 links are proposed and in Peninsular component 14 links are proposed for the water transfer, which is approx 174 billion m^3 through a canal based system of about 14,900 Km over Indian rivers. The river linking project is benefited for irrigation of land, generation of electricity, reduction of floods and social aspects. National River Linking Project is technically feasible and justifiable from political point of view (IWMI-TATA, 2012). Amarsinghe (2012) focused on flood and drought concerns in India, which is potentially surplus water transfer towards deficit parts.

Country's First River linking Plan "Ken-Betwa Link" has approved by the Government of India covers in the State of Madhya Pradesh and Uttar Pradesh.

Extremely erratic rainfall, unevenly distribution and very heavy precipitation in short time resulting in flash floods and inundation in India became usual phenomena in recent years (Rao *et al*., 2012). Gourdji *et al.* (2005) developed a hydrological model of the Ganga basin to estimate the flow at Allahabad, Patna and Farakka under a river linking scenario. The ILR plan is expected to meet the growing energy demand within the economy by provide 34,000 MW of electricity generation with the construction of hydropower facilities in both the Himalayan and Peninsular components of the plan and potential human health implications of major water development projects in India and around the world.

Need of Proposed River Link Canal Project for Economic, Environmental feasibility and Irrigation benefits through river linking plan due to increase in water availability in different rivers, which can help in rise in productivity.

Fig: 2.9 Linking of River Source: Google

2.7 NATIONAL PERSPECTIVE PLAN (NPP)

National Perspective Plan was formed in 1980 and by Ministry of Water Resources of India to carry out studies on water resource Management to face the problem of Flood and Drought in respect of both Peninsular Rivers and Himalayan Rivers of the country and indentified a number of large scale Inter- Basin Water Transfer Links or “Interlinking of Rivers” in India. NPP has proposed nearly 30 links over 37 rivers to join the major rivers of India **(Fig 2.10).** The two components of NPP are Himalayan and Peninsular river development.

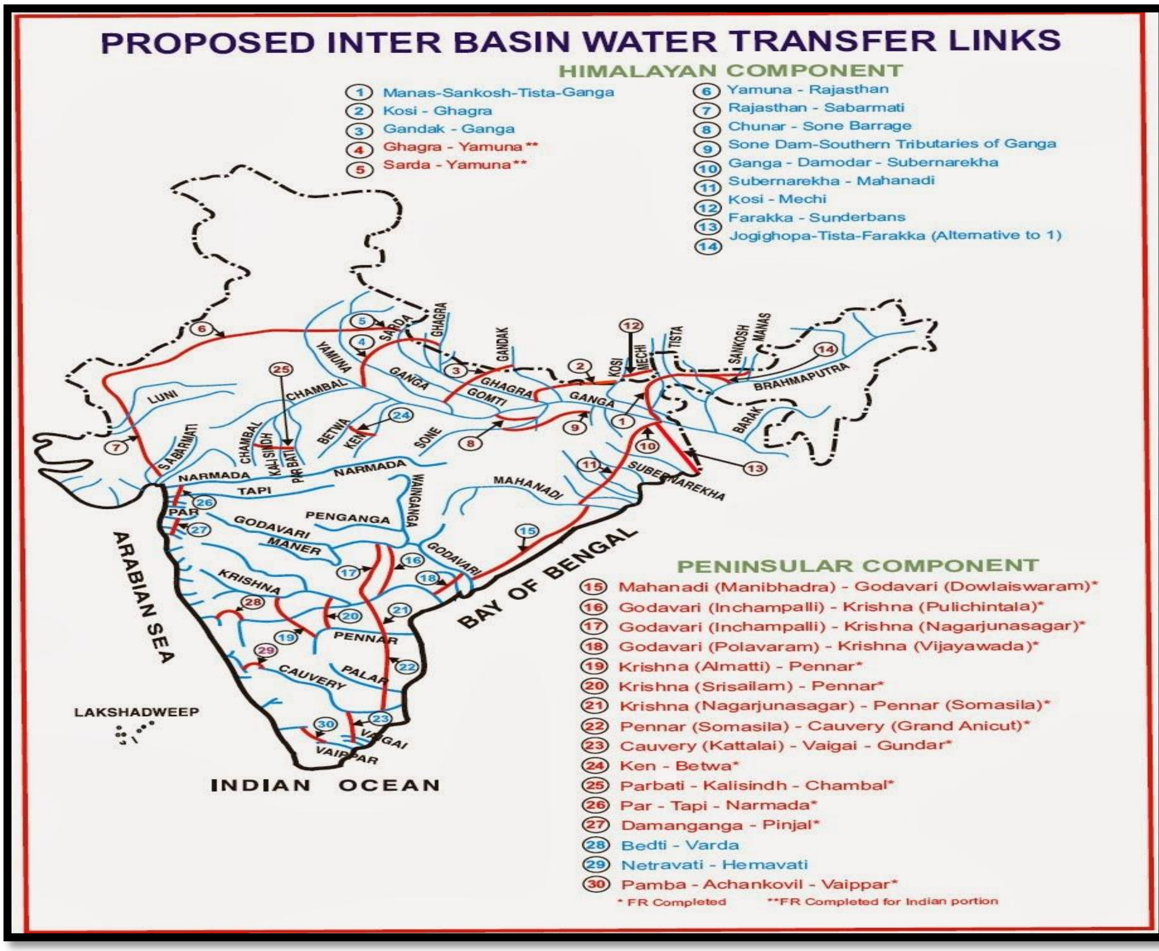


Fig: 2.10 Proposed Interlinks of River throughout the country Source: Google

2.7.1 TWO COMPONENTS OF NPP

The National Perspective Plan has two components:

1) **Himalayan River Development Component:** It carries 14 links.

2) Peninsular River Development Component: It carries 16 links.

2.7.1.1 HIMALAYAN RIVER DEVELOPMENT COMPONENT

- It is a part of NPP plan in India for the transfer of surplus water from tributaries of river Ganga in eastern region towards the western part. It is planned to link the tributaries of the Brahmaputra River with the river Ganga and Manahnadi **(Fig 2.11).**
- The Himalayan River Development Component will reduce the flood arise in Ganga and Brahmaputra basins. It envisages transferring surplus flows of water from east towards west in India and linking of Ganga with Mahanadi and Brahmaputra with Ganga in India and Nepal to provide water in many states of the country. It consists of about 14 links, in which 12 are interdependent and 2 are independent **(Table 2.1).**
- The construction of the Himalayan Component is for the storage of surplus monsoon water in India and Nepal for the conservation of water for other such useful purposes like irrigation, hydropower etc.
- The transfer of water from the rivers such as Sharda, Gandak and Ghagara towards western areas.

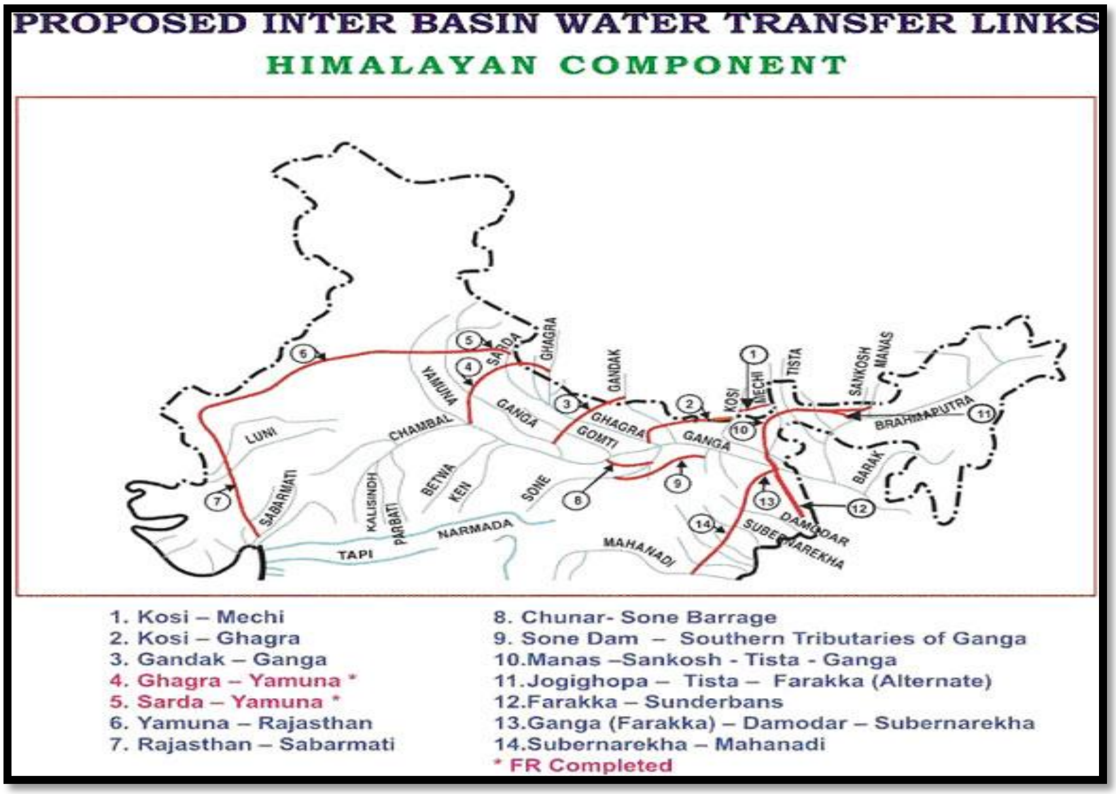


Fig: 2.11 Proposed River Basins of Himalayan Rivers Development Component in India

Source: Google

Proposed Links in the Himalayan Component of NPP

S. No	Proposed Inter-Link of Rivers
1.	Kosi- Mechi Link
2.	Kosi- Ghagra Link
3.	Gandak- Ganga Link
4.	Ghagara-Yamuna Link
5.	Sharda-Yamuna Link
6.	Yamuna- Rajasthan Link
7.	Rajasthan- Sabarmati Link
8.	Chunar- Sone Barrage Link
9.	Sone dam- Southern tributaries of Ganga Link
10.	Brahmaputra- Ganga (Manas-Sankos-Tista-Ganga) Link

11.	Brahmaputra- Ganga (Jogigopha-Tista-Farakka) Link
12.	Farakka- Sunderbans Link
13.	(Ganga) Farakka- Damodar-Subernarekha
14.	Subernarekha- Mahanadi Link

Table: 2.1 Sources: NWDA

2.7.1.2 PENINSULAR RIVER DEVELOPMENT COMPONENT

The Peninsular River Component consists of 16 river interlinks, among which 9 are interdependent and 7 are independent links **(Fig 2.12).** Among all the river links, Ken-Betwa Link has moved a step ahead. The diversion of water from River Mahanadi and Godavari towards Krishna, Pennar, Vaigai and Cauvery rivers. The transfer of water from west-flowing rivers of Kerala and Karnataka towards east parts. Interlinks of rivers of west parts, to Tapti in south direction and the southern tributaries of river Yamuna **(Table 2.2).**

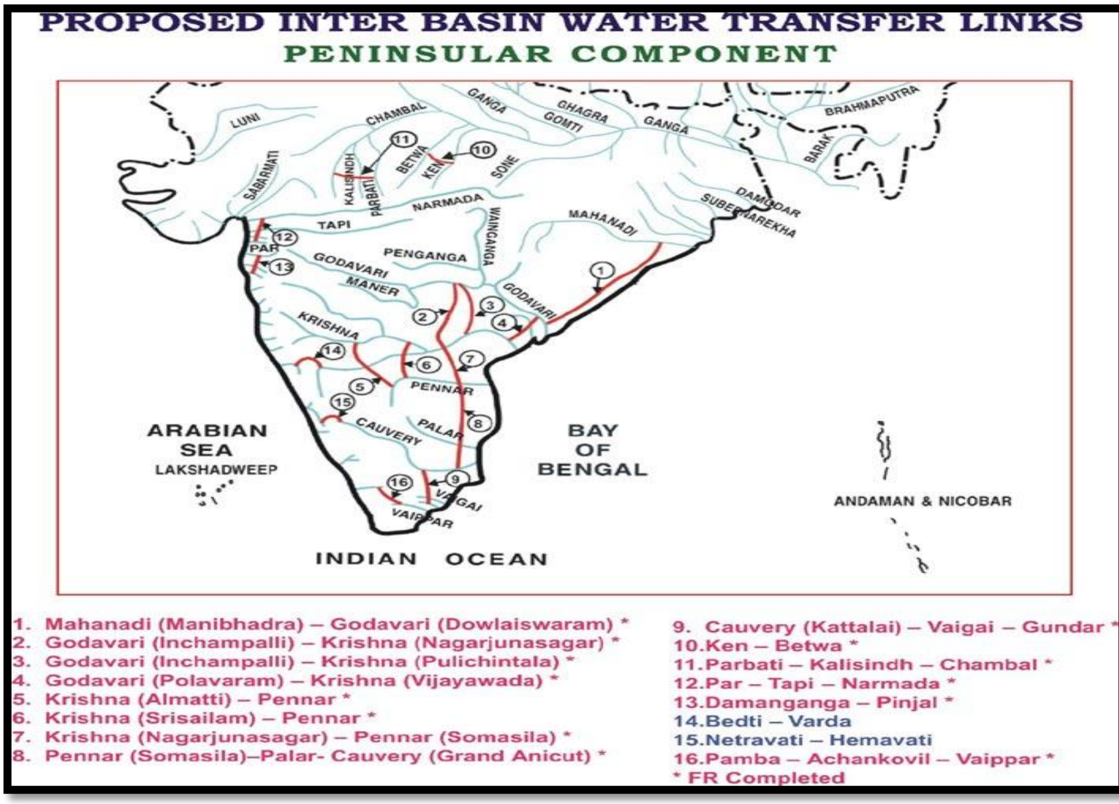


Fig: 2.12 Proposed River Basins of Peninsular Rivers Development component in India

Source: Google

Proposed Links in the Peninsular Component of NPP

S. No	Proposed Inter-Link of Rivers
1.	Mahanadi (Manibhadra) - Godavari Link
2.	Godavari (Inchampalli) - Krishna (Nagarjunsagar) Link
3.	Godavari (Inchampalli Low Dam) - Krishna (Nagarjunsagar Tali Pond) Link
4.	Godavari (Polavaram) - Krishna (Vijaywada) Link
5.	Krishna (Almatti) - Pennar Link
6.	Krishna (Srisailam) - Pennar Link
7.	Krishna (Nagarjunsagar) - Pennar (Somalisa) Link
8.	Pennar (Somalisa) - Cauvery (Anicut) Link
9.	Cauvery (Kattalai- Vaigai-Gunder Link
10.	Ken- Betwa Link

11.	Parbati- Kalisindh- Chambal Link
12.	Par-Tapti- Narmada Link
13.	Damanganga- Pinjal Link
14.	Bedti- Varda Link
15.	Netravati- Hemavati Link
16.	Pamba- Achankovil Vaippar Link

Table: 2.2 Source: NWDA

The Interlinking system of Sharda-Yamuna is a Himalayan River Component of the National Perspective Plan (Fig 2.13).

2.8 PROPOSED SHARDA-YAMUNA LINK

Proposed Sharda-Yamuna link is a Himalayan Component project, which is proposed for flood and drought management in U.P, U.K, Rajasthan, Gujarat, Haryana western drought prone parts. The link will cross through the States of Uttarakhand and Uttar Pradesh in India. It will also fulfil the water demands of its Enrouted and Command areas like irrigation & domestic uses etc. This Sharda-Yamuna link canal has being suggested for transferring surplus water of about 11,680 million cubic meters from river Sharda near Tanakpur town of Champawat district of Uttarakhand into the Yamuna River near Kairana village of Muzaffarnagar district of Uttar-Pradesh **(Fig 2.13;14).**

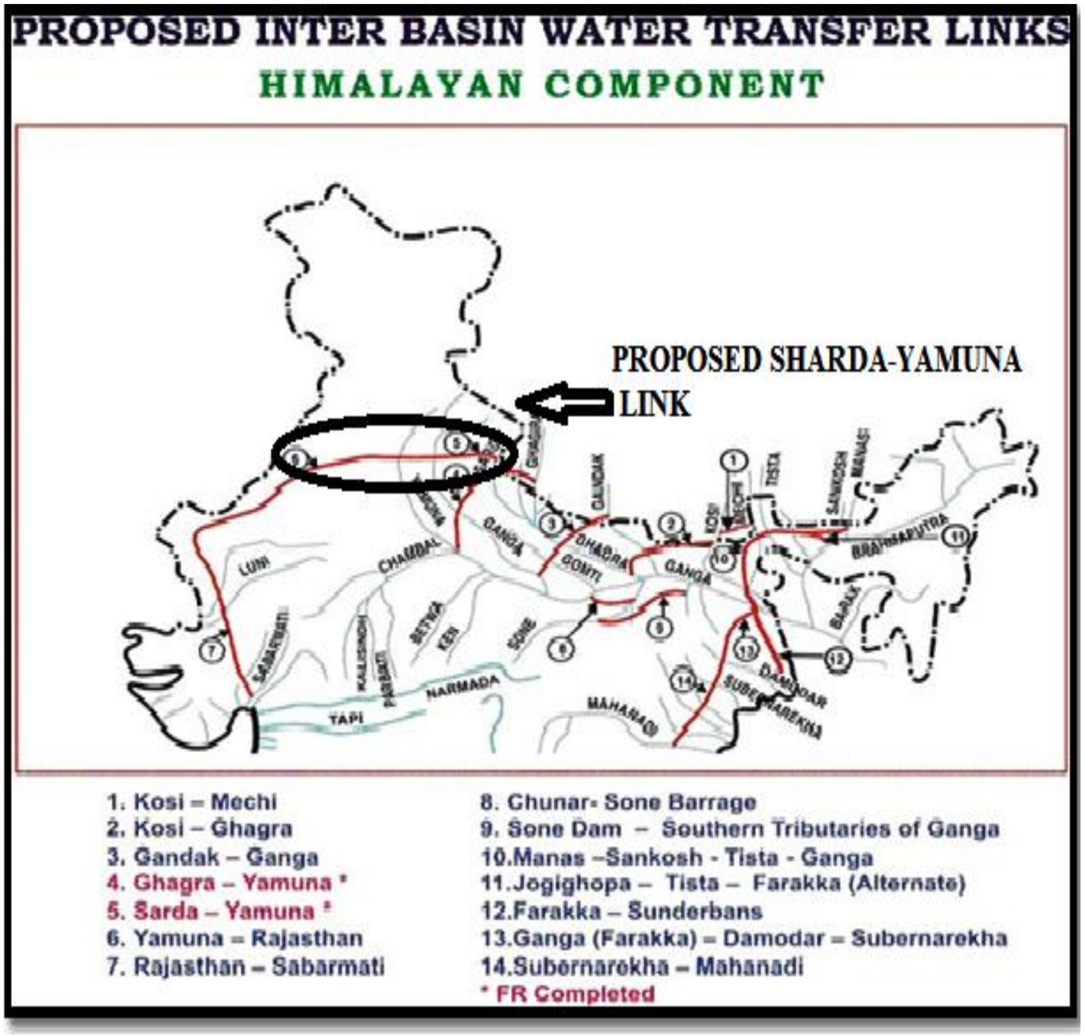


Fig: 2.13 Proposed Sharda-Yamuna Link Source: Google

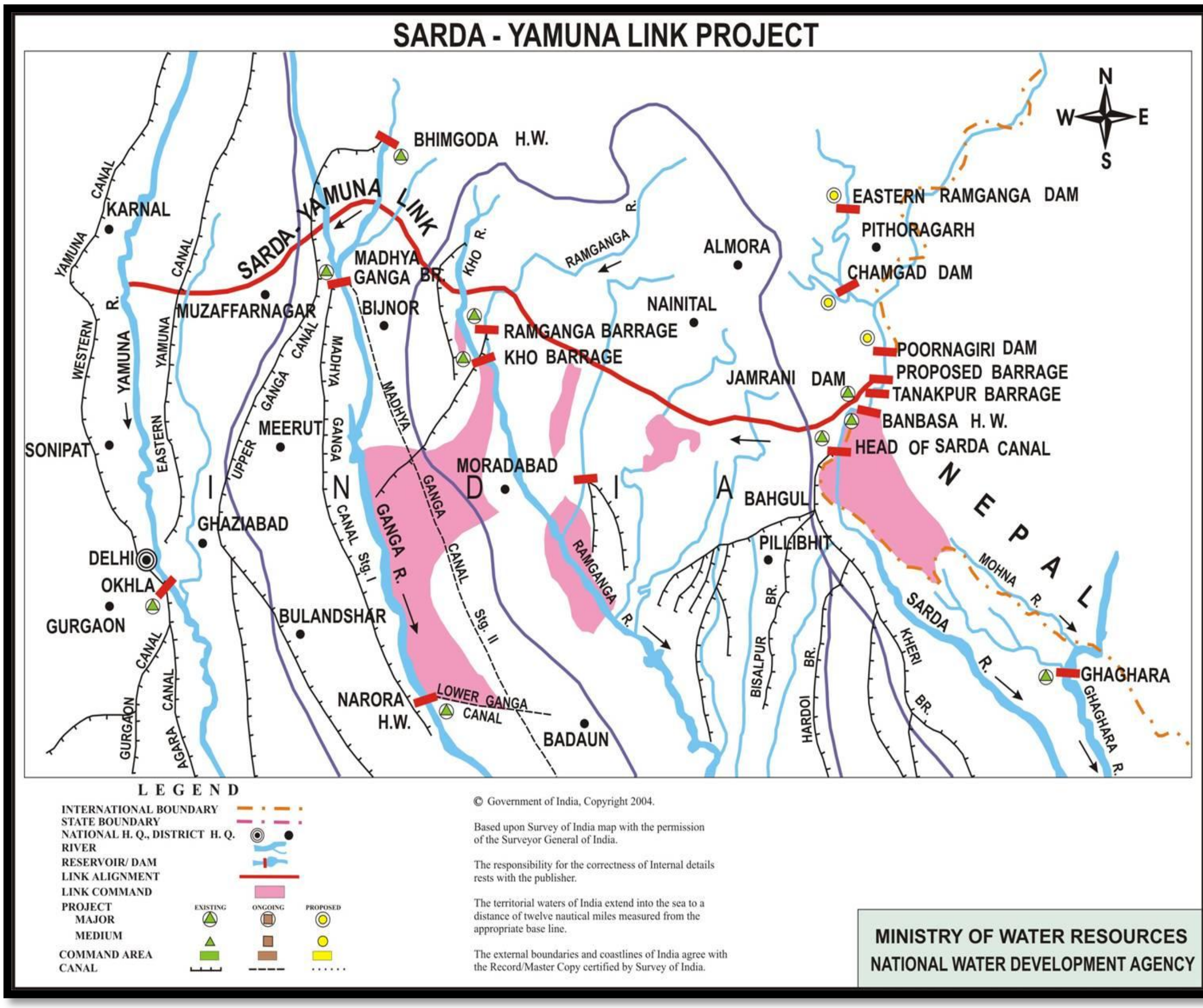


Fig: 2.14 Proposed Sharda-Yamuna Link Map Source: NWDA

2.9 SHARDA AND YAMUNA RIVER

Sharda and Yamuna are the rivers of Ganges River System. Both are the tributaries of river Ganga. River Yamuna runs parallel to Ganga before contributing its water to Ganga at Allahabad. Sharda starts from Bihar near Indo-Nepal border **(Fig 2.15).**

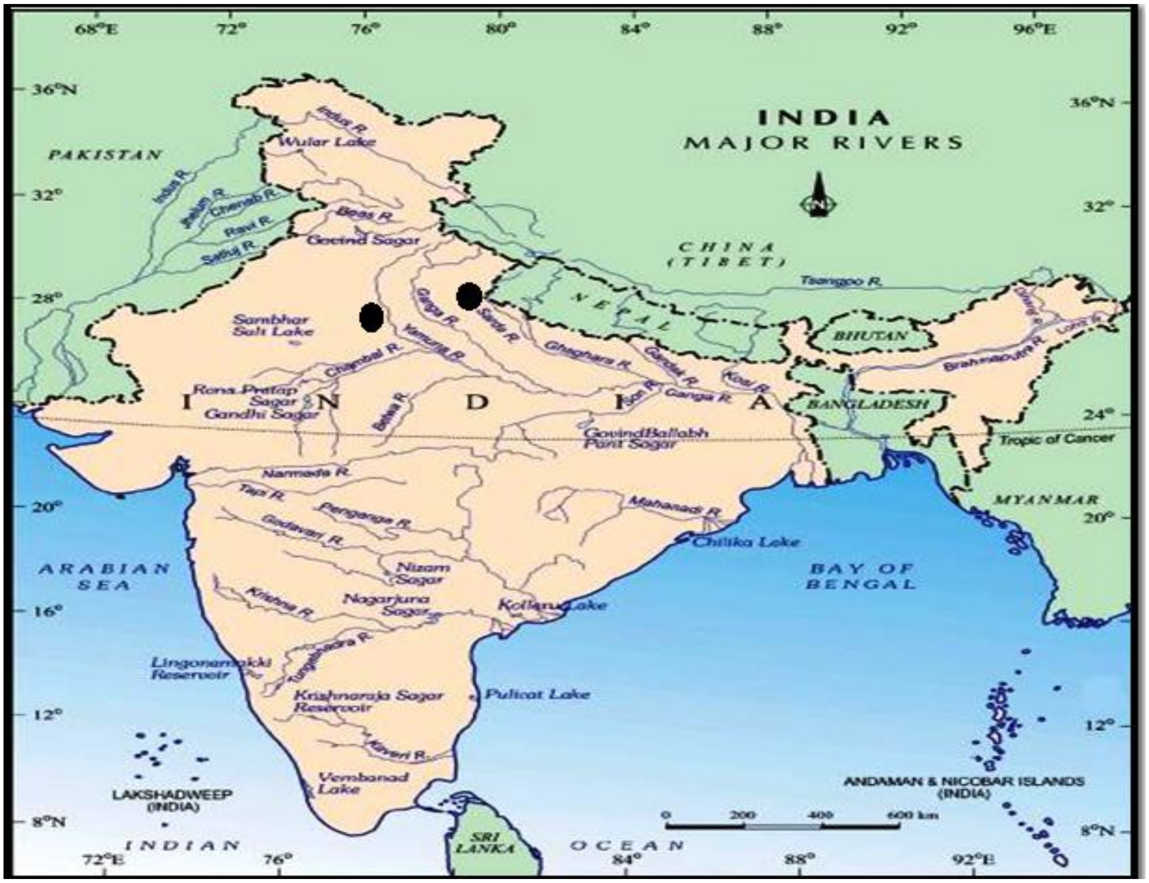


Fig: 2.15 Sharda and Yamuna Rivers in India

2.10 ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment process is a method for identification of causes of any developmental activity on environment. It is a mechanism which proves the efficient use of natural and human resources for sustainable development. EIA process is related to types if environmental consequences such as adverse, harmful, short term, long term etc regarding their intensity, direction, duration, frequency, reversibility and probability. EIA is the process to identify, predict, evaluate and mitigate the environmental, social and other potential impacts and consequences of any developmental projects (Canter, 1999). It is an important management tool to predict the magnitude, type and probability of impacts for the sustainable development of environment and decrease the level of negative impacts. The study on the relation of EIA and economic development, environmental preservation was done by Novek (1993). Gullett (1998) proposed the precautionary principle of Environmental Impact Assessment for environmental protection such as environmental 'significance', environmental uncertainty during the decision making. It has been widely discussed in the literature that unplanned urban growth or sprawl has high environmental and economic costs (Forman, 2014).

2.10.1 Purpose of Environmental Impact Assessment

The main purpose of an EIA process is to identify and evaluate the expected environmental impacts of any project. It relates with Socio-Economic, Cultural and Biological factors. The main function of EIA process is to predict and reduce the negative impacts suffered by the environment as a result of sustaining all human action (Moron *et al.*, 2009).

2.10.2 EIA relation with various sectors

The Environmental Impact Assessment should address possible impact on the basic factors such as flora, fauna, soil, water, land, air, vegetation, human beings, meteorology, air quality, levels of pollutants, hydrology, water quality, developmental site and its surroundings etc. The EIA process is related with the various fields such as Industrial, Mining, Thermal Power Plants, Irrigation, River valley, Nuclear Power plants etc.

2.10.3 Basic Principles of EIA

- ✓ It should be more valid and effective.
- ✓ It should evaluate the accuracy.
- ✓ Efficient
- ✓ Participative

- ✓ Purposive
- ✓ Focused
- ✓ Systematic

2.10.4 Procedures and Stages in EIA

Procedures for EIA are based on Identification, Prediction and Evaluation of environmental considerations. It is based on both significant amounts of primary and secondary data of any project for proper understanding of the existing environmental status. Primary data is based on the collection of data from the survey work that defines the environmental status such as air quality date land use data; water quality data etc and the secondary data are those which are collected over the long time to understand the environmental parameters of the study area of any activity. Fedra *et al*. (1991) studied the several methods of EIA process and approaches of the various techniques **(Fig 2.16).** .

2.10.5 Basic Steps in EIA method are following

- ➢ Screening
- ➢ Scoping
- ➢ Prediction and Evaluation of Impacts
- ➢ Impact Mitigation and Monitoring
- ➢ Auditing and Public Participation
- ➢ EIA Report or Environmental Impact Statement (EIS).

Screening Identification of projects requiring EIA, to determine which developmental project requires a full or partial impact assessment. Scoping the term derive for the impact assessment; identify the issues or significant impacts in an EIA method. Reporting the Environmental Impact Statement (EIS) or EIA report, Review of the completed EIA process comprises Environmental Management Plan (EMP), based on scoping method and public participation. It covers all positive and negative aspects of any developmental activity. EIA method is required information to the decision makers in making suitability about a project. Decision-making process is to approve the project, whether it is beneficial and sustainable or not. At last (EMP) Environmental Management Plan is the mitigation measure plan to reduce the harmful impacts of any developmental projects **(Fig 2. 17; 18).**

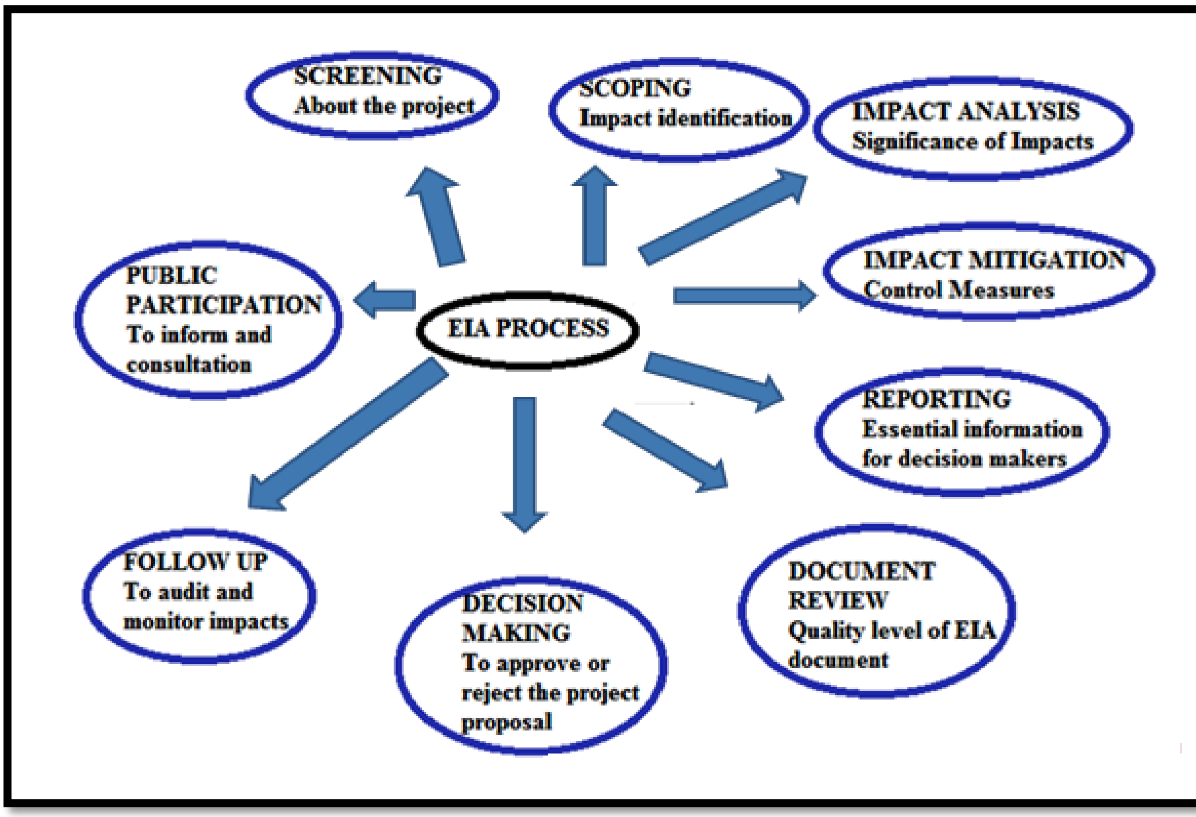


Fig: 2.16 Flow Chart Basic Steps in EIA

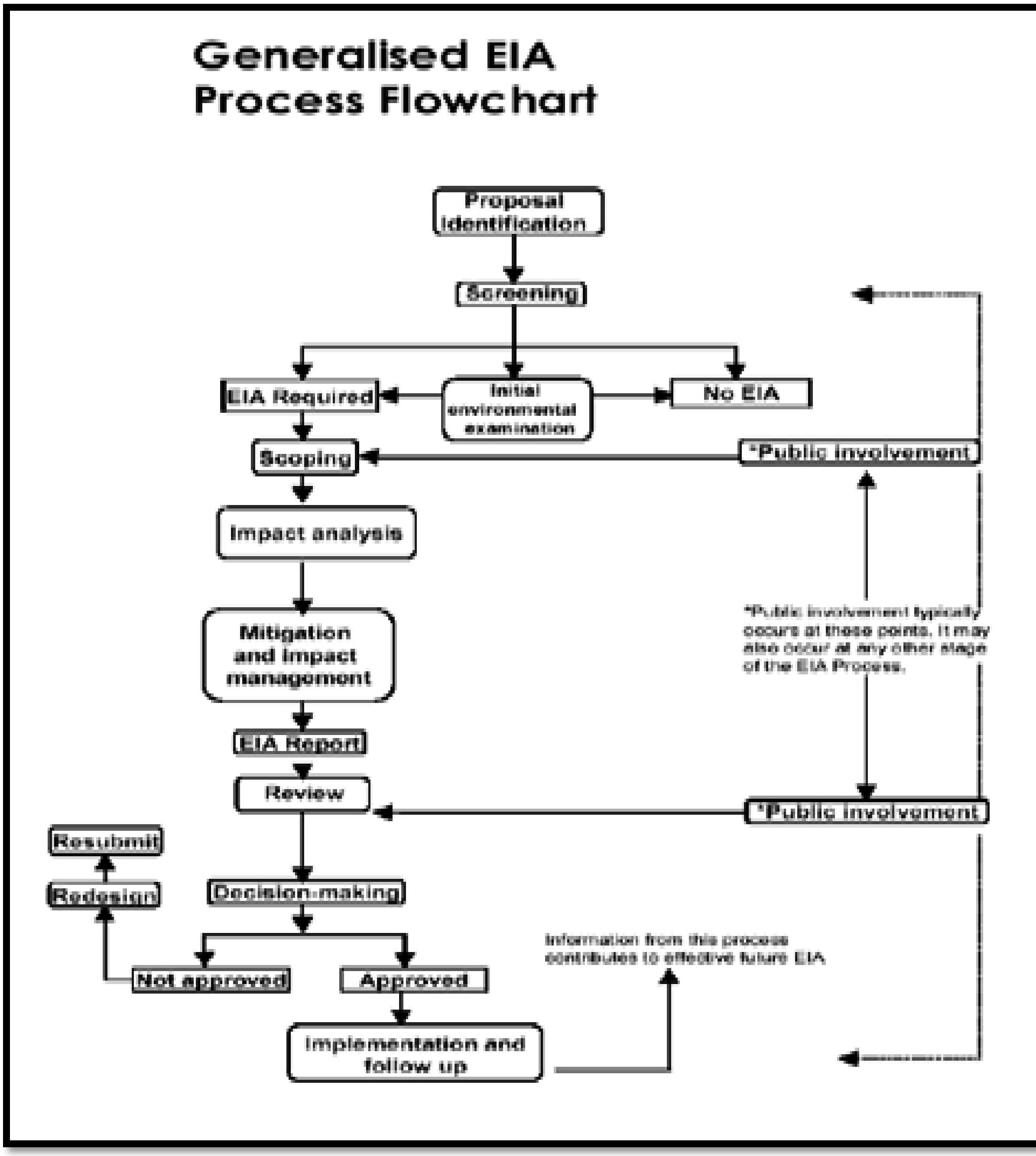


Fig: 2.17 EIA Process Flow chart (Pacifica and Ogola, 2007)

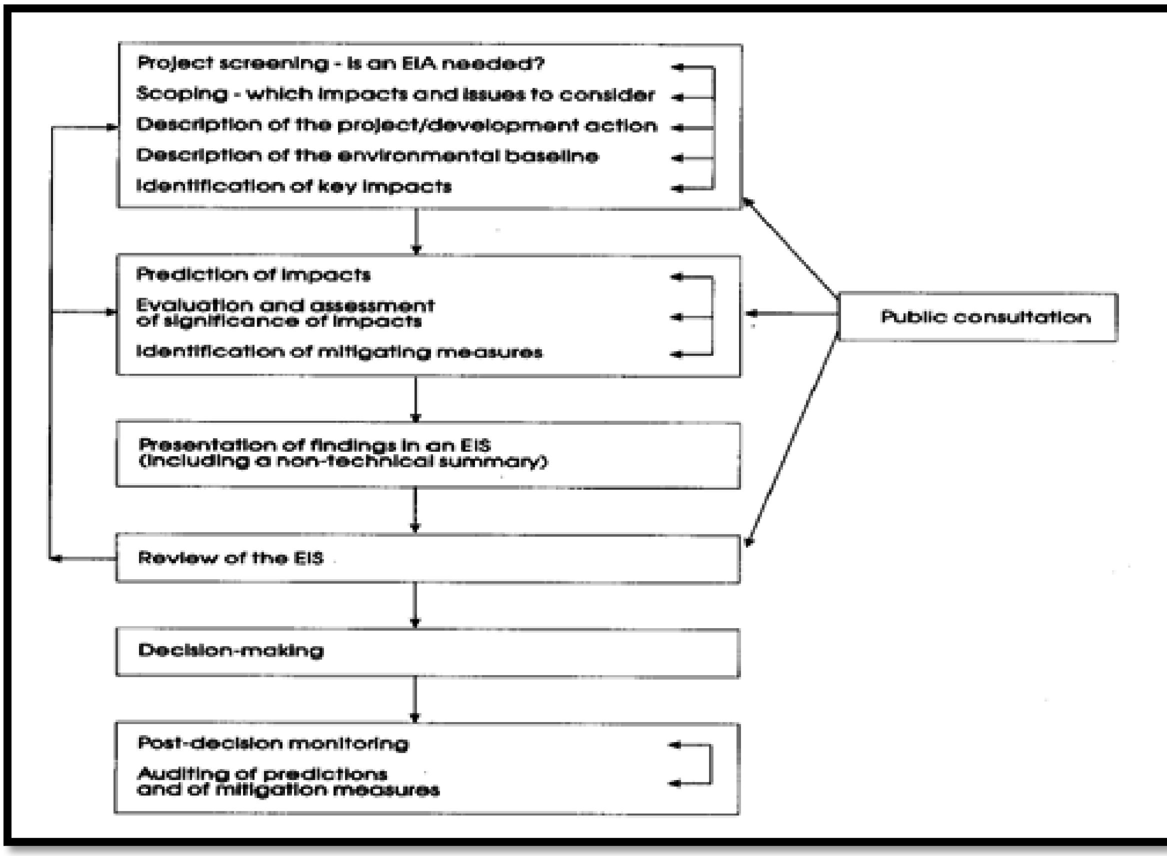


Fig: 2.18 EIA Process (Glasson *et al*., 1994)

2.10.6 Tools / Techniques in EIA method (EIA Methodologies)

The EIA methodologies can be categorized into following methods.

- Ad-hoc or Baseline studies
- Checklists
- Matrix Method
- Networks
- Overlays and (GIS) Geographic Information Systems
- Mathematical modelling
- Expert advice
- Economic techniques

(i) Ad-hoc or Baseline studies

Adhoc method is the first stage of EIA process. Available data and local knowledge is required for the scoping process. Key issues are identified, the need for further depth studies. In the process a group of experts recognize the different types of environmental impacts whether positive or negative, short term or long term, harmful or beneficial etc.

(ii) Checklist

It is a structured list to identify environmental parameters. It is a discussion method for representing the collective knowledge judgments. It ensures that nothing is left out. Checklist is a collection of data to ensure that it is efficient and targeted to answer specific questions, and to quantify impacts.

(iii) Matrix Method

It is also a method for the identification of environmental impacts. It is a combine form of environmental impacts and project actions. Some types of matrix methods are Simple, Time dependent, Magnitude, Quantified and Weighted.

(iv) Networks

This method is a diagram based method of environmental impacts and its effects. It carries information about an impact in a description form both direct and indirect impacts. The display of primary, secondary, tertiary and higher order of impacts is covered in the networks method.

(v) Overlays and Geographic Information Systems

Overlays & GIS are spatially visual aid methods to illustrate the geographical feature of various types of environmental impacts. It is a map of distribution of environmental parameters.

2.11 EIA CHECKLIST METHOD

It is a common, simple and inexpensive method for impact identification. A checklist carries a series of parameters of environment; information's for the detection and estimation of an expected impacts. It is a method to study the environmental parameters. It may or may not carry guidelines on impacts of the parameters, which are to be assessed. A Checklist method is found to be useful to define both information required for scoping process and baseline studies required for prediction and monitoring. Some environmental factors considered for the evaluation of impacts are soil, water, atmosphere, flora, fauna, resources, recreation and cultural etc. EIA quality mark review on checklist was discussed by Landfill (2012).

2.11.1 Types of EIA Check-List Method

2.11.1.1 Simple Checklist

It is a simple list of environmental component that is considered by the assessor. No information is needed for the importance and magnitude of the impacts.

2.11.1.2 Descriptive Checklist

It is a description of information's with magnitude, importance, prediction and indicators. It covered with environmental variables need to be measured to characterize each component in an identification process.

2.11.1.3 Questionnaire Checklist

It includes discussion, by certain asking questions regarding impacts.

2.11.1.4 Scaling Checklists

This method is same as descriptive checklists. The description of impacts includes additional information on scaling of parameters.

STUDY AREA

3 STUDY AREA

3.1 SHARDA- YAMUNA LINK

Sharda-Yamuna link is a “National Water Transfer River Linking Project” to provide surplus water to all the water demands drought prone regions in western parts of the country and to avoid flood and drought situations.

The area of the project comes under the States of Uttarakhand and Uttar Pradesh in India. Enrouted and Command regions are two main parts of the project. Proposed S-Y link will cross through Enrouted districts like Champawat, Nainital, Udham Singh Nagar and Haridwar in Uttarakhand State and Bijnor, Muzaffarnagar districts in Uttar Pradesh Command areas are the surrounded areas such as Bareilly, Rampur, Moradabad, Badaun and Bijnor states in Uttar Pradesh and Udham Singh Nagar state in Uttarakhand.

3.2 PURPOSE OF THE STUDY

It is necessary to know the expected Impacts of any proposed developmental activity for sustainable development of environment. A case study was done on the ILR project S-Y link with assessment of its Environmental Impacts. An EIA Checklist method was applied for expected positive and negative environmental impacts and for the effectiveness and feasibility of the ILR project.

3.3 ABOUT THE STUDY AREA

3.3.1 Champawat District

Champawat is one of the districts of Uttarakhand state, which is situated in northern part of India. It divided into five tehsils named as Bajkot, Barakot, Champawat, Lohaghat, Pati and Poornagiri. The district is covered by Pithorgarh east part; Nepal in south part. Nainital district is located in its northwest direction with Almora district. Tanakpur region of Champawat District is the Enrouted area of the S-Y link canal **(Fig 3.1).**

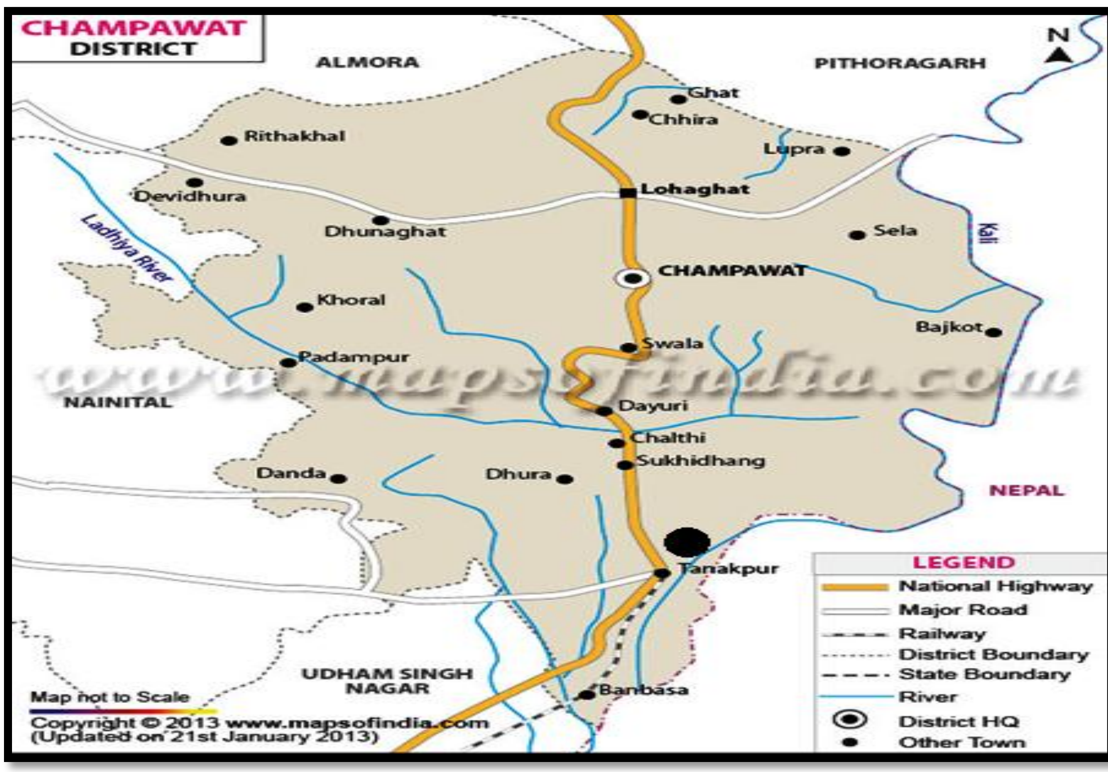


Fig: 3.1 Map of Champawat District Source: Map of India

3.3.2 Nainital District

Nainital district is another district of the Uttarakhand state in India. It is situated in the Kumaon Division, which is bounded by the Almora district in the north and Udham

Singh Nagar in the south direction. Haldwani is the largest town in the district and one of the Enrouted areas of the S-Y link canal **(Fig 3.2).**

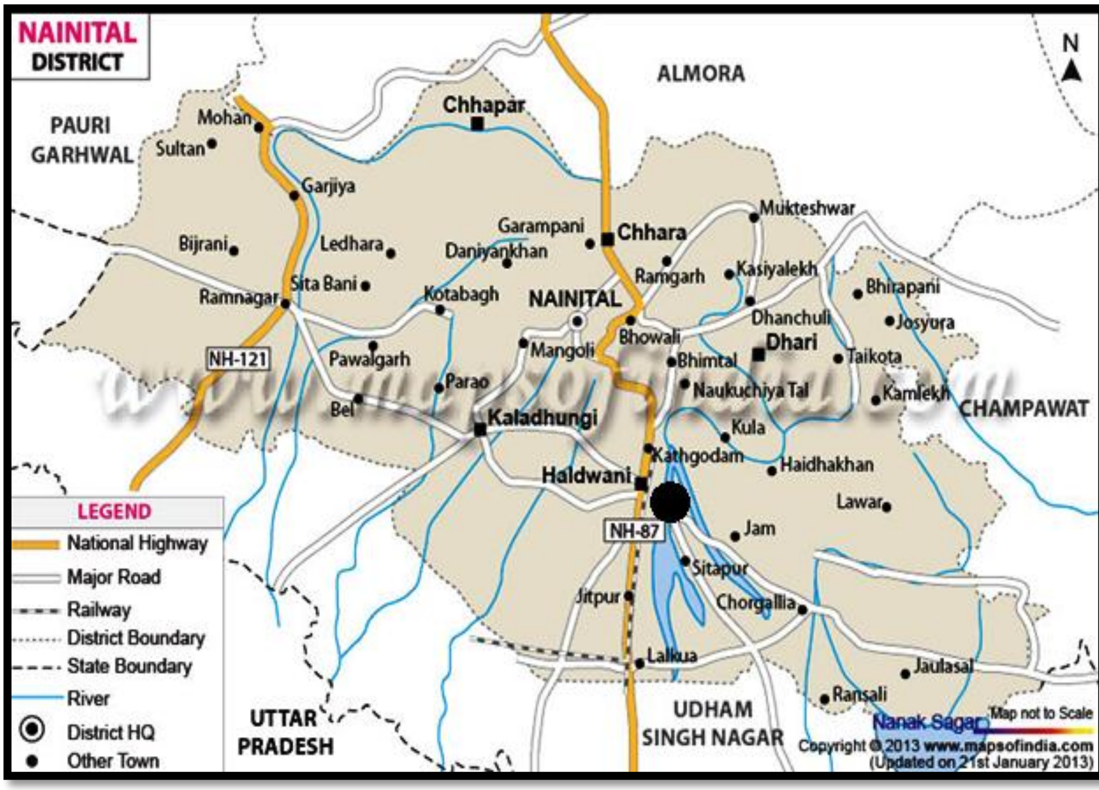


Fig: 3.2 Map of Nainital District Source: Map of India

3.3.3 Udham Singh Nagar District

The district is located in Uttarakhand region in the north part of India and divided into seven tehsils such as Bajpur, Kashipur, Gadarpur, Kichha, Jaspur, Sitarganj and Khatima. It is a part of Kumaon region and situated in terai region. The district is covered by Nainital in north and Uttar Pradesh state in south west direction. It is one of the most populous districts of Uttarakhand state. Bajpur and Jaspur are the Enrouted areas of the S-Y link canal and Kichha is the Command area. Kashipur is both Enrouted and Command region of the link canal **(Fig 3.3).**

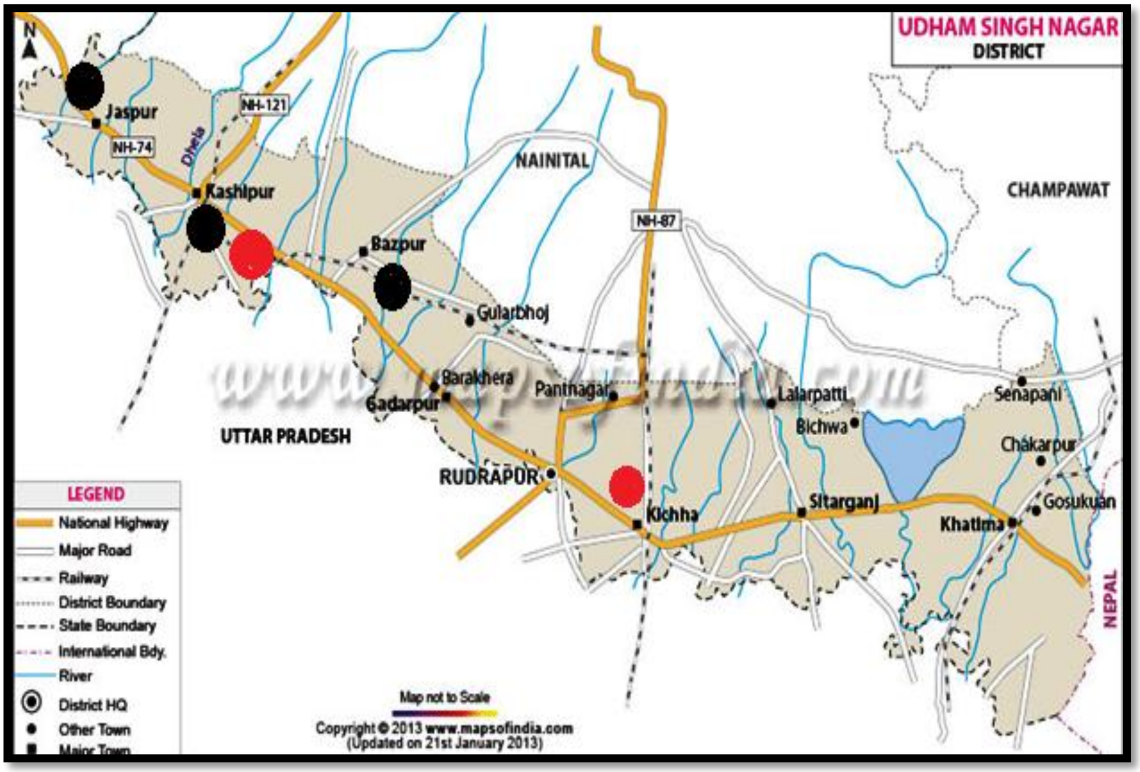


Fig: 3.3 Map of Udham Singh Nagar District Source: Map of India

3.3.4 Haridwar District

Haridwar district is one of the largest districts located in the south western part of the Uttarakhand state. Dehradun is located in its north region and Pauri Garhwal is present in the east. Muzaffarnagar and Bijnor districts are located in its south part and Saharanpur is located in the west. It is one of the seven holiest places of India and well irrigated district. The district is administratively divided into three tehsils Haridwar, Roorkee and Laksar which are the Enrouted areas of the S-Y link canal **(Fig 3.4).**

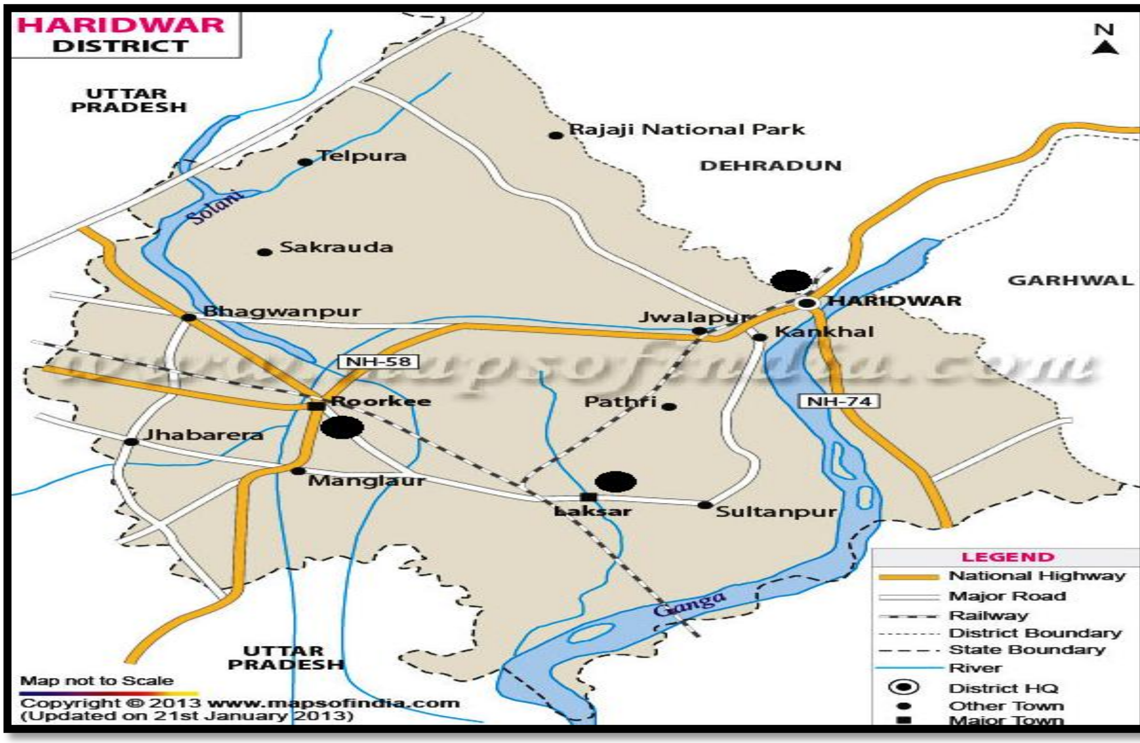


Fig: 3.4 Map of Haridwar District Source: Map of India

3.3.5 Bijnor District

Bijnor is the district present in the Uttar Pradesh state. Moradabad division is located in its north-west direction. The western boundary is formed by the river Ganga, beyond which four districts lies such as Dehradun, Saharanpur, Muzaffarnagar and Meerut. Nagina and Najibabad are the Enrouted areas of the S-Y link canal and Chandpur and Dhampur are the Command areas **(Fig 3.5).**

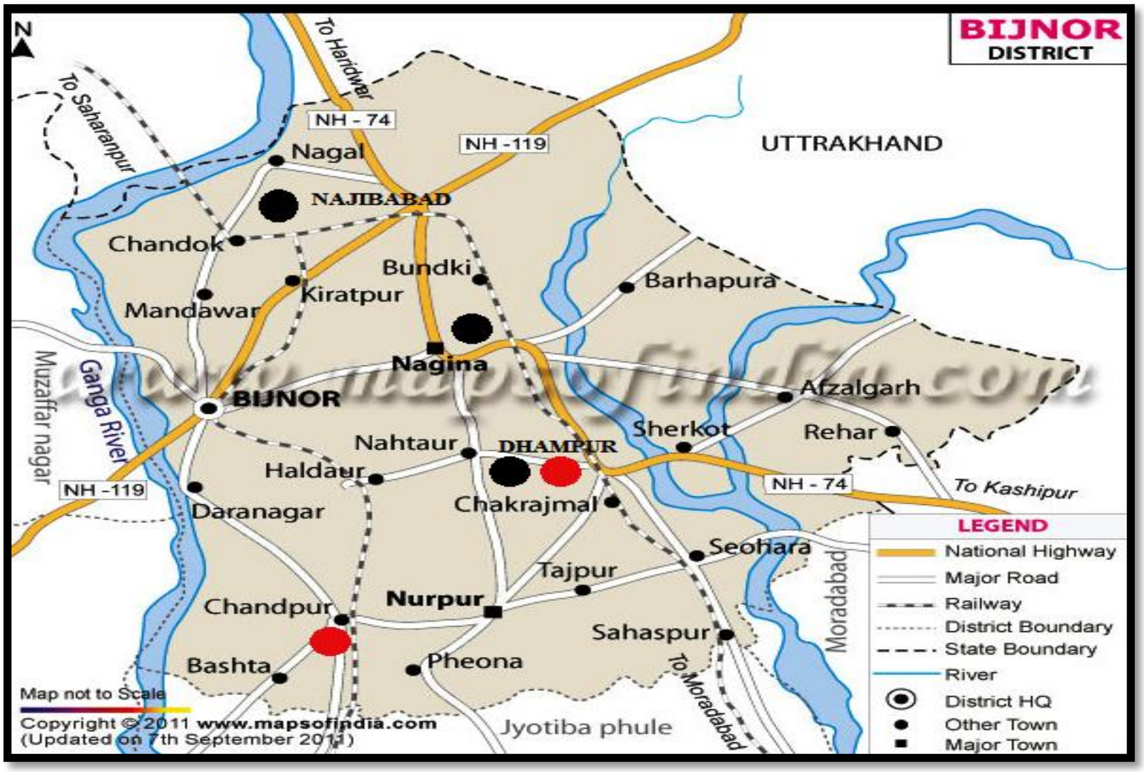


Fig: 3.5 Map of Bijnor District Source: Map of India

3.3.6 Muzaffarnagar District

Muzaffarnagar is another district of the state U.P. The district is very fertile due to Gangetic plain and located between Delhi and Haridwar on mid way (NH 58). The district is one of the highest producers of sugarcane in country. Muzzafarnagar, Shamli and Kairana are the Enrouted areas of the S-Y link canal **(Fig 3.6).**

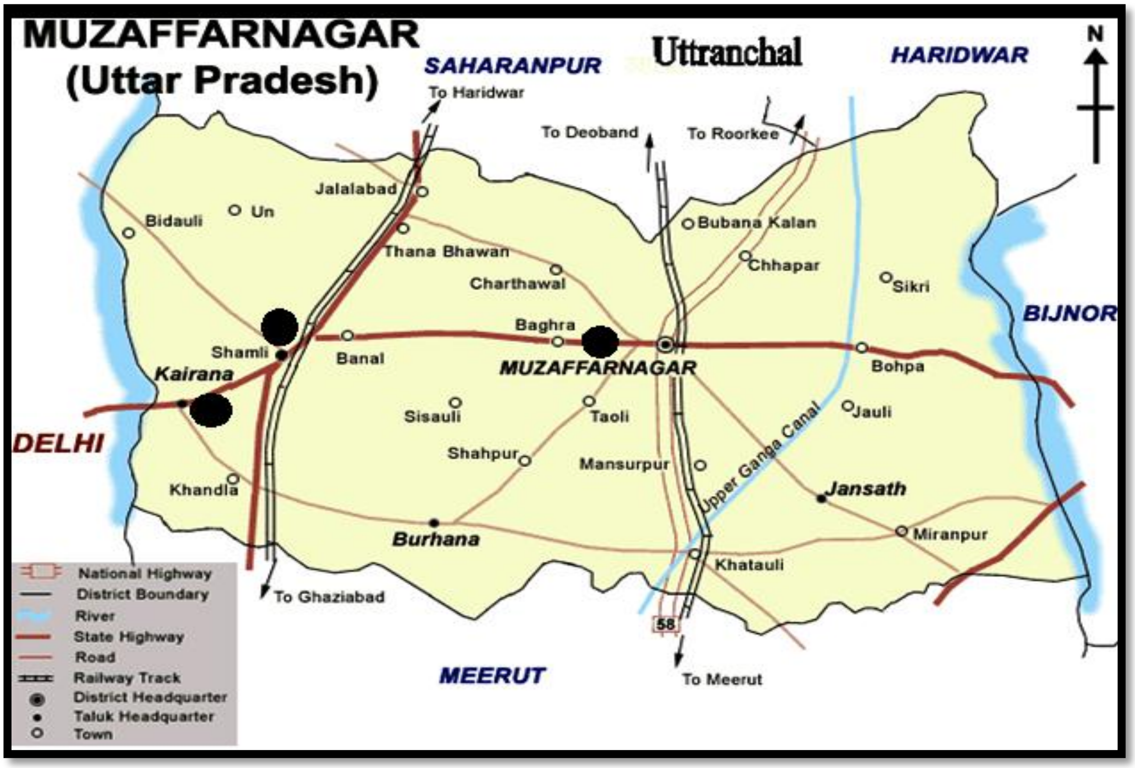


Fig: 3.6 Map of Muzaffarnagar District Source: Map of India

3.3.7 Rampur District

Rampur is the district of Uttar Pradesh and commonly known for its industries, sugar refining and cotton production. Suar, Rampur and Shahabad are the Command areas of the S-Y link canal **(Fig 3.7).**

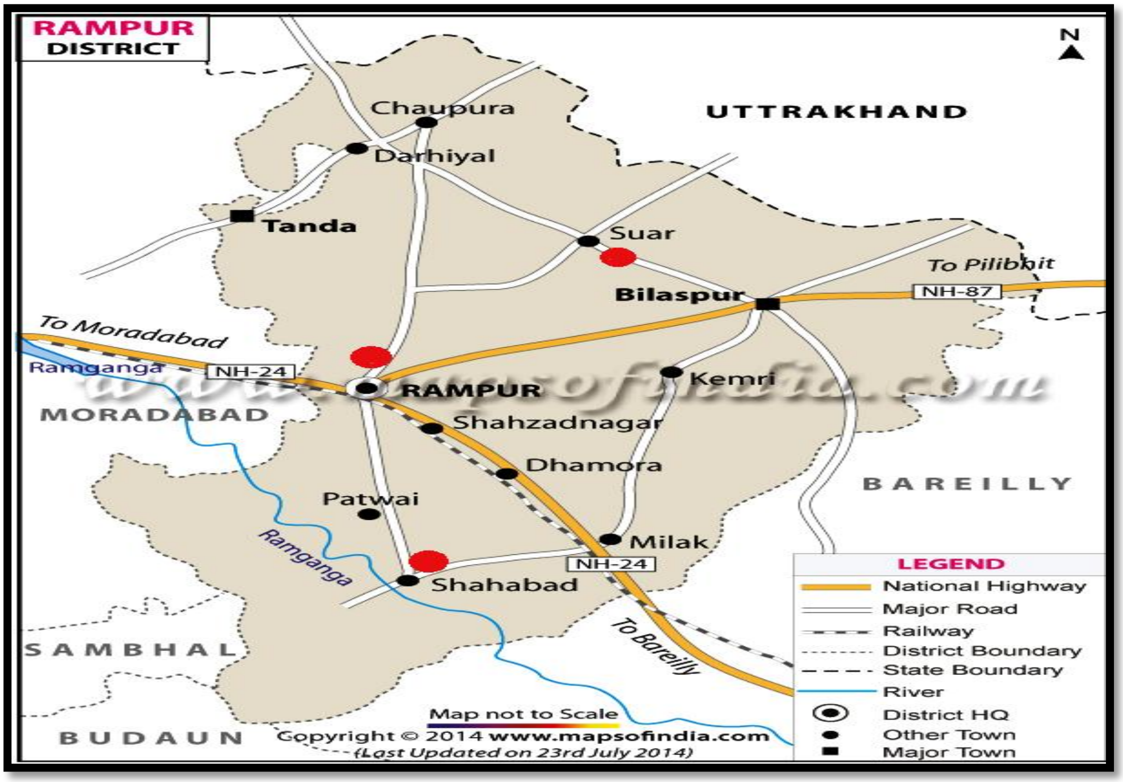


Fig: 3.7 Map of Rampur District Source: Map of India

3.3.8 Bareilly District

The Bareilly district lies in the state Uttar Pradesh. The district is divided into six tehsils such as Baheri, Bareilly, Mirganj, Faridpur, Aonla and Nawabganj. It is covered with Shahjahanpur and Pilibhit in the east and Rampur in west. In its north part Udham Singh Nagar district is situated and in south direction Bijnor is located. The district is present in Gangetic plain having humid subtropical climate with great variations in temperatures. Baheri, Meerganj and Aonla are the Command areas of the S-Y link canal **(Fig 3.8).**

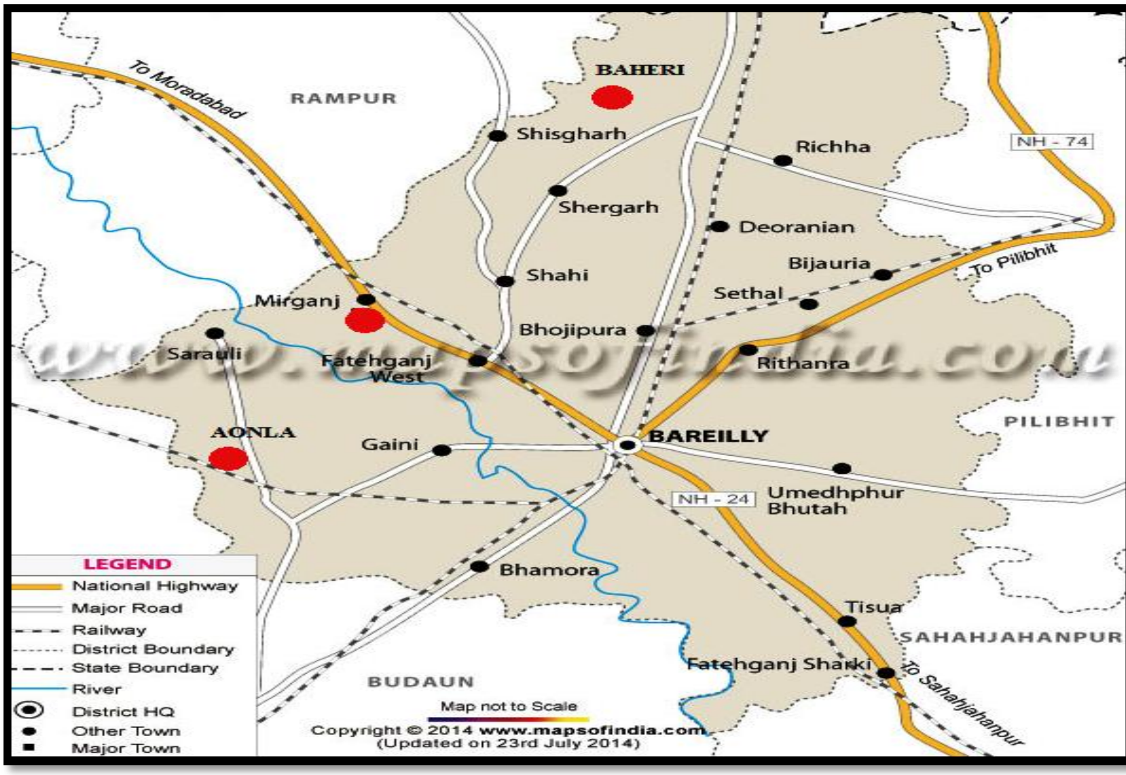


Fig: 3.8 Map of Bareilly District Source: Map of India

3.3.9 Badaun district

Badaun is also a district of Uttar Pradesh state, which locates near the holy river Ganga. The district is divided into six tehsils such as Badaun, Bisauli, Bilsi, Dataganj, Khair and Sahaswan. Sahaswan, Bisauli and Gunnaur are the Command areas of the S-Y link canal **(Fig 3.9).**

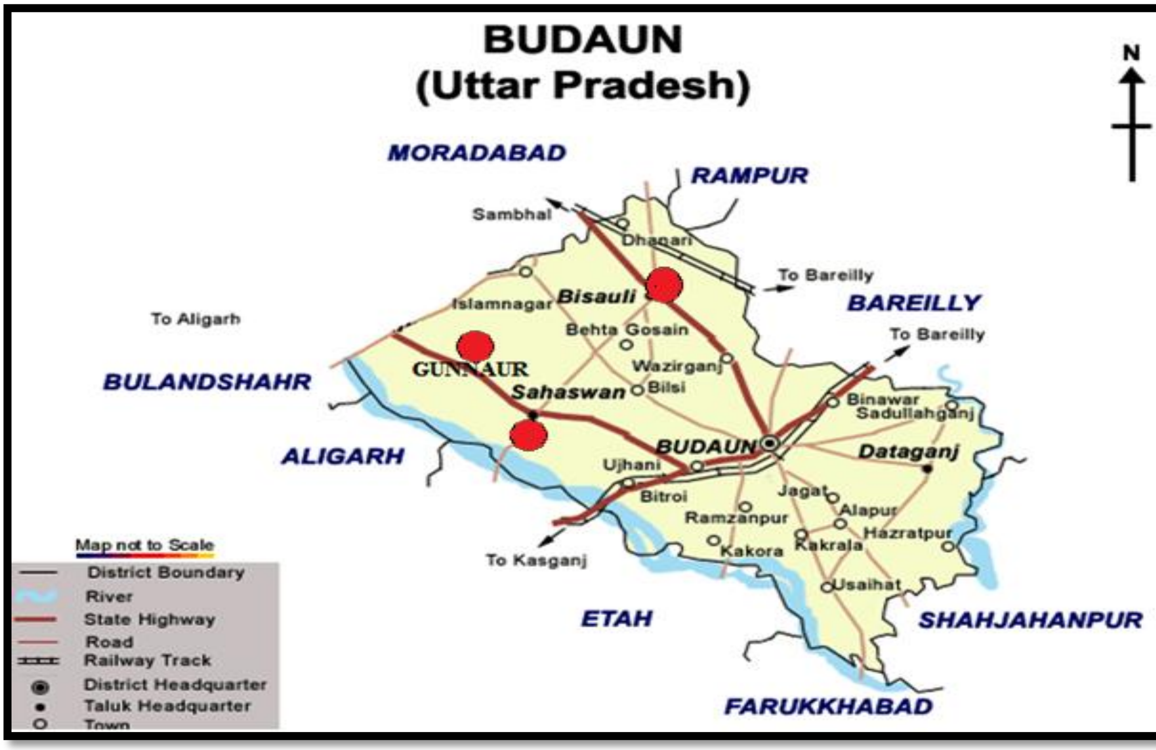


Fig: 3.9 Map of Badaun District Source: Map of India

3.3.10 Moradabad district

Moradabad is districts headquarter of the state Uttar Pradesh. It lies in the east of the river Ganga and Rampur district in west direction. Moradabad and Kanth are the Command areas of the S-Y link canal **(Fig 3.10).**

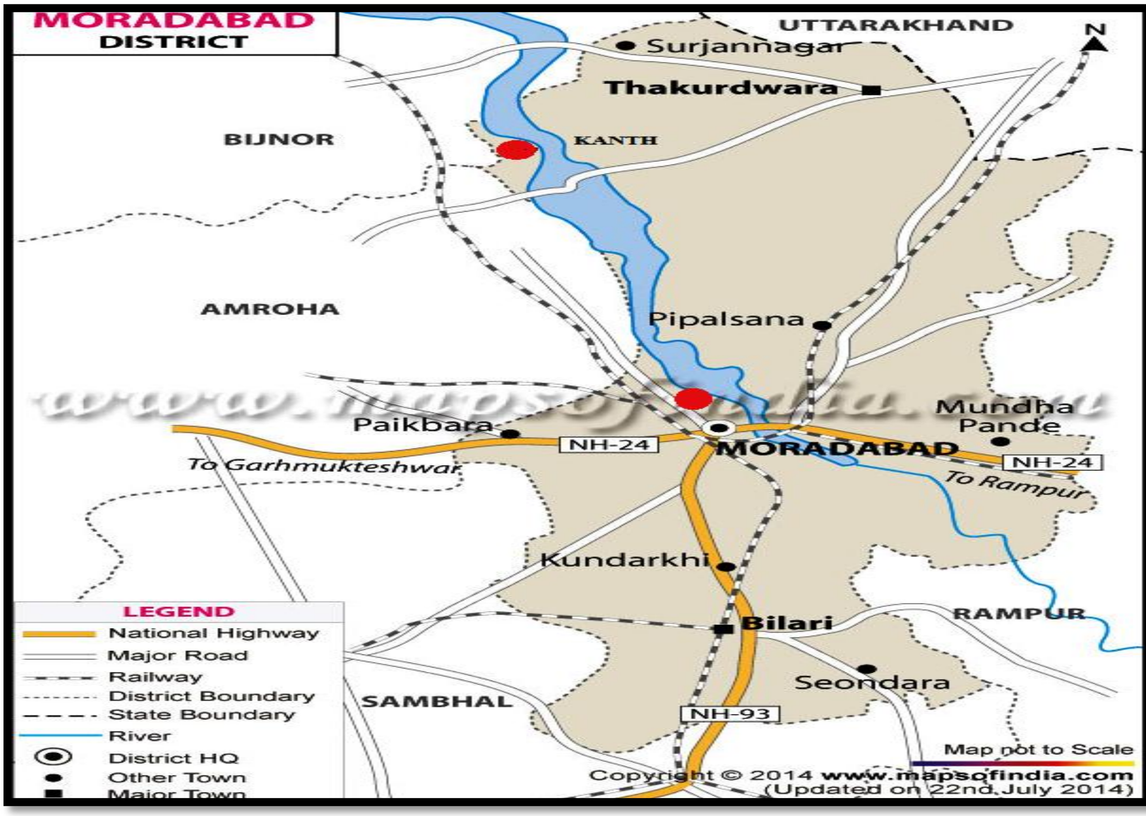


Fig: 3.10 Map of Moradabad District Source: Map of India

3.3.11 Amroha District or Jyotiba Phule Nagar or J. P. Nagar

Amroha district is also known as “Jyotiba Phule Nagar” and “Amroha District”, which is also a district of Uttar Pradesh state. Moradabad district is situated in its southeast direction, Badaun in south and river Ganga in west. Agriculture is main occupation in the district. Amroha, Hasanpur and Dhanaura are the Command areas of the S-Y link canal **(Fig 3.11).**

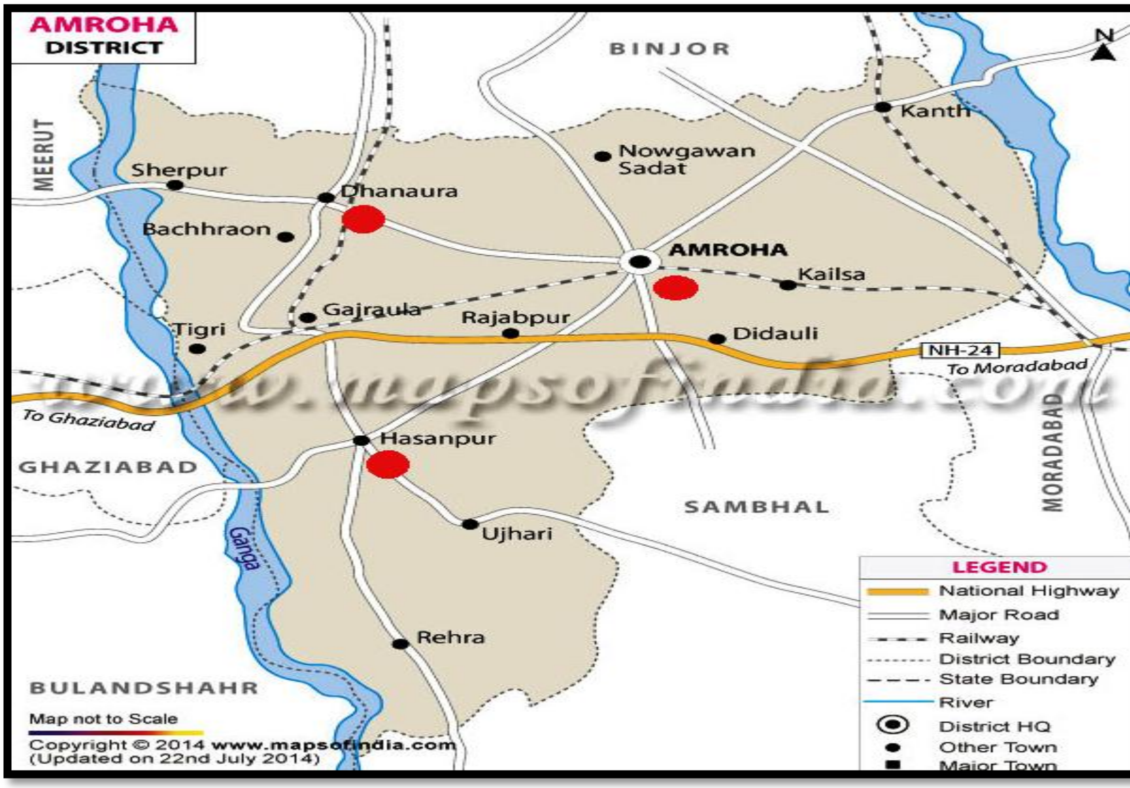


Fig: 3.11 Map of Jyotiba Phule Nagar Source: Map of India

METHODOLOGY

4 METHODOLOGY

The key objectives of the case study were to study the description of the Proposed S-Y Link project including location, design, structure and operation of the S-Y link. Current Baseline Environmental factors of the Enrouted and Command areas of the S-Y link were studied. Expected Environmental impacts of the proposed S-Y link were assessed with a proper Environmental Management Plan to mitigate the negative impacts. Current Baseline Ecological Status was also studied in details with its impacts. A field survey was done to know the Socio-Economic conditions of the people in Enrouted district Haridwar in Uttarakhand State and (Village Kanth), Moradabad and Bijnor districts of Uttar Pradesh state. Bijnor district is both Enrouted and Command area of the S-Y link. Socio-Economic Impacts were discussed on the basis of EIA Checklists method.

The methodology of the Case study was used to observe the Impacts of proposed S-Y link canal on Enrouted and Command areas, by studying the different Baseline Environmental Parameters and Socio-Economic Conditions.

4.1 Methodology of the different segments of the Case study is as follows:

The case study was based on data collection from literature sources, research papers, internet sources, discussion methods and field visit of the Enrouted and Command areas of the S-Y link canal. Extensive review of literature was done to collect the information's and get a fair understanding of the case study. Various national and international research papers were reviewed related to the Large Scale Inter Basin Water Transfer Project. Research study was based on Impact assessment of the S-Y link canal on surrounding environment with extensive field surveys. Collecting and processing of data is necessary for the calculation of expected environmental impacts of proposed S-Y link. Effectiveness of Large Scale Inter Basin Water Transfer S-Y Project is based on environmental impacts of the proposed link canal.

The methodology was based on Ancillary Data, Recent Data and Field Visit.

4.1.1 Ancillary Data

Environmental reports, analytical monitoring reports for the current baseline data were studied. To study the Description, Baseline Environmental factors and Baseline Ecological status of the proposed Sharda- Yamuna Link, the data was collected from Internet Sources, Literature Review and Govt. Departments (NWDA). The Description of the study was based on the literature survey and consultation with the water department. It includes project location, Salient features of the S-Y link canal, proposed barrages and dams, construction schedule, manpower planning and key machineries of the project. Certain other important ancillary data was collected such as Base maps of the study area e.g. District Maps, Satellite maps, Location maps, State maps, Physiographic map, Geological map, Physical, River basin map, Soil map, Land-Use map, Agriculture map, Climatic zones map and Rainfall maps, which were obtained from the various distinct sources, websites and departments.

4.1.2 Recent Data

The study on Baseline Environmental factors such as Physiography, Geology, Soil, Land use, Agriculture, Surface Hydrology, Ground Water Hydrology, Meteorology and Ecological Status of the S-Y link canal include flora, fauna was based on current literature available for describing the current status and data collection from websites of different departments. Current Information regarding the Baseline Socio Economic Status was based on EIA Checklist method.

4.1.3 Comparison between Ancillary Data and Recent Data

For calculation of expected impacts of the proposed Sharda-Yamuna Link on Enrouted and Command areas, qualitative analysis and assessment of data was done by comparing recent data of different Govt. departments and consultancy with NWDA Department as per need of the case study **(Fig 4.1).**

4.1.4 Field Visit or Site Selection

Field survey was administered via questionnaires and EIA Checklist. To make deep understanding of the recent Socio Economic Status of the S-Y link canal, a field check was carried out in (October to November month of 2014 year). Three sites of the Enrouted areas such as Haridwar, Najibabad in Bijnor district were selected. Among the Command areas of the S-Y Link, Moradabad and Noorpur village of Bijnor was surveyed. The recent study on Socio Economic Status was done for the identification and Prediction of Impacts on the basis of EIA Checklist Method. For this study, we inspected the study area by personal survey and check the accuracy. EIA Checklist method was applied to know the Socio-Economic Impacts with clarity.

4.1.5 Checklist Method

EIA checklist method is one of the strong tools of EIA process for the identification of impacts of any proposed activity or plan. Descriptive Checklist method was applied to know the expected impacts of the S-Y link canal. Five local sites were selected for asking the questions. Some Socio-Economic and Environmental parameters were considered. A group of people were selected on the basis of their education, knowledge, occupation and interest. These people include researchers, academician, industry experts and some other people within the age group of 30 to 50. Questions were asked from the local individuals of the selected areas of the S-Y link canal. This was done from door to door interview with the help of pre-prepared questionnaire and discussed with the experts.

The survey provides information regarding literacy rate or education, electrical availability or supply, water availability, water quality, agriculture, occupation, family income, important landmark, spoil generation, industry, climate, religious monument, flood status, drainage System, water collection, tourism, seepage and percolation or absorption of water, traffic, air quality, construction development, soil, fishery, public health status and medical facilities.

4.1.6 Surveys and Investigations

With regards to the ancillary data, the surveys & investigations works is carried out by several agencies, which was divided into two types of works the Topographical Survey and Investigation works. National Water Development Agency carried the topographical survey and various investigation works were carried out by different organisations. The survey works carried out by Investigation Division NWDA, Lucknow under the administrative control of Investigation Circle NWDA, Gwalior. The other Agencies were involved for investigation works are namely Central Soil and Materials Research Station New Delhi, Central Water Commission, Geological Survey of India Lucknow etc. Survey of head works and power houses was done by Central Water Commission. Other organizations are such as Irrigation Department, Govt. of Uttarakhand. Surveys for construction materials have been carried out by (CSMRS) Central Soil and Materials

Research Station, New Delhi. The investigations work with regards to the Geology of S-Y link project was carried out by the Geological Survey of India Lucknow and Geophysical Investigation was done by Geo-engineering department, College of Engineering, Andhra University, Vishakhapatnam. Soil testing was carried out by the Agriculture Department of Uttar Pradesh.

4.1.7 METHODOLOGICAL FRAMEWORK ADOPTED FOR THE STUDY

The procedure followed throughout the case study of proposed Sharda- Yamuna Link is presented using the flow chart. It shows the steps followed from beginning to conclusion with Environmental Management Plans **(Fig 4.1; 4.2).**

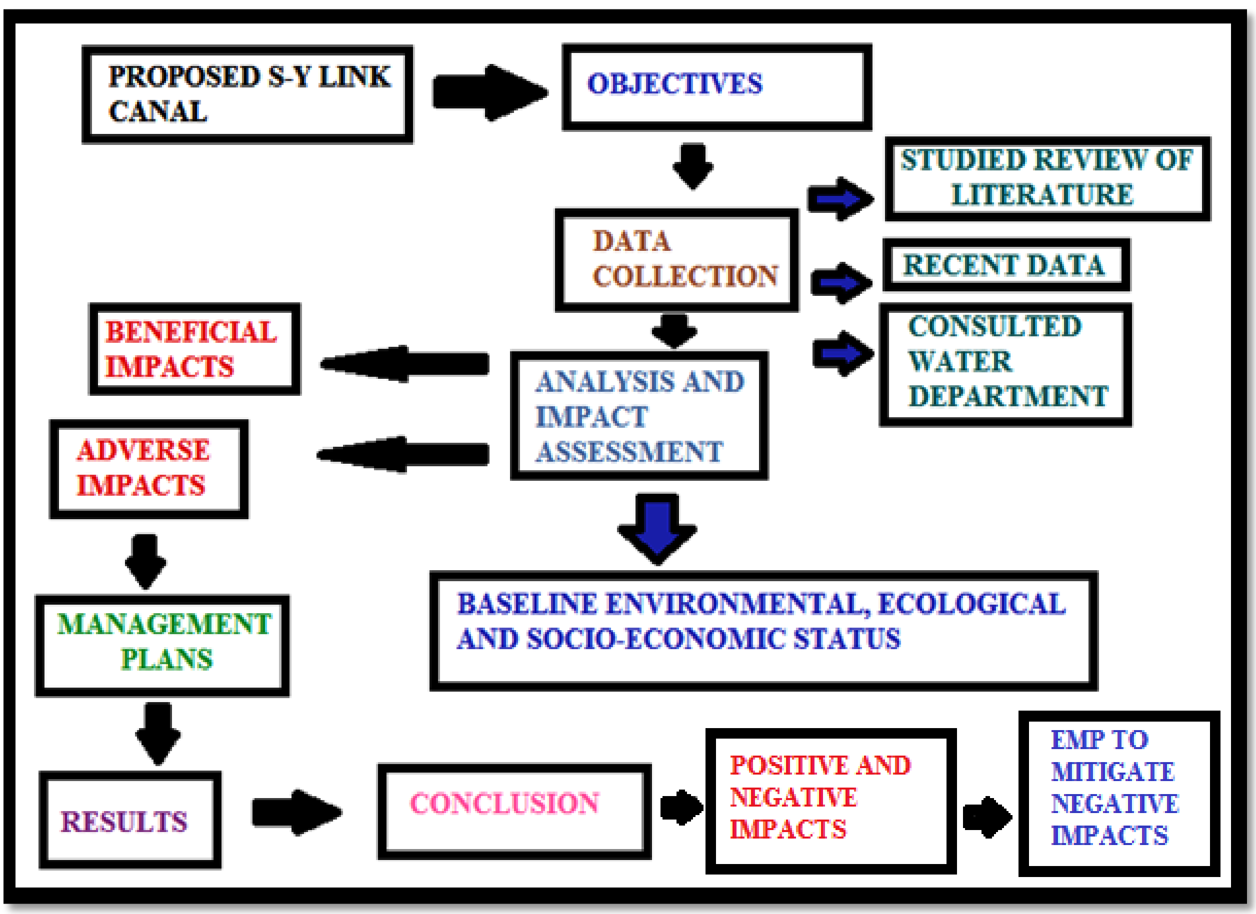


Fig 4.1 Flow Chart of Methodology

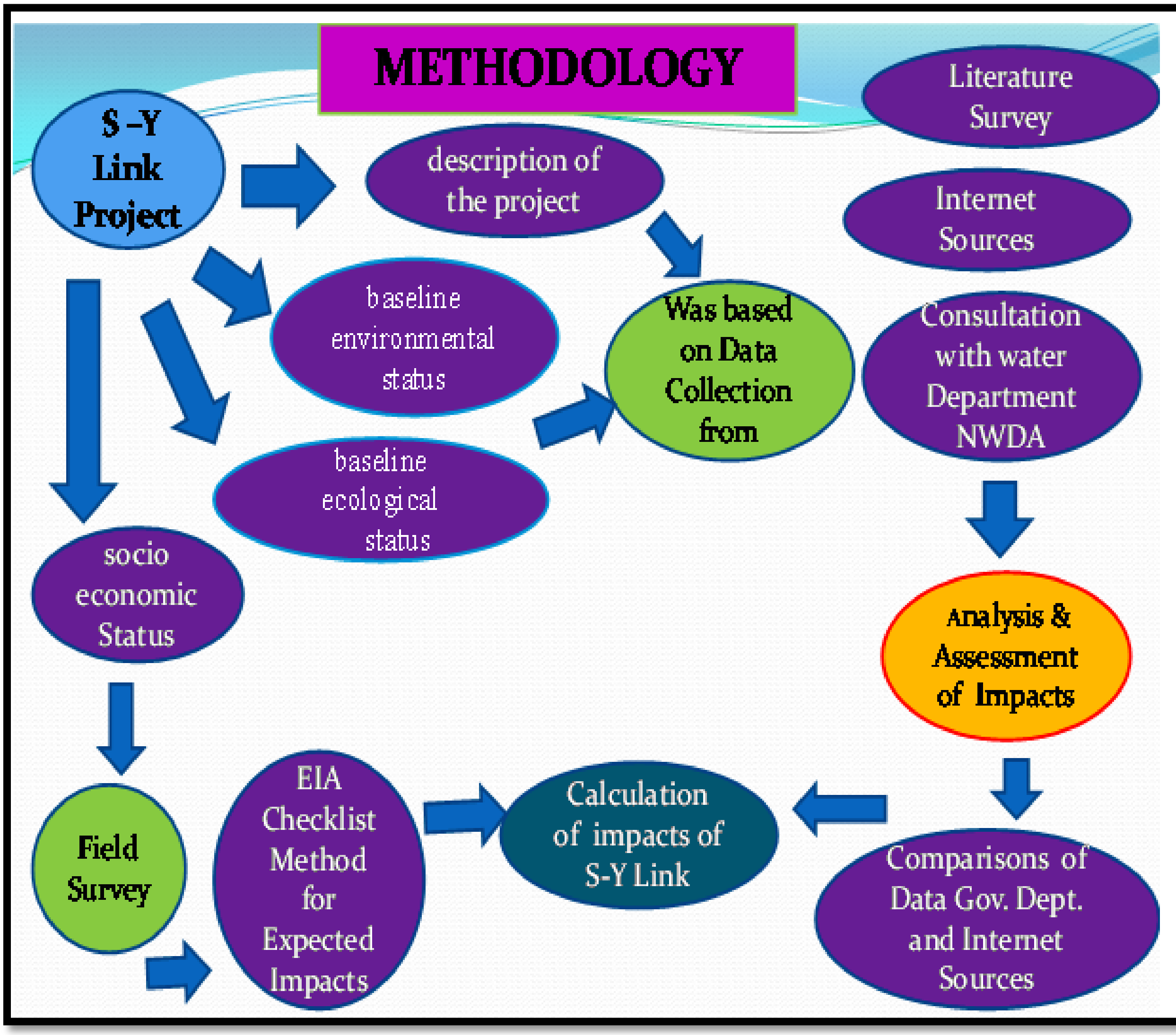


Fig 4.2 Methodology

It is beneficial to know the Current Baseline Environmental Status, Ecological Status and Socio-Economic Status of the Enrouted and Command areas of proposed S-Y Link to know the impacts, whether the S-Y link will beneficial for the surrounded people or not.

A focus of the research study was to make the case study qualitative, in which a group of people were asked about their perceptions, suggestions, opinions, beliefs and attitudes towards the Proposed Sharda-Yamuna Link Project. An idea about the possible management plans is provided to the mitigation of adverse impacts of River linking project in India.

RESULTS AND DISCUSSION

5 RESULTS AND DISCUSSION

5.1 DESCRIPTION OF PROPOSED SHARDA–YAMUNA LINK PROJECT VIZ. SIZE, AREA, LOCATION OF THE PROJECT

5.1.1 PROJECT BRIEF

Sharda-Yamuna link (S-Y Link) project covers in the Uttar Pradesh and Uttarakhand states in India **(Fig 5.1.7).** It is a part of Himalayan river development component and one of the proposed links of National Perspective Plan to minimize the problem of water scarcity. It is one of the proposed links of Inter- Basin Water Transfer Project, which has been conceived to transfer surplus water of river Sharda towards deficit areas, for the proper distribution of water and to overcome the problems of flood and drought. The proposed link will cross through Enrouted areas such as Champawat, Nainital, Udham Singh Nagar and Haridwar districts in Uttarakhand State and Bijnor, Muzaffarnagar districts in Uttar Pradesh. The Command areas or surrounded areas of the S-Y link would be Bareilly, Rampur, Moradabad, Badaun and Bijnor districts of Uttar Pradesh and Udham Singh Nagar district of Uttarakhand state **(Fig 5.1.3; 5.1.4).** It will fulfil other water requirements of its Enrouted and Command areas. The aim of the S-Y link is to divert the surplus water from Sharda river to Yamuna for use of water in drought prone western states of the country.

"Sharda-Yamuna link can be quicker and efficient plan for proper distribution of water and to mitigate the major water problems of flood and drought in Uttar Pradesh, Uttarakhand and some western states Haryana, Rajasthan and Gujarat in India".

5.1.2 PROJECT LOCATION ENROUTED AND COMMAND AREAS OF PROPOSED SHARDA –YAMUNA LINK

Enrouted and Command areas are the two main components covered under S-Y link project. Enrouted areas are through which the proposed S-Y link will cross and Command areas are the surrounded areas of the link.

5.1.2.1 ENROUTED AREAS

The lining of the proposed S-Y link will traverse though Champawat, Nainital, Udham Singh Nagar and Haridwar states of Uttarakhand state and Bijnor and Muzaffarnagar states of Uttar Pradesh in India. The link starts from Tanakpur town of Champawat district of Uttarakhand state to Kairana village of Muzaffarnagar district of Uttar-Pradesh state. **(Fig 5.1.1; 5.1.2; 5.1.5), (Table 5.1.1).**

Administrative Set-up of Enrouted Area

States (2)	**Districts (6)**	**Tehsils (14)**	**Villages (170)**
Uttarakhand	Champawat (13 Km)	Poonagiri/Tanakpur	8
	Nainital (67 Km)	Haldwani	5
	Udham Singh Nagar (62 Km)	Bajpur	13
		Kashipur	2
		Jaspur	4
	Haridwar (52 Km)	Haridwar	12
		Roorkee	10

		Laksar	9
Uttar Pradesh	Bijnor (100 Km)	Dhampur	9
		Nagina	14
		Najibabad	22
	Muzaffarnagar (90 Km)	Muzaffarnagar	44
		Shyamli	10
		Kairana	8

Table: 5.1.1 Source: NWDA

5.1.2.2 COMMAND AREAS

The command areas of the S-Y link canal lies in Bareilly, Rampur, Moradabad, Badaun, Bijnor and Jyotiba Phule Nagar districts of Uttar Pradesh state and Udham Singh Nagar district of Uttarakhand **(Fig 5.1.1; 5.1.2; 5.1.6)**, **(Table 5.1.2).**

Administrative Set-up of Command Area

States (2)	**Districts (7)**	**Tehsils (18)**	**Blocks (34)**
Uttarakhand	Udham Singh Nagar	Kichaa	Kichaa, Rudrapur
		Kashipur	Kashipur
Uttar Pradesh	Moradabad	Moradabad	Dhingarpur, Munda Pandey, Moradabad, Bhagatpur Tanda
		Kanth	Chajlet
	Jyotiba Phule Nagar	Amroha	Amroha, Joya
		Hasanpur	Hasanpur
		Dhanaura	Dhanaura, Gajraula
	Bijnor	Chandpur	Noorpur, Jalilpur
		Dhampur	Budhanpur, Allehpur
	Rampur	Suar	Suar
		Rampur	Chamraua, Saidnagar
		Sahabad	Sahabad
	Bareilly	Meerganj	Meerganj
		Aonla	Ramnagar

		Baheri	Baheri, Sheragarh
	Badaun	Sahaswan	Sahaswan, Ambiapur, Dahrawan
		Gunnaur	Gunnaur, Janawai
		Bisauli	Asafpur, Islamnagar, Bisauli, Wazirganj

Table: 5.1.2 Source: NWDA

Overall proposed S-Y link canal will passes through 2 states, 6 districts, 14 tehsils and 170 villages. The link canal could be beneficial for fulfilling the water requirements of both Enrouted and Command areas.

Location of Enrouted and Command Districts of Proposed S-Y link in Uttar Pradesh and Uttarakhand State

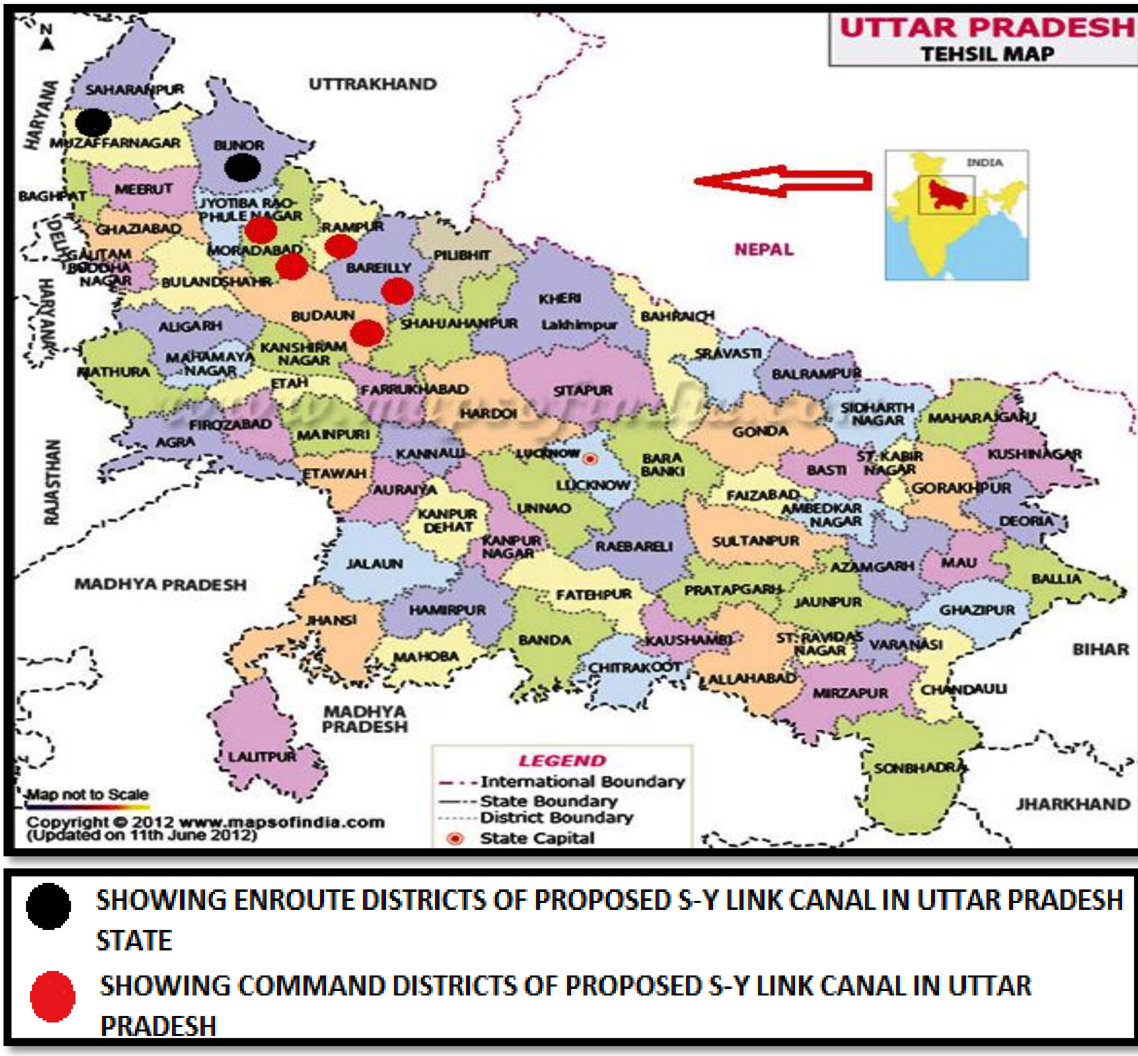


Fig: 5.1.1 Uttar Pradesh (State Map) Source: Map of India

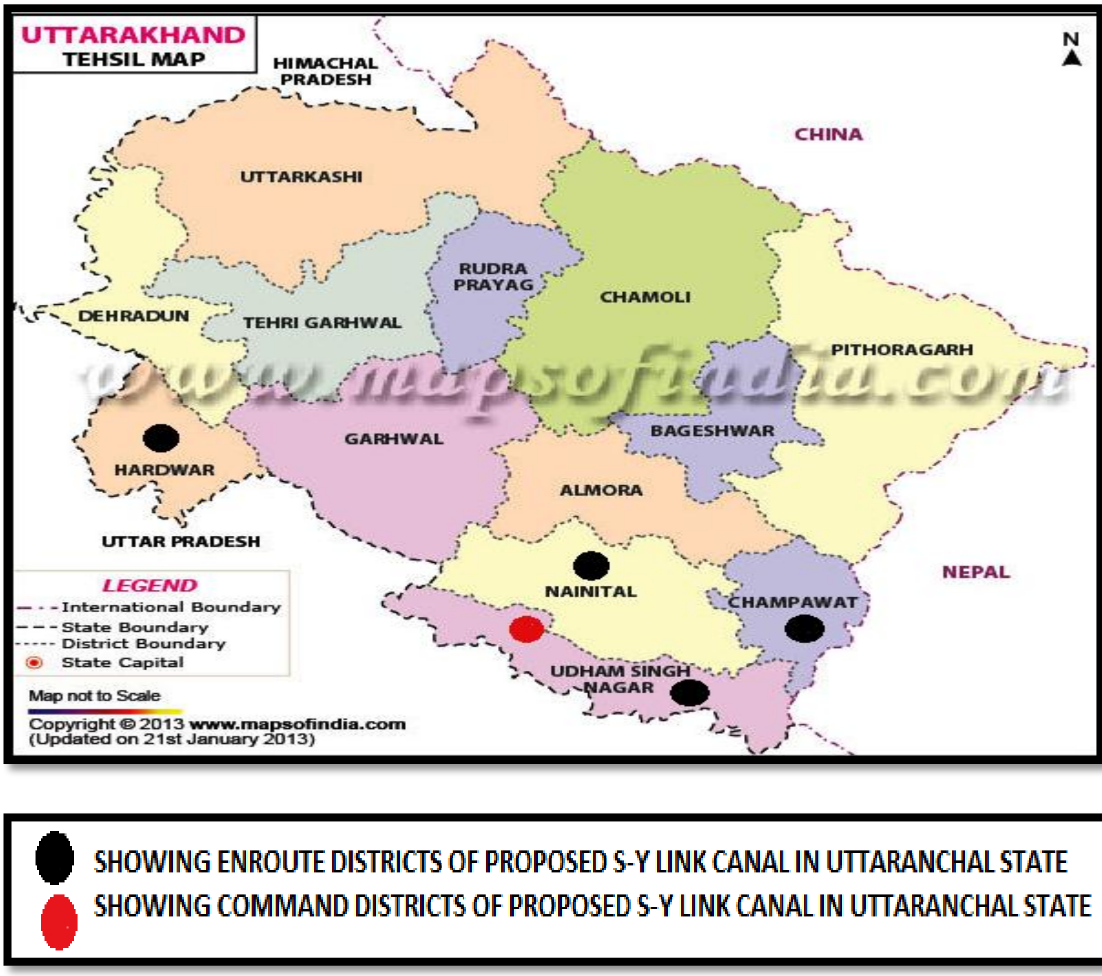


Fig: 5.1.2 Uttarakhand (State Map) Source: Map of India

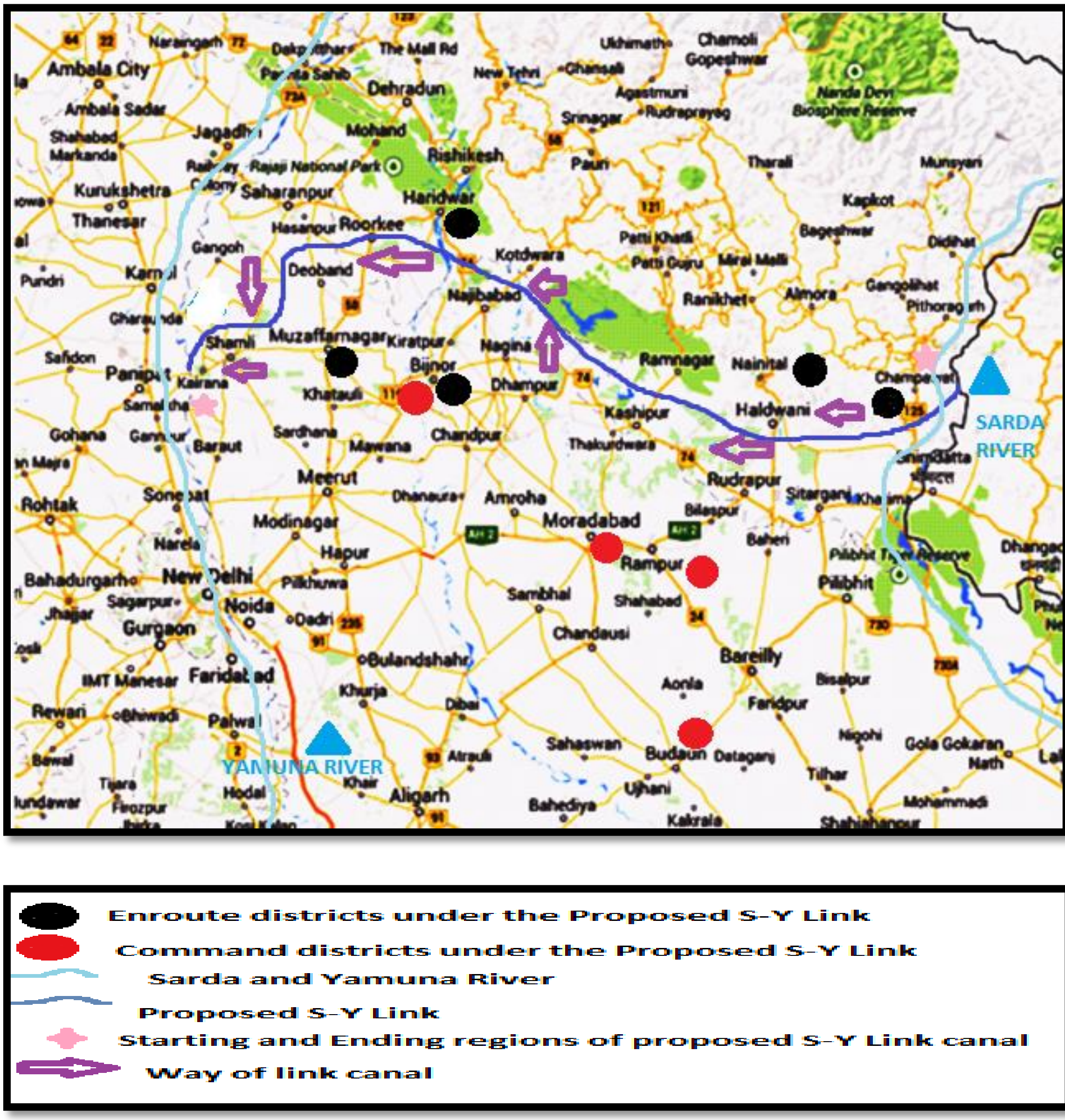


Fig: 5.1.3 Google map

Enrouted and Command Areas of the Proposed S-Y Link Canal (Location Map)

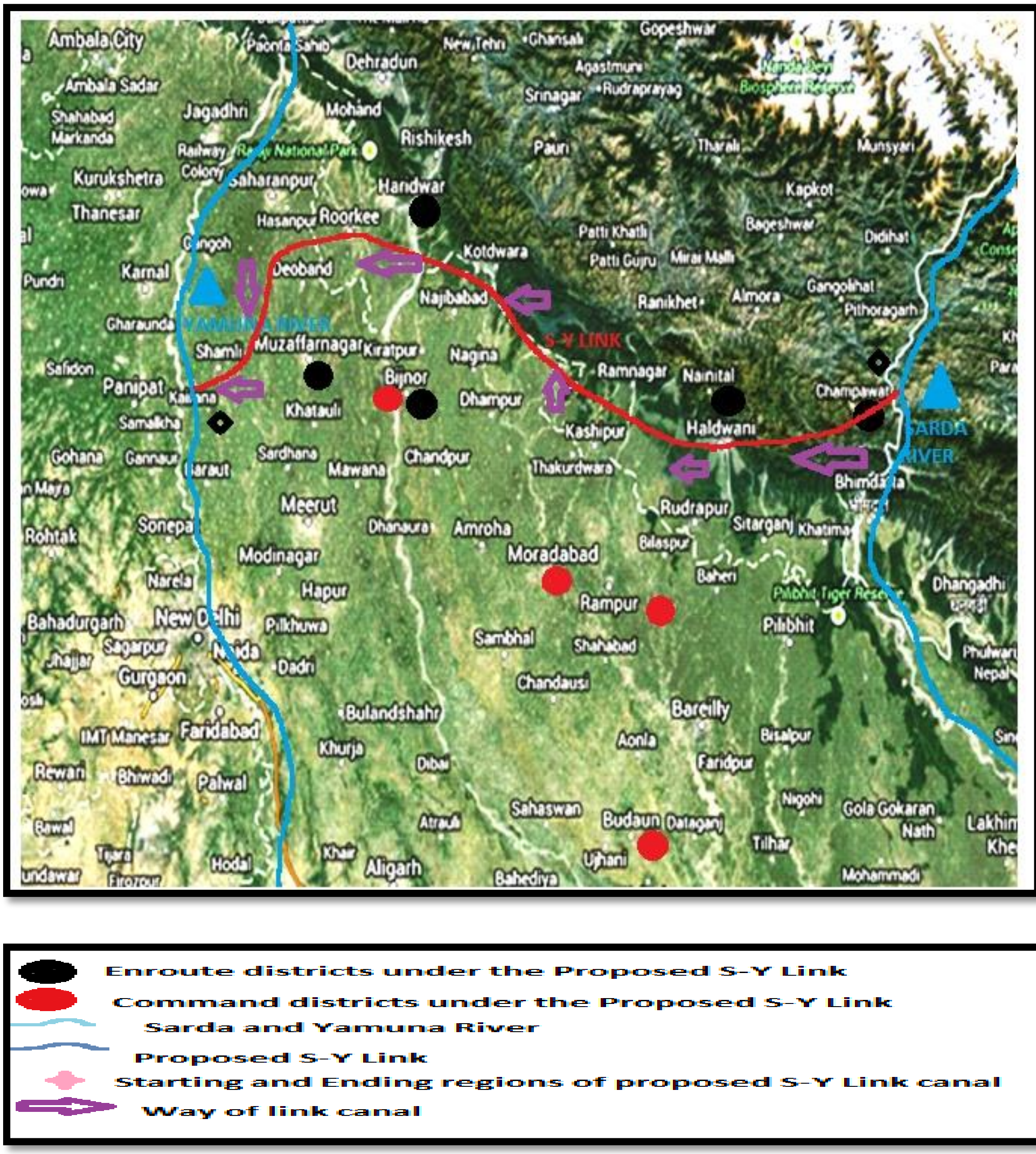


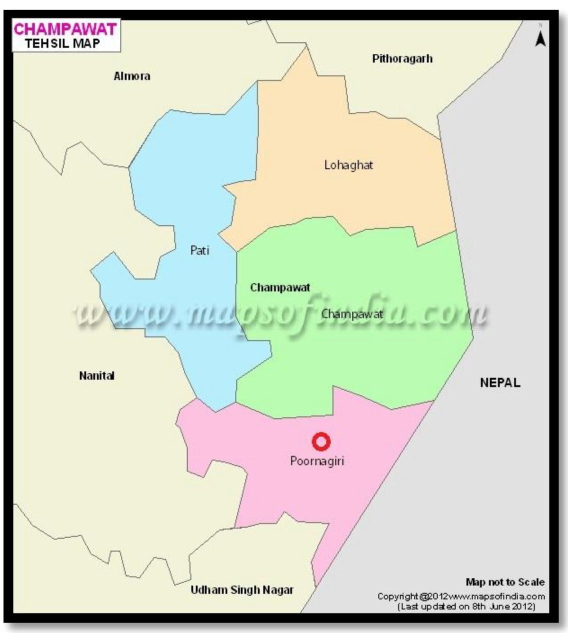
Fig: 5.1.4 Google map

Enrouted and Command Areas of the Proposed S-Y Link Canal (Satellite map)

District Maps showing Enrouted Tehsils of Proposed S-Y Link

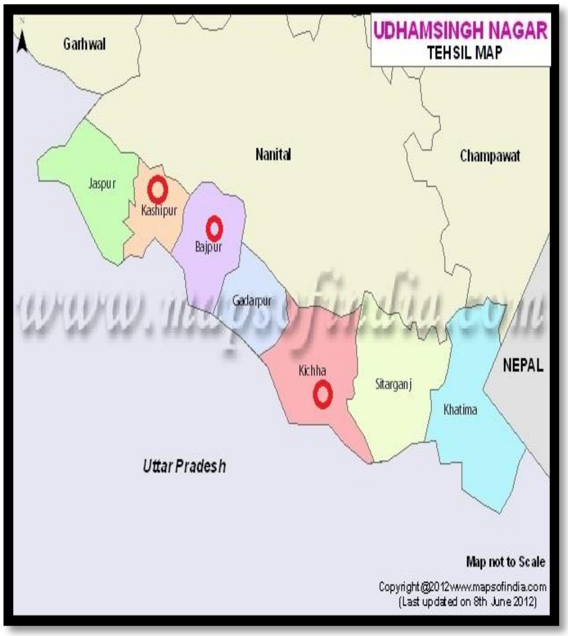
(a) BIJNOR

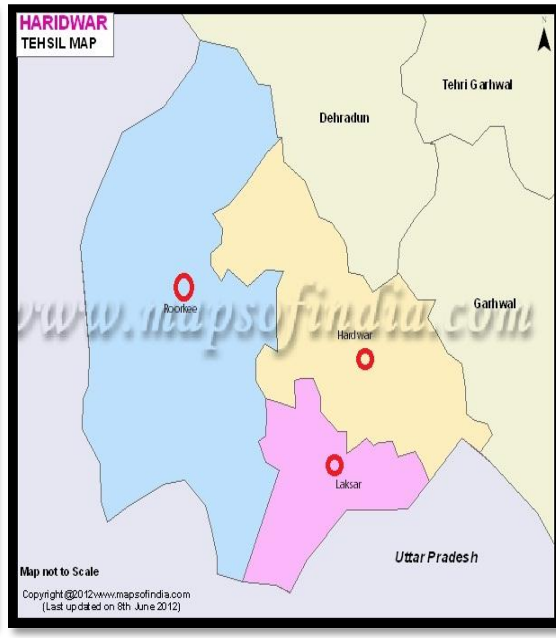
(b) MUZZAFARNAGAR



(c)CHAMPAWAT

(d) NAINITAL



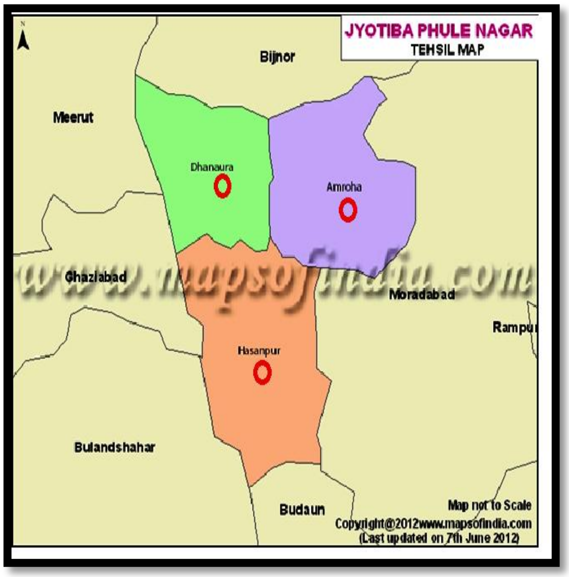


(e) UDHAM SINGH NAGAR **(f) HARIDWAR**

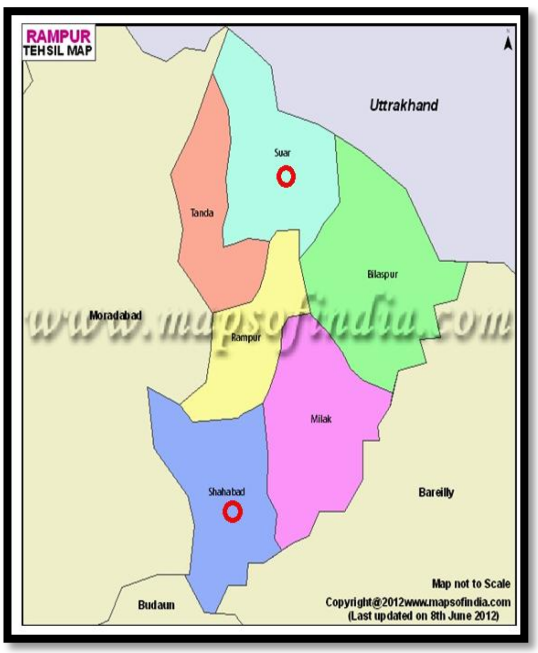
Fig: 5.1.5

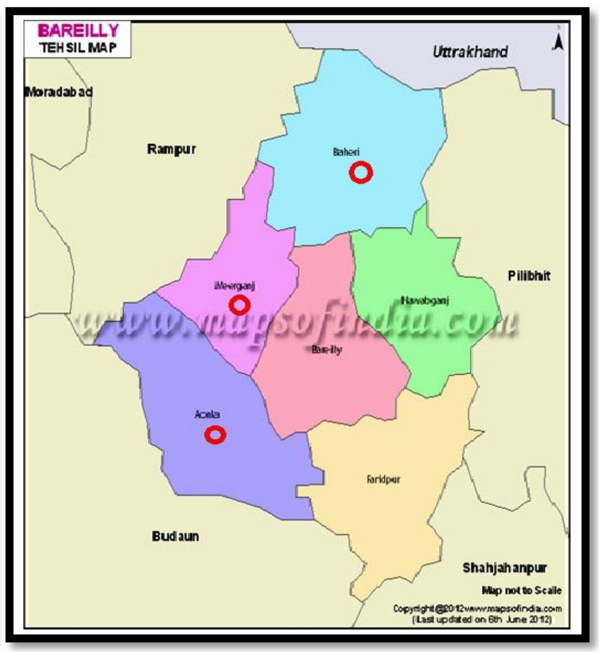
District Maps showing Command Tehsils of Proposed S-Y Link

(a) UDHAM SINGH NAGAR **(b) MORADABAD**



(c) J.P.NAGAR (OR AMROHA) (d) BIJNOR





(e) RAMPUR (f) BAREILLY

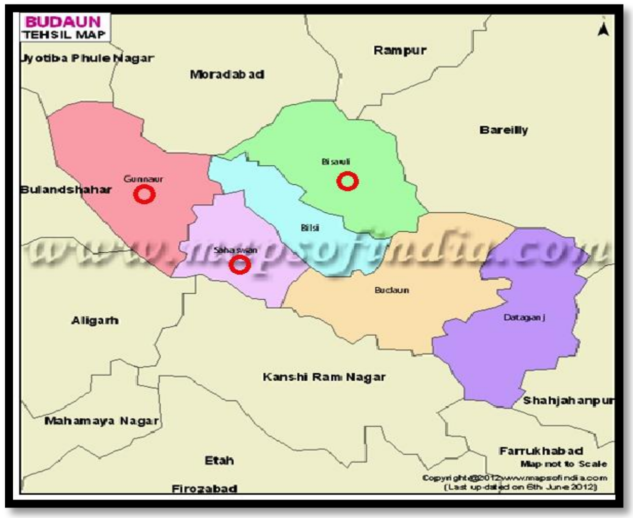


Fig: 5.1.6 **(g) BADAUN**

Fig: 5.1.7 Satellite Map showing the Proposed Sharda-Yamuna link Source: Google

5.1.3 STRUCTURES OF PROPOSED SHARDA YAMUNA LINK CANAL

- Salient Features of Sharda-Yamuna Link
- Pancheshwar and Poornagiri Dams
- Barrages at Sharda river off-take point, Enrouted major river crossing points at Ramganga, Kosi and Ganga
- Road and Rail crossings
- Plant and Colony area

- Enrouted Command Area Development

5.1.3.1 Salient Features of Proposed Sharda-Yamuna Link

1.	**River Basin**	Sharda (Mahakali)
2.	**States Cover**	Uttar Pradesh and Uttarakhand
3.	**En-routed Districts**	Champawat, Nainital, Udhamsingh Nagar, Haridwar in Uttarakhand State Bijnor and Muzaffarnagar in Uttar Pradesh State
4.	**Command Districts**	Udham Singh Nagar (Uttarakhand State) and Moradabad, Jyotiba Phule Nagar, Rampur, Bareilly, Bijnor, Badaun (Uttar Pradesh State)
5.	**Basin Cover**	Sharda, Ramganga, Upper Ganga and Yamuna Sub-basins of Ganga basin.
6.	**Off-take area**	Sharda River, 10 Km North East to Tanakpur town of Champawat district in Uttarakhand
7.	**Out-fall area**	Yamuna River in Kairana village of tehsil Kairana of Muzaffarnagar district in Uttar Pradesh
8.	**Water available for transfer from Sharda river**	11,680 Mm^3
9.	**Transmission Loss of water**	541 Mm^3
10.	**Water utilization in the Enrouted areas of S-Y link**	1758 Mm^3
11.	**Full supply depth**	7.8 m in depth
12.	**Bed width**	At head of canal 55 m and at tail of the canal 44.5 m
13.	**Velocity of flow of water**	1.363 m/s to 1.334 m/s.
14.	**Flow**	By gravity
15.	**Length of Canal**	384 Km
16.	**Lining**	Lined with cement concrete all along the stretch (canal)
17.	**Barrages**	Sharda, Kosi, Ramganga and Ganga Barrage
18.	**Dams (For Hydro Power Generation)**	Poornagiri, Pancheshwar Dams

19.	**Annual electrical Energy Generation**	8378 MKwh
20.	**Irrigation Benefit (Enrouted, Command areas)**	2.94 Lakh ha
21.	**Estimated Cost**	35404.77 Crore
22.	**Power**	10785.53 Crore
23.	**Economic Irrigation Benefit**	1306.63 Crore
24.	**Economic Power Benefit**	1935.60 Crore

Table: 5.1.3 Source: NWDA

5.1.3.2 PROPOSED PANCHESHWAR AND POORNAGIRI DAMS

The development of Pancheshwar and Poorangiri dams are proposed for the generation of power during the construction work of the S-Y link. Dams will also provide the domestic and irrigation facilities. The Pancheshwar and Poornagiri dams are proposed to be constructed across Sharda River known as Mahakali in Nepal, with 11,355 Mm^3 and 3680 Mm^3 gross storage capacities respectively **(Table 5.1.4; 5.1.5).** The available water in upper catchment of Sharda, will be first stored in the Pancheshwar Stage-I reservoir. Then, release of water from this reservoir after generating power will again be stored at Poornagiri dam (also known as Pancheshwar Stage-II). The diverted water through S-Y will be utilized for the irrigation purposes in the Enrouted and Command areas.

5.1.3.2.1 Pancheshwar Dam

The S-Y link project is a joint project between Nepal and India Countries. The gross storage capacity and live storage capacity of the Pancheshwar reservoir are 11,355 Mm^3 respectively. Catchment area of Pancheshwar Dam will be 12,100 Km^2 with a length of 869 m. Eight units of 350 MW are proposed to be installed on each side of Mahakali river on the foot of Pancheshwar dam to generate 8378 MKwh energy annually. The remaining water available at river Yamuna will transfer further towards water scarce areas of west part of India through other links such as Yamuna-Rajasthan and Rajasthan-Sabarmati links.

- **Features of Pancheshwar Dam**

Pancheshwar Dam	State	Uttarakhand
	District	Champawat
	River	Sharda River
	Gross storage and live storage capacity	11,355 Mm^3
	Catchment area	12,100 Km^2
	Top of Dam	695 m
	Length of Dam	869 m
	Annual Electrical Energy	8378 MKwh

Table: 5.1.4

5.1.3.2.2 Poornagiri Dam

The proposed Poornagiri dam site is located 20 Km north-east of Tanakpur town of Champawat district of Uttaranchal. The gross and the live storage capacities of Poornagiri reservoir are considered as 3,680 Mm^3 and 2,330 Mm^3 respectively. The catchment area of Sharda up to Poornagiri site is 15,000 Sq. Km, out of which 10,950 Sq. Km lies in India and 4,050 Sq. Km lies in Nepal. It is proposed to provide three units of 165 MW each on either side of the river at Poornagiri dam. About 4525 MKwh energy is proposed to be generated annually at Poornagiri dam.

- **Features of Poornagiri Dam**

Poornagiri Dam	State	Uttarakhand
	District	Champawat
	River	Sharda River
	Gross storage and live storage capacity	3,680 Mm^3 and 2,330 Mm^3
	Catchment area	15,000 Sq km

	Top of Dam	695 m
	Length of Dam	869 m
	Annual Electrical Energy	4525 M Kwh

Table: 5.1.5

5.1.3.3 PROPOSED BARRAGES

The S-Y link will cross major rivers viz. Sharda, Kosi, Ramganga and Ganga before falling into Yamuna River. On these crossings four barrages are proposed to control flood are namely Sharda, Kosi, Ramganga and Ganga Barrage.

5.1.3.3.1 Sharda Barrage

The Sharda barrage is proposed to be located on Sharda river at Indo-Nepal Border near Barmedeo village of about 10 km north east to Tanakpur town in Champawat district of Uttarakhand state in India. The length of the Sharda barrage is 277 m. The catchment area of the Sharda barrage is 15000 Sq Km and design flood is of 16990 Cumec **(Table 5.1.6).**

Sharda River

Sharda River or Mahakali River is also known as Kali or Kosi river. It locates in the region of Northern India and Western Nepal. It is the border between state Uttarakhand and Nepal. Descending from the hills, it enters the Indo-Gangetic Plain at Barmdeo Mandi (Nepal).The Sharda then continues through northern Uttar Pradesh state and then joins to Ghaghara River southwest of Bahraich in India.

- **Features of Sharda Barrage**

Sharda Barrage	Location	
	State	Uttarakhand
	District	Champawat
	River	Sharda River
	Access to the Project	Barmedeo village
	Catchment area	15000 Sq Km
	Design Flood	16990 Cumec
	Total Length	277 m

Table: 5.1.6

5.1.3.3.2 Kosi Barrage

The Kosi barrage is proposed across the river Kosi near Gulzarpur village in Bazpur tehsil of the district Udham Singh Nagar of U.K. The length of barrage across the river is 416 m. The catchment area of the Kosi barrage is 1901.875 Sq Km and design flood is of 5184 Cumec (**Table 5.1.7).**

Kosi River

Kosi River is the river of Nepal and northern India. In India it drains the northern slopes of the Himalayas in the Tibet region and the southern slopes in Nepal. It is also known as Saptakoshi River joined by seven upper tributaries before joining the Ganga near Kursela in Katihar district. The river flows in the northern plain in Bihar state. It has long been notorious for floods, because of its great out flushing; it has no permanent channel.

Features of Kosi Barrage

Kosi barrage	Location	
	State	Uttarakhand
	District	Udham Singh Nagar
	River	Kosi River
	Access to the Project	Gulzarpur Village

	Catchment area	1901.875 Km^2
	Design Flood	5184 Cumec
	Total Length	416 m

Table: 5.1.7

5.1.3.3.3 Ramganga Barrage

The Ramganga barrage is proposed on the Ramganga river near Laduawala village in the Bijnor district of U.P. The length of barrage across the river is 423 m. The catchment area of the Ramganga barrage is 3171 Sq Km and design flood is of 7607 Cumec **(Table 5.1.8).**

Ramganga River

Ramganga River is one of the tributaries of river Ganga which originates from the district of Pauri Garhwal, Uttarakhand state of India. Ramganga flows by the Corbett National Park near Ramnagar of Nainital district. Moradabad, Bareilly and Badaun cities of Uttar Pradesh are situated on its banks. It flows to south west from Kumaun in Himalaya region.

Features of Ramganga Barrage

Ramganga Barrage	Location	
	State	Uttar Pradesh
	District	Bijnor
	River	Ramganga River
	Access to the Project	Laduawala Village
	Catchment area	3171 Km^2
	Design Flood	7607 Cumec
	Total Length	423 m

Table: 5.1.8

5.1.3.3.4 Ganga Barrage

The Ganga barrage is proposed on the river Ganga near Nagal village of tehsil Najibabad of district Bijnor in U.P state. The length of barrage across the river is 481.5 m. The catchment area of the Ganga barrage is 24179 Sq Km and design flood is of 18800 Cumec (**Table 5.1.9).**

Ganga River

Ganga river is a river of north India plain, which is a trans-boundary river and one of the largest river of Asia. The origin of the river Ganga is western Himalayas in Uttarakhand state, which flows towards south and east parts of India through Gangetic plain, enters into Bangladesh and eventually falls into Bay of Bengal. Its tributaries are divided into Ghagara, Gomti and Gandak rivers, which are the left-bank tributaries and Son, Damodar and Yamuna rivers, which are the right bank tributaries.

Features of Ganga Barrage

Ganga Barrage	Location	
	State	Uttar Pradesh
	District	Bijnor
	River	Ganga River
	Access to the Project	Nagal village
	Catchment area	24179 Km^2
	Design Flood	18800 Cumec
	Total length	481.5 m

Table: 5.1.9

5.1.3.4 RAIL AND ROAD CROSSINGS

About 89 road bridges and 8 no. of railway bridges are proposed along the lining of S-Y link canal (**Fig 5.1.8; 5.1.9)**.

5.1.3.5 PLANT AND COLONY AREA

Places have been proposed for the execution of the works of proposed S-Y link is summarized below in the given table **(Table 5.1.10).**

Plant and Colony Area

S. No	**Locations identified**	**Main work to be handled at such locations**
1.	Lucknow, Moradabad	Offices of Senior level officers
2.	Moradabad	Main canal Construction, Command area development, Command Structures work
3.	Tanakpur	Poornagiri Dam, Sharda Barrage, Power house, Initial stage of canal, Command Structures work
4.	Kashipur	Kosi Barrage, Command Structures work
5.	Kalagarh	Ranga Barrage, Command Structures work
6.	Najibabad	Ganga Barrage, Command Structures work
7.	Haldwani	Canal Construction and Command Structures work
8.	Muzzafarnagar, Laksar, Shamli, Lalkuan, Rampur, Kicha, Nagina	Canal Construction, Command Structures work and Command area Development

Table 5.1.10 Source: NWDA

5.1.3.6 ENROUTED AND COMMAND AREA DEVELOPMENT

The area is bounded by river Kosi in the east and Ganga in west, S-Y link in the north and Ghaghara-Yamuna link in the south has been considered for the Command area development (2,94,500 ha) of the S-Y link canal. The command area comes under the bhabar and tarai zones, western plain zone and south-western semi- arid zones.

Command area development works mainly consists of the following steps:

(a) Some part of Udham Singh Nagar district and some area nearby to river may require levelling of land. The levelling of land may be done by the owner and beneficiaries.

(b) Construction of Canals

The Construction of Canals includes the main canal, branch canals and distributaries. The network includes some minor canals within the service area.

(c) Construction of field channels and water courses

For supporting infra structures for the farmers.

(d) Field Drainage

To avoid the water drainage problem, sustainable use of Ground and Surface water and other useful purposes such as irrigation, domestic, industrial etc in an area.

(e) Farm Roads

After the construction work of S-Y link, some new roads, developmental works, marketing, banks, easy availability agricultural inputs, land holding etc will develop for proper command area development.

5.1.4 CONSTRUCTION SCHEDULE AND MANPOWER PLANNING

The construction work of the S-Y link canal is based on perfect planning of construction and manpower. Many key types of machinery with good technical professionals will be required for the construction of S-Y link.

5.1.4.1 Construction Schedule

The duration considered for the construction work of proposed S-Y link is approx a period of 9 years, which is divided into investigation of pre-construction phase, design preparations, management of organizations, machinery and materials arrangement like cement, steel, completing formalities of land acquisition for projects, construction of camps, quarries, land and approach roads, branch canals, distributaries and minors etc.

5.1.4.2 Manpower Planning

Many Technical professionals will be required for the construction and maintenance of the S-Y link project like Technical Directors, Administrative Directors, Finance Directors, Public Relation Officers and Labour welfare Officers. Chief Engineers will design the work of canal and canal structures from RD (Regional Distance) 0.00 Km to 100.00 Km, 100.0 Km to 225.0 Km and 225.00 Km to 384 Km, Superintending Engineers will see the design of Pancheshwar and Poornagiri dams, four Barrages & Power houses. Some other professionals like Civil, Electrical/Mechanical Draftsman's, Ferro printers, tracers, photo copiers, laboratory assistants for quality control laboratory, medical professional's for dispensary in the project area, administrative managers, officers, accounts officers, accountants, skilled, semi-skilled labours, work charged staff and daily wages staff, contractor's and so many other persons are required.

5.1.5 TOOLS/ KEY MACHINERIES FOR THE CONSTRUCTION WORK

The main items of the construction work for the entire S-Y project are further classified as gravity dams, spill channels, tunnel control shaft, surge tank, power house, water pools, approach tunnel to power house, link canal, branch canals, distributaries and excavation of earth work for four barrages etc (**Table 5.1.11).** The approximate no. of following key machineries is required for the construction of S-Y link project.

Tools/ Key Machineries for the Construction Work

S. No.	**Name of Tools**	**Quantity**
1.	Diamond core drilling machines	7
2.	Vibratory compactors	6
3.	Sheep foot rollers	6
4.	Diesel road rollers	5
5.	Crawler tractors	6
6.	Concrete mixers	10
7.	Concrete vibrators	13
8.	Trucks (Dumpers)	20
9.	Tippers	24
10.	Water tankers	15
11.	Diesel pumps	100
12.	Stone crushers	6
13.	Concrete batching plants	5
14.	Cars	60
15.	Diesel Jeeps / Vans	231
16.	Mini buses	12
17.	Ambulances	12
18.	Small cranes	5

Table: 5.1.11 Sources: NWDA

5.1.6 DESCRIPTION OF PROPOSED SHARDA-YAMUNA LINK

The Sharda-Yamuna link has being suggested for transferring surplus water of about 11,680 Million cubic meters (Mm^3) of river Sharda near Tanakpur town of Champawat district of Uttarakahand state into the Yamuna River near Kairana village of Muzaffarnagar district of Uttar-Pradesh state **(Table 5.1.3).** It is an interdependent link for the diversion and utilizations of water to overcome the problems of drought and flood by transferring estimated surplus water of Sharda River into S-Y link. Diversion of water of Sharda river from proposed Sharda barrage to Yamuna river after meeting Enrouted water demands for irrigation & domestic uses and further transfer of water to the drought prone and water short areas in western parts of India. The flow of water will be by the gravity and the S-Y link will be lined with cement concrete all along the stretch (canal). About 541 Mm^3 of water would be loss during the transmission. About 1758 Mm^3 of water from S-Y link would be used for the irrigation works of the En-route Command areas of Uttar Pradesh and Uttarakhand state. The length of the proposed S-Y will be 384 Km with a 55.0 m bed width and 7.8 m full supply depth. Two dams for Hydro Power Generation are proposed namely Poornagiri and Pancheshwar dams. The proposed S-Y link will take water from Sharda river near Tanakpur town of Champawat district of Uttarakhand state between proposed Poorangiri dam and Tanakpur barrage. The S-Y link will transfer water from the right side of the proposed barrage across Sharda River into the Yamuna River about 2.5 Km near Kairana village of Muzaffarnagar district of Uttar Pradesh state. First the water available in the catchment of Sharda River will be stored in the reservoir of Pancheshwar dam, then the release of water from this reservoir after generating the power, will again stored at proposed Poornagiri dam which is located of about 58 Km distance of Pancheshwar dam. A barrage is proposed at a distance of 5 Km of Poornagiri dam to divert the water from Poornagiri dam to S-Y link. The S-Y link traverse through 170 villages and 15 tehsils belongs to Champawat, Nainital, Haidwar and Udham Singh Nagar districts of Uttarakhand state and Bijnor and Muzaffarnagar districts of Uttar-Pradesh. The discharge of water at starting and ending of the S-Y link canal will be 757.32 Cumec and 605.77 Cumec and the transmission losses would be of 541 Mm^3. During the journey, S-Y link will cross the major rivers viz. Gola, Kosi, Ramganga and Ganga. Barrage on these crossings are proposed and to be constructed at the time of level crossing which would be named as Sharda barrage, Kosi barrage, Ramganga barrage and Ganga barrage. The S-Y link with proposed four barrages will locate in the Ganga basin. There will be development of Pancheshwar and Poorangiri dam for the generation of power during and after construction work of the S-Y link and to provide the domestic and irrigation facilities to other areas in the western parts of the country. The construction of Pancheshwar and Poornagiri dams would be across the Sharda river known as Mahakali in Nepal with having the gross and live storage capacities of 11,355 Mm^3 and 3680 Mm^3. It is a joint project between Nepal and India. The Catchment area of Pancheshwar dam will be 12,100 Km^2 with a length of 869 m. Eight units of 350 MW are proposed to be installed on each side of Mahakali river on the foot of Pancheshwar dam to generate 8378 MKwh energy annually. The proposed Poornagiri dam site is located 20 Km north-east of Tanakpur town of Champawat district of Uttarakhand state. The region covered by Sharda up to Poornagiri site is approx 15,000 Sq Km, in which the 10,950 Sq Km covers in India and 4.050 Sq Km in Nepal. Tanakpur barrage is for diversion of water through run of the rivers hydropower plant. Overall this proposed S-Y link will passes through 2 states, 6 districts, 15 tehsils and 170 villages. The S-Y link could be beneficial for fulfilling the water requirements of its Enrouted and Command areas with other water scarce areas.

Fig: 5.1.8 U.P State (covering road, villages, railway, dams and crossings etc

Source: Maps of India

Fig: 5.1.9 Uttarakhand State (covering road, villages, railway, dams and crossings etc)

Source: Maps of India

5.1.7 COST ESTIMATE FOR THE PROJECT

The total cost of the proposed S-Y Link project comprising three main components as head works, canalization and power generation has been estimated to be Rs. 35,404.77 Crores based on 2003-2004 price level. The total cost of canalization from barrage construction at Sharda to outfall to Yamuna including Enrouted Command area developmental work is estimated around 9513.19 Crores, out of this amount about Rs 369.43 Crores, Rs 5.5 Crores and Rs 214.09 Crores marked for land acquisition, plantation and barrage construction. The irrigation benefits are estimated to be Rs.27.76 lakh per 100 ha of cropped area. The net annual benefit from irrigation from Sharda-

Yamuna link project is approx Rs.1306.63 Crore. About Rs. 1935 Crore are estimated for the annual benefits from the generation of electricity.

5.2 BASELINE CURRENT ENVIRONMENTAL STATUS AND IMPACTS OF PROPOSED SHARDA-YAMUNA LINK PROJECT ON BASELINE ENVIRONMENTAL FACTORS

The key objective of the study of Baseline Environmental Status is to know the level of Environmental Parameters in Enrouted and Command areas, directly or indirectly associated with the development of Proposed S-Y Link. The study reveals the information and expected impacts due to project size, area and location during and after construction phase of S-Y link on baseline environmental components.

It is necessary to understand the Environmental features in Enrouted and Command areas of the proposed S-Y link for the proper Environmental Management Plan and to minimise the adverse Impacts of S-Y link canal.

The Baseline Environmental study of S-Y link regarding Geology, Soil, Land use, Agriculture, Surface hydrology, Groundwater hydrology, Meteorology and the Impacts are described on various attributes such as air quality, water quality, settlements, land use, agricultural sectors, soil, groundwater and water use in the following subsequent paragraphs:

5.2.1 PHYSIOGRAPHY AND GEOLOGY

The project Enrouted and Command area falls in two states Uttar Pradesh and Uttarakhand, as these states have different physiographic divisions.

5.2.1.1 PHYSIOGRAPHY

Physiography is the physical feature of earth surface, which includes geographic topography, climate, soil and vegetation. The maximum physiographic regions of Uttarakhand state are covered with western Himalayas and Uttar Pradesh from northern plain in India **(Fig 5.2.1).**

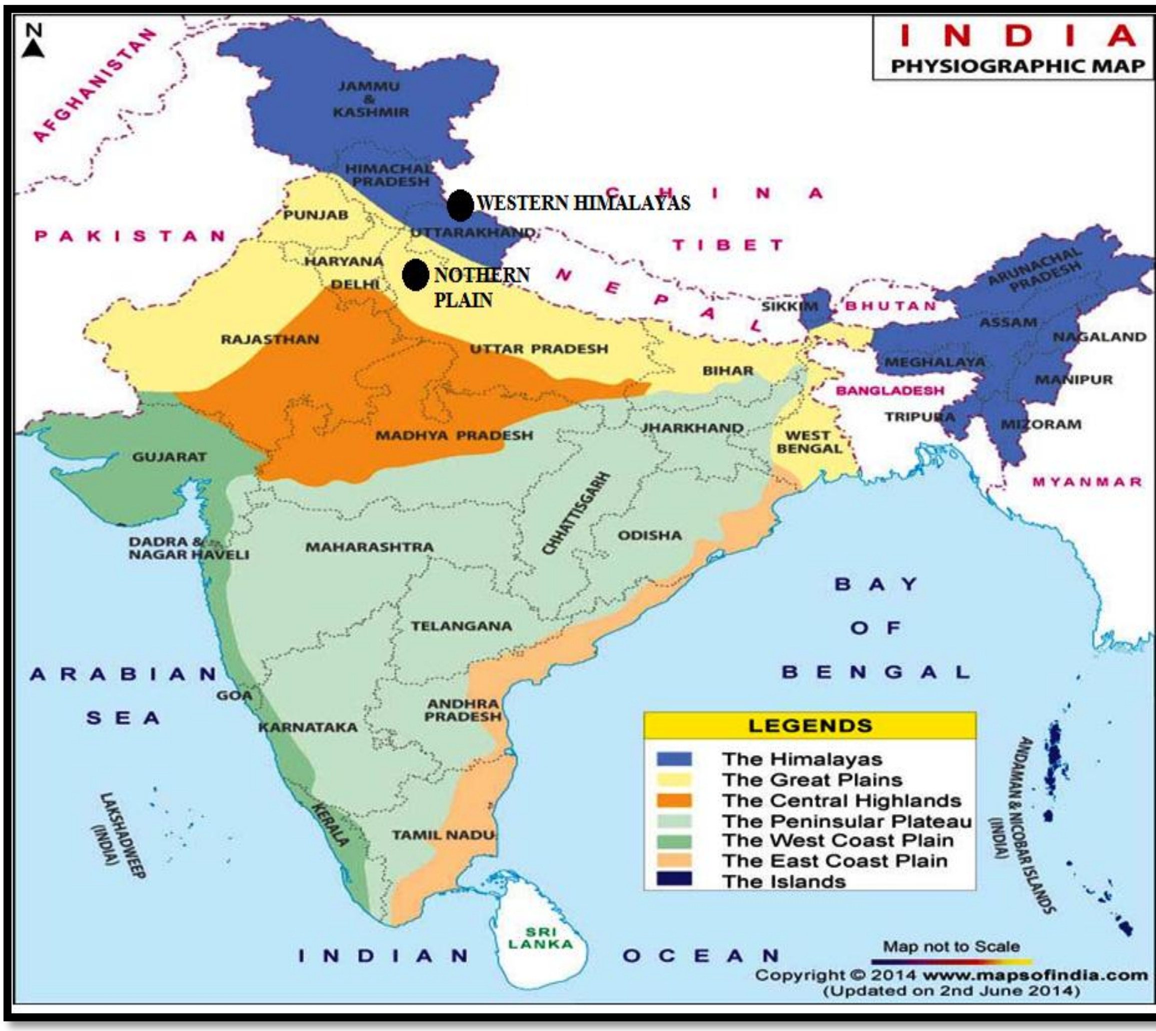


Fig: 5.2.1 Physiographic Map Source: Map of India

5.2.1.2 GEOLOGY

Geology is the physical features of the earth's surface, which includes geographic topography, climate, soil and vegetation. The geology of Uttarakhand state is comes under Sivalik range and Uttar Pradesh state in Alluvium range **(Fig 5.2.2).**

Fig: 5.2.2 Geological map Source: Map of India

5.2.1.3 Physiography and Geology of Uttarakhand State

Uttarakhand state lies in the south part of Himalaya range which is covered by ice and bare rock. It has 93% mountains. The total G.A of the Uttarakhand is 53,484 Sq. Km. It is situated in the northwest portion of Uttar Pradesh state and one of the most populous states. The state is famous for its beauty. An important part of Uttarakhand geography is the presence of two major rivers of India's the river Ganga and the Yamuna, generally origin is the glaciers of Uttarakhand. The highest altitudes are covered by ice and bare rock. Most of the northern parts of the state are comes in the greater Himalayan range, and covered by the glaciers and dense forests. Uttarakhand region is fed by so many lakes, glacial melts and streams. The Himalayan ecosystem is covered with a huge species of flora and fauna including leopards, tigers, plants, shrubs, western Himalayan alpine shrubs, moist deciduous forests and rare herbs etc. The climate generally differs in the region based on the higher altitude from the glaciers to lower altitude of tropical forest. Plateaus, planes, hills, mountains, river valleys, river basins in the state Uttarakhand are come under the Himalayan range. Among the Enrouted regions of the proposed S-Y link, Champawat, Nainital districts are situated at high altitudes and Haridwar and Udham Singh Nagar are situated at low altitude **(Fig 5.2.3.).**

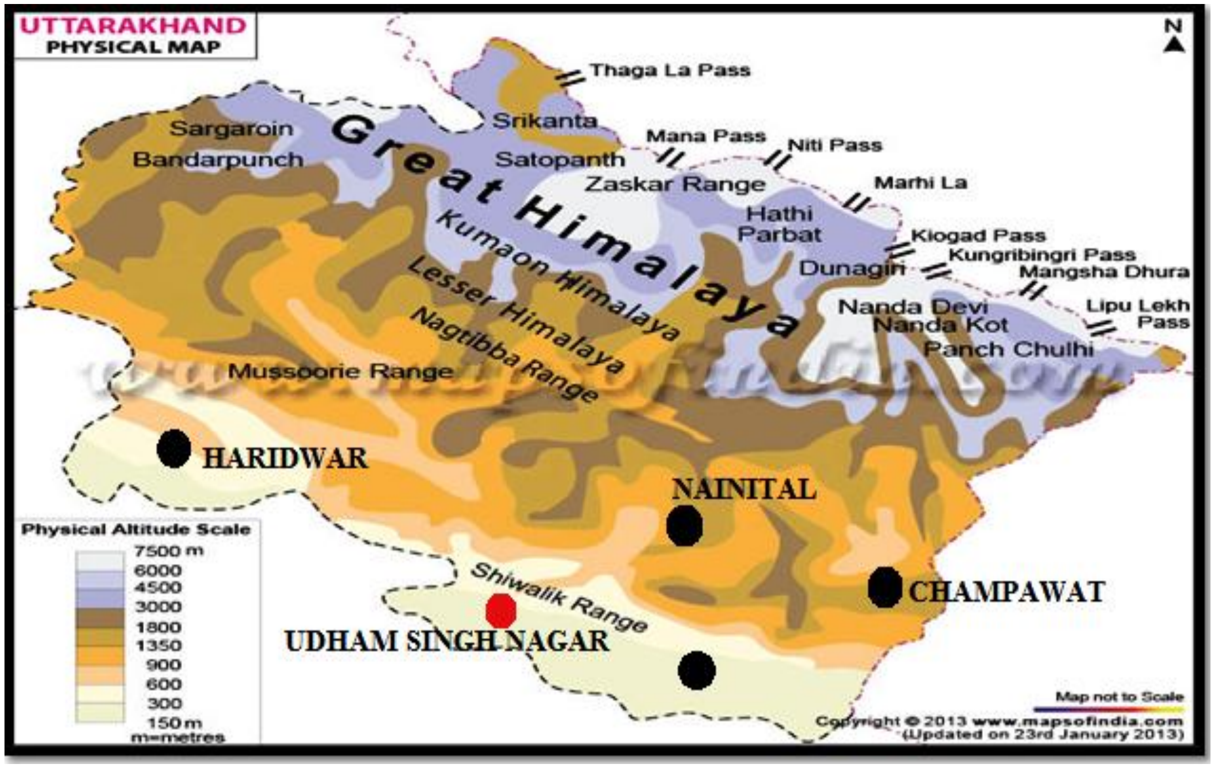


Fig: 5.2.3 Map of Physiography and Geology of Uttarakhand Source: Map of India

5.2.1.4 Physiography and Geology of Uttar Pradesh State

The geographical area of the state Uttar Pradesh is approx 2, 40,928 Sq. Km. It is the largest state. The Gangetic plain covered the Himalayan in north and hilly rocks in its southern part **(Fig 5.2.4).** The physiography of the state is divided into three distinct physiographical regions from north to south viz. the Sivalik hills in the north, the great Himalayas and the Vindhya range plateau on the south. The main physiographic plains are the plain of Ganga and its tributaries (part of the Indo-Gangetic Plain). Enrouted districts of the proposed S-Y link canal are Bijnor and Muzaffarnagar and Command districts are Moradabad, J.P. Nagar, Bijnor, Rampur, Bareilly and Badaun falls in Himalayas and Gangetic plain of Uttar Pradesh State

5.2.1.4.1 The Himalayan region

The Himalayan Region is present in the north part of U.P state. The elevation of the Himalayan region ranges from 300 to 5000 m.

5.2.1.4.2 Sivalik Range

Sivalik range present in the south part of the Himalayas, which slopes down the region Bhabar and Terai area. The Sivalik ranges forms a low range of hills and run parallel with the Himalaya. It is rich in forest. The terai runs parallel to the bhabhar region. The main crops are wheat, rice, and sugarcane. The whole plain is alluvial and very fertile.

5.2.1.4.3 Gangetic plains

Centre part is covered by the Gangetic plain that lays between Himalayas in the north and Vindhyan hills and Plateau in the south. The source of Ganga River is from here. The Gangetic Plain is covered with the tributaries of river Ganga. It is very deep from north-west to south- east. The Gangetic Plain is divided into numerous ponds, lakes and rivers. The region is highly fertile with alluvial soils. Its topography is divided into numerous lakes, ponds and rivers. It is divided into alluvium soil (Banger) at higher elevations and the new alluvium soil (Khadir) in lower areas along the rivers and their distributaries such as Gomti, Gandak and Ghagara etc.

5.2.1.4.4 The Vindhya Hills

Vindhya hills are located in the south part of the Gangetic plain. The north region is bound by river Yamuna and partly by the river Ganga. The topography is divided into plains, hills, plateau and valleys, which has limited water availability.

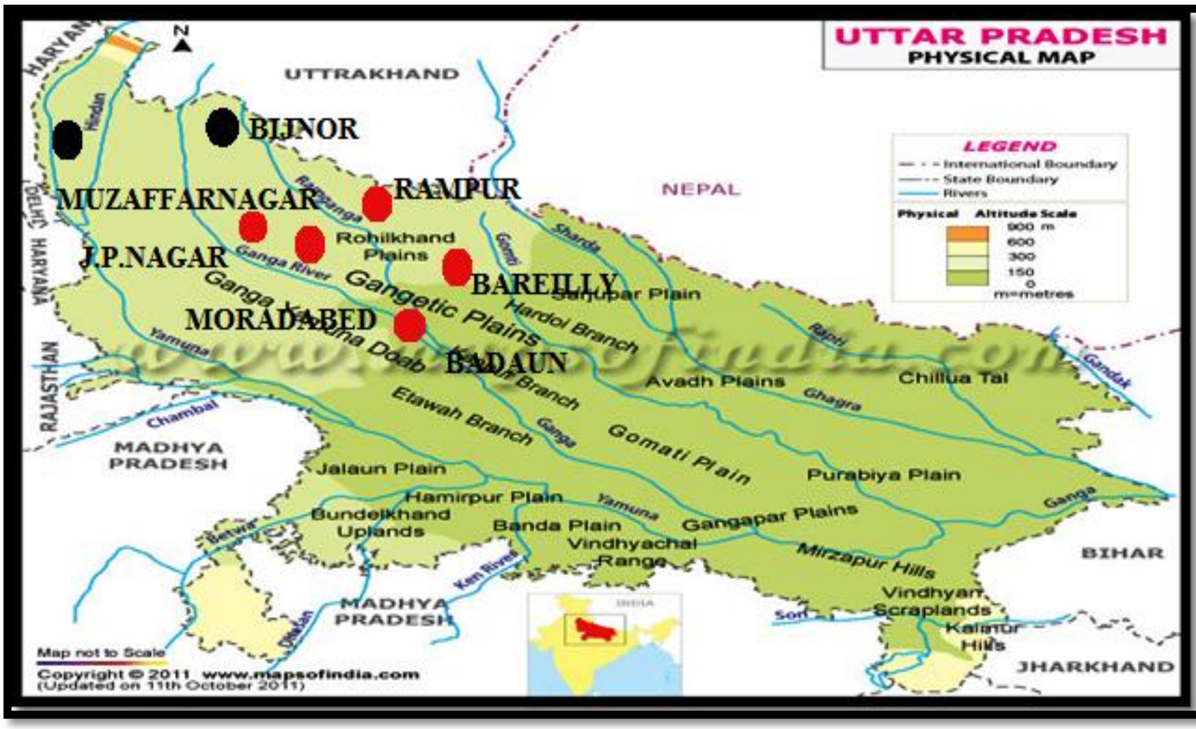


Fig: 5.2.4 Map of Physiography and Geology of U.P in Gangetic Plain Source: Map of India

5.2.1.5 Physiography of the Canal Alignment

According to the National Bureau of Soil Survey and Land Use Planning, the proposed S-Y link canal has an elevation ranging from 230 to 284 m. The canal is passing only through plain land, but in Champawat district it passes through the hilly area. The relative distance of canal alignment from regional distance 0 Km to 13 Km (Sharda river) covers in bhabar plain, from regional distance 13 Km to 142 Km near Udham Singh Nagar and

Nainital boundary through bhabar and tarai plain and from regional distance 142 Km to 384 Km (outfall point Yamuna River) through alluvial plain. Enrouted Command districts such as Moradabad, J.P. Nagar, Rampur, Udham Singh Nagar, Badaun, Bareilly and Bijnor falls in the terai region. The general slope of Command districts is from North West to south west (**Table 5.2.1).**

Physiographic division of Canal Alignment

S. No.	Relative Distance (R.D) of Canal Alignment	Physiographic Sub-Divisions
1.	R.D 0 to Km (Sharda River) to 13 Km.	Bhabar Plain
2.	R.D 13 Km to 142 Km near Udham Singh Nagar and Nainital Boundary	Bhabar and Tarai Plain
3.	R.D 142 to 384 Km (Outfall point Yamuna River)	Alluvial Plain

Table: 5.2.1 Source: National Bureau of Soil Survey and Land use Planning

5.2.1.6 Impact of Proposed Sharda-Yamuna Link on Physiography and Underlain Geology of Enrouted and Command Areas

The S-Y canal passes through foothills of Himalayas and the Gangetic plain. The construction of the canal will involve excavation of soil up to 8 m depth and 55 m width. The Geology of the area will not be altered due to the development of canal. No significant impact is envisaged due to development of the S-Y canal.

5.2.2 SOIL

Soil is an important natural resources and uppermost protective layer of the earth's crust, which supports life. It is formed by weathering of rocks. In India soils are differ in composition and structure. Soil type's classification is based on many factors like colour, texture, pH, productivity, depth and way of formation.

5.2.2.1 Regional Features

The S-Y canal passes through the regions of Uttar Pradesh and Uttarakhand states having different types of soil is present. The entire S-Y canal area including Enrouted and Command districts lies in the Gangetic plain (**Fig 5.2.5).** The soil in this plain are developed from alluvium deposited by the Ganga and Yamuna major rivers and tributaries.

5.2.2.1.1 Ganga basin

The Ganges basin is the largest basin among the world in area and length. The area covered by Ganga basin is 1,086,000 Sq Km. It covers over about 12,500 Sq. Km in northern India. The river Ganga is joined by other Himalayan rivers such as Gomti, Gandak, Yamuna, Ghagara and Kosi which causes flood.

Soils of Ganga Basin

The types of soil present in the Ganga basin is sandy, loamy, clay **(Fig 5.2.5)**. Soils of Gangetic plain occurring in different landforms of the project area are described below:

5.2.2.1.2 Bhabar Soils

Bhabar types of soils are found in southern region of the Himalayas and Sivalik hills. The porosity of the soil is very high. The bhabar is generally comprises of pebble-studded rocks in the shape of porous beds. This type of soil is not much suitable for agriculture.

5.2.2.1.3 Tarai Soils

Tarai soils lies to south part of the bhabar and run parallel to it. Due to heavy rainfall throughout the year, this type of soil makes the region moist and densely forested with a large diversity of wildlife.

5.2.2.1.4 Alluvial soils

Alluvial soils are formed by the deposition of sediments by rivers during flood along rivers. These soils are very productive and very fertile in nature because they are rich in humus but deficient in nitrogen and phosphorus. These soils are found in lower valleys of Narmada, Great Northern plain, Tapti and Northern Gujarat. Alluvial soils are renewed every year comes from the silt that washes down into rivers. These are so fertile soils which are rich in potash and humus and appear black colour. These soils are suitable for growing jute, rice, sugarcane cotton, and wheat etc.

5.2.2.1.5 Bhangar Soils

Bhangar soils are the largest part of Northern plain; consist of older alluvium and makes the flood area. It is covered by laterite deposits. This type of soil is not so fertile due to calcareous deposits locally known as 'Kankar '.

5.2.2.1.6 Khadar Soils

Such type of soil is present in the lowest part of Northern plain and made by alluvium soil, deposited during flood due to the flow of rivers.

5.2.2.1.7 Soils of Active Flood Plain

Soils of active flood plain are present along the rivers. The soils are deep, well drained coarse loamy, fine loamy, sandy loamy, calcareous and non- calcareous.

5.2.2.1.8 Soils of Ravenous Plain

Soils of ravenous plain are confined near river banks in the project area. Major soils of the area are deep, excessive drained, coarse fine loamy and calcareous. They are eroded and prone to drought.

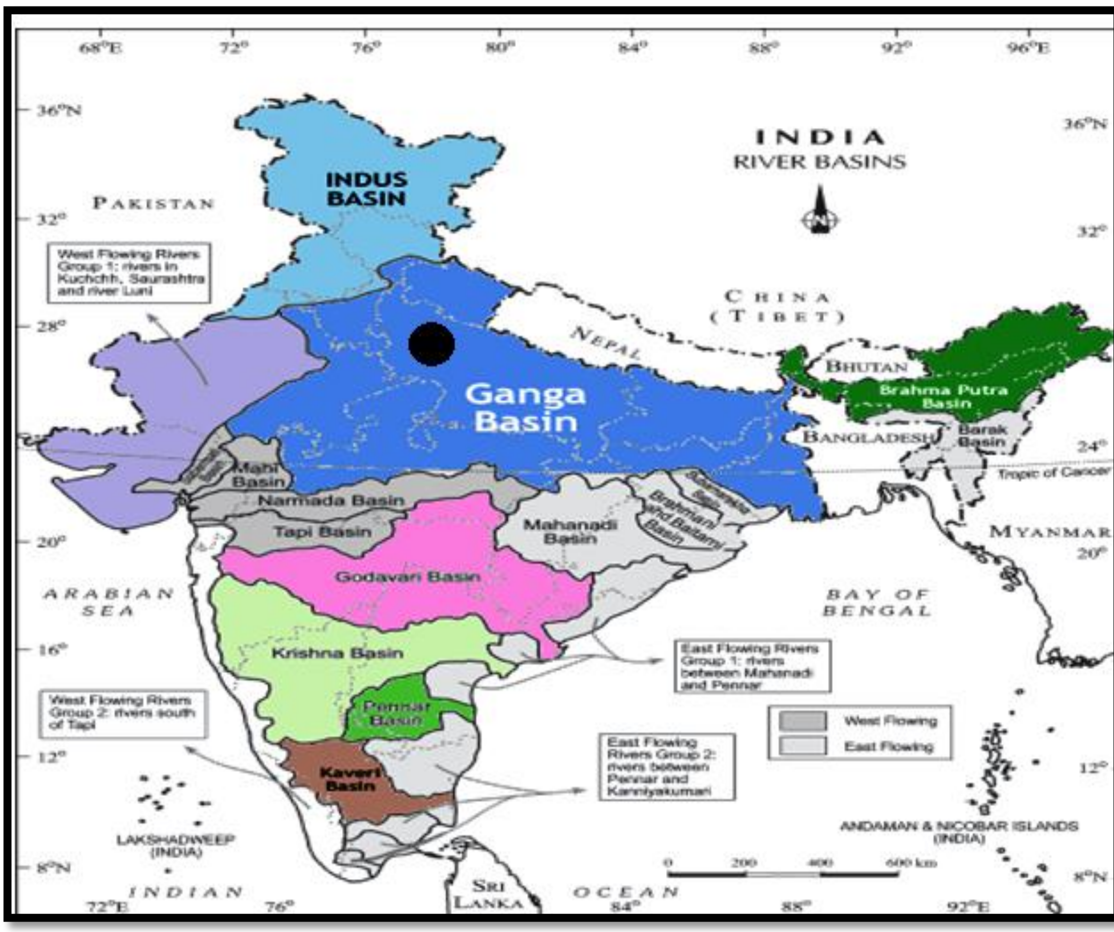


Fig: 5.2.5 U.P and U.K States lies in Ganga Basin Source Google

5.2.2.2 SOIL OF UTTARAKHAND STATE

Uttarakhand state has forest and mountain types of soils are present, which are susceptible to soil erosion due to hilly area. The soil ranges from gravel to clay. In bhabar region soils are coarse-textured, sandy to gravelly, highly porous and infertile. But in terai region, soils are rich in humus and organic matter cultivation of rice and sugarcane **(Fig 5.2.6).**

5.2.2.2.1 Forest and Mountain soils in Uttarakhand

These soils are formed by accumulation of organic matter derived from forest growth. Such types of soils are occurring at both high and low elevations to support biodiversity. Such soils are infertile in nature for the production of field crops shallow, steep and stony, but are very useful for the production of timber and fuel. Forest and Mountain soils vary in different regions according to altitude and found in Himalayan region, where the rainfall amount is sufficient. Mountain soil texture ranges from sandy to loamy and are formed from organic matter deposited from forests in the slopes of hills. These soils are suitable for growing tea coffee, spices, and tropical fruits **(Fig 5.2.6).**

5.2.2.3 SOIL OF UTTAR PRADESH STATE

Major area of Uttar Pradesh state is covered by alluvial soils (flooded soils), which are usually formed by Ganga river system, in which quantity of water is more. This type of soil is extremely fertile in nature. Such soil is both sandy and clay loamy. The soils are found in the south part of the Uttar Pradesh state and are red-black or red-to-yellow in colours (**Fig 5.2.6).**

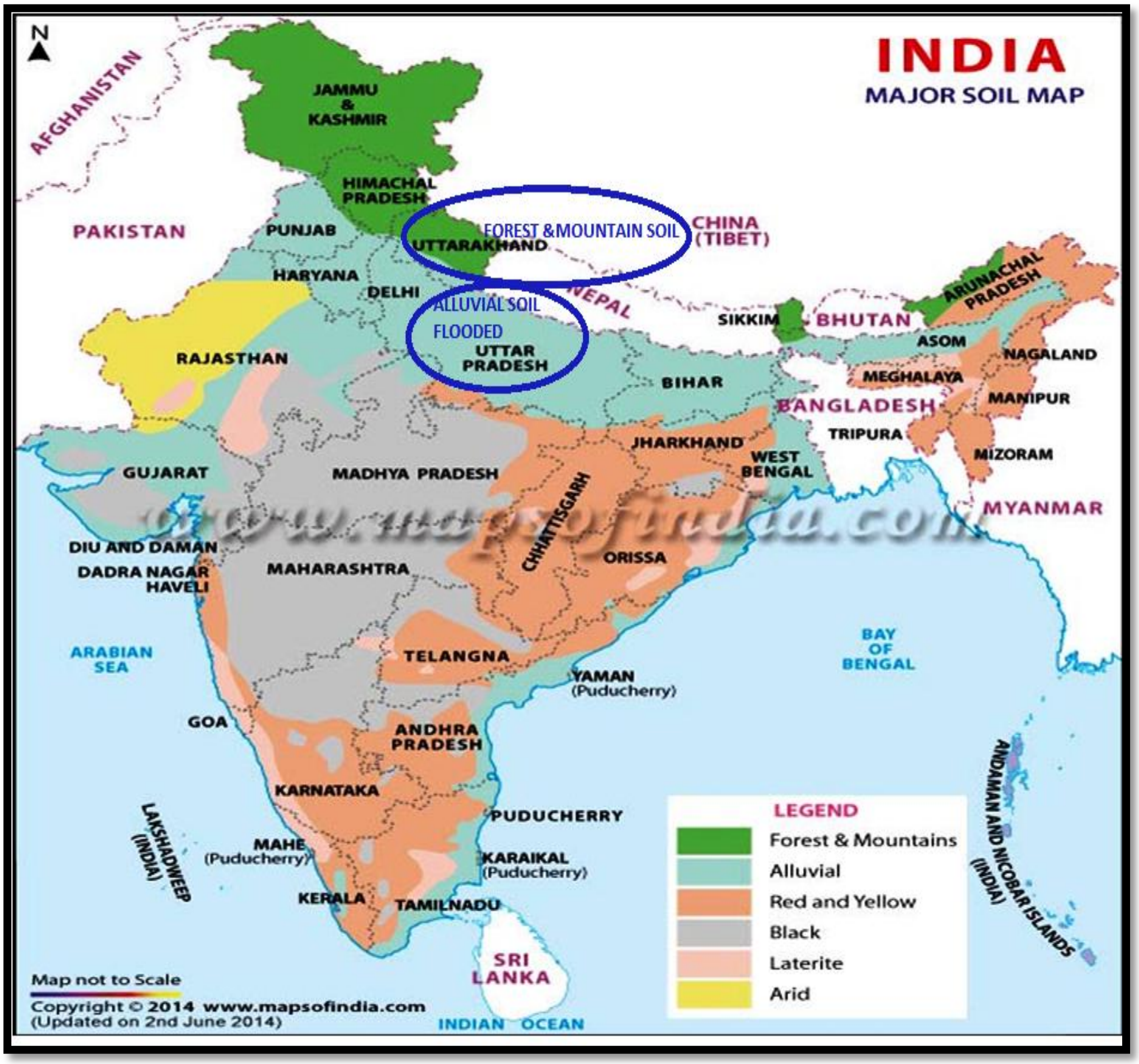


Fig: 5.2.6 Types of Soil in Uttar Pradesh and Uttar Pradesh in India Source: Maps of India

Soil Characterization along Canal Alignment

S. No.	Soil Characteristics	Distribution along the Canal Alignment
1.	Soil Depth	1. Shallow (25 to 50 cm) to moderately shallow (50 to 75 cm) in Bhabar and Tarai region. 2. Deep (more than 100) in alluvial plain along the canal. 3. No rocks are is present.
2.	Drainage	1. Drainage soils present in Bhabar region. 2. Sandy soils along the rivers.

		3. Alluvial plain all along the stretch of canal.
3.	Particle Sizes	1. Fine loamy along the canal with sandy soils in the active plain. 2. Coarse loamy in Bhabar region.
4.	Soil Erosion	1. Moderate in Bhabar region and slight along the canal. 2. Some regions are prone to erosion.
5.	Soil Reaction	Slightly alkaline and neutral in Muzaffarnagar districts.
6.	Calcareous Status	Non- Calcareous along the canal and Calcareous in Bijnor in Muzaffarnagar districts.
7.	Soil salinity	Normal all along the canal

Table: 5.2.2 Source: NWDA

Soil in Enrouted and Command Area

S. No.	**Soil Characteristics**	**Distribution along the Canal Alignment**
1.	Soil Depth	1. Moderately shallow (50 to 75 cm) in Udham Singh Nagar, Bijnor, Moradabad, J.P.Nagar and Rampur command districts. 2. Deep (more than 100 cm) in remaining command districts.
2.	Drainage	1. Drainage is good in all command districts 2. Excessive drainage in Ganga along Badaun Districts. 3. No water logged area.
3.	Particle Sizes	1. Coarse loamy in Moradabad, Rampur and Bareilly regions. 2. Fine loamy in remaining regions.
4.	Soil Erosion	Whole the area is prone to erosion.
5.	Soil Reaction	1. Neutral in Udham Singh Nagar and Moradabad, Slightly alkaline in Bijnor, Badaun, Rampur and J.P .Nagar. 2. Moderately alkaline in Bareilly.
6.	Calcareous Status	Slightly Calcareous in Bijnor, J.P .Nagar, Udham Singh Nagar, Moradabad, Rampur and Badaun.
7.	Soil salinity	Normal all along the canal

Table: 5.2.3 Source: NWDA

Result of Analysis of Soil Samples of Enrouted and Command area

S. No	Parameters and Unit	Range
1.	pH 30 %	7.25-8.6
2.	Conductivity µ mhos/cm	157-380
3.	Texture	Sandy clay to Silty clay
4.	Sand %	3.5 -56.4
5.	Silt %	8.5-62.1
6.	Clay %	2.7-46.4
7.	Total Organic matter %	0.53-1.88
8.	Sodium µg/gm	6.00-72.00
9.	Potassium µg/gm	23.00-164.00
10.	Phosphate µg/gm	1.3 -12.4
11.	Total Nitrogen %	0.32-1.7
12.	Salinity µg/gm	19.1-164.5
13.	Oil content µg/gm	Below detectable limit

Table: 5.2.4 Source: NWDA

On the basis of Soil Survey done by NWDA, alkaline nature of soil is observed in the whole command area and salinity levels are well within the permissible limit. Analysis results show that soils in command area are fertile and suitable for growing the crops. Soil organic content is at optimum level of 1.5 to 2.5 %. Proportion of organic matter in most of the soil samples in command area are observed less than 1.5%, much of it even below than 1%. The only wheat-rice cropping pattern and lack of suitable crop rotation may be attributed for this **(Table 5.2.2; 5.2.3; 5.2.4).**

5.2.3 IMPACT OF PROPOSED SHARDA-YAMUNA LINK ON SOIL OF UTTAR PRADESH AND UTTARAKHAND STATES

5.2.3.1 Positive Impacts:

In U.K, forest and mountain types of soil are present. They occur at high altitude areas where rainfall is moderate; such soils are infertile for production and are less

productive. Due to proposed Sharda-Yamuna Link, soil may change into high productive soil due to increase in water availability which may be positively benefited by the S-Y link canal.

i. Soil of the region is very fertile and very productive in nature. The soil is commonly deposited by rivers during flood. Agriculture is predominant occupation of the area U.P and U.K. The canal will irrigate about 2.94 lakh ha land in the En-routed and Command area which will boost the already established agricultural practice in the area. However, the impact on agriculture land will be positive.
ii. S-Y link will increase the soil fertility of Enrouted and command areas due to good availability of water.
iii. It will help in reducing flood in U.P and U.K states by transferring surplus water of river Sharda towards Yamuna.
iv. Increase crop productivity in agriculture both quality and quantity. About 2.5 lakh ha of area will be irrigated.
v. Increase in employment by increase in agriculture.

5.2.3.2 Negative Impacts:

i. The project activities are likely to accelerate the soil erosion during the construction phase such as excavation work, construction of temporary and permanent road, vehicles etc.
ii. Soil erosion may occur during canal and barrage construction due to borrow areas. The project construction activities are likely to increase soil erosion during construction time.

iii. The land along the canal alignment and barrage sites is required to be cleared; clearing of vegetation will accelerate the erosion process.

iv. Certain reaches of proposed canal alignment such as near Roorkee and Laksar are vulnerable, as the area has undergone erosion due to excavation of soil for brick kiln by local people.

v. The canal alignment crosses Ganges Khadir from R.D. 283 Km in Bijnor district to R.D. 305 Km, this section is vulnerable to erosion, siltation, flooding and water logging.

vi. The link canals will transverse of about 241.3 Km along agricultural land. Approx 3483 ha of agriculture land will be required for the construction of canal.

5.2.4 LAND USE

The study of land use highlights the environmental health, human activity with their interaction of a region. It is influenced by the nature of soil, water availability and climatic conditions. Maximum area of the U.P and U.K. states are covered by vegetation. The main occupation of the region is agriculture and the main crops are sugarcane, paddy , wheat etc. Approximately 3843 ha of agricultural land will be acquired for the project **(Fig 5.2.7).**

5.2.4.1 Existing Land use pattern in the catchment

The entire area of the catchment comes under the Himalayan range. There are also snow and mountainous area. The maximum area is covered with forest in both countries India and Nepal. The major land use pattern of Pancheshwar and Poornagiri catchment area are forest, Irrigated or un-irrigated land, agricultural land etc. are given below (**Table 5.2.5 ; 5.2.6).**

(a) Land use pattern of Pancheshwar Catchment Area

S. No.	Land Use Category	Area (ha)
1	Reserved Forest	1051
2	Protected Forest	980
3	Cultivated Irrigated	1078
4	Un-Irrigated Land	1117

Table: 5.2.5 Source: NWDA

(b) Land use pattern of Poornagiri Catchment Area

S.No.	Land Use Category	Area (ha)
1.	Reserved Forest	1932
2.	Agricultural Land	116
3.	Open Shrub/Barren Land	65

Table: 5.2.6 Source: NWDA

5.2.4.2 Land Use along Canal Alignment

The land use pattern along the canal alignment is necessary to know the impact of S-Y link on land use. The land use along the canal lining is based on topo sheets and findings of field surveys conducted by CES given below in table (**Table: 5.2.7).**

Land Use along Canal Alignment

S. No	**Distance**	**Forest Length**	**Agriculture Length (Km)**	**Others including Rivers and Canals**
1.	0-20 Km	14 Km	5	1
2.	20-40 Km	19 Km	-	1
3.	40-60 Km	17 Km	1.8	1.2
4.	60-80 Km	17.7 Km	1.2	1.1
5.	80-100 Km	19.3 Km	-	0.7
6.	100-120 Km	3.5 Km	15.3	1.2
7.	120-140 Km	6.5 Km	13.5	-
8.	140-160 Km	2 Km	18	
9.	160-180 Km	10 Km	8.5	1.5
10.	180-200 Km	1 Km	18	1

11.	200-220 Km	-	20	-
12.	220-240 Km	-	18.2	1.8
13.	240-260 Km	-	17	3
14.	260-280 Km	2 Km	17.5	0.5
15.	280-300 Km	-	20	-
16.	300-320 Km	-	19.7	0.3
17.	320-340 Km	-	19.5	0.5
18.	340-360 Km	-	19.5	0.5
19.	360-384 Km	-	23.5	0.5
	Total	**112 Km**	**256.2 Km**	**15.8 Km**

Table: 5.2.7 Source: Toposheet and field Survey by CES

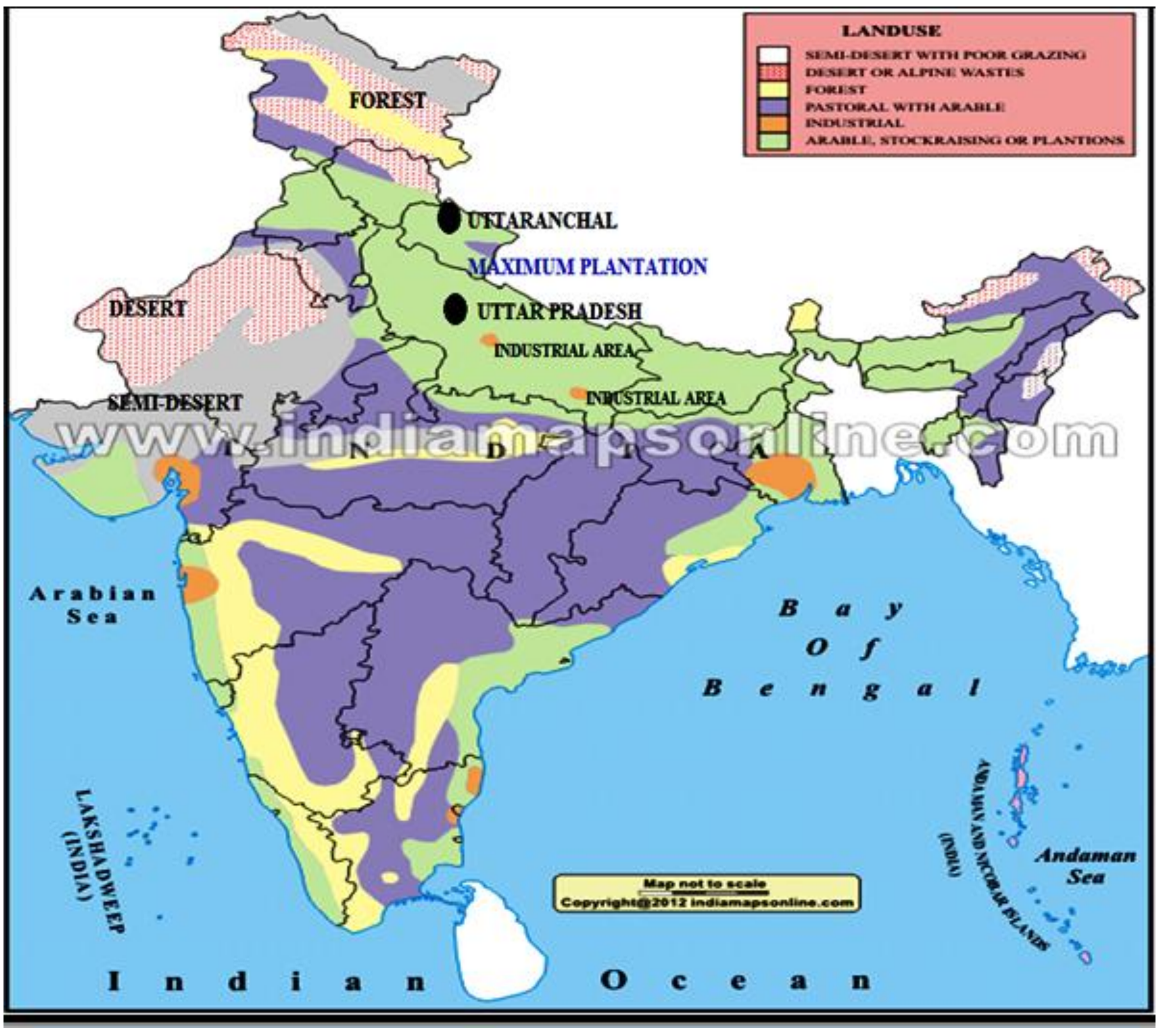


Fig: 5.2.7 Land-Use map of Uttarakhand and Uttar Pradesh states Source: Map of India

5.2.5 IMPACT ON LAND-USE

i. As per study, the total Enrouted Command area likely to benefit from S-Y link canal is approx 2, 95,000 ha.

ii. Some region of barren land would reduce from 1.82 % to about 1%.

iii. The scope for increase in gross sown area is highly anticipated due to canal irrigation and its conjunctive use with ground water.

iv. The benefit by canal irrigation in project with cultivable land in project blocks is covered under some proposed canal irrigation schemes.

v. The construction of the S-Y link canal may increase the developmental activities. Therefore, changes in land use such as development of market place, settlements and agricultural industries may take place.

vi. There are possibilities of development of tourist and recreation centres along the S-Y link canal **(Table 5.2.8).**

vii. Extension of market areas may take place.

viii. The availability of water may increase the agricultural practice in command area.

5.2.5.1 Possibility of change in land use at following locations:

i. Haldwani to Lalkuan, R.D (Regional Distance) 64 Km to 66.8 Km

ii. Fatehhullapur Village, R.D 136 Km to 164 Km

iii. Near Muazzampur Railway Station, R.D 231.2 Km

iv. Laksar- Haridwar Road Crossing – Village Mohammadpur Kunhari, R.D 245 Km Shepur Village, R.D 330.7 Km.

Land use pattern of Command Blocks due to canal water irrigation

S. No	Particulars	Post Project
1.	Total Geographical Area	No change.
2.	Forest	No change expected.
3.	Barren Land	It is expected that, some part of the barren land could be shifted for use to non-agricultural purposes and it would reduce from 1.8.% to about 1%
4.	Area put to non agricultural use	Due to irrigation by canal, area for non-agriculture use would be restricted to about 10.5%
5.	Permanent pasture &other Grazing land	No appreciable change expected
6.	Cultural Waste	No appreciable change expected
7.	Other fallows	It is expected that some part of current and other fallows land would be put to non-agricultural purposes such as agro processing industries, farm produce processing etc.
8.	Current fallow	
9.	Net area sown	No scope for horizontal development in net area sown as per its high current proportion.
10.	Area sown more than once	This portion of land use will undergo major changes with conjunctive use of canal water and groundwater and it is expected to reach from 44.87 % up to 82.97% (net sown area)
11.	Gross area sown	At least, 30% increase in gross area sown is expected due to assure irrigation benefits by canal.

Table: 5.2.8 Source: NWDA

5.2.6 AGRICULTURE

The proposed S-Y link traverses through the agricultural fields for about 256.2 Km. The alignment traverses through agricultural area mostly in Udham Singh Nagar, Haridwar, Bijnor and Muzaffarnagar Districts of U.P and U.K states in India **(Fig 5.2.12).**

The present section describes the agriculture pattern of the canal region. The study is based on some existing features of agriculture are given below:

5.2.6.1 AGRICULTURE IN UTTARAKHAND STATE

Uttarakhand is an agricultural state. Maximum population of the state is depends on agricultural occupation. The cultivated area is approx 7, 84,117 hectares. About 12 % area is irrigated and 64 % are covered by the natural springs. The sandy soils are present in region which does not carry water for the long duration. Due to lack of water in the soil the crop productivity is very low. Due to irregular rainfall, the crop productivity ranges.

5.2.6.1.1 Main Agricultural and Horticulture Crops in Uttarakhand State

Main crops of Uttarakhand State include rice, wheat, barley, corn, maize and potato etc (**Fig 5.2.8).** The soil of the region is very fertile which supports crop productivity. The irrigation area is mostly the plains and valleys. The food grain production varies in different districts such as Haridwar, Udham Singh Nagar, Nainital and Dehradun, which is very high. In hilly areas the crop productivity is very low and the valleys are fertile.

5.2.6.1.2 Cropping Pattern in Enrouted and Command areas in Uttarakhand State

Maximum cultivation in U.K State include wheat; rice and sugarcane and some other crops like kharif, rabi, zaid, chilli, ragi, potato and some fruits like apple and mango are also cultivated **(Fig 5.2.8).** In Champawat, Nainital and Udham Singh Nagar districts, cultivation of sugarcane and in Haridwar, cultivation of mango take place (**Table 5.2.9).**

Cropping Pattern in Enrouted and Command Districts

S. No	Enrouted and Command Districts	Major Cultivation
1.	Champawat	Sugarcane
2.	Nainital	Sugarcane
3.	Udham Singh Nagar	Sugarcane
4.	Haridwar	Sugarcane, Fruits like Mango, Apple and others

Table: 5.2.9

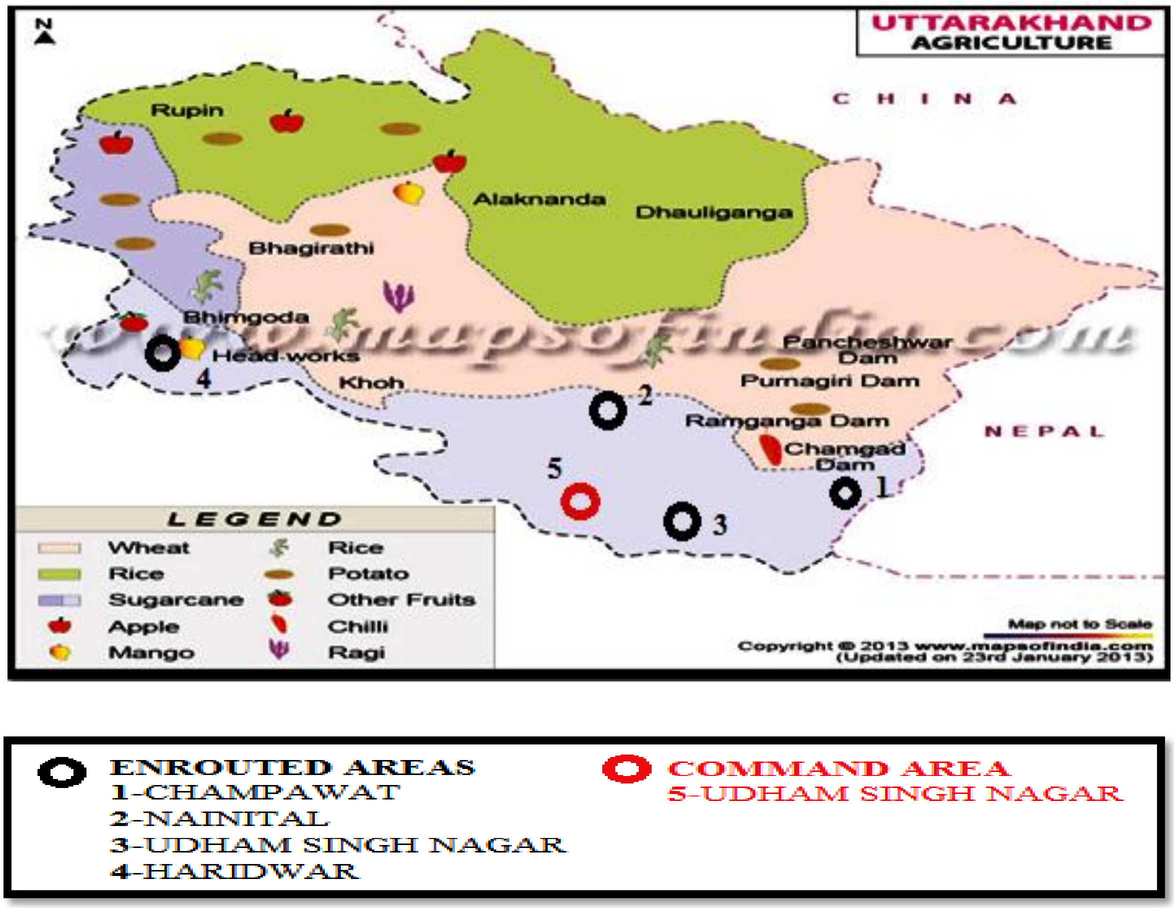


Fig: 5.2.8 Agriculture in Uttarakhand State   Source: Maps of India

5.2.6.2 AGRICULTURE IN UTTAR PRADESH STATE

Uttar Pradesh is an agricultural state; the fertility of the state is due to Indo-Gangetic plain. Agriculture generally occurs more in the western region in the state (**Fig 5.2.9; 5.2.10; 5.2.11).**

5.2.6.2.1 Main Agricultural and Horticulture Crops in Uttar Pradesh

Main cultivation of Uttar Pradesh is rice, bajra, wheat, mustard, pulses, sugarcane, mango, oil seeds and potatoes etc. Some varieties of horticulture crops are given below (**Table 5.2.10).**

Horticulture Crops

1. Fruits	Mango, Aonla, Banana, Ber, Guava, Litchi etc
2. Vegetables	Potato, Cabbage, Brinjal, Peas, Cucumber, Parwal, Tomato, Okra, Cauliflower, Onion and Lobia etc.
3. Spices	Garlic, Ginger, Chillies, Coriander and Turmeric
4. Floriculture	Rose, Gladiolus, Tuberose, Jasmine and Marigold etc.
5. Medicinal / Aromatic plants	Mentha, Sarpgandha, Ashwagandha, Aloevera, Tulsi and Damask rose etc.
6. Others	Mushroom, Betel vine and Honey etc

Table: 5.2.10

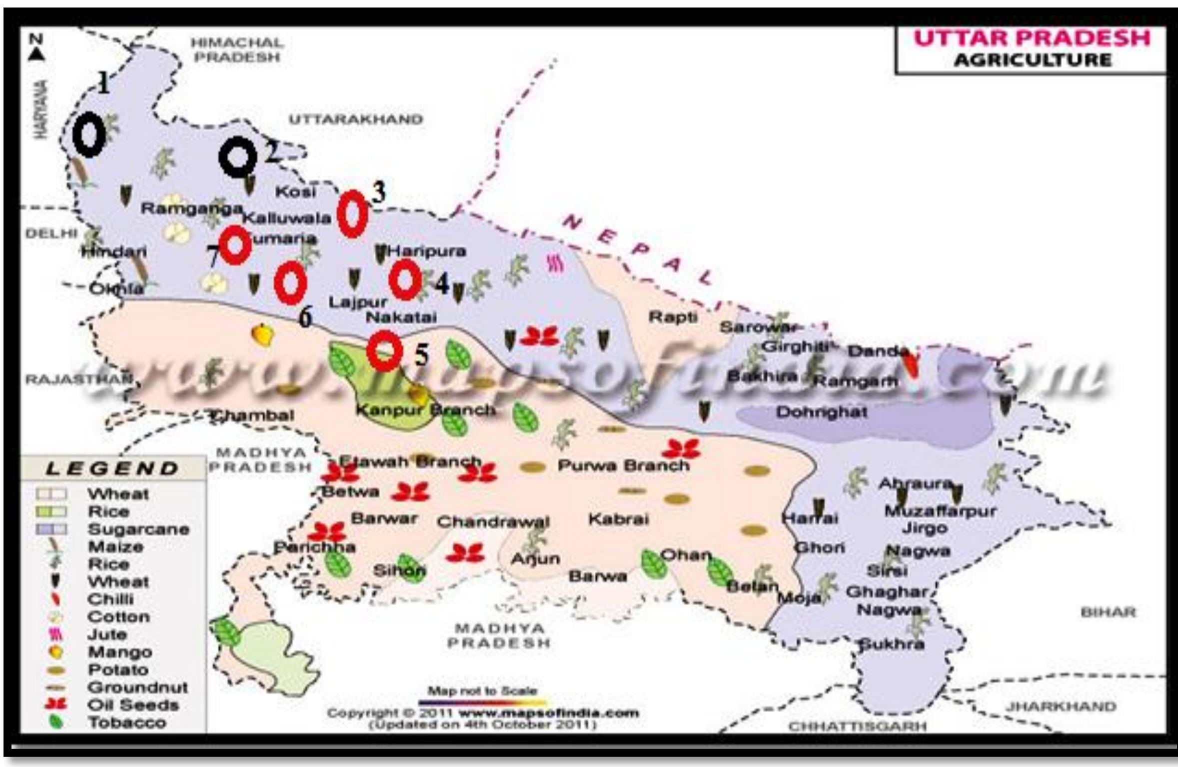
5.2.6.2.2 Cropping Pattern in Enrouted and Command areas in Uttar Pradesh State

Sugarcane and wheat are the maximum cultivation in U.P state in some areas, rice is also cultivated. Some other crops are also grown include kharif, rabi, zaid, chilli, jute, mango, potato, groundnut and oil seeds **(Fig 5.2.9; 5.2.10; 5.2.11),** (**Table 5.2.11).**

Cropping Pattern in Enrouted and Command areas in Uttar Pradesh State

S. No	Enrouted and Command Districts	Major Cultivation
1.	Muzaffarnagar	Rice, Sugarcane and Maize
2.	Bijnor	Wheat and Sugarcane
3.	Rampur	Sugarcane
4.	Bareilly	Rice, Wheat and Sugarcane
5.	Badaun	Wheat, Tobacco and Sugarcane
6.	Moradabad	Rice, Wheat and Sugarcane
7.	J. P. Nagar	Cotton, Rice, Wheat and Sugarcane

Table: 5.2.11



ENROUTED AREAS
1-MUZAFFARNAGAR
2-BIJNOR

COMMAND AREAS
3-RAMPUR
4-BAREILLY
5-BADAUN
6-MORADABAD
7-J.P.NAGAR

Fig: 5.2.9 Agriculture in Uttar Pradesh — Source: Maps of India

Fig: 5.2.10 Pictures showing Agriculture in U.P (Sugarcane crop)

Fig: 5.2.11 Pictures showing Agriculture in U.P (Sugarcane crop)

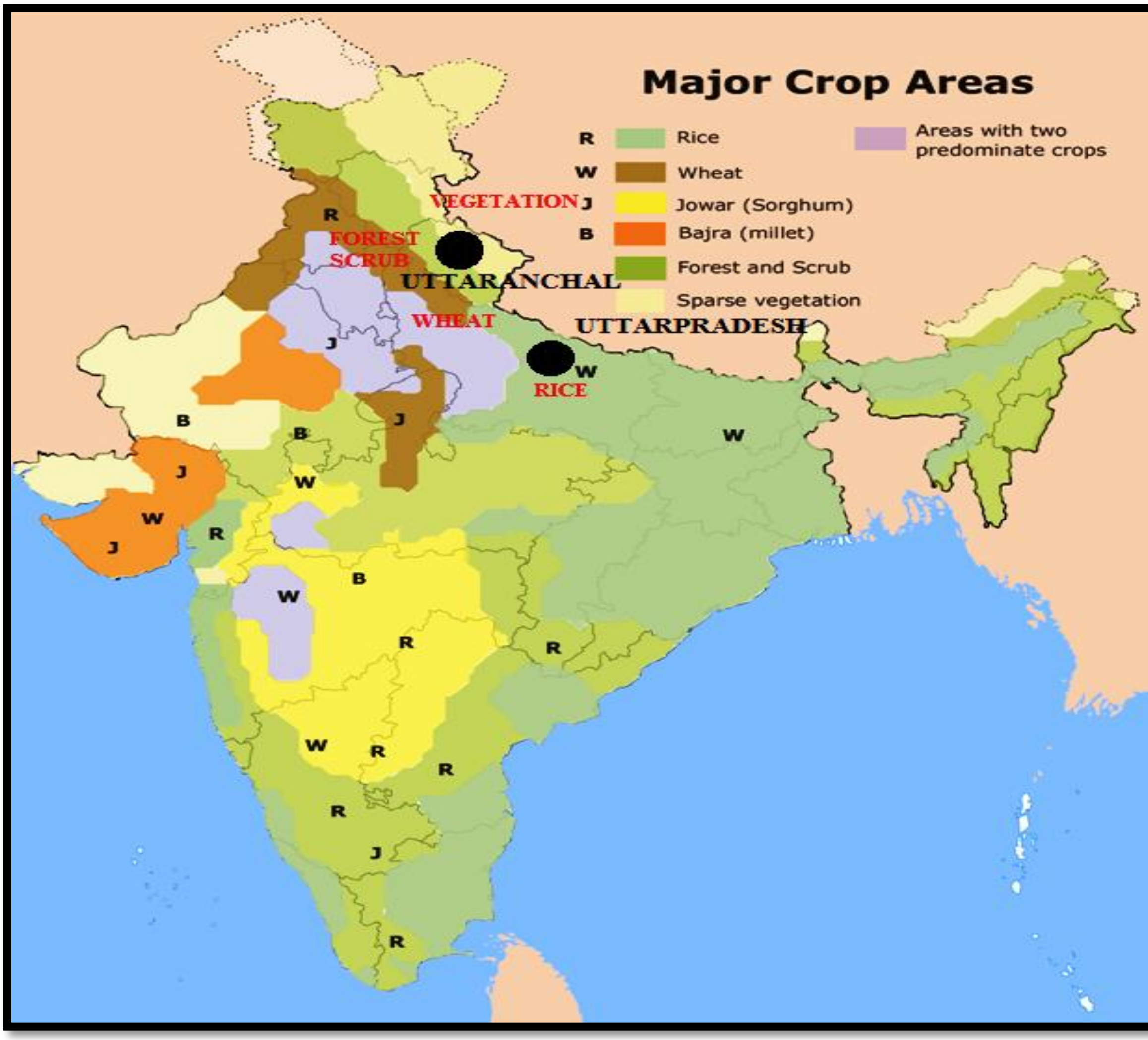


Fig: 5.2.12 Major crops in U.P and U.K Source: Google

5.2.6.3 IRRIGATION PROFILE

For the cultivation and agricultural activities irrigation process is necessary which means Supply of water from wells, canals, rivers, tanks and other artificial projects. In India maximum cultivation land depends on rainfall. S-Y link lining is passes through the canal irrigated land all along the stretch.

5.2.6.3.1 Irrigation status in Uttar Pradesh and Uttarakhand State

The irrigation status of Uttar Pradesh state is mainly based on canal systems and wells. So, many rivers and their tributaries are the main source of water for irrigation in the state. The irrigation is mainly based on tube wells and ground water systems. Uttar Pradesh has more agricultural production (approx 46.7 Million Tonnes/Year) and in the state Uttarakhand (1.7 Million Tonnes/Year) (**Table 5.2.12) (Fig 5.2.13; 14)**

Irrigation Status in Uttar Pradesh and Uttarakhand

Irrigation Status in States	**Production Million Tonnes /Year**	**Total Production %**	**Productivity Tonnes Hectare/ Year**	**Cultivated area under irrigation %**
Uttarakhand	1.7	0.7	1.7	42.9
Uttarakhand	46.7	19.9	2.3	75.9

Table: 5.2.12

5.2.6.3.1.1 IRRIGATION STATUS IN UTTAR PRADESH STATE

i. In Uttar Pradesh state, the major source of surface water are Ganga, Gandak, Sone, Yamuna, Ghagra, Gomti and Sharda rivers, which flows from south east to southwest direction.
ii. Main small branches in plains provide water for the irrigation.
iii. During monsoons, such rivers cause flood in Eastern part of U.P. and huge loss to life.

5.2.6.3.1.2 IRRIGATION STATUS IN UTTARAKHAND STATE

In Uttarakhand state, the major source of irrigation is canals and tube wells. Two major rivers Yamuna and the Ganga originates from the glaciers of Uttarakhand and others include Bhagirathi, Alaknanda, Mandakini provide water for canal irrigation. Heavy rainfall occurs in Uttarakhand causes flood and landslides, resulting considerable loss in agriculture. The status of irrigation in Enrouted and Command areas of S-Y Link canal in Uttarakhand is given in **(Table 5.2.13).**

Irrigation Status in Uttarakhand State

S. No.	**Items**	**Statistics**
A.	**Net and Gross Irrigated Area**	
1.	Canals (Ha)	95922
2.	Tube Wells (Ha)	198193
3.	Other Wells (Ha)	15587
4.	Tanks (Ha)	770
5.	Other Sources (Ha)	29657
6.	Net Irrigated Area (Ha)	340129
7.	Gross Irrigated Area (Ha)	569769
B.	**Irrigation Infrastructure**	
1.	Length of Canals (Km)	11081
2.	Length of Lift Canals (Km)	201
3.	No. of Tube Wells (State)	981
4.	No. of Pump Sets (Boring/ Free Boring)	54361
5.	No. of Hauj	29507
6.	Revenue Collection by Irrigation (Lakh)	243.61

Table: 5.2.13 Source: Irrigation Department Uttarakhand

5.2.6.4 Irrigation Status in Enrouted Areas of S-Y Link in Uttarakhand

5.2.6.4.1 Irrigation Status in Champawat District

In Champawat district, the irrigation is done by springs and rivers in the southern part of the district. The source of groundwater is tube wells and hand pumps. The length of the canals present in the district is 229.7 Km. The net irrigated area is approx 2171 and the gross irrigated area is 3541 ha respectively **(Table 5.2.14).**

Irrigation by Different Sources in Champawat District

1. Tube wells or bore wells	Deep-06, Shallow-628
2. Tube wells or bore wells (Govt.)	12/728
3. Tanks of Ponds in (ha)	488
4. Canals or Irrigated area	229.7/759 Km
5. Other sources	196
6. Net Irrigated area in (ha)	2171
7. Gross Irrigated area in (ha)	3541

Table: 5.2.14 Source: cgwb.gov.in

5.2.6.4.2 Irrigation Status in Nainital District

Nainital is a hilly region. Water sources are not easily accessible in this region. Drinking and irrigation water problem is very common in the area. Agriculture is mostly rain fed; hence new sources need to be identified and existing sources. The total area covered by Tube wells/bore wells is 44.78 Sq. Km and length of the canals are 241.30 Sq. Km (**Table 5.2.15).**

Irrigation by Different sources in Nainital District

1. Tube wells/bore wells	44.78 Sq. Km
2. Dug wells	Nil
3. Tanks/Ponds (ha)	Nil
4. Canals (Length km) / irrigated area (ha)	Canals 241.30 Sq. Km
5. Other sources	5.49 Sq. Km
6. Net Irrigated area (ha)	293.37 Sq. Km
7. Gross Irrigated area (ha)	584.84 Sq. Km

Table: 5.2.15 Source: cgwb.gov.in

5.2.6.4.3 Irrigation Status in Udham Singh Nagar District

The major rivers in Udham Singh Nagar District are Kosi, Sharda to meet the irrigation demand in the area of tarai belt in the districts. The length of the canals present in the district is 924.3 Km; and about 24703 shallow tube wells and 400 deep tube wells are present in the district **(Table 5.2.16).**

Irrigation by Different sources in Udham Singh Nagar District

1. Dug wells (ha)	12099
2. Tube wells or bore wells	10899 / 85602
3. Tanks or Ponds (ha)	20
4. Tanks or Ponds (ha)	30224/924.3
5. Other sources (ha)	6582
6. Net Irrigated area (ha)	145426
7. Gross Irrigated area (ha)	232912

Table: 5.2.16 Source: cgwb.gov.in

5.2.6.4.4 Irrigation Status in Haridwar District

The source of Ground water in Hardwar district is tube wells. The length of canals is about 300 Km. Gross irrigated area is 1010 Ha and Net irrigated area is 1450 Ha (**Table 5.2.17).**

Irrigation by Different Sources in Haridwar District

1. Dug wells (ha)	Nil
2. Tube wells/bore wells	33,155 (84%)
3. Tanks/Ponds (ha)	Nil
4. Canals (ha) /length (Km)	300 Km (15%)
5. Other Sources (ha)	Natural Precipitation
6. Net Irrigated Area (ha)	1010
7. Gross Irrigated Area	1450

Table: 5.2.17 Source: cgwb.gov.in

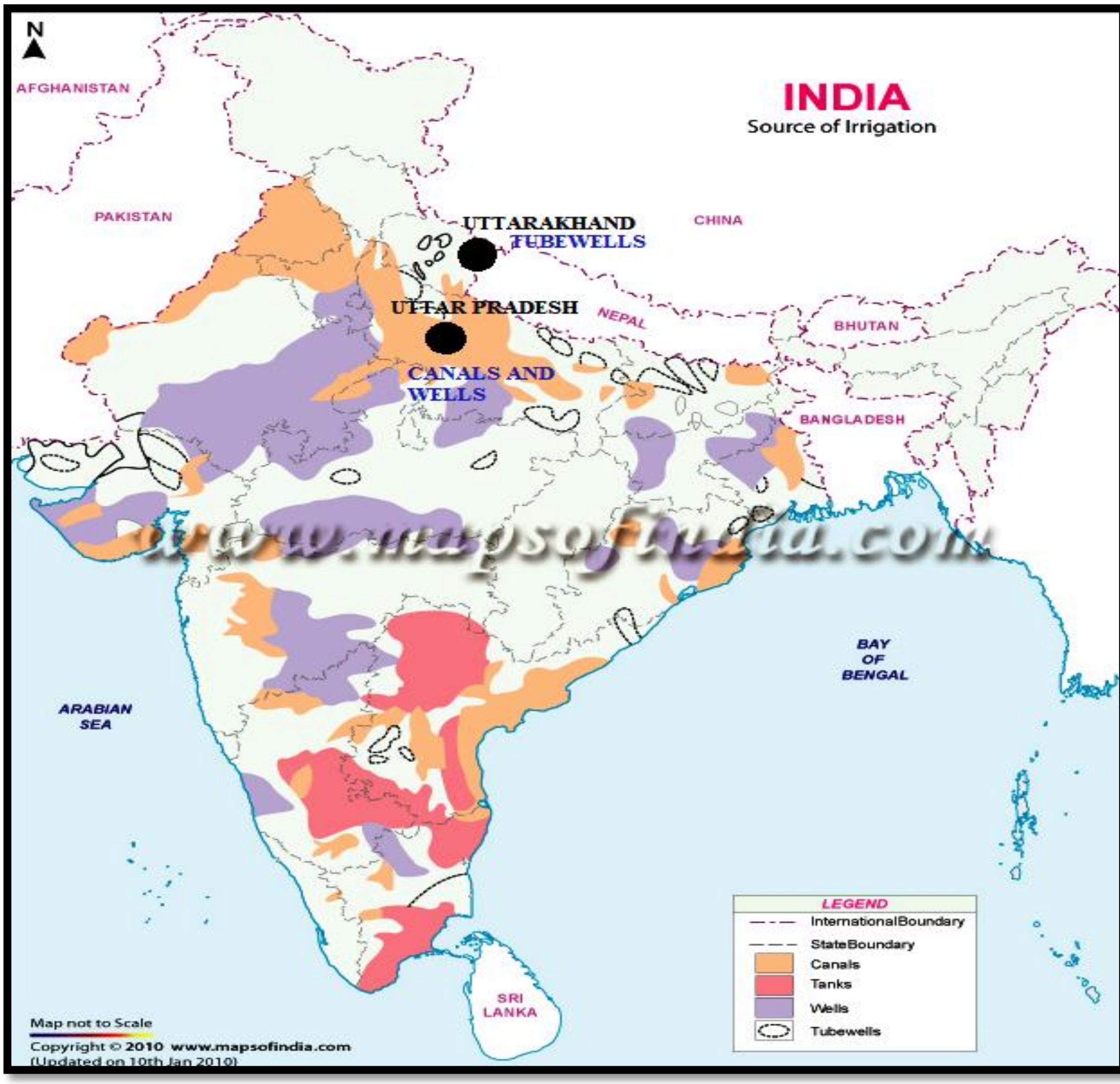


Fig: 5.2.13 Map showing Source of Irrigation in Uttar Pradesh and Uttarakhand States in India Source: Map of India

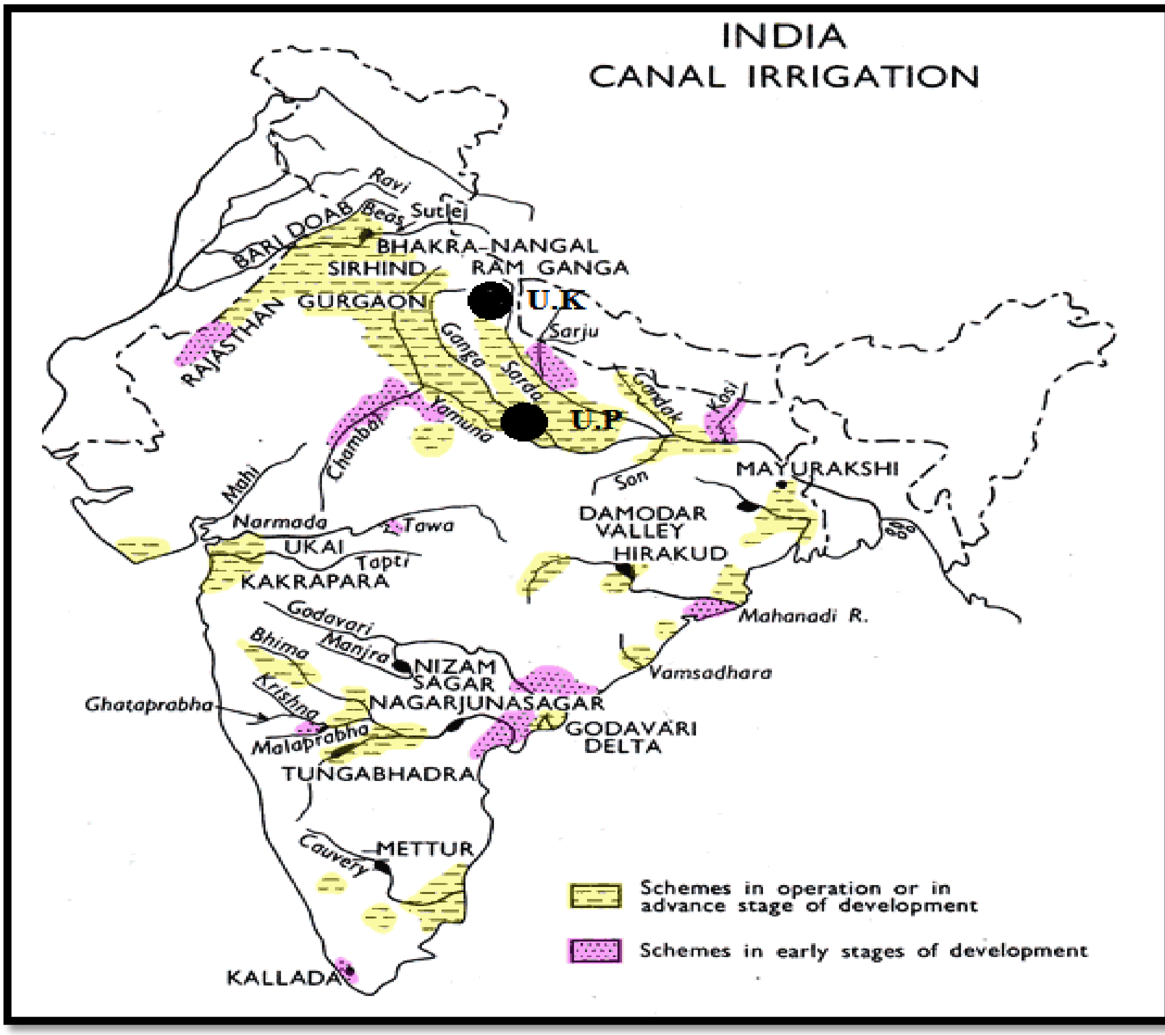


Fig: 5.2.14 Map showing Canal Irrigation in Uttar Pradesh and Uttarakhand States in India Source: Google

5.2.7 IMPACT OF PROPOSED SHARDA-YAMUNA LINK ON AGRICULTURAL STATUS OF UTTAR PRADESH AND UTTARANCHAL STATES

This section provides information of about expected impacts of proposed S-Y link on agricultural sector of its Enrouted and Command areas.

The following indicators determine the major impacts of the proposed link project are:

- **Cropping Intensity**
- **Cropping Pattern**
- **Crop Productivity**
- **Food Grain Production**
- **Fertilizer Use**
- **Agricultural Labour**
- **Annual Agriculture Benefits**
- **Use of High Yielding Varieties (HYV) Improved seed**
- **Impact on Agricultural area**

5.2.7.1 Impact on Cropping Intensity

It is expected that, cropping intensity will rise with rise in gross cropped area due to increase in availability of water by the S-Y link during non-monsoon seasons, which minimizes the risk of crop failure. It is anticipated that the cropping intensity in the post project phase will go up to a minimum of 175 % with the assured minimum two crops from land under net area sown **(Table 5.2.18**).

Cropping Intensity in percentage

S. No	Particulars	% Rise
1.	Net area sown	Unchanged
2.	Gross Cropped area	29.95%
3.	Cropping Intensity	29.95%

Table: 5.2.18 (Source): The project feasibility report pre project estimates

5.2.7.2 Impact on Cropping Pattern

In the post project scenario, it is expected a qualitative change may arise in the cropping pattern. The cropping pattern of seasonal crops to perennial crops may raise high value crops due to increase level in ground water irrigation by S-Y canal water irrigation. Paddy, wheat and sugarcane are the predominant crops of the region and will continue to be predominant after irrigation by the S-Y link canal. Proposed S-Y link will also help in increasing the ground water level. Decreasing the ground water level and its increasing pumping cost, the command region will be forced to shift from high water demanding crops such as paddy and wheat to low water suiting cropping pattern such as coarse cereals pulses and oilseeds by canal water irrigation. S-Y link canal water will provide 100 % coverage of net sown area under irrigation with ground water supplement (**Table 5.2.19).** Area under vegetables, fruits and sugarcane may rise in the post project stage. Taking these factors into consideration, the cropping pattern at post project stage is presented in the following table.

Cropping Pattern

S. No.	Crop	Post-Project Cropping Pattern
		% age of area under the crop
1.	Paddy	18.0
2.	Wheat	30.0

3.	Coarse Grain	3.0
4.	Oil Seed	6.0
5.	Pulses	6.0
6.	Vegetables	6.0
7.	Sugarcane	25.0
8.	Fodder	3
Total		100.00

Table: 5.2.19 Source: NWDA

5.2.7.3 Impact on Crop Productivity

As mentioned earlier, irrigation increases the crop productivity to a very high level along with improved seeds, fertilizers, plant protection measures, improved tools and equipments etc. There will be more area coverage under high yielding varieties of crops, more balanced fertilizer application, higher labour utilization and other improved cultural practices at the post-project stage (**Table 5.2.20)**.The anticipated post project productivity of different crops is presented in table below.

Crop Productivity

S. No	**Crop**	**Average Yield (Post Project) Quintal/Ha**
1.	Paddy	60
2.	Wheat	45
3.	Coarse Grain	40
4.	Pulses	20
5.	Oil Seed	30
6.	Sugarcane	611
7	Vegetables	250
8.	Fodder	250

Table: 5.2.20 Source: NWDA

5.2.7.4 Impact on Food Grain Production

As a consequence of increase in cropped area are as well as productivity of cereals mainly paddy and wheat, there will be increase in total production of food grains also after the construction of S-Y link project. Increase in canal water, surface water and ground water level may rise with increase in productivity of food grain.

5.2.7.5 Impact on Fertilizer Use

There would qualitative and quantitative change in fertilizer use also. As the irrigation increases the consumption of fertilizers is expected to increase. More use of major fertilizers like nitrogen, phosphate and potash (**Table 5.2.21).**

Fertilizer Use

S. No.	Fertilizer	Increase in fertilizer use at post-project stage	
		Quantitative Increase	Percentage
1.	Nitrogen	81.5	48.36
2.	Phosphate	22.67	53.55
3.	Potash	21.67	118.22
	Total	**125.84**	**220.13**

Table: 5.2.21 Source: NWDA

5.2.7.6 Impact on Agricultural Labour

With the completion of the S-Y link project, the agricultural labour will direct or indirect benefited. Project influence the household labour availability, labour market, wage rates and technology adoption level, Additional direct employment generation, the post harvest operations, processing, marketing and other related factors of agriculture in general, the employment potential of post project period will be much more (**Table 5.2.22).**

Agricultural Labour

S. No.	Crop	Increase in Labour days	
		at Post-Project stage	**% increase from Pre-Project stage**
1.	Sugar Cane	45	27.27
2.	Paddy	26	30.95
3.	Wheat	18	31.57
4.	Maize	12	17.64
5.	Jowar/Bajra	11	22.44
6.	Potato	25	10.20
7.	Groundnut	23	37.09
8.	Mustard	10	20.0
9.	Barley	10	18.18
10.	Arhar	15	21.42
11.	Gram	20	25.0
12.	Lentil	10	15.38
13	Vegetables	50	31.25

Table: 5.2.22 Source: NWDA

5.2.7.7 Annual Agriculture Benefit

After the study of such agricultural factors, it is expected that there will be benefit in annual agriculture status of U.P and U.K states. It is also assumed that the post project scenario from annual agriculture will direct benefit. Irrigation with canal would be increased after the construction of the link canal, the En-routed and Command areas will would be benefited (**Table 5.2.23).**

Results of annual agriculture benefits by S-Y Link

S. No.	Parameters	Post Project Canal irrigation (Rs.)
1.	Gross Receipt of the farm produces	4334497.5
2.	Expenses	1556341.25
2.	Net Annual Irrigation Benefits	2694124.73

Table: 5.2.23 Source: NWDA Field Survey

5.2.7.8 Use of High Yielding Varieties improved seed.

With the availability of canal irrigation, the use of hybrid seeds such as paddy (Kharif), Paddy (Zaid), Maize, Wheat, Barley, Gram, Groundnut, Potato and Sugarcane are expected to rise (**Table 5.2.24).** There will be marginal rise in the low value crops like coarse cereals (barley). As a consequence, these changes in the cropping pattern would bring about rise in labour, production of high value crops, marketable, increase in farm income and a marked qualitative change in the people’s diet also.

High Yielding Varieties Status

S. No	Crops	Post Project Stage (%)
1.	Paddy (Kharif)	90
2.	Paddy (Zaid)	100
3.	Maize	75
4.	Wheat	100
5.	Barley	35
6.	Gram	62
7.	Groundnut	70
8.	Potato	90
9.	Sugarcane	100

Table: 5.2.24 Source: The project Baseline Survey for pre project estimates

5.2.7.9 Impact on Agricultural area

Due to proposed S-Y link, the agriculture area may rise with increase in crop productivity both quality and quantity of crops due to increase in water quality.

- Net Cultivated area of U.P is 167.50 Lakh hectares
- Net Cultivated area of U.K is 7, 84,117 hectares.
- The total cultivated area of U.P and U.K is 78,42,8450 × 10^9 Hectares.

- ✓ ***S-Y Link will increase 2.94 lakh ha of Agricultural area in Enrouted and the total cultivated area of U.P and U.K will be increases from 78428450 × 10^9 Hectares to 78428452.94 × 10^9 Hectares.***

In Muzaffarnagar District canal traverses through water scarce area such as Dhansini, Alipurkala, Butrace, Karaund and Goharpur. Tube wells are used to irrigate the land which consumes electricity for at least 6 hrs. The S-Y link canal will provide water to these areas and enhance agriculture in the districts as well save electricity. In Udham Singh Nagar and Bijnor there are irrigation problems at Jagdishwala Village, Dharampur, Alipur Ganga, Sadipur, Sahajadpur etc. due to unavailability of water in the existing canals. The construction of S-Y link canal in the area is likely to meet the irrigational requirement of the area.

Negative Impact

Deforestation, about 256 Sq. Km (25600 Ha) of agricultural fields will due during construction of canal and Barrage construction. Acquisition of agricultural land likely to have significant impact on the livelihood of the people.

5.2.8 SURFACE HYDROLOGY

Surface water hydrology is the study of flow of all surface waters. It is the measurement of flow of water of canals, streams, rivers, ponds, wetlands, lakes, marshes and oceans etc. Measurement includes statistical variability, flood and drought status, the levels of risk etc.

***Proposed Sharda-Yamuna Link alignment including Enrouted and Command areas falls mainly in Sharda, Ramganga and Yamuna sub-basins of Ganga Basins* (Fig 5.2.15).**

5.2.8.1 Features of Ganga Basin

The Ganga basin covered in the countries such as India, Tibet (China), Nepal and Bangladesh countries. In India it covers the states of West Bengal, Jharkhand, Uttar Pradesh, Haryana, Madhya Pradesh, Uttarakhand, Rajasthan, Chhattisgarh, Bihar, Himachal Pradesh and Union Territory of Delhi in India. The Ganga basin covers of about 26 % of the total geographical area of India. It divides into many tributaries such as Ramganga, Kosi, Mahananda, Yamuna, Ghaghra, Gandak, Sone, Chambal and Betwa.

5.2.8.2 Features of Sharda Basin

The Sharda River is also known as Mahakali River. It flows near Nepal's western border with India. The river is also proposed as source for one of the many water projects in the Himalayan component of the "Inter Basin Water Transfer Projects". Below the Nepal-Uttarakhand border the Sharda River enters the Uttar Pradesh state. The Basin area of 18,140 Sq. Km and length is 350 Km.

5.2.8.3 Features of Yamuna Basin

The Yamuna also called as Jamuna, which is the largest part of Ganga. It originates from the Yamunotri glacier in the uppermost region of the lower Himalayas in Uttarakhand state. It has a drainage system of 3, 66,223 Sq. Km. It crosses several states such as Haryana, Uttarakhand and Uttar Pradesh. Length is 1,376 Km.

5.2.8.4 Features of Ramganga Basin

In Uttarakhand, the Ramganga River originates from the district Pauri Garhwal. It flows from Kumaun towards the south west region in Himalaya. It is also a tributary of river Ganga. Bareilly, Badaun, Moradabad and Hardoi cities are located on its banks. It has a drainage area of about 30,641 Sq. Km.

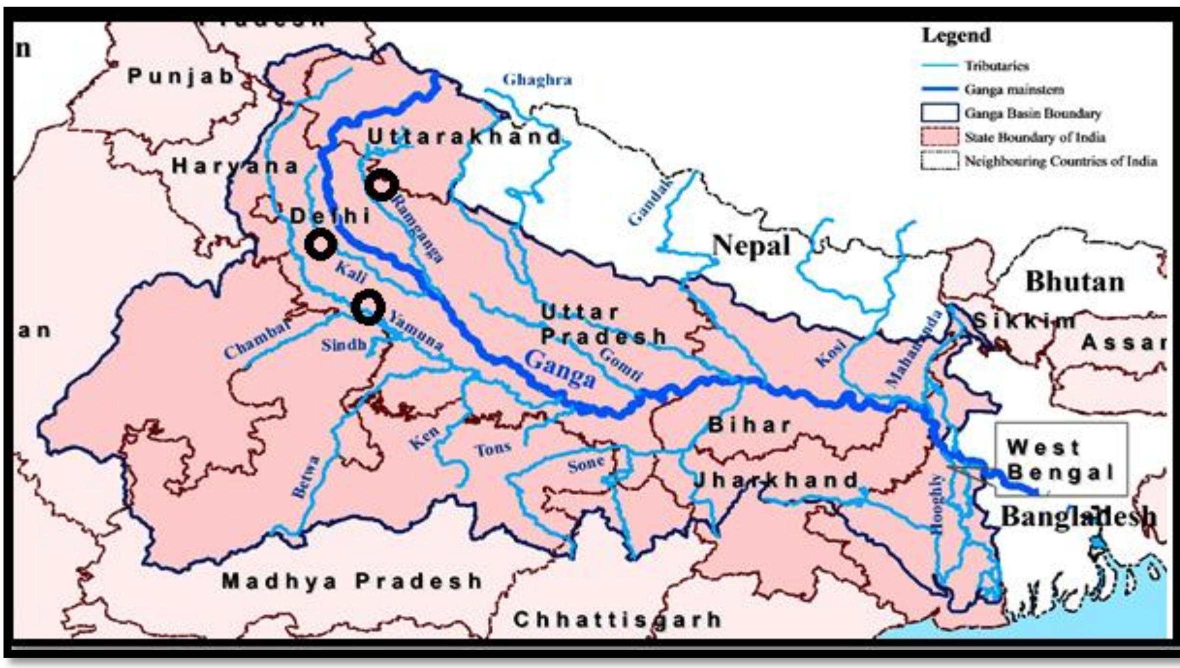


Fig: 5.2.15 Map showing River Basins in Uttar Pradesh and Uttarakhand States Source: Google

5.2.8.5 Surface Hydrology along the S-Y Canal Alignment

The purpose of the S-Y link is to transfer the surplus water from river Sharda to river Yamuna. According to NWDA, the S-Y link canal is traversing the following tracks between two main rivers crossing and a no. of small networks of canals is given :

i. Track between Sharda and Kosi River drained by rivers mainly Bhakra and Baur.
ii. Track between Kosi and Ramganga River drained by rivers mainly Dhela, Phika and Dhara.
iii. Track between Ramganga and Ganga River drained by Khoh Ganga and Malin.
iv. Track between Ganges canal and Yamuna River drained by rivers Kali near Muzaffarnagar town, Hindon and Krishni.
v. In addition, proposed S-Y canal is passing through canal irrigated area crossing network of existing main canals, distributaries, minors and field channels.

5.2.8.6 Surface Hydrology along the Enrouted and Command Area of S-Y link

All the Enrouted and Command areas of the S-Y link canal fall in Sharda and Ramganga Ganga basins, which covers with Ganga River and its tributary Ramganga which control the drainage system of Enrouted and Command areas of the S-Y link canal. Bijnor and Udham Singh Nagar are the Enrouted districts drained by Ganga and Ramganga Basin. Command area Udham Singh Nagar drained by Sharda and Kosi Rivers, further south to canal alignment. J. P. Nagar, Moradabad, Rampur and Bareilly are the adjoining command districts. In south direction of the S-Y link, Badaun command district is located in Ganga basin. All the command districts fall in Ganga and Ramganga basins except Rampur, which is located in Kosi- Sharda Basin. Ramganga, which is a tributary of River Ganga drain the command districts Moradabad with J.P. Nagar **(Fig 5.2.16).**

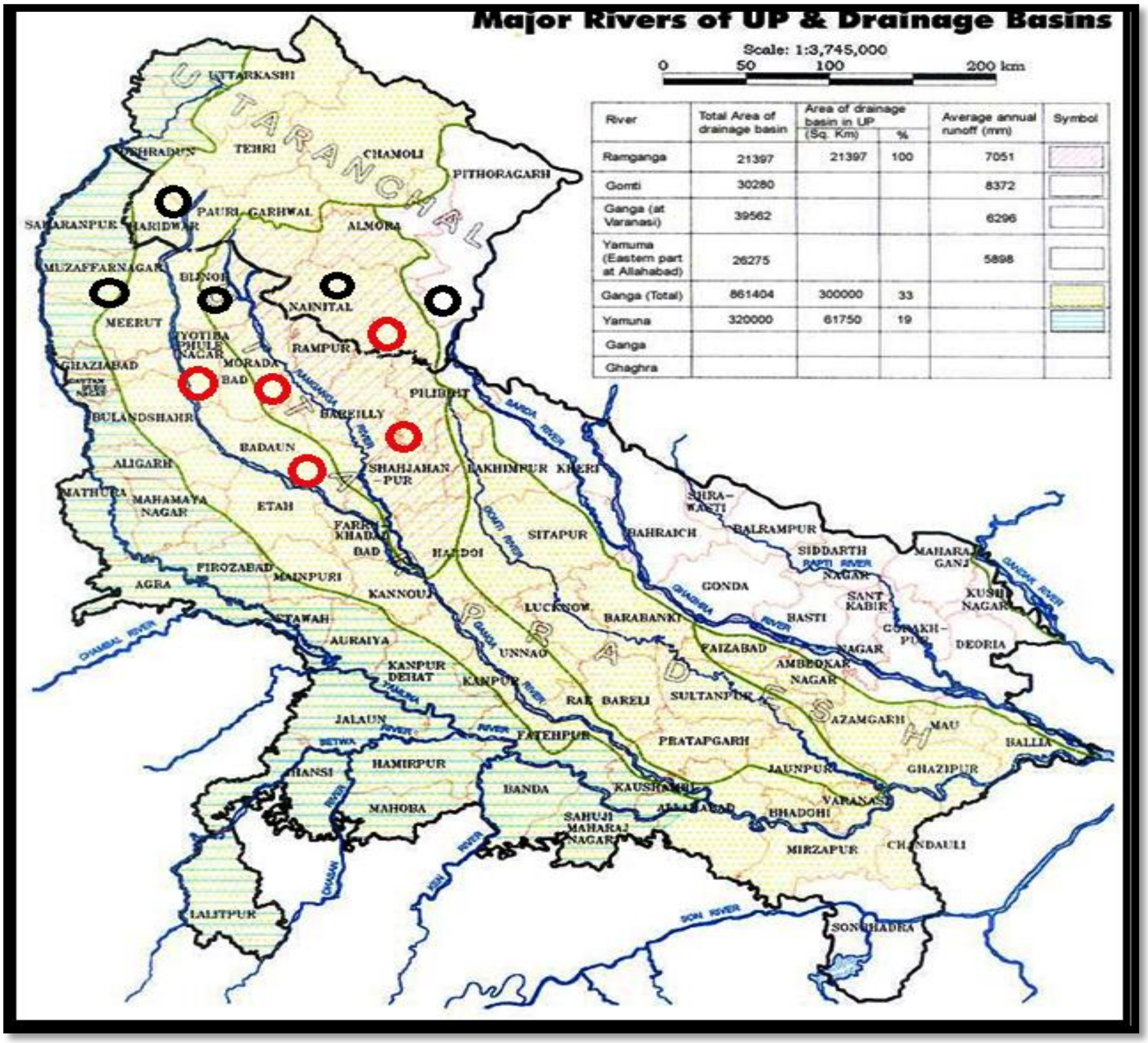


Fig: 5.2.16 Map showing Basins in Enrouted and Command area and drainage systems

Source: Google

5.2.9 GROUND WATER HYDROLOGY

Ground water is the water flows under the surface of earth and located in soil pore spaces. Groundwater is recharged and flows in form of springs and seeps, Groundwater is useful for many purposes such as agricultural, municipal and industrial use etc. It plays an important role in fulfil the water needs of various user-sectors in India.

5.2.9.1 GROUND WATER STATUS IN UTTARAKHAND

Uttarakhand is a hilly state; it has a varied hydro geological setup such as the Gangetic alluvial plain and Himalayan mountain belt. It is covered with alluvium and sedimentary material of varying in size. In the hilly regions the ground water mostly occurs in springs.

5.2.9.2 GROUND WATER STATUS IN UTTAR PRADESH

The state Uttar Pradesh is divided into five zones namely Central Ganga plains, Bhabar, Tarai, Marginal alluvial plains and Southern Peninsular zone. The central and eastern part of the Uttar Pradesh state shows difference in ranges of water levels. In Hamirpur, Jalaun, Banda, Allahabad and Jhansi districts and along the Yamuna and Betwa rivers, the deepest water levels are present. The decrease in water levels trends over the last years due to over exploitation of the ground water resource.

5.2.9.3 IMPACT OF S-Y LINK CANAL ON WATER ENVIRONMENT

The diversion of water from Sharda River will have positive impact on the hydrological balance and development of the country.

5.2.9.3.1 Positive Impact on Water Environment

i. The S-Y link canal will help in making proper water balance in river basins such as Ramganga and Sharda basins, which are the tributaries of Ganga basin in U.P and U.K states.

ii. During the monsoon season, S-Y link may help in maintaining proper distribution of water to manage flood situations.

iii. Increase water availability by transferring surplus water towards drought areas and water storage capacity.

iv. Irrigation by S-Y canal will recharge the ground water.

v. About 3,054 MCM of water is in provision for drinking & industrial use.

vi. About 2,733 MCM of water is in provision to transfer water through Yamuna-Rajasthan Link.

vii. About 5,842 MCM of water is in provision to transfer water through Rajasthan-Sabarmati Link.

viii. S-Y link will fulfil all the water based requirements in Enrouted and Command districts.

ix. At some locations such as Chandpur, Bikampuri in Udham Singh Nagar district there is a drinking water problem due to presence of iron content in water; drinking water may be provided to these villages by the S-Y link.

x. S-Y link canal may become source of drinking water for wildlife in forest area, which may increase biodiversity of the region.

5.2.9.3.2 Negative Impact on Water Environment

i. Water quality of the Enrouted and Command areas may get deteriorated and unfit for drinking as the canal traverses through settlements and agricultural area during the construction time of S-Y link.

ii. Water is likely to get polluted where the S-Y link passes through the settlement or close to the settlement such as shown in (**Table 5.2.25).**

iii. There are drains in the area and during flood/ rainy season mixing of polluted water into canal is likely to take place.

iv. Agricultural runoff may pollute the water as there is extensive farming in the area.

v. The fate of the water-bodies in our country is very unfortunate and is glaring examples of pollution due to negligence and irresponsible attitude of Govt. & people towards this scarce and precious resource. The possibility to converting the canal into a drain cannot be ruled out.

Table of settlements

S. No.	Settlements	Distance
1.	Intwa	109 –110 Km
2.	Gulzarpur	114 -115 Km
3.	Jagdishewal	137.20 Km
4.	Jhadharpur	300.05 Km
5.	Ghunsorpur	49.02 Km
6.	Jitinwala	227.5 Km
7.	Bukanpur	281.25 Km
8.	Bamankheri	328.49 Km
9.	Sherpur	227.5 Km

Table: 5.2.25 Source: NWDA

5.2.9.3.3 Impact of Proposed S-Y Link Canal on Ground Water of U.P and U.K

5.2.9.3.3.1 Positive Impacts on Ground Water

1. The maximum benefit of the S-Y project is the prevention of groundwater with increase in water availability.
2. Ground water recharging. Availability of ground water will rise, .any blocks under command area districts such as Badaun, Bareilly, Jyotiba Phule Nagar and

Moradabad have ground water problem due to its overexploitation for agriculture purpose.

- **In Uttarakhand State**

The net annual ground water availability is 2,100 Mm^3. S-Y link will recharge of about 713.83 Mm^3 of ground water. The Ground water of U.K state will increase to 49,493.87 Mm^3.

- **In Uttar Pradesh**

The net annual ground water availability is 70,180 Mm^3. S-Y link will recharge of about 713.83 Mm^3 of ground water. The Ground water of U. P state will increase to 70,893 Mm^3.

5.2.9.3.3.2 Negative Impact on Ground Water

Along S-Y canal alignment in Tarai area water level is shallow therefore, water logging and possibility of seepage is likely to take place.

5.2.10 METEOROLOGY (CLIMATE AND RAINFALL STATUS)

5.2.10.1 CLIMATE

Climate is the average weather over a long duration of time in any region and a measure of the average pattern of changes in humidity, atmospheric pressure, temperature, humidity, wind, precipitation and other meteorological variables in a given area over a long time. A climate system in any region is generated by the components such as atmosphere, hydrosphere, lithosphere and biosphere.

Factors affecting the Climate of any region.

i. Latitude
ii. Himalaya Mountains
iii. Altitude
iv. Distance from the sea
v. Geographical Limits
vi. Climate types
vii. Desert
viii. Glaciers
ix. Humid tropical regions
x. Indian Ocean

5.2.10.2 CLIMATE OF UTTAR PRADESH AND UTTARAKHAND STATE

5.2.10.2.1 CLIMATE OF UTTAR PRADESH STATE

The state Uttar Pradesh has a climate of extremes. The temperatures of the state ranges from 0 °C to 50 °C in various parts and causes droughts, floods due to irregular rains. ***Uttar Pradesh has Humid Subtropical climate (Warmer summers) and some areas are semi arid regions*** **(Fig 5.2.17; 5.2.18).** The summer season is very hot, winters are cold and rainy season can be very wet or very dry. Average high temperature varies from 38 °C in May and June to lower about 20 °C in January month. Maximum rainfall occurs from June to September month. Annual rainfall ranges from 1,000–2,000 mm in the east to 600–1,000 mm in the west. Variations in rainfall exist in different parts due to the presence of Indo-Gangetic Plain.

5.2.10.2.1.1 Classification of Climate in Uttar Pradesh State

According to Indian Meteorology Department, the climate of U.P is divided into three seasons.

1. **Winter Season** – From November to February, very cold (Temperatures ranges 3- 4 °C).
2. **Summer season** - Hot & dry (Temperatures ranges 47- 48 °C) with humidity (20%), dust and winds.
3. **South-west Monsoon -** Average annual rainfall is 990 mm and (temperatures ranges 40- 45°C).

5.2.10.2.2 CLIMATE OF UTTARAKHAND STATE

Uttarakhand state is a region which is known for its outstanding natural beauty. It is covered by beautiful Himalayan peaks and glaciers, which is a part of the Great Himalayan. Uttarakhand state gives rise to two important holy rivers Ganga and Yamuna in India. The climate varies from tropical to severe cold on the basis of altitude. ***Uttarakhand has Mountainous and Humid Subtropical climate is present*** **(Fig 5.2.17; 5.2.18).** The climate of Uttarakhand is marked by seasonal variations in temperature and affected by tropical monsoons.

5.2.10.2.2.1 Classification of the Climate in Uttarakhand State

1. **Winter Season**

In Uttarakhand state, the winters in the state are very cold; the temperatures go below 5°C, in some parts of the higher areas the temperature can drop below the freezing point. Many places receive regular snowfall and the season lasts from month November to

February. Floods and landslides are the general problems during the rainy season in the stretches of the valleys.

2. Summers

In summers, most part of the Uttarakhand state is very pleasant, but in some places climate is very hot. The maximum temperature can cross the 40° C with considerable humidity. The season extends from the month April to June.

3. Monsoon

The monsoon temperature ranges from month July to September, which is 15 to 25° C. About 90% of annual rainfall occurs in this season. Heavier rainfalls occur in the eastern parts of Himalayas to westerns drier parts.

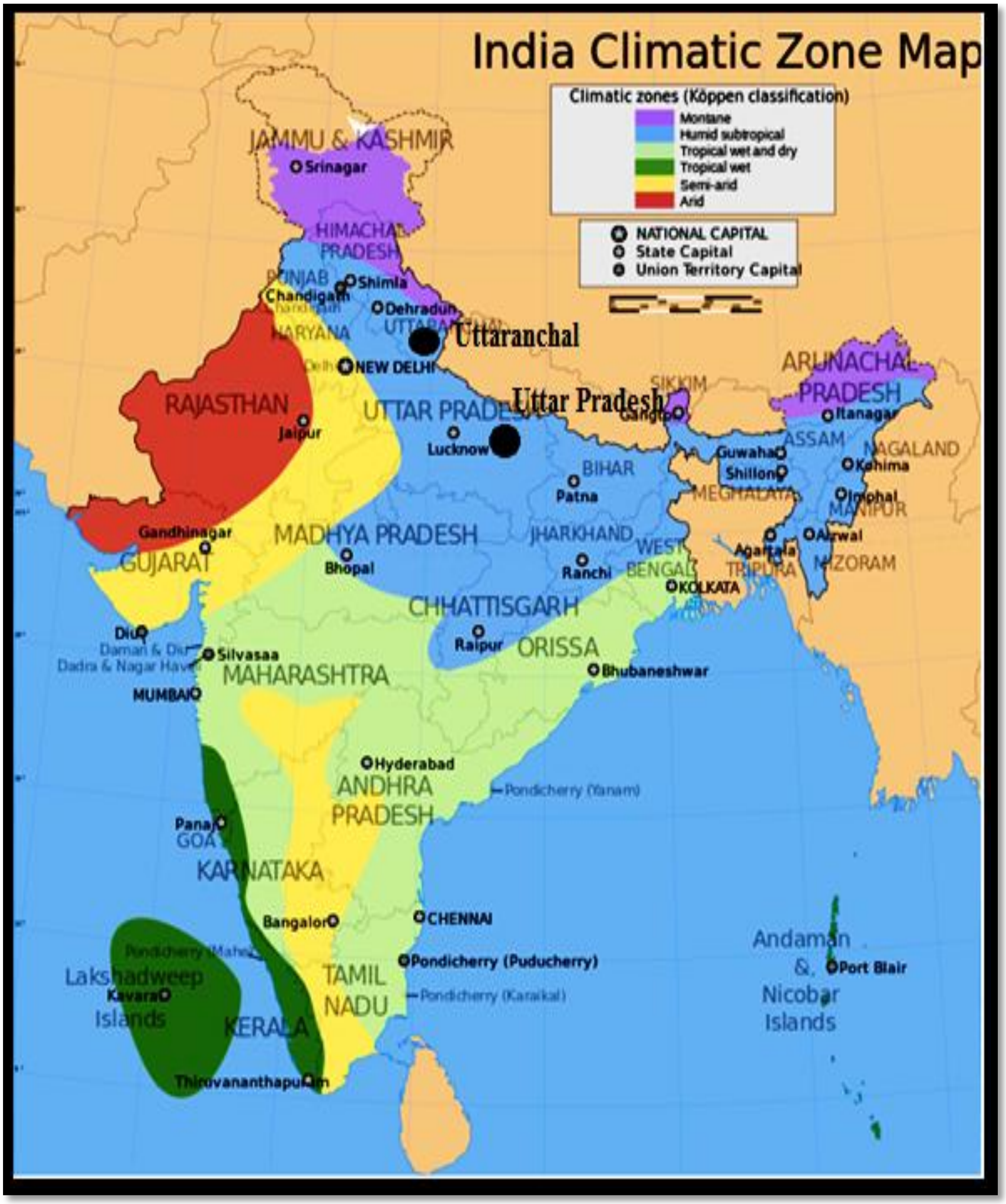


Fig: 5.2.17 Map Showing Humid Subtropical Climate present in U.P and U.K Source: Google

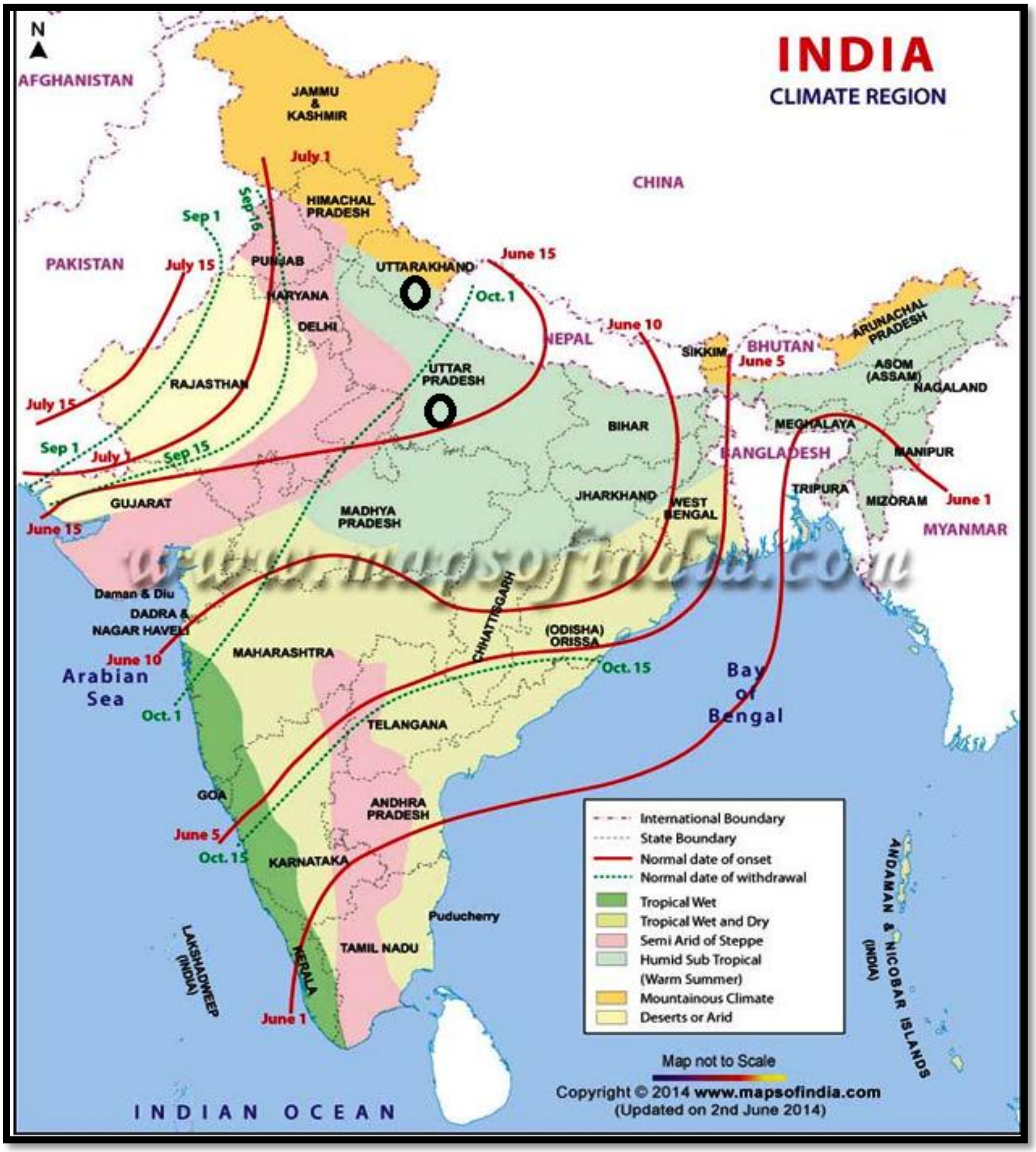


Fig: 5.2.18 Map Showing Climatic Region in India Source: Map of India

5.2.10.3 RAINFALL STATUS

When liquid water change into atmospheric water vapour and then precipitated in the form of droplets under gravity that is known as rain. It provides water for ecosystems, hydroelectric power plants and crop irrigation etc. In mountainous areas, heavy precipitation is possible due to slope flow, which forces to rainfall along the sides of mountains. The average annual precipitation is 11,871 mm highest recorded rainfall in Asia, in the village of Mawsynram, which is the hilly north-eastern state of Meghalaya in India on Earth. It is the world's wettest place.

5.2.10.3.1 Variation in the rainfall

In the year 2013, rainfall in India was rise with 6.3 % excess. Western, central and north eastern regions were faced with high rainfall in India and regions like Bihar and Jharkhand were faced with drought. Several districts of Uttarakhand including Uttarkashi, Chamoli and Rudraprayag were faced with heavy rainfall (**Fig 5.2.19; 5.2.20; 5.2.26).**

5.2.10.3.2 Variations in the rainfall classified on the basis of precipitation

i. **Low Rainfall Zone-** Precipitation rate is less than 2.5 mm per hour. Distribution of rainfall in the areas of low zones implies rainfall around 50 to100 cm a year. Some low rainfall zones are Western Rajasthan Northern J & K, Kutch areas, where rainfall is below 50 cm. Tamil Nadu is also a region of low rainfall in India.

ii. **Medium Rainfall Zone-** Precipitation rate is ranges between 2.5 mm - 7.6 mm per hour. Distribution of rainfall in the areas of medium zones implies rainfall in between 100 to 200 cm a year. Some medium rainfall zones are Eastern Ghats, Upper Ganga Valley, Gujarat, Punjab and Rajasthan areas in India.

iii. **High Rainfall Zone** - When the precipitation rate is above 7.6 mm per hour. Distribution of rainfall in the areas of heavy zone implies rainfall above 200 cm a year. Four rainy months in the northern part are June to September of high rainfall. July is the rainiest month. Zones of the very high rainfall are the states of north eastern and Darjeeling district of West Bengal areas in India. Arunachal Pradesh and Tripura are also the regions of very high rainfall (**Fig 5.2.21; 5.2.22).** ***"According to Indian Meteorological Department, the irregular distribution of rainfall in last year's, causes great variations in climatic conditions which causes disasters drought, flood etc (Fig 5.2.19).***

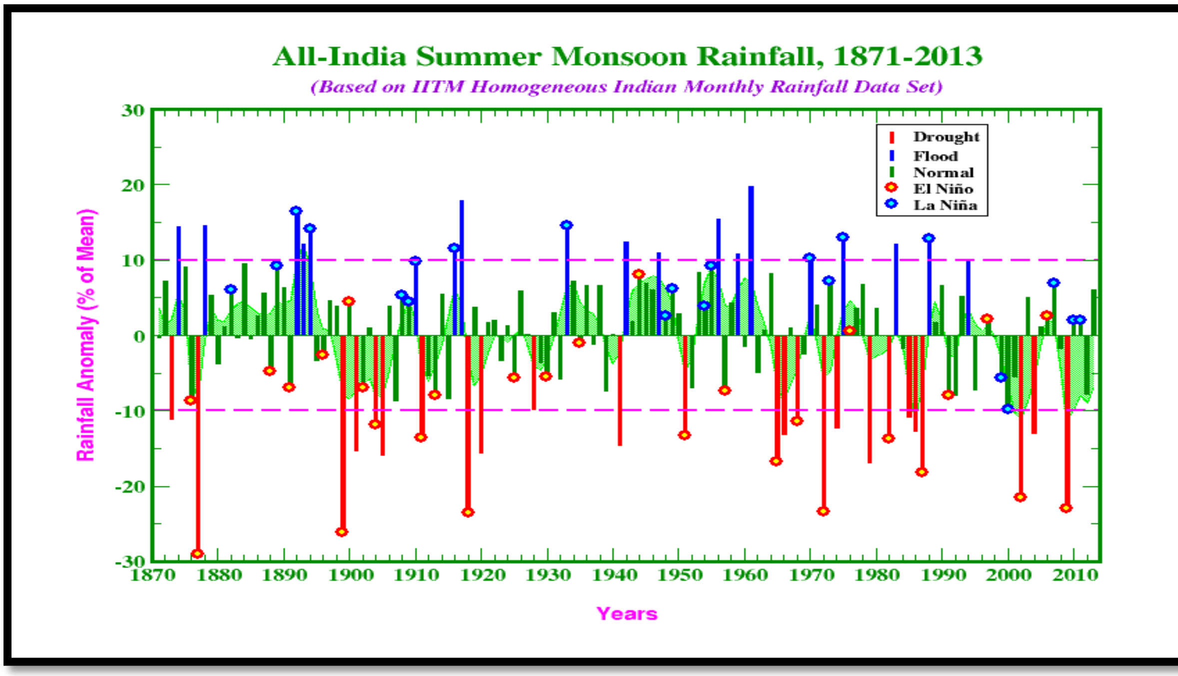


Fig: 5.2.19 All-India Summer Monsoon (June-September) Rainfall (AISMR) Anomalies during (1871-2013) Source: India Meteorological Department

5.2.10.3.3 Monthly and Seasonal rainfall

Seasons in India is based on the changing monsoon. According to the Indian Meteorological Department, the following seasons are divided:

i. **Winter Season (January and February month)**

Occurring when the average temperatures gradually falls, when temperatures average around 10–15 °C (**Fig 5.2.24).** .

ii. **Summer or pre-monsoon season (March, April and May month)**

Occurring from month April to June month. Temperatures average around 32–40 °C (**Fig 5.2.25).**

iii. **Monsoon or rainy season (June, July, August and September month)**

Rainy season starts from the month July to September. It begins from North India at the beginning of October. South part of India receives more rainfall (**Fig 5.2.23).**

iv. **Autumn Season and Post monsoon Season**

Autumn Season and Post monsoon Season starts from October to November month. In north-western part of India, October and November months are cloudless. In the northeast Monsoon season, Tamil Nadu state receives most of the annual precipitation. Due to different climates and weather patterns in India, natural disasters arise such as floods, droughts, cyclones etc.

5.2.10.4 RAINFALL IN U.P AND U.K

Uneven monsoon, variations in rainfall distribution results flood and drought in northern region in India. Flood disaster causes heavy loss to crops productivity, property. The eastern part of the state and low monsoons results in drought conditions. Reasons for excessive colds in north India states are like being far away from the sea experience continental climate, snowfall in the Himalayan ranges and create cold wave over north western part of India.

If we see the map of variation in annual rainfall status in India (Fig 5.2.20; 5.2.21; 5.2.22) the average annual rainfall in U.P and U.K is more than other states which is in UP (100-120 cm) and UK (120-400 cm).

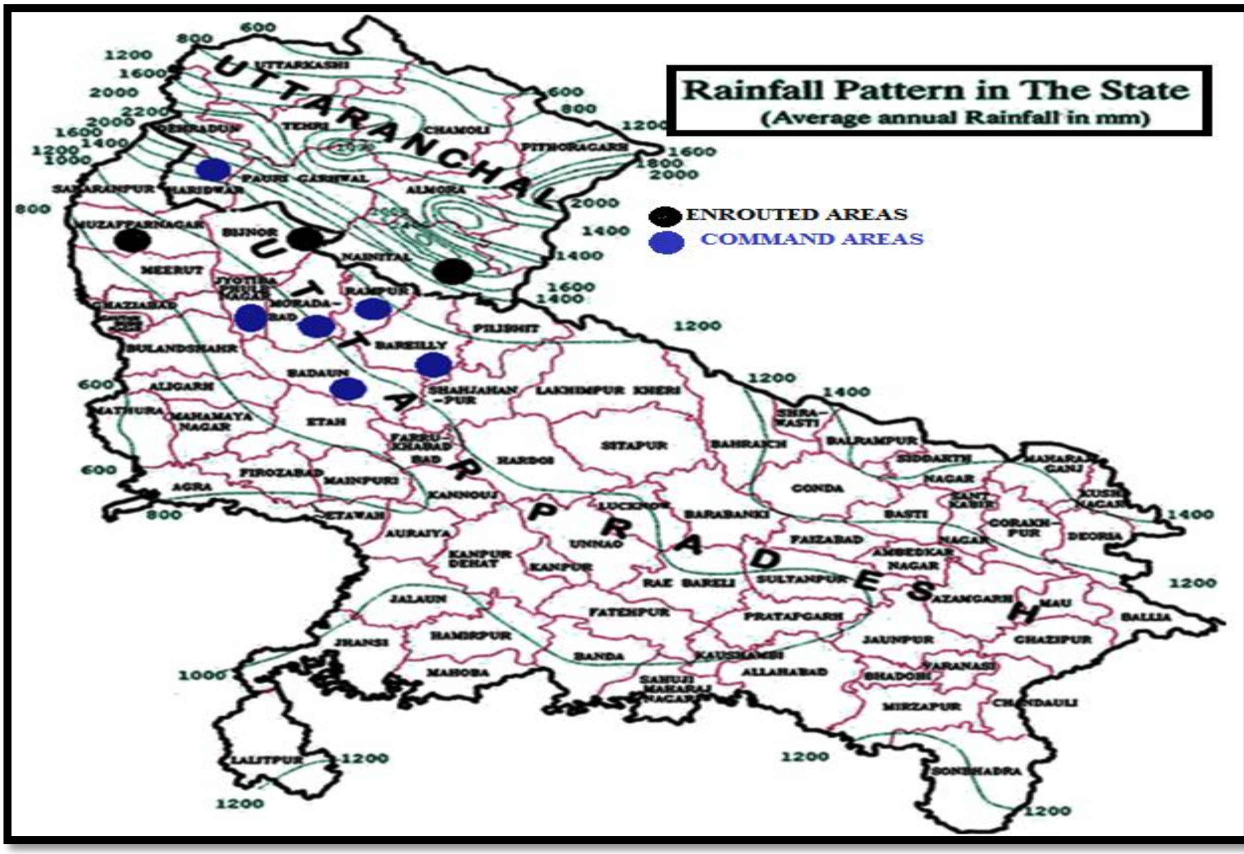


Fig: 5.2.20 Rainfall Variation in U.P and U.K States Source: Irrigation Department U.P

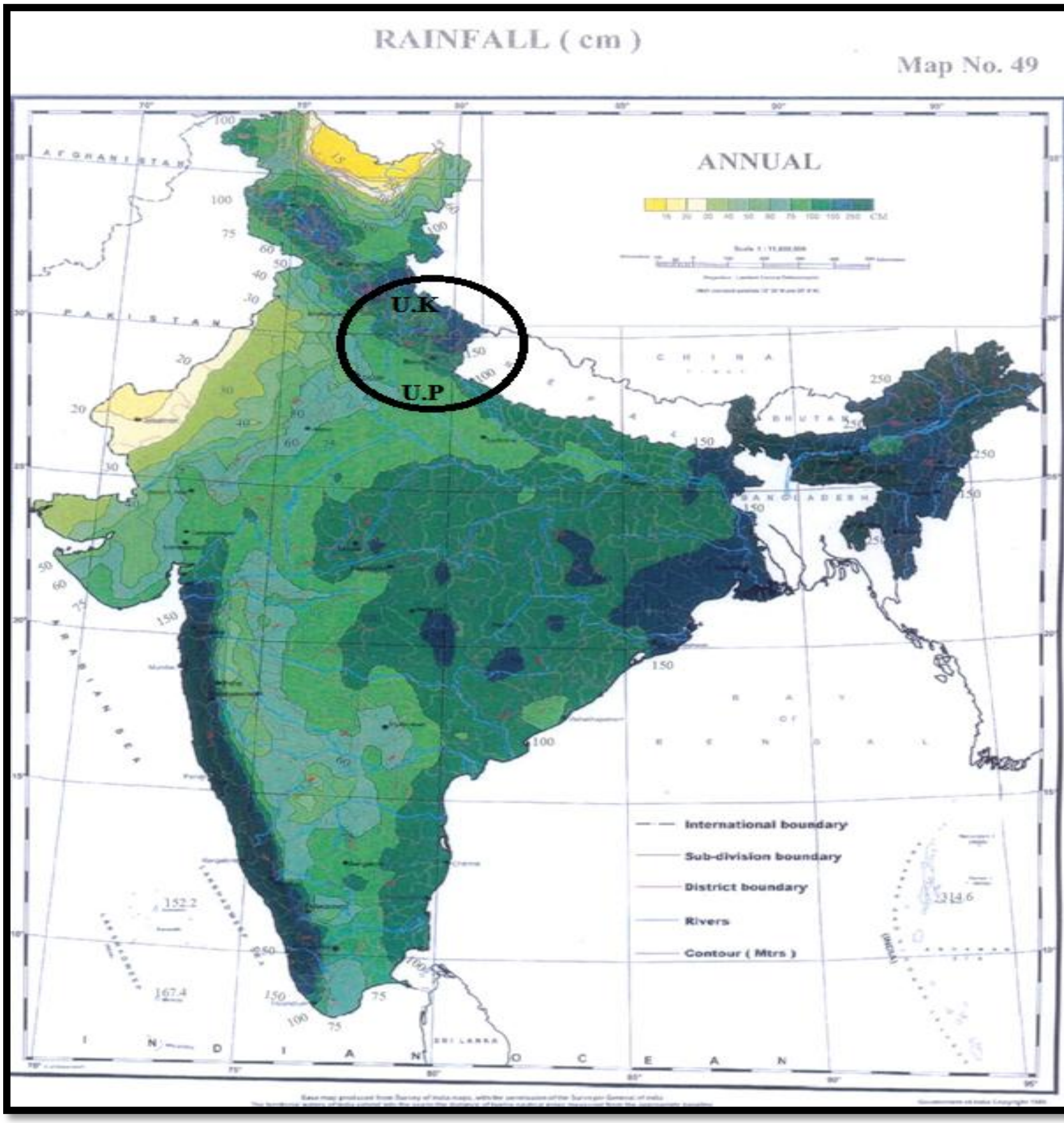


Fig: 5.2.21 Map showing Variation in Annual Rainfall Status in India Source: India Meteorological department

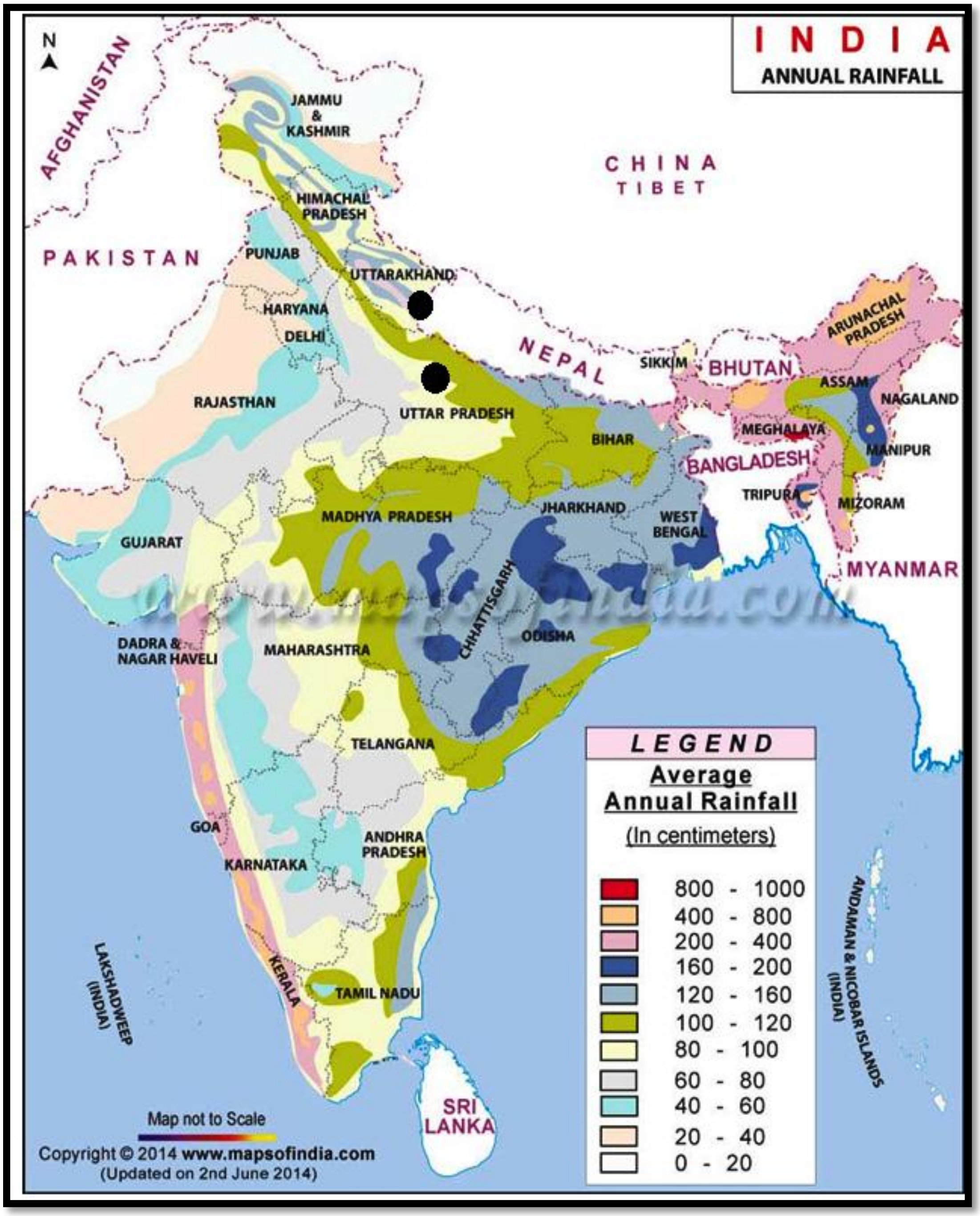


Fig: 5.2.22 Map showing Average Annual rainfall in India (in cm) Source: Maps of India

5.2.10.4.1 Current Rainfall Status in India (July month)

On the basis of current data, it shows that during monsoon rainy Season, U.P faced normal rainfall (66.9 mm) in east and (65.6 mm) in western part. While in U.K (107.4 mm) of rainfall occurs which is normal **(Fig 5.2.23).** .

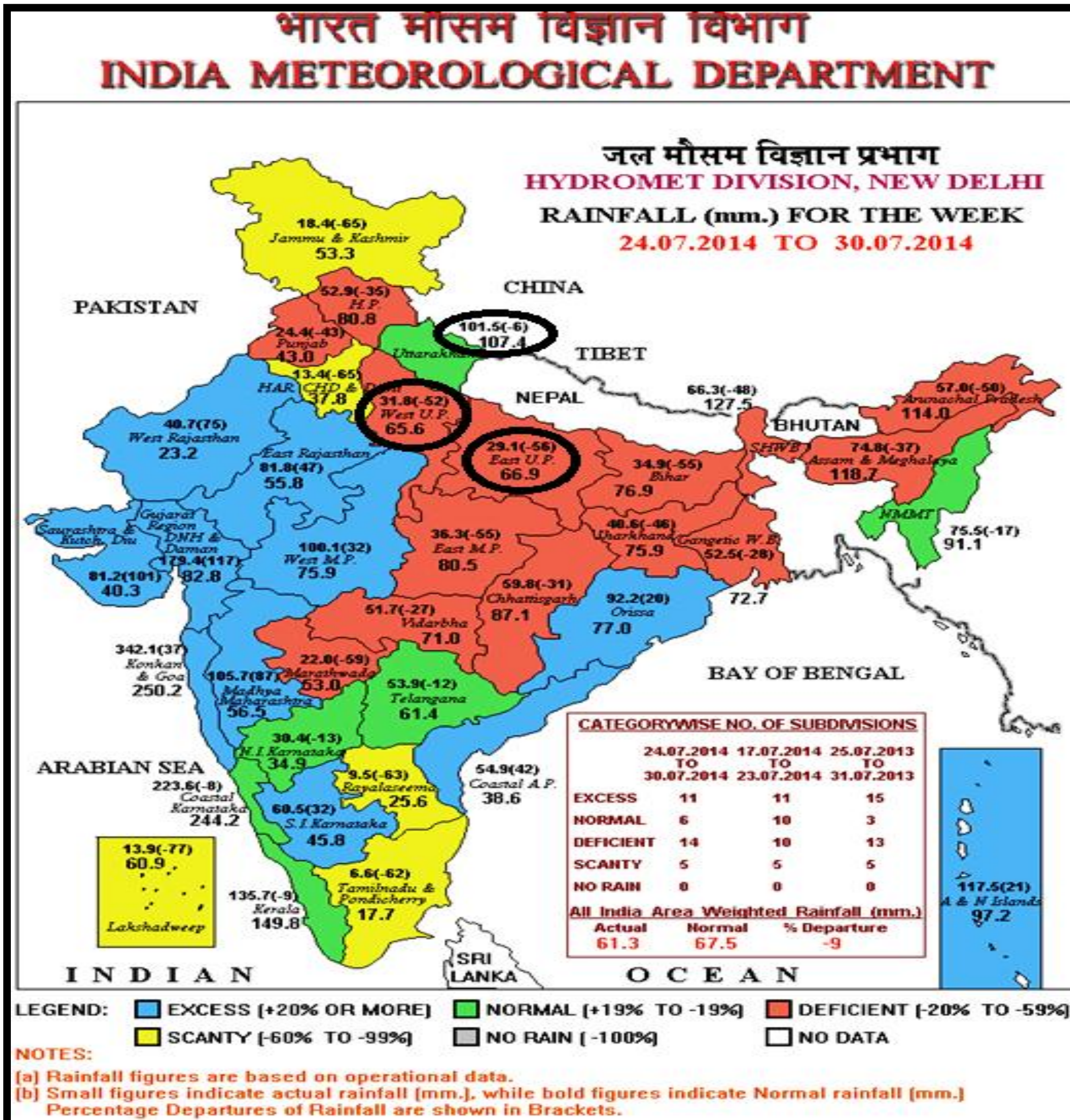


Fig: 5.2.23 Current Rainfall Status in India (July month) Source: India Meteorological department

5.2.10.4.2 Current Rainfall Status in India (January month)

During winters U.P faced from excess rainfall which is (18.2 mm) in western region and (16.8 mm) in eastern part and in U.K about (52.1 mm) of rainfall occurs which is normal **(Fig 5.2.24).**

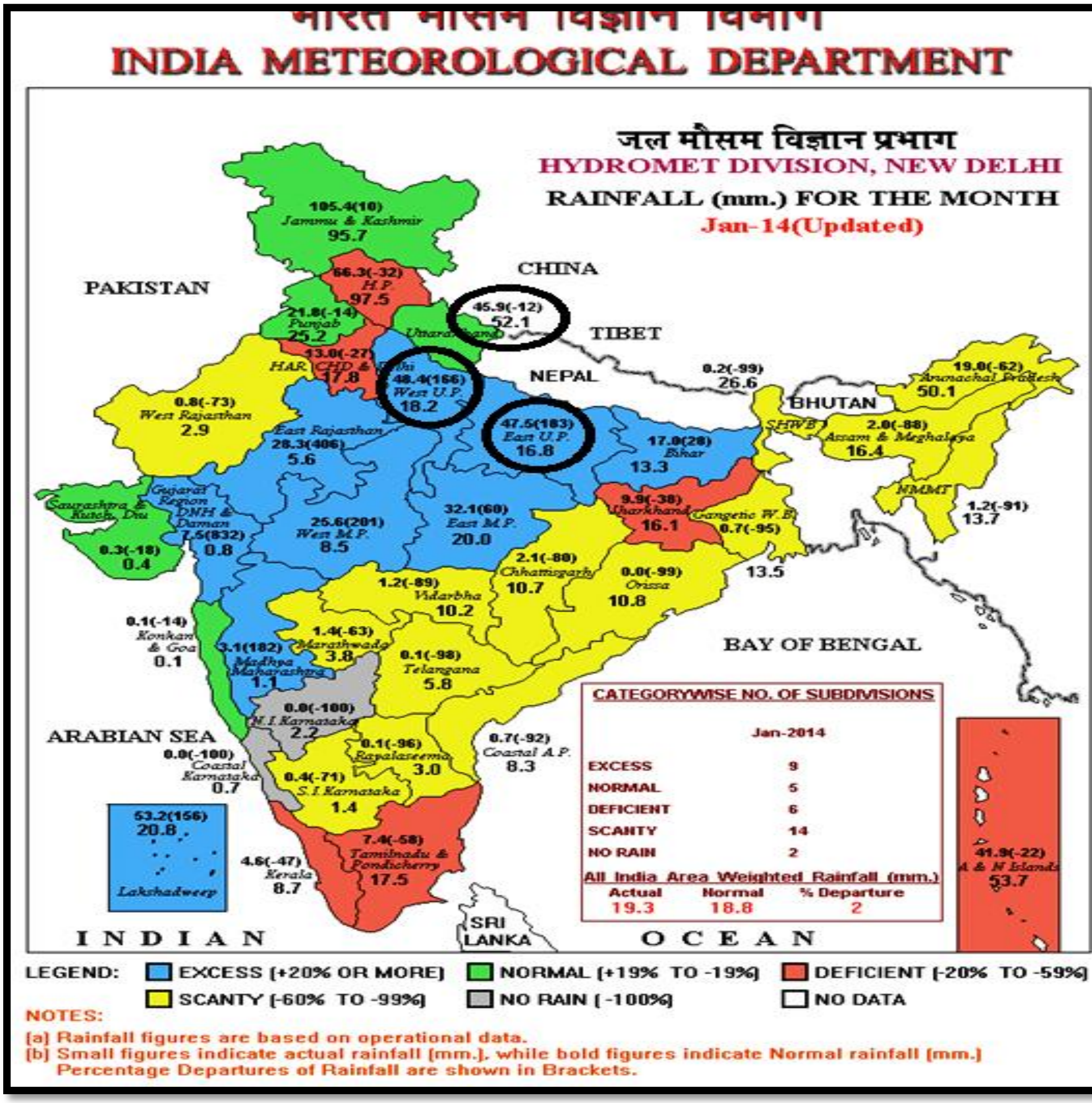


Fig: 5.2.24 Current Rainfall Status in India (January month) Source: India Meteorological department

5.2.10.4.3 Current Rainfall Status in India (March month)

In (**Fig 5.2.25)** it shows that during March both U.P and U.K states faced from excess rainfall which is (47.6 mm) and (8.9 mm) in western U.P and (7.2 mm) in eastern U.P.

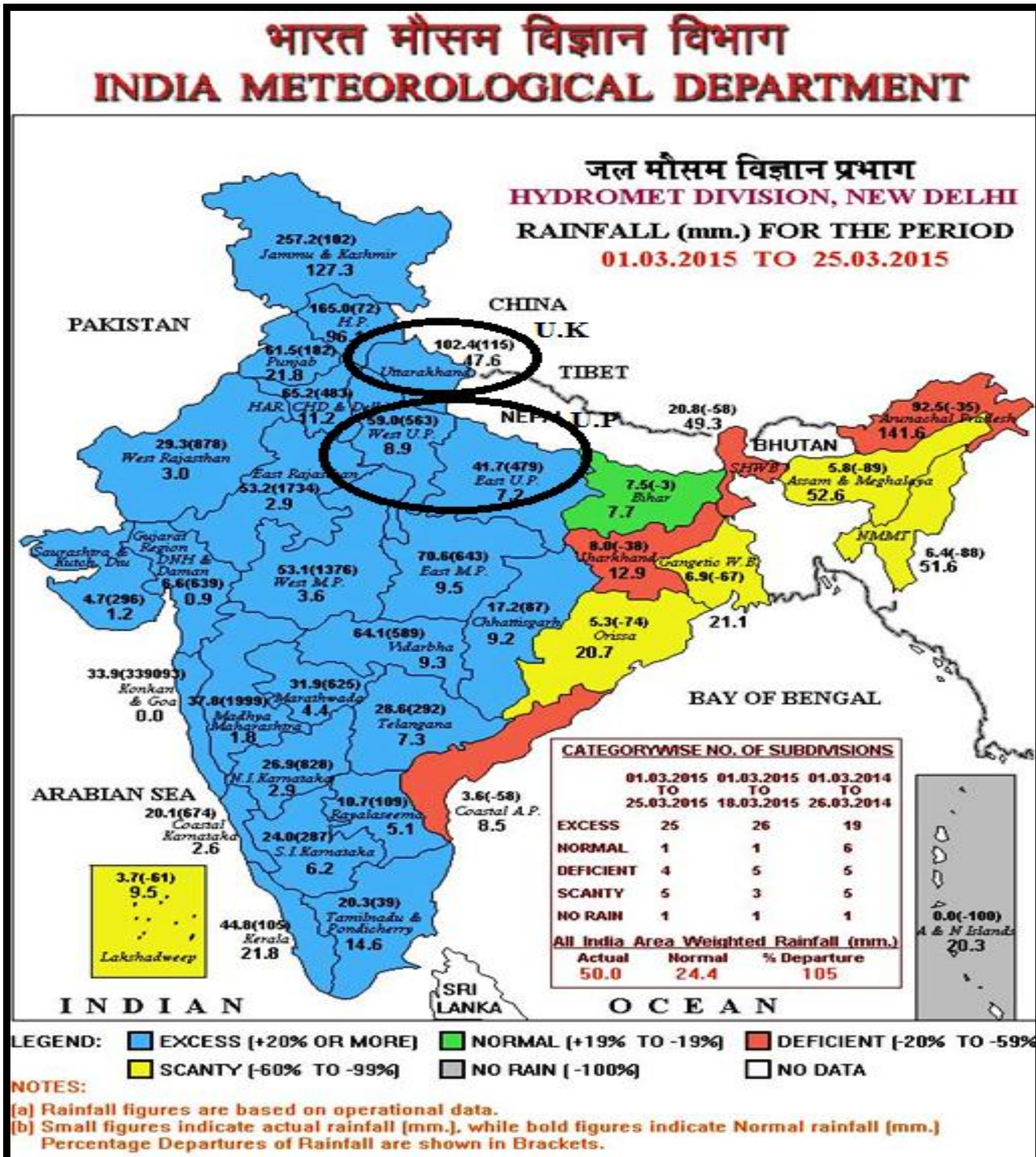


Fig: 5.2.25 Current Rainfall Status in India (March month) Source: India Meteorological department

5.2.10.5 DISTRICT WISE RAINFALL STATUS FOR LAST FIVE YEARS (mm)

On the basis of last five years rainfall data, it seems that Enrouted and Command areas of the S-Y link in U.P (Bijnor, Muzzafarnagar, Rampur, Moradabad, J.P. Nagar, Bareilly and Badaun) and in U.K (Champawat, Nainital, Udham Singh Nagar and Haridwar) have faced excess rainfall during monsoon seasons, the S-Y link will helpful in maintaining water balance in such regions **(Table 5.2.26; 5.2.27; 5.2.28; 5.2.29; 5.2.30; 5.2.31; 5.2.32; 5.2.33; 5.2.34 ; 5.2.35; 5.2.36).** Uttarakhand is one of the highest rainfall states of India (**Fig 5.2.26).** Total cost loss due to flood and landslides during the year (1973-2014) affected humans, animals, population, villages, agricultural area and houses etc. are shown in **(Table 5.2.37).** On the basis of Indian Meteorological Department, New Delhi, the rainfall status in India in last five years in Enrouted and Command districts are given in following tables:

1. **Rainfall Status in Champawat District (mm)**

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	0.0	205.4	462.1	**790.4**	186.8
2.	2010	72.0	83.8	**810.1**	791.0	490.5
3.	2011	104.0	369.0	584.7	**656.5**	175.5
4.	2012	1.0	23.0	**404.7**	391.5	401.5
5.	2013	12.0	**537.0**	391.5	215.5	76.0

Table: 5.2.26 Source: India Meteorological Department

2. **Rainfall Status in Nainital District (mm)**

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	51.4	62.6	226.2	**493.7**	301.0
2.	2010	57.7	120.3	**819.0**	703.4	702.5
3.	2011	64.1	334.2	551.6	**656.1**	250.9

4.	2012	2.1	62.9	**596.9**	472.1	310.9
5.	2013	15.2	741.0	**482.1**	411.7	136.0

Table: 5.2.27 Source: India Meteorological Department

3. Rainfall Status in Udham Singh Nagar District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	0.0	0.0	119.1	**201.3**	112.6
2.	2010	90.0	7.0	**748.5**	497.9	604.6
3.	2011	74.6	116.8	517.7	**699.3**	209.9
4.	2012	0.0	11.7	248.5	**324.8**	161.9
5.	2013	1.1	**412.8**	329.8	279.8	70.4

Table: 5.2.28 Source: India Meteorological Department

4. Rainfall Status in Haridwar District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	17.2	67.3	**315.0**	257.2	222.7
2.	2010	35.3	39.9	**551.0**	283.2	456.1
3.	2011	62.7	225.9	482.4	**484.4**	126.8
4.	2012	0.5	34.8	171.7	**514.5**	186.9
5.	2013	6.6	387.8	304.7	**412.8**	48.2

Table: 5.2.29 Source: India Meteorological Department

5. Rainfall Status in Bijnor District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	16.8	43.6	99.3	**262.3**	230.0
2.	2010	20.3	7.9	**568.0**	299.8	347.5
3.	2011	52.2	154.5	188.0	**368.1**	62.2
4.	2012	0.7	1.6	179.3	**212.3**	175.2
5.	2013	0.0	208.1	219.3	**383.6**	63.3

Table: 5.2.30 Source: India Meteorological Department

6. Rainfall Status in Muzzafarnagar District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	3.0	1.9	**81.8**	28.1	113.5
2.	2010	9.0	17.1	**189.5**	186.1	146.3
3.	2011	37.1	76.0	**142.7**	105.0	51.6
4.	2012	1.1	0.0	191.3	**217.7**	48.4
5.	2013	11.0	219.1	95.0	**385.5**	67.3

Table: 5.2.31 Source: India Meteorological Department

7. Rainfall Status in Rampur District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	0.0	2.7	66.1	**160.5**	95.7
2.	2010	0.8	7.7	242.2	**293.1**	299.0
3.	2011	29.3	107.9	130.5	**221.1**	49.5
4.	2012	0.0	0.0	111.0	**169.1**	75.4
5.	2013	0.0	151.5	224.8	**226.1**	53.2

Table: 5.2.32 Source: India Meteorological Department

8. Rainfall Status in Moradabad District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	5.7	13.3	145.6	**195.9**	171.2
2.	2010	45.7	18.7	**555.1**	450.9	436.1
3.	2011	43.4	193.6	242.7	**518.6**	134.3
4.	2012	1.1	4.2	190.4	**288.6**	137.2
5.	2013	0.5	**364.3**	340.6	311.8	54.4

Table: 5.2.33 Source: India Meteorological Department

9. Rainfall Status in J. P. Nagar District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	11.5	0.0	161.5	**223.7**	92.7

2.	2010	7.0	1.5	**564.3**	295.3	397.3
3.	2011	30.5	180.5	255.0	**411.2**	128.5
4.	2012	0.0	2.0	260.1	**296.4**	70.4
5.	2013	0.0	86.1	130.0	**235.5**	34.0

Table: 5.2.34 Source: India Meteorological Department

10. Rainfall Status in Bareilly District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	8.6	44.1	174.5	**384.9**	159.8
2.	2010	25.6	9.1	50.8	**427.9**	425.9
3.	2011	37.5	141.1	369.7	**432.3**	166.7
4.	2012	0.2	12.7	166.2	**248.5**	148.5
5.	2013	8.1	371.1	**428.8**	244.6	90.7

Table: 5.2.35 Source: India Meteorological Department

11. Rainfall Status in Badaun District (mm)

MONTHS						
S. No	YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1.	2009	16.0	0.0	154.6	**296.2**	102.5
2.	2010	1.6	2.0	219.3	**269.8**	230.1
3.	2011	30.8	162.9	**253.2**	198.8	72.4
4.	2012	0.0	3.3	169.4	**190.4**	68.9
5.	2013	0.4	166.7	**190.5**	117.2	75.0

Table: 5.2.36 Source: India Meteorological Department

Humans, Animals, Population, villages, Agricultural area, houses, Total cost loss affected due to flood and landslides during year (1973-2014)

S. No	Year	Affected Population	Affected villages	Total Affected area (Ha)	Affected Agricultural area	Affected houses	Humans	Animals	Total cost loss
1.	2000	63.86	5882	7.84	4.724	0.0839	453	977	-
2.	2001	27.15	3819	4.63	2.89	0.09	201	251	-
3.	2002	3.86	770	1.10	0.62	0.0061	33	37	-
4.	2003	134.80	17011	23.60	15.03	0.35	964	3201	-
5.	2004	14.36	865	2.439	-	-	88	217	-
6.	2005	24.511	3652	3.597	3.835	0.7732	203	259	-
7.	2006	4.53	678	-	-	-	353	588	-
8.	2007	26.53	758	849	5.66	0.34	272	170	519.88
9.	2008	41.75	6287	4.988	-	5.30	889	1898	-
10.	2009	20.38	1712	4.988	-	0.04	35	90	129.30
11.	2010	53.76	6719	-	6.700	1.19	118	714	1013.784
12.	2011	23.06	3587	5.25	3.96	0.48	729	239	1438.44
13.	2012	6.835	1118	-	1.241	0.0553	105	70	117.87
14.	2013	35.44	5785	5.646	3.49	0.7960	380	550	3259.53
15.	2014	15.39	1895	4.72	4.72	0.7828	104	199	754.32

Table: 5.2.37 Source: India Meteorological Department

5.2.10.6 Status of Rainfall and Flood in various River Basins in year 2014

During monsoon season, Flood occurs in several river basins of U.P and U.K states, Sharda which is a tributary of River Ganga overflows many times causes flood in surrounded regions (**Table 5.2.38).**

S. No.	**Basin**	**Average rainfall in October**	**Moderate Rainfall (mm)**	**High Rainfall (mm)**
1.	Ganga	Haridwar	758.4	120.60
2.	Ramganga	Bijnor	957.30	140.30
3.	Sai	Raibareilly	857.6	140.80
4.	Ghagara	Behraich	1047.1	128.10
5.	Rapti	Behraich	1047.1	106.80
6.	Kunhara	Sidharath nagar	1160.0	118.60
7.	Gandak	Champawat	1042.8	110.80

Table: 5.2.38 Source: India Meteorological Department

- ✓ ***There will be no impact of S-Y Link Canal on the climate and rainfall status of U.P and U.K, but due to surplus water transfer, S-Y Link will provide an equal distribution of water in states U.P and U.K.***
- ✓ ***Excess water during monsoons will be transferred through S-Y Link to the drought regions of India.***
- ✓ ***S-Y Link is quite helpful in minimising the risk of flood in U.P and U.K regions by proper distribution of water.***

Fig: 5.2.26 State of Highest Rainfall Source: Map of India

5.3 TO STUDY BASELINE ECOLOGICAL STATUS OF THE PROPOSED SHARDA- YAMUNA LINK

The Sharda Yamuna Link will cross through the foot hills of Himalayas and the Gangetic plain in India. With change in topography, the flora and fauna of the area exhibit great variations. Terrestrial ecosystem along the entire S-Y canal can be categorized as forests, plantation and agricultural areas. Out of the 384 Km lining of the canal, 112 Km is likely to traverse through the forest area.

- ***In Uttarakhand State, Himalayan Ecosystem is present in the highest mountain range.***
- ***In Uttar Pradesh State, Indo-Gangetic Plain Ecosystem is present*** **(Fig 5.3.2).**

5.3.1 ECOSYSTEM OF HIMALAYAS

The Himalaya is one of the highest mountains in world. About 15 highest mountains of the world are situated in the Himalaya **(Fig 5.3.1)**. The elevation of Himalayas is over 7,200 meters (23,600 ft), which is the highest peak. Himalayan system is divided in three ranges the greater Himalayas, the lesser Himalayas and the outer Himalayas which are collectively known as "**the Great Himalayan Range"**. It ranges from 2,400 kilometres in acre from west-northwest to southeast. The Himalayan range is including the highest mountain range Mount Everest in South Asia which is 8,849 meters. It crosses about five countries India, Pakistan, Bhutan Nepal, and China bordered by the Tibetan plateau in north and the south by Plain. It is a source of the great river systems the alluvial plains **(Table 5.3.1).**

5.3.1.1 Formation of the Himalayas

The Himalaya was formed approx 40-50 million years ago due to the lighter rock of the seabeds of the Indian tectonic plate that being changed into mountains.

5.3.1.2 Five main rivers in the Himalayas

The rivers are the main sources of human and animal life. The five main rivers of the Himalayas are Ravi, Beas, Jhelum, Chenab, and Sutlej. World's three major rivers namely the Ganges, Indus and the Brahmaputra rise in the Himalayas.

Features of Himalayas

S. No.	**Features of Himalayas**	
1.	Peak	Mount Everest in Nepal and China
2.	Elevations	8,848 m
3.	Length	2,400 km
4.	Elevation	8,848 m
5.	Area	1,089,133 km²
6.	Highest point	Mount Everest
7.	Countries	Bhutan, India, China, Pakistan, Afghanistan, Myanmar, Nepal

Table: 5.3.1

Fig: 5.3.1 NASA Landsat-7 Images of Himalayas Source: Google

5.3.1.3 Climate of the Himalayas

The climate ranges from snow at the highest elevations and tropical climate at the base of the mountains. Rainfall rises from west to east yearly. Himalayan region supports distinct plant and animal species due to the great diversity of changing rainfall, altitude and soil conditions. The floral and faunal wealth of the region also changes for example extremophile organisms survive the extreme cold along with high altitude (low atmospheric pressure). Various species generally shifts to higher elevations due to increase in temperature.

5.3.1.4 Flora and Fauna of the Himalayas

Flora and Fauna of the Himalayas changes with climate, rainfall, altitude, and soils factors.

5.3.1.4.1 Flora of the Himalayas

The Himalayan slopes covered from rich forests, river valleys, mountain villages, alpine meadows and lakes. Oak, Pine, Juniper and Deodar etc common types of plant species are found. The highest tree species in the Himalayas is *Juniperus tibetica* located at 4,900 meters in south eastern Tibet. Himalayan subtropical forests are found like sal tree (*Shorea robusta*) mainly in the Himalayas. The western end of part of Himalaya is occupied by Chir Pine (*Pinus roxburghii*). The oak forest is found in the Garhwal region of Himalaya. Subalpine conifer forests are found in eastern part of the Himalaya. Some other important trees are East Himalayan Fir, West Himalayan Spruce, and Himalayan Hemlock. Its central part is Terai belt which is occupied by the Savanna, Grasslands, Deciduous and Evergreen forests.

5.3.1.4.2 Fauna of the Himalayas

The region Himalayas are covered with a huge variety of fauna. The most common animals are musk deer, tigers, Snow leopard, blue sheep, elephants, wild boar and crocodiles and some endangered species of animals are found. Indian rhinoceros (*Rhinoceros unicorns*) are found in the grasslands of the terai belt. In the north part of the Himalayas many animal species move to the lower regions of the Himalayas as the temperature falls below freezing point adapted to survive. During the cold winters most of them become hibernate like the bear, yak, ox, sheep etc. Major wildlife species in the Himalayas are found in Jim Corbett National Park, the Royal Chitwan park, Kaziranga National Park, Royal Bardia National Park and Great Himalayan National Park.

5.3.2 ECOSYSEM OF INDO-GANGETIC PLAIN

The Indo-Gangetic Plain is a very large and fertile plain, covers most of northern and eastern parts in India. Indo-Gangetic Plain formed by Ganges River & its tributaries which is called as **North Indian Plain**. The Indus-Ganga plains, also known as the **"Great Plains,"** which are large flood plains of the Ganga–Brahmaputra River and Indus river systems. The region is named after the flow of twin river systems Indus and the Ganga. They run parallel to the Himalaya Mountains, from Jammu Kashmir in the west to Assam in the east and draining most of eastern and northern India. The area of the plains is approx 700,000 Sq. km. The Indo-Gangetic Plain stretches across Assam and Bangladesh in the east, Sindh in the west, Kashmir in the north and the Vindhya, Satpura range and Chota Nagpur Plateau in the south. The Indus-Ganga plain in north region is bound by Himalayas.

5.3.2.1 Formation of Indo-Gangetic Plain

The Terai belts constitute the northern boundary of Indo-Gangetic Plain. Formation of Indo-Gangetic Plain takes place in the foothills of Himalayas by the deposition of coarse sands and pebbles by mountainous streams. The flowing water from these regions flows on the surface where the plains begin and changes into the large areas along the rivers into swamps.

5.3.2.2 Climate of Indo-Gangetic Plain

The eastern part of the Indus-Gangetic Plain is very warm in summers. The areas become swamps or shallow lakes and very light rainy in winter causes drought. The west part is very progressively drier where drought occurs.

5.3.2.3 Rivers of the Indo-Gangetic Plain

The major rivers of Indus-Gangetic Plain are Ganga and the Indus along with their tributaries Yamuna, Ravi, Beas, Chambal, Sutlej, Gomti, and Chenab. Largest cities of the Indo-Gangetic plain are Kanpur, Lahore, Chandigarh, Hyderabad, Allahabad, Varanasi, Patna Kolkata and Jaipur etc.

5.3.2.4 Soils

The Indus-Gangetic region is the most densely populated areas contains the richest alluvial soil, deposited by the three main rivers and their tributaries. The soil of this region is very fertile so, the population density is very high. The area is also rich in ground water sources. The Indo-Gangetic Plain is good for agriculture main crops include rice wheat, maize, sugarcane and cotton.

5.3.2.5 Flora of Indo-Gangetic Plain

The Indo-Gangetic Plain is situated at the base of the mountains, an alluvial plain and drained by the Indus Ganges-Brahmaputra river systems. Vegetation in the plain ranges from west to east according to rainfall. Moist deciduous forests are found in the Upper Gangetic Plains includes mostly trees like sal (*Shorea robusta*) some other included are *Lagerstroemia parviflora, Ficusspp, Adina cordifolia, Dillenia pentagyna and Terminalia belerica*. Savanna ecosystems with *Saccharum narenga,* Common Shrubs like *Heteropogon contortus , Chrysopogon fulvus,* and *Thysanolaena maximus,* while some herbs include *Milletia auriculata* and *Bauhinia vahlii*. The soils of the Gangetic Plain have high concentration of salts, many saline species include *Aeschynomene indica*, *Portulacea oleracea* and some grasses are *Aristita hystrix and Desmostachya bipinnata,* the palm include *Phoenix sylvestris,* perennial grass like *Sporobolus pallidus* , annual grass like *Chloris Montana.*

5.3.2.6 Fauna of Indo-Gangetic Plain

Indo-Gangetic plain is covered by several large species of animals having large numbers of herbivores like Indian rhinoceros, Javan rhinoceros, Sumatran rhinoceros. Some others species are buffalo, elephants, lions, rhinos, Gazelle, hippo, gazelles, antelopes elephants, horses, wild pig, deer and several species of wild cattle, Water Buffalo, hippopotamus.. Some other wildlife community includes tiger, swamp deer, sloth bear (*Melursus ursinus*), Greater one-horned rhinoceros, Asian elephant, wild water buffalo and several hornbill species. Some threatened mammals including tiger, Asian elephant. About 290 species of the bird fauna consists of Indian bustard (*Ardeotis nigriceps*), Oriental pied-hornbill (*Ocyceros birostris),* dolphins (*Platanista gangetica*), mugger crocodile, (*Crocodylus palustris*) and Gangetic ghariyal (*Gavialis gangeticus*) are globally threatened species**.**

5.3.3 FOREST AND TREE COVER IN U.P. & U.K.

The proposed Sharda Yamuna Link Canal covers some districts of the U.P and U.K. states of India, which exhibit large difference in percentage of forest cover **(Fig 5.3.2).**

- ***In Uttarakhand Forest types are found such as Dry temperate with Grasslands and Wet temperate*** **(Fig 5.3.3**; **5.3.4).**

- ***In Uttar Pradesh Forest types are found such as Tropical dry deciduous and some tropical thorn forest*** **(Fig 5.3.3; 5.3.4).**

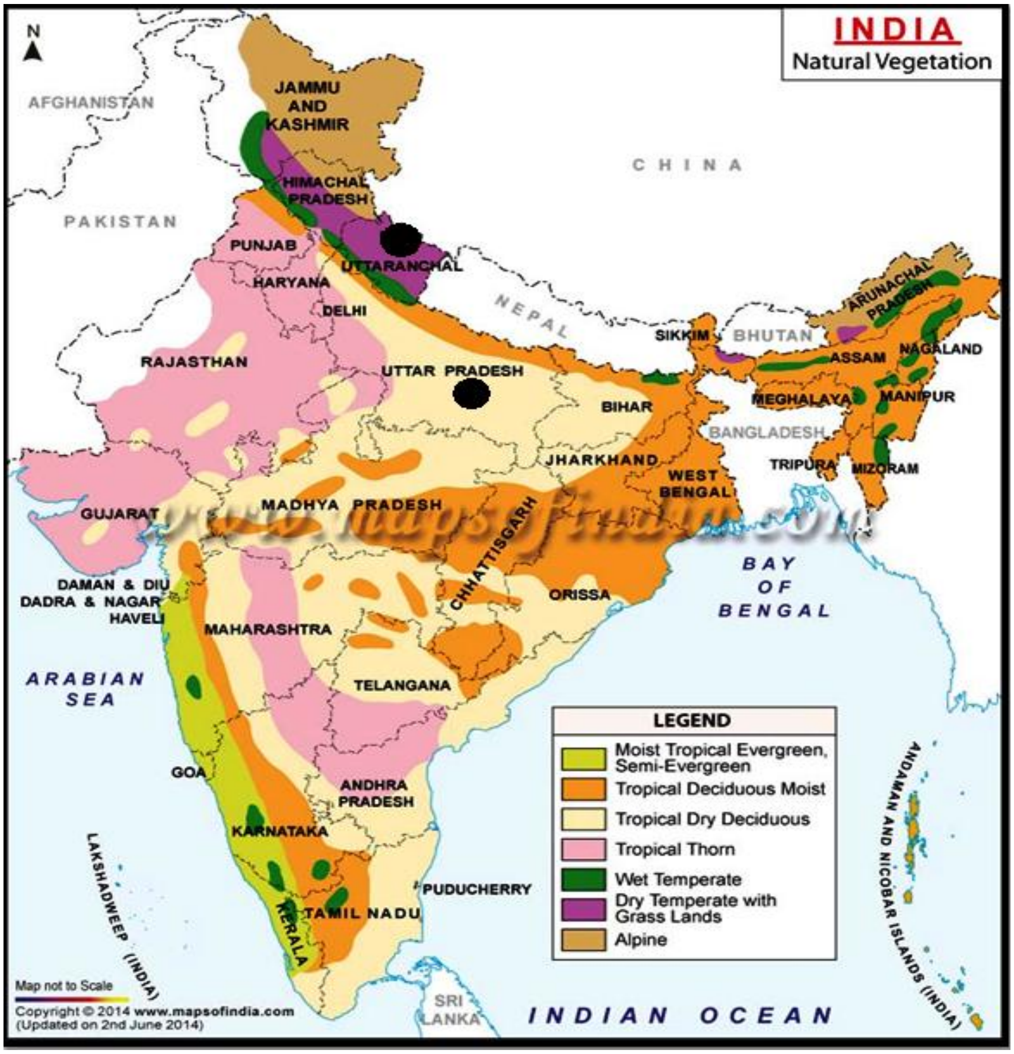
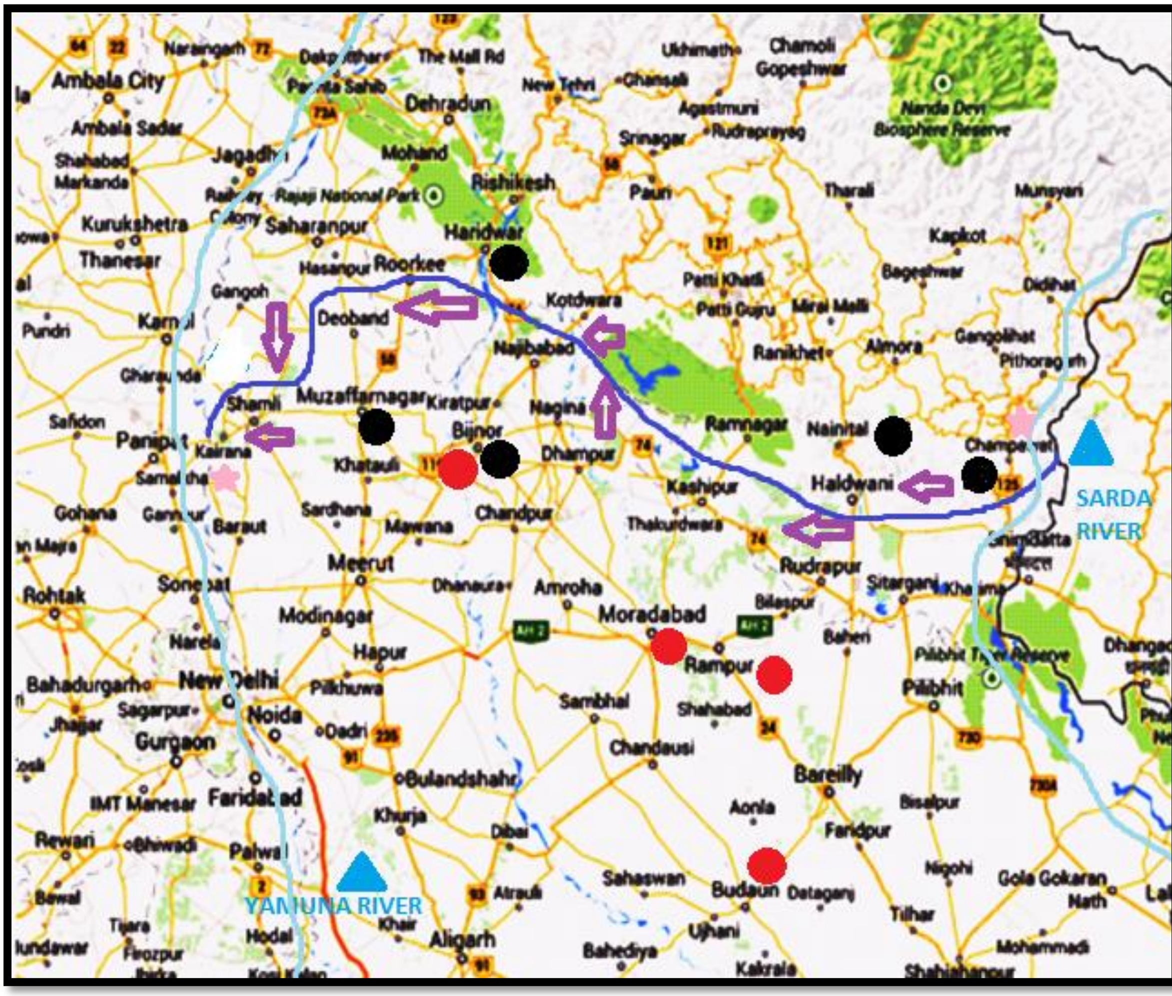


Fig: 5.3.2 Types of Natural vegetation in U.P. And U.K. Source: Maps of India



Source: Google

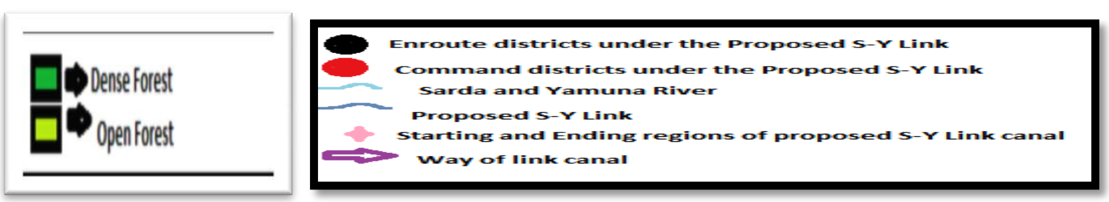
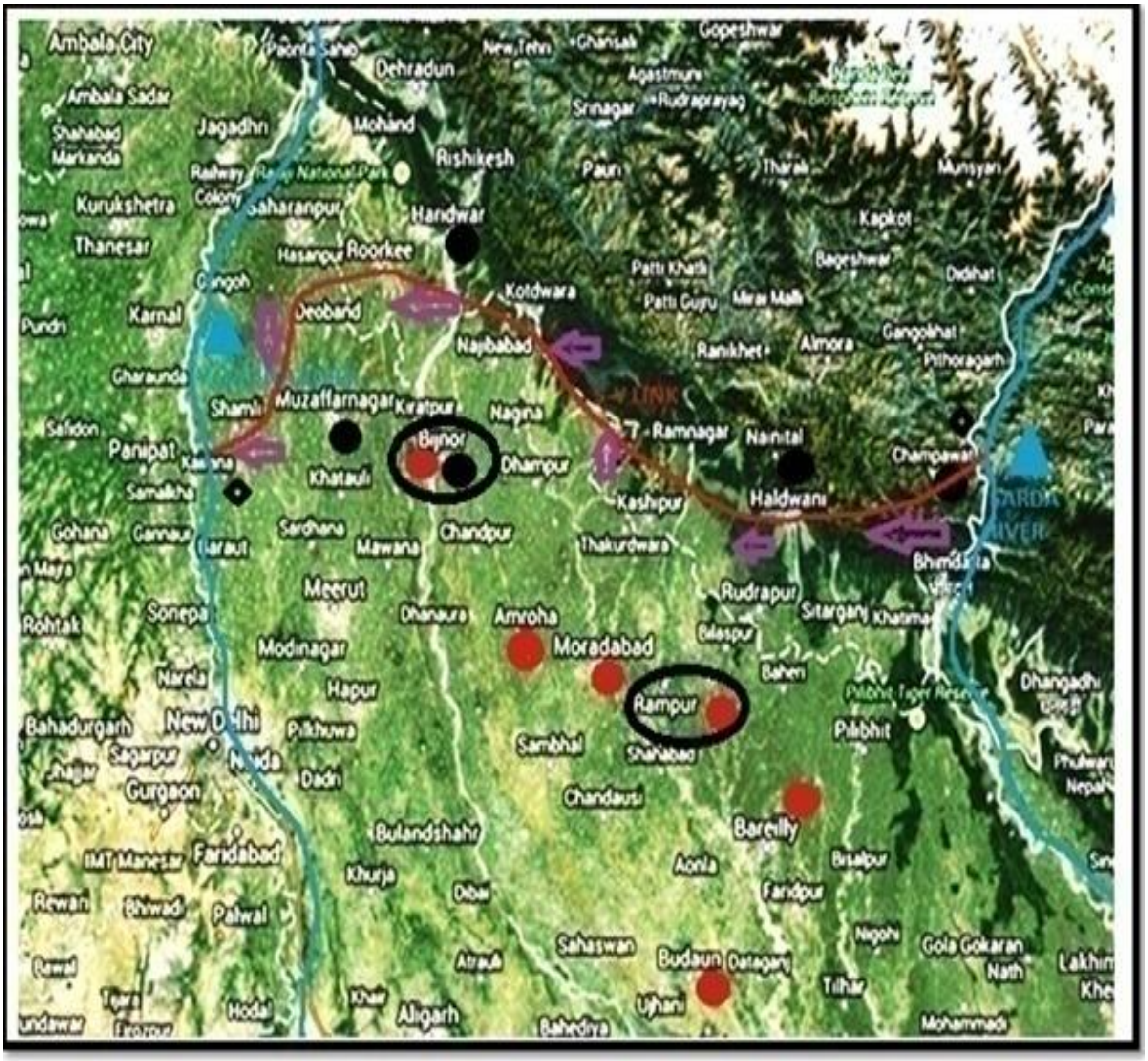


Fig: 5.3.3 Proposed Sharda-Yamuna Link Canal with forest cover in U.P & U.K. states in India. (Location map)



Source: Google

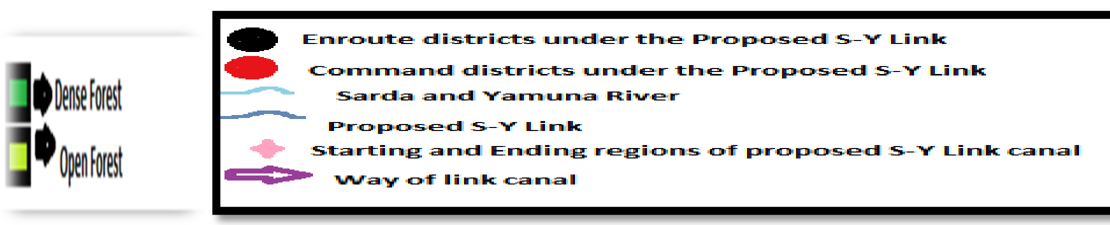


Fig: 5.3.4 Proposed Sharda-Yamuna Link Canal with forest covers in U.P & U.K. States in India. (Satellite Map)

5.3.3.1 Forest Cover in Uttarakhand State

Types of Forest in Uttarakhand State are Sub Tropical Pine Deciduous, Himalayan Moist Temperate, Tropical moist Deciduous, Tropical Dry Deciduous, Sub alpine forest, moist alpine forest, Himalayan Dry Temperate, and Dry alpine Forest**.** According to India State of Forest Report 2013, About 24,508 Sq. Km (45.8 %) of area is covered by total forest in Uttarakhand state out of the total geographical area (G.A) 53,483 Sq. Km. Out of the total forest cover 24,508 Sq. Km, 4,785 is very dense forest, 14,111 Sq. Km is moderate forest and 5,612 Sq. Km is the open forest area. The urban area is about 797 Sq. Km; Total tree cover is 703 Sq. Km (1.32 %) of total G.A of Uttarakhand state. Urban tree cover is 68 Sq. Km (8.58 %), total forest and tree cover is 25,211 Sq. Km (47.1%) of state G.A of Uttarakhand state. The change in forest cover with respect to India state of forest report 2011 is 1 (0.02%) and number of stems are 1628.633 **(Table 5.3.2)**.

Forest cover in Uttarakhand

1.	Total Geographical area in Uttarakhand	53,483 Sq. Km
2.	No. of districts (as per census 2001)	13
3.	No. of hill districts	13
4.	No. Tribal districts	0
5.	Very Dense Forest (V.D.F)	4,785 Sq. Km
6.	Moderate Dense Forest (M.D.F)	14,111 Sq. Km
7.	Open Forest Area (O.P)	5,612 Sq. Km
8.	Total Forest Cover	24,508 Sq. Km
9.	% Forest Cover Total Geographical area	45,8 %
10	Urban Area	797 Sq. Km
11.	Total Tree cover	703 Sq. Km
12.	Urban Tree cover	68 Sq. Km
13.	Total forest and Tree cover	25,211 Sq. Km
14.	% of tree cover out of total G.A of Uttarakhand	1.32
15.	% of Total forest and Tree cover out of state G.A of U.K	47.144
16.	% of India’s Forest and Tree cover	3.19

18.	Change in Forest cover ISFR 2011	12 Sq. Km
19.	Change %	0.02
20.	Urban tree cover	68 Sq. Km
21.	% of urban area	8.58
22.	Stems	1628.633

Table: 5.3.2 Source: India State of Forest Report 2013

5.3.3.1.1 Types of Forest cover of Uttarakhand State

The area covered by Non- Forest, Open Forest, Very Dense Forest, Moderate Dense Forest and Scrub in Uttarakhand are shown in percentage given below (**Fig 5.3.5 ; 5.3.6).**

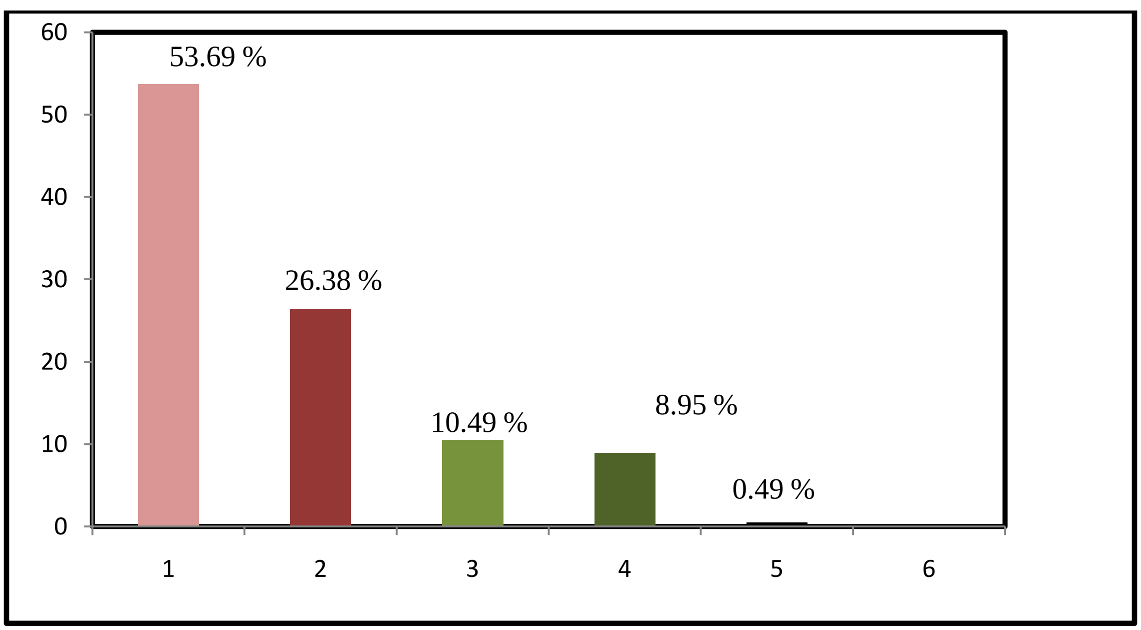
i. Non Forest (N.F) = 53.69 %

ii. Open Forest (O.P) = 26.38 %

iii. Very Dense Forest (V.D.F) = 10.49 %

iv. Moderate Dense Forest (M.D.F) = 8.95 %

v. Scrub = 0.49 %



Source: India State of Forest Report 2013

Fig: 5.3.5 Graph showing Types of Forest cover of Uttarakhand State (in Percentage)

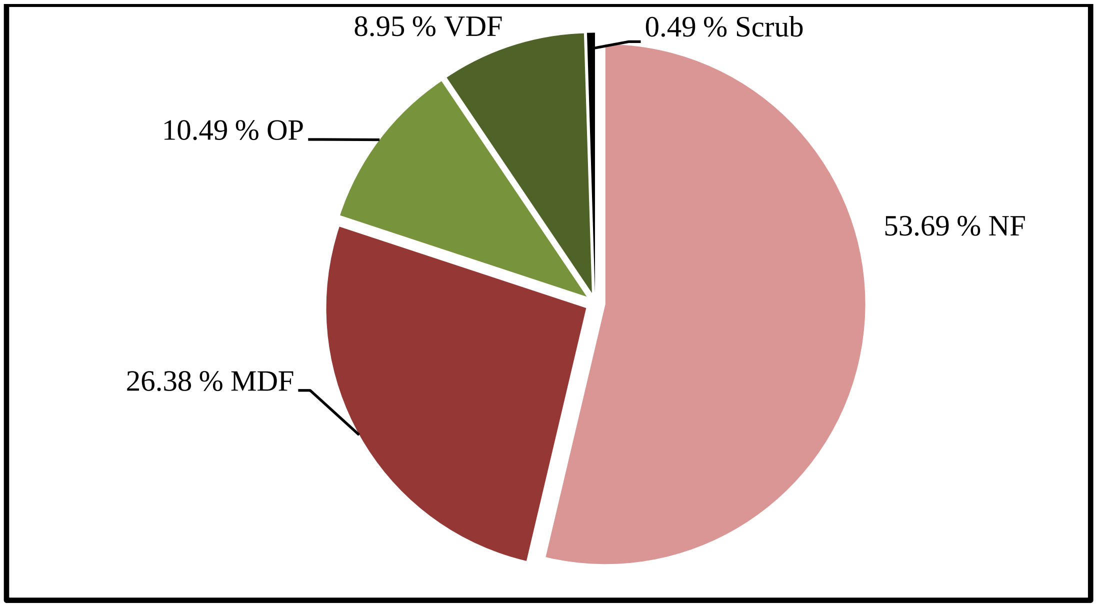


Fig: 5.3.6 Pie Diagram showing Types of Forest cover of Uttarakhand State

Source: India State of Forest Report 2013

5.3.3.1.2 Types of forest present in Enrouted and Command districts of Proposed Sharda Yamuna Link Canal of Uttarakhand State

Champawat and Nanital have both Open and dense types of Forest are present. Haridwar and Udham Singh Nagar have Open Forest Area **(Table 5.3.3), (Fig 5.3.7).**

Types of Forest Present in Enrouted and Command areas

Areas	**Districts**	**Type of Forest**
1. Enrouted Areas	1. Champawat	Open Forest
		Dense Forest
	2. Nainital	Open Forest
		Dense Forest
2. Command Areas	3. Haridwar	Open Forest
	4. Udham Singh Nagar	Open Forest

Table: 5.3.3

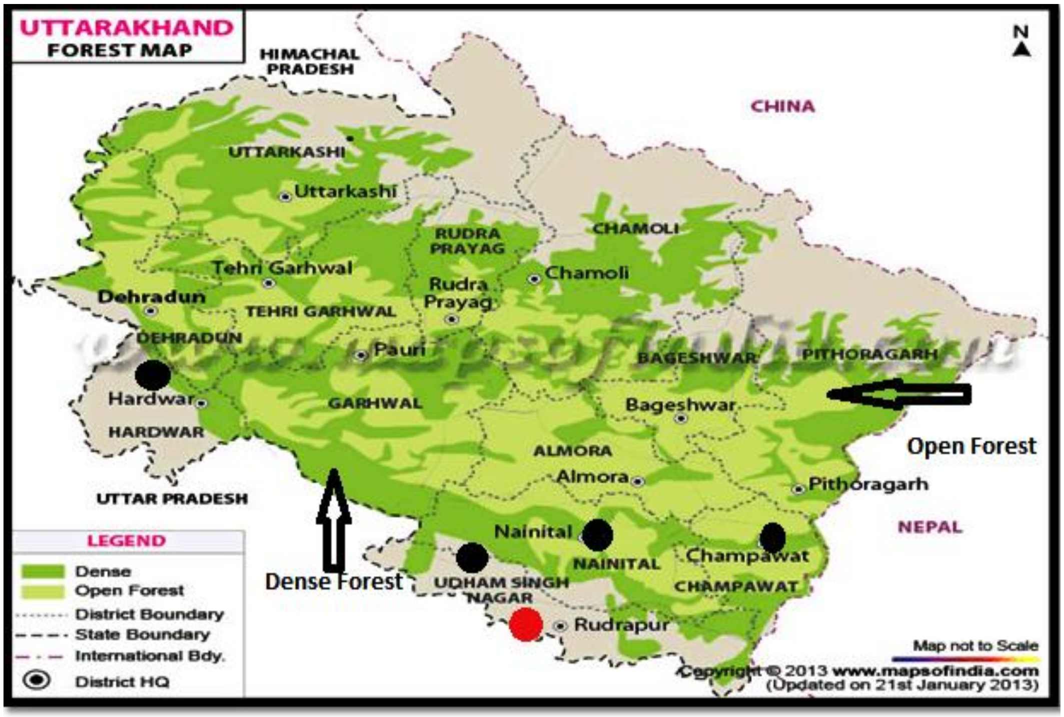


Fig: 5.3.7 Forest Map of Uttarakhand Source: Maps of India

5.3.3.1.3 District wise Forest Cover in Uttarakhand (Fig 5.3.8)

i. In Champawat district 1,187 Sq. Km (67.21 %) of area is covered by Forest part and 579 Sq. Km (32.78 %) of area is covered by Non- Forest part **(Fig 5.3.9)**

ii. In Nainital, the total Geographical area is 4251 Sq. Km, out of which it has 3074 Sq. Km Forest part (72.37%) and 1177 Sq. Km (27.68%) is Non- Forest part **(Fig 5.3.10)**

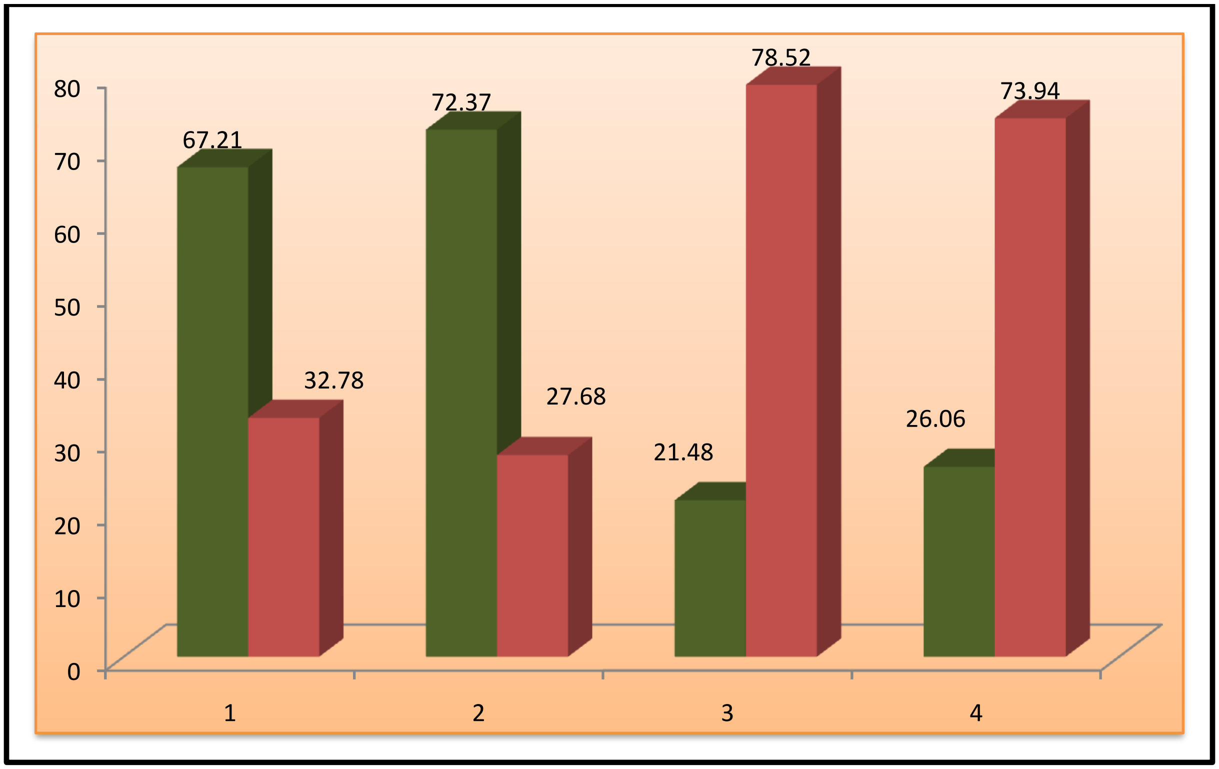
iii. In Udham Singh Nagar, about 5, 46 Sq. Km (21.48%) of area is covered by Forest and 1996 Sq. Km (78.92 %) of area is covered by Non-Forest part **(Fig 5.3.11).**

iv. In Haridwar district, about 615 Sq. Km (26.06 %) of area is covered by Forest and 1745 Sq. Km (773.94 %) of area is covered by Non- Forest part **(Fig 5.3.12), (Table 5.3.4).**

District wise Forest covers in Uttarakhand

S. No	Districts	Total G.A	Very Dense Forest (Sq. Km)	M.D.F (Moderate Dense Forest)	O.F (Open Forest)	Total Forest Area	% of Forest Area	Non-Forest Area	% of Non-Forest Area
1.	**Champawat**	1,766	337	576	274	**1,187**	67.21	**579**	32.78
2.	**Nainital**	4,251	605	1,899	570	**3,074**	72.37	**1177**	27.68
4.	**Haridwar**	2,360	25	333	257	**615**	26.06	**1745**	73.94
3.	**Udham Singh Nagar**	2,542	175	236	135	**5,46**	21.48	**1996**	78.52

Table: 5.3.4 Source: India State of Forest Report 2013



Graph showing percentage of Forest and Non-Forest cover in Different districts of Uttaranchal

1- Champawat
2- Nainital
3- Udham Singh Nagar
4- Haridwar

Non-Forest Area
Forest Area

Fig: 5.3.8

1. **CHAMPAWAT**

2. **NAINITAL**

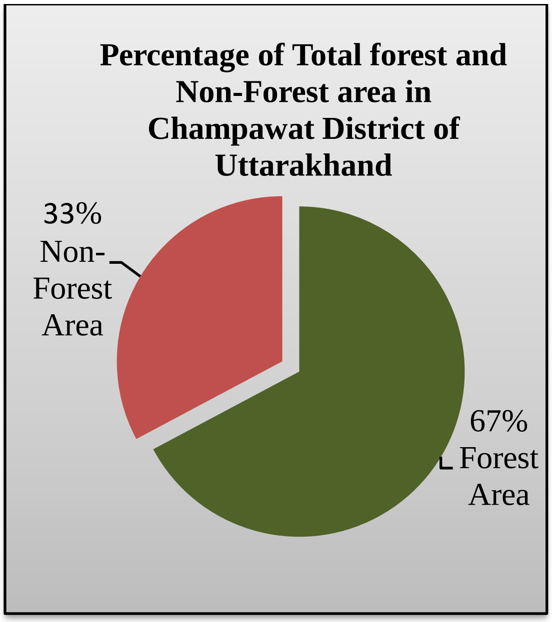


Fig: 5.3.9

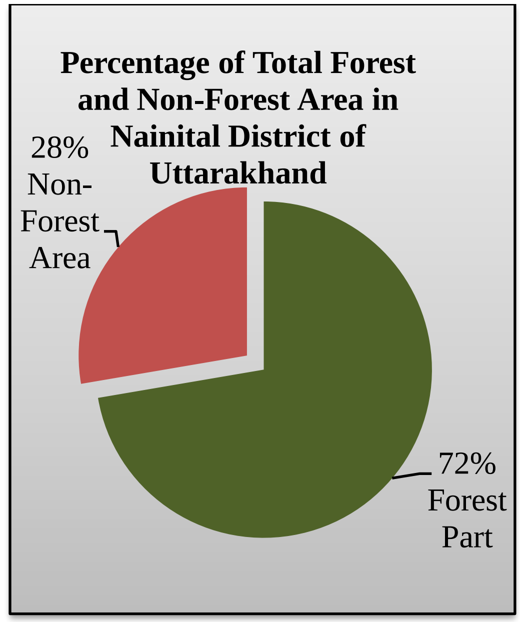


Fig: 5.3.10

3. **UDHAM SINGH NAGAR**

4. **HARIDWAR**

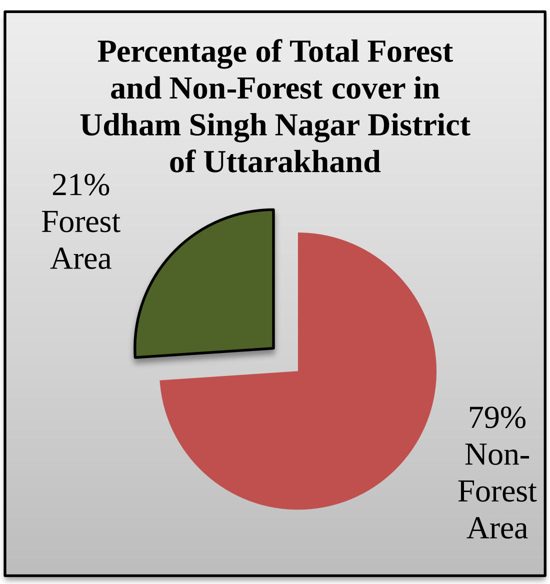


Fig: 5.3.11

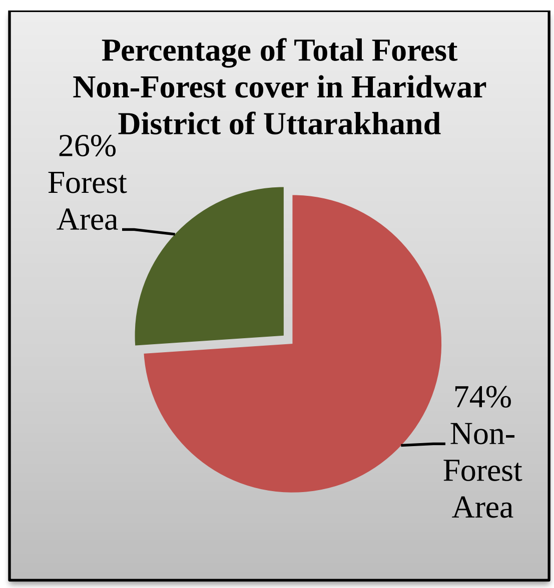


Fig: 5.3.12

5.3.3.2 Forest Cover in Uttar Pradesh

5.3.3.2.1 Types of Forest in Uttar Pradesh State

According to India State of Forest Report 2013, About 14,349 Sq. Km (5.96%) of area is covered by total forest out of the total geographical area 240,928 Sq. Km of Uttar Pradesh state **(Table 5.3.5).** Very Dense Forest is approx 1,623 Sq. Km. and about 4,550 Sq. Km. is Moderate Forest and 8,176 Sq. Km. is Open Forest area. The urban area is about 6,558 Sq.Km. The total tree cover is 6,895 Sq. Km which is (1.32 %) of total G.A of Uttar Pradesh. Urban tree cover is 816 Sq. Km which is (12.45%) of total forest and tree cover 21,244 Sq. km in U.P, which is about (8.82%) out of the state G.A of Uttar Pradesh. Approx 2.69 % area is covered by forest and tree out of the total forest and tree cover in India. The change in forest cover with respect to India state of forest report 2011 is 11 Sq. Km (0.00 %) and number of stems are 17,219.536. The Vindhyan forests mostly consist of scrubs like mahua, salai, chironji, teak and tendu. Shisham grows along the river banks. Sal and Gigantic haldu types of forest present on the Sivalik foothills and in the terai-bhabhar area. Some species of grasses are also found in the Gangetic plain. Main types of forest found in U.P state are Dry tropical deciduous forests, Wet tropical deciduous forest and Tropical thorny forest. **(Fig 5.3.15).**

Forest covers in Uttar-Pradesh

1.	Total Geographical Area.	240,928 Sq. Km
2.	No. of districts (as per census 2001)	68
3.	No. of hill districts	0
4.	No. Tribal districts	1
5.	Very Dense Forest	1,623 Sq. Km
6.	Moderate Dense Forest	4,550 Sq. Km
7.	Open Forest	8,176 Sq. Km
8.	Total Forest Cover	14,349 Sq. Km

9.	% Forest Cover Total Geographical Area	5.96
10.	Urban Area	6,558 Sq. Km
11.	Total Tree cover	6,895 Sq. Km
12.	Urban Tree cover	816 Sq. Km
13.	Total forest and Tree cover	21,244 Sq. Km
14.	% of Total forest and Tree cover out of state G.A	8.82 %
15.	% of India's forest and tree cover	2.69 %
17.	Change in Forest cover 2011	11
18.	Change in % of forest	0.00
19.	Urban Tree cover	816 Sq. Km
20.	% of Urban area	12.45
21.	Stems	17,219,536

Table: 5.3.5 Source: India state of forest report 2013

5.3.3.2.2 Types of forest present in Enrouted and Command districts of Proposed Sharda Yamuna Link canal of Uttar Pradesh State (Table 5.3.6).

- Bijnor and Rampur has both Open and Dense Forest area.
- Muzaffarnagar, Moradabad, Jyotiba Phule Nagar, Bareilly and Badaun Districts have Open Forest area

Types of Forest Present in Enrouted and Command areas

Areas	**Districts**	**Type of Forest**
Enrouted Areas	Bijnor	Open Forest
		Dense Forest
	Muzzaffarnagar	Open Forest
Command Areas	Moradabad	Open Forest
	Jyotiba Phule Nagar	Open Forest
	Bijnor	Open Forest
	Rampur	Open Forest

		Dense Forest
	Bareilly	Open Forest
	Badaun	Open Forest

Table: 5.3.6

Area covered by Non- Forest, Open Forest, Very Dense Forest, Moderate Dense Forest and Scrubs in Uttar Pradesh **(Fig 5.3.13 ;5.3.14)** .

1. Non Forest Area (N.F) = 93.72 %
2. Open Forest (O.P) = 3.39 %
3. Very Dense Forest (V.D.F) = 0.675 %
4. Moderate Dense Forest (M.D.F) = 1.89 %
5. Scrub = 0.33 %

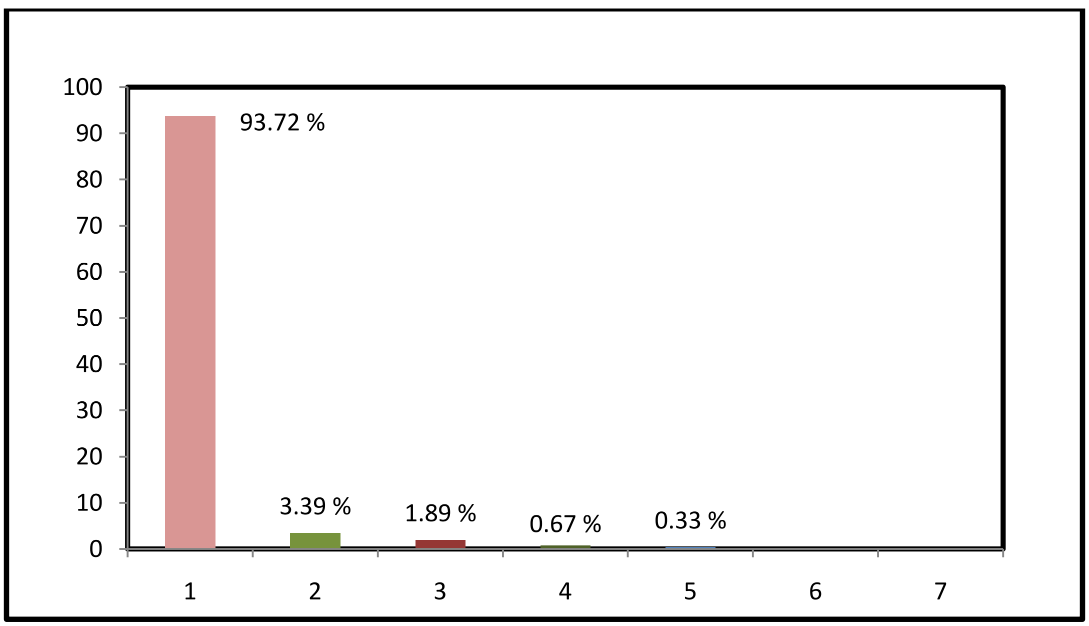


Fig: 5.3.13 Graph showing Types of Forest cover of Uttar Pradesh State (in Percentage)

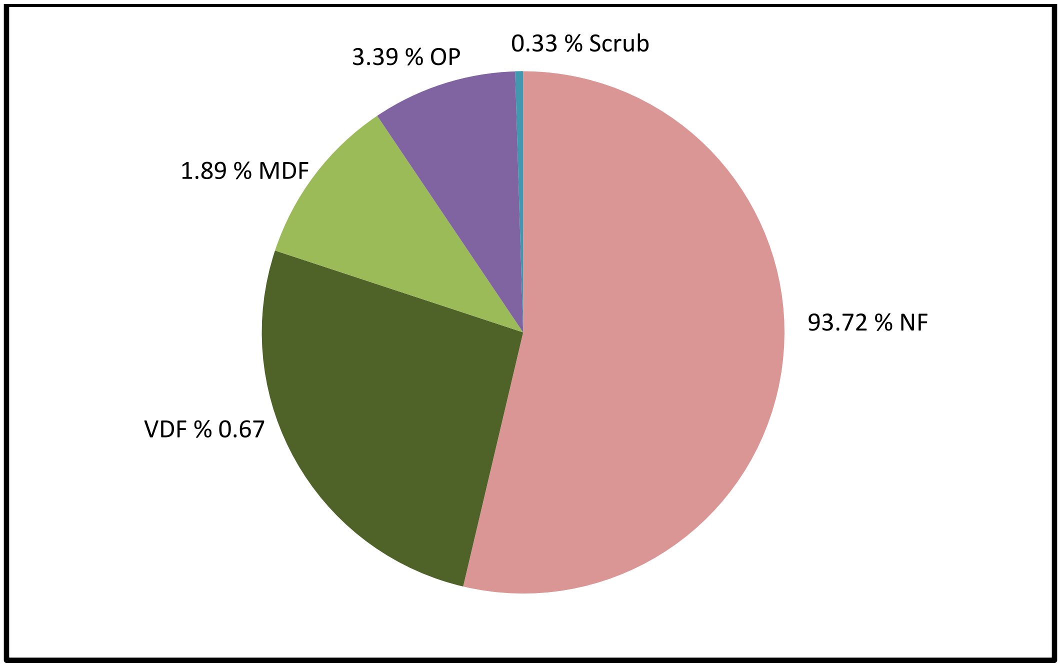


Fig: 5.3.14 Pie Chart showing Types of Forest cover of Uttar Pradesh State (in Percentage)

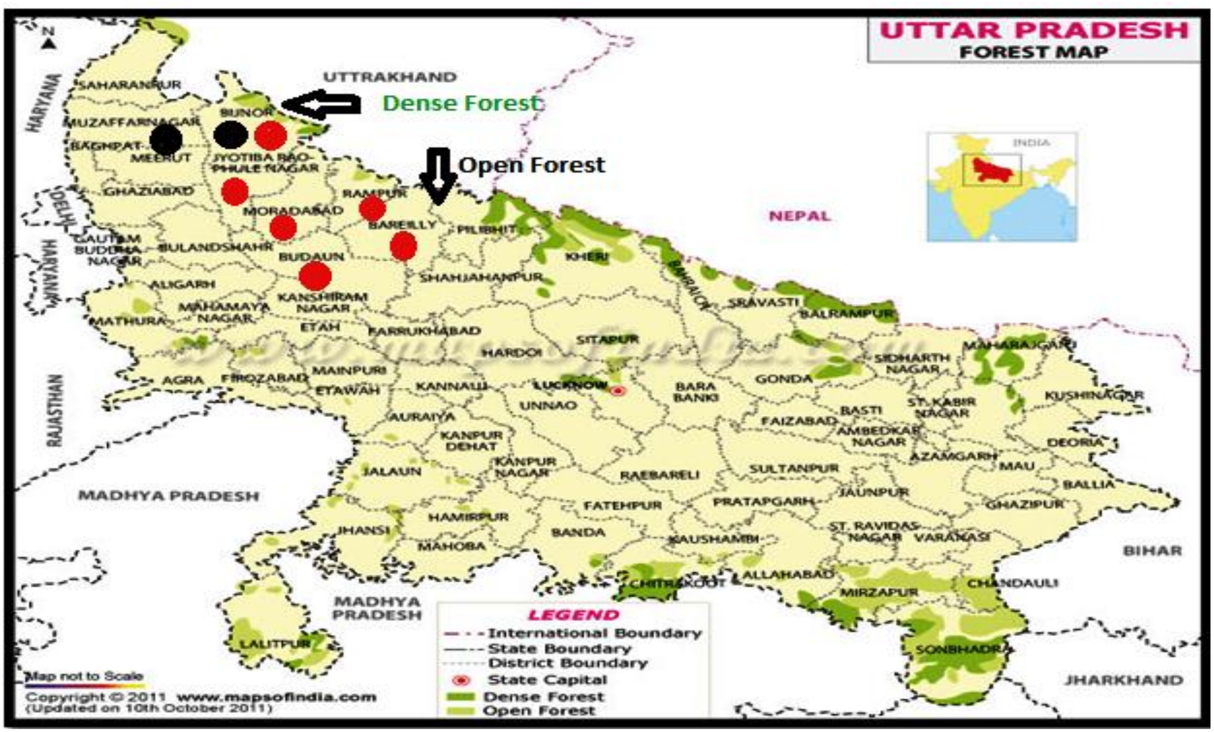


Fig: 5.3.15 Forest Map of Uttar Pradesh Source: Maps of India

Types of Forest Present in Enrouted and Command areas of Proposed Sharda Yamuna Link Canal

5.3.3.2.3 District wise Forest Cover in Uttar Pradesh (Fig 5.3.16)

- **i.** Bijnor has approx (9.14%) of Forest cover out of the total G.A of Bijnor 4561 Sq. Km **(Fig 5.3.17).**
- **ii.** Muzzafarnagar has (1.02 %) of Forest cover out of the total G.A of Muzzafarnagar 4008 Sq. Km **(Fig 5.3.18)**.
- **iii.** Moradabad has (0.07 %) of Forest cover out of the total G.A of Moradabad 4008 Sq. Km **(Fig 5.3.18).**
- **iv.** Approx (3.82 %) of area is covered by Forest by Jyotiba Phule Nagar out of the total G.A of Jyotiba Phule Nagar 2249 Sq. Km **(Fig 5.3.18).**
- **v.** Rampur has (3.35 %) of Forest cover out of the total G.A of Rampur 2367 Sq. Km **(Fig 5.3.18).**
- **vi.** Bareilly has approx (1.07 %) of forest cover out of the total G.A of Bareilly 4120 Sq. Km **(Fig 5.3.19).**
- **vii.** About (0.85 %) of Forest covered by Badaun out of the total G.A of Badaun 5268 Sq. Km **(Table 5.3.7).**

District wise forest cover in Uttar Pradesh

S. No	**Districts**	**Total G.A (Sq. Km)**	**V.D.F (Sq. Km)**	**M.D.F (Sq. Km)**	**O.F (Sq. Km)**	**Total (Sq. Km)**	**% Forest Area**	**Non-Forest (Sq. Km)**	**% Non-Forest**
1.	**Bijnor**	4561	42	228	147	**417**	9.14	**4144**	90.85
2.	**Muzzafarnagar**	4008	0	14	27	**41**	1.02	**3967**	98.97
3.	**Moradabad**	3718	0	5	21	**26**	0.69	**3692**	99.3
4.	**Jyotiba Phule Nagar**	2249	0	24	62	**86**	3.82	**2163**	96.17
5.	**Rampur**	2367	4	26	47	**77**	3.25	**2290**	96.74
6.	**Bareilly**	4120	0	7	37	**44**	1.065	**4076**	98.93
7.	**Badaun**	5168	0	12	32	**44**	0.851	**5124**	99.14

Table: 5.3.7 Source: India State of Forest Report 2013

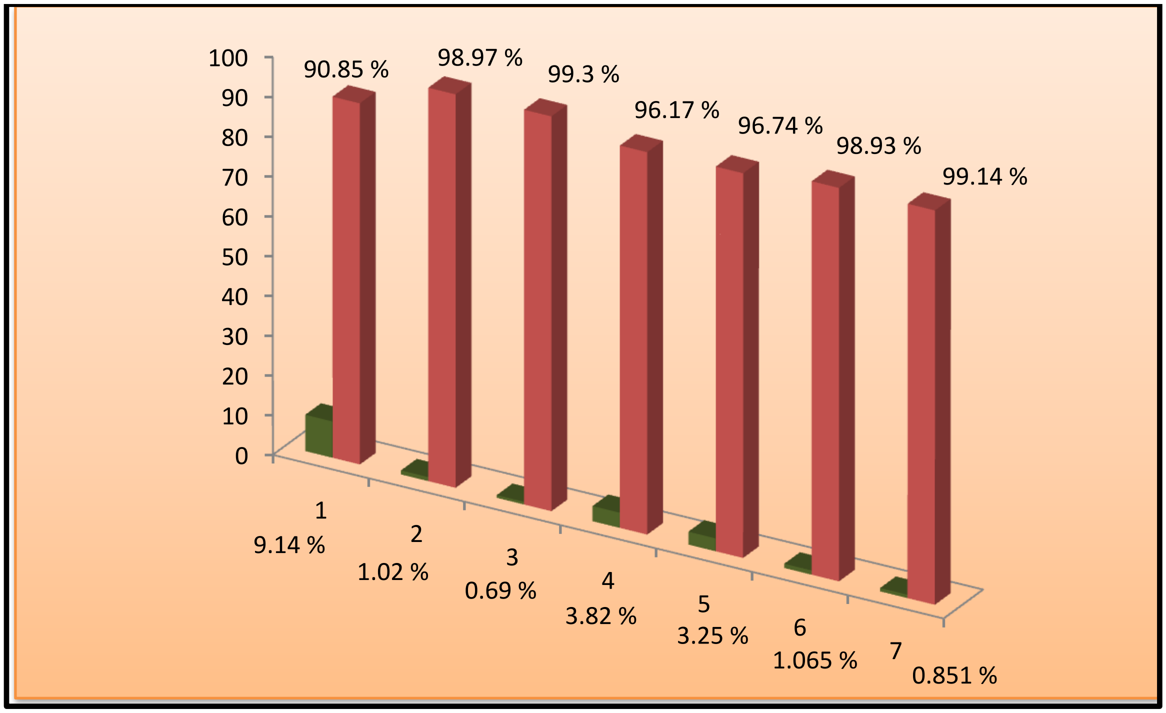


Fig: 5.3.16 District wise forest cover in Uttar Pradesh

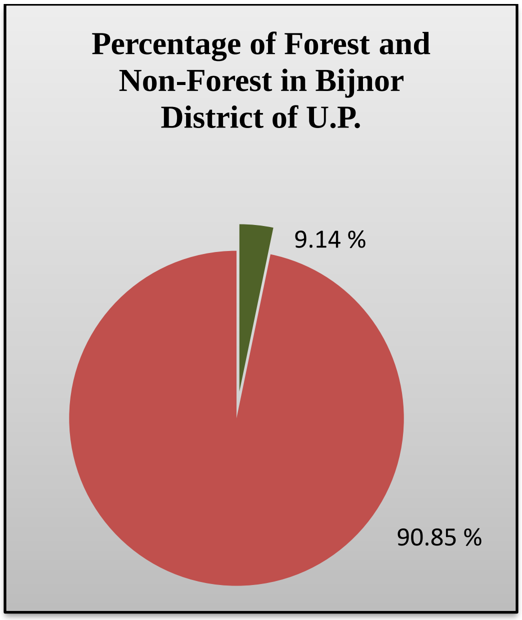


Fig: 5.3.17

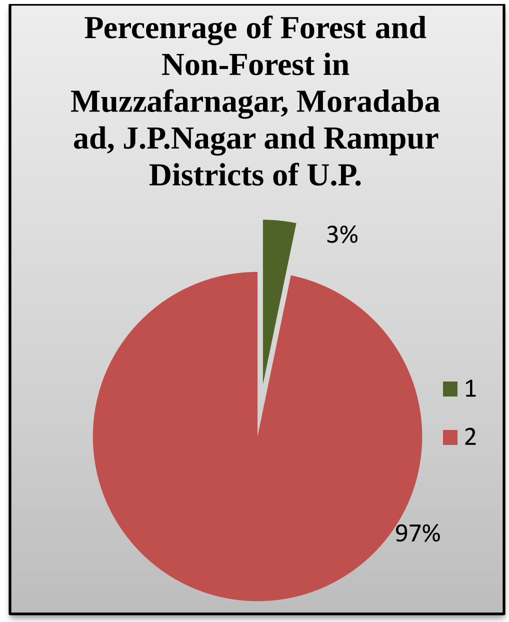


Fig: 5.3.18

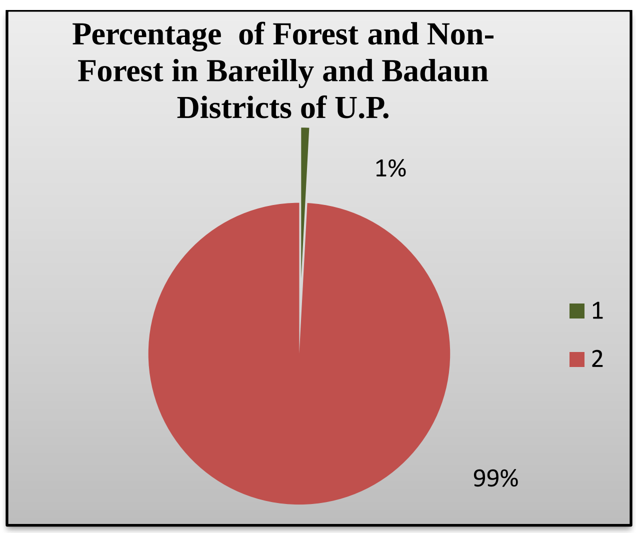


Fig: 5.3.19

Percentage of Forest and Non- Forest in Districts of U.P

5.3.4 FOREST ADMINISTRATIVE SET UP ALONG THE CANAL

Field survey was conducted by CES team along the canal alingment, about 112 Km of the strech of proposed link canal pass through reserve forest. **(Table 5.3.8)** shows forest administrative set up along the canal below. Some other species (Trees, Shrubs, Herbs, Grasses, Climbers, Bamboos, Timber, Fruits and Ornamental plants) of flora in the Enrouted and Command area of the link canal are given below in **(Table 5.3.9 ; 5.3.10; 5.3.11; 5.3.12; 5.3.13 ; 5.3.14 ; 5.3.15).**

Vegetation along the canal alingment

S. No	Canal Division	Forest Division	Range	Predominant Species
1.	0 Km -13.5 Km	Haldwani	Sharda, Chela, Guliapani	Mixed mainly Kanju, Teak,Sal and Khair
2.	13.5 Km - 21.5 Km	Tarai East	Kalipura, Dogari	Mixed forest and plantation of Teak
3.	21.5 Km -28.2 Km	Haldwani	Sharda, Jaulasal	Mixed forest mainly Sal
4.	28.2 Km -29.5 Km	Tarai East	South Jaulasal	Mainly Sal
5.	29.5 Km -41.7 Km	Haldwani	Jaulasal	Mixed forest mainly Sal
6.	41.7 Km -49.2 Km	Tarai East	Ransali	Mixed forest mainly Teak, Sheesham
7.	49.2 Km -50 Km	Private land mainly agricultural land		
8.	50 Km -53.3 Km	Haldwani	Nandhaur	Mainly Teak and Sal
9.	53.3 Km -66.8 Km	Tarai East	Kisanpur	Mainly Teak, Sal, Sheesham, Khair and degraded forest land
11.	66.8 Km -99 Km	Tarai Central	Barheni	Eucalyptus mixed plantation, Teak and sheesham
12.	99 Km -101.5 Km	Tarai West	Bannakhera	Eucalyptus vulnerable to degradation
13.	101.5 Km-110.4 Km	Private land mainly agricultural land		
14.	110.4 Km-117.5 Km	Tarai West	Ramnagar	Degraded Open Sal, Mixed forest mainly Eucalyptus and Sheesham
15.	117.5 Km-119.7 Km	Private Land		

16.	119.7 Km-121.5 Km	Tarai West	Ampokhra	Mixed forest, mainly Sheesham plantation
17.	121.5 Km-122.8 Km	Private land mainly agricultural land		
18.	122.8 Km-126.8 Km	Gausala (Military Land)		
19.	126.8 Km -130 Km	Private land mainly agricultural land		
20.	130 Km -136.3 Km	Tarai West	South Jaspur	Mixed forest mainly Sal
21.	136.3 Km-142.8 Km	Private land mainly agricultural land		
22.	142.8 Km -144.3 Km	Tarai West	South Jaspur	River bank with Sheesham Forest
23.	144.3 Km -147 Km	Private land mainly agricultural land		
24.	147 Km -151 Km	Forest Area	Alamgarg	Degraded Area
25.	151 Km -163 Km	Private land		
26.	163 Km -165 Km	Ramganga River bed forest area	-	Degraded Area
27.	165 Km -166.7 Km	Private land		
28.	166.7 Km -170.5 Km	Forest near Bhogpur Settlement	-	Degraded Area
29.	170.5 Km -171.5 Km	Private land		
30.	173.10 Km -180 Km	Forest near Tanda	Sahuwala	Sal, Eucalyptus and Mixed forest
31.	180 Km -261.5 Km	Private land mainly agricultural land		
32.	261.5 Km -263.5 Km	Pathari	-	Mixed forest including Palm
33.	263.5 Km-384 Km	Private land mainly agricultural land		

Table: 5.3.8 Source: NWDA

5.3.5 FLORA SPECIES FOUND ALONG THE CANAL ALIGNMENT

- **List of Trees**

S. No	Common Name	Scientific Name
1.	Aru	*Ailanthus Excelsa*
2.	Bel	*Embelica officinalis*
3.	Aam	*Mangifera Indica*
4.	Imli	*Tamarindus Indica*
5.	Kusum	*Scleichera oleosa*
6.	Kanju	*Holoptelia integrifolia*
7.	Khajoor	*Phoenix humilis*
8.	Khadik	*Celtis tetranda*
12.	Gutel	*Trewia nudiflora*
16.	Neem	*Azadirachta indica*
17.	Peepal	*Ficus religiosa*
18.	Paper mulberry	*Broussonetia papyrifera*
19.	Bel	*Aegel marmelos*

Table: 5.3.9

- **List of Shrubs and Herbs**

S. No	Common Name	Scientific Name
1.	Karaunda	*Carissa carandus*
2.	Aak	*Calotropis procera*
3.	Bansa	*Adhatoda vasica*
4.	Manta	*Desmodium cephalotes*
5.	Kuri	*Lantana camara*
6.	Falsa	*Grewia sapida*
7.	Lantana	*Lantana camara*

Table: 5.3.10

- **List of Grasses and Climbers**

S. No	Common Name	Scientific Name
1.	Kus	*Chrysopogon griseus*
2.	Kanguli	*Clemetis species*
3.	Daab	*Desmostachya bipinnata*
4.	Kukriya Mulsa	*Oplismenos undulatifolius*
5.	Baan	*Sorghum halepense*

6.	Paneri	*Choris incompleta*
7.	Dhaula	*Chrysopogon Fulvus*
8.	Bhadiya	*Dalbergia volubilis*
9.	Baallu	*Setaria species*
10.	Suhi	*Aristida cynantha*
11.	Bet	*Calamus tenuis*
12.	Kans	*Saccharum spontaneum*

Table: 5.3.11

- **List of Bamboos**

S. No	Common Name	Scientific Name
1.	Bans	*Dendrocalamus Strictus*
2.	Kathbans	*Bambusa arundinaceae*

Table: 5.3.12

- **List of Timber**

S. No	Common Name	Scientific Name
1.	Teak	*Tectona grandis*
2.	Sal	*Shorea robusta*
3.	Khair	*Acacia Catechu*
4.	Sheesham	*Dalbergia Sissoo*
5.	Safeda	*Eucalyptus*
6.	Haldu	*Adina cordifolia*

Table: 5.3.13

- **List of Fruit Species**

S. No	Common Name	Scientific Name
1.	Manga	*Magnifera indica*
2.	Amla	*Embelica officinalis*
3.	Palm	*Phoenix siylrestris*
4.	Imlia	*Tamasnindus indica*
5.	Ber	*Zyxiphus jujuba*

Table: 5.3.14

- **List of Ornamental Species**

S. No	Common Name	Scientific Name
1.	Chhitwan	*Alstonia scholanis*
2.	Kachnar	*Bauhinia variegata*
3.	Amaltar	*Cassia fistula*
4.	Semal	*Bombax ceiba*

Table: 5.3.15

5.3.6 MEDICINAL & AROMATIC PLANTS ALONG THE ALINGMENT

Uttarakhand is rich in varieties of herbs, medicinal and aromatic plant species.

i. There is an increase in the cultivation of aromatic and medicinal plants **(Table 5.3.16).**

ii. The Himalayan region supports medicinal species includes about 18,440 species Angiosperm species of about 8000 species, Gymnosperm 44 species, Pteridophytes 600 species, Bryophytes 1736 species lichens 1159 species and Fungi of about 6900 species having medicinal properties of about 45%.

Medicinal Plants and Trees with their Uses

S. No.	Local Name	Botanical Name	Parts Used	Uses
1.	**Garila**	*Trifolium repens*	Whole plant	For Satrika
2.	**Danti Brajdanti**	*Potentilla argyrophylla*	Leaf/Root	For stomach problem
3.	**Chaitula**	*Rhamnus virgata*	Fruit	In Leg swelling
4.	**Silfhora**	*Bergenia ciliata*	Root	For Hydrophobia
5.	**Dhow**	*Woodfordia floribunda*	Flower	As energy syrup
6.	**Samyo, Dhup**	*Valeriana hardwichii*	Root	For titaini
7.	**Quiar, Indraw**	*Holarrhena antidysenterica*	Seed & bark	In fever, Gastric & dysentery
8.	**Ank**	*Calotropis procera*	Root	In indigestion
9.	**Ratpatia**	*Ajuga parviflora, Benth*	Whole plant	In arthritis
10.	**Tulsi**	*Ocimum sanctum*	Whole plant	In fever
11.	**Jangali tulsi**	*Origanum vulgare*	Whole plant	Indigestion
12.	**Karuijhar**	*Scutellaria angulosa*	Whole plant	In acidity
13.	**Esabgol**	*P. orata*	Seed	In dysentery

Table: 5.3.16 Source: Google

5.3.7 PROTECTED AREAS IN UTTAR PRADESH

5.3.7.1 Flora and Fauna

Uttar Pradesh state has plenty of natural resources. It the state has many species of flora and fauna are found in the upper mountainous forest. It includes varieties of species such as woody plants 1,000, trees 3,000, shrubs 400 and woody climbers 100 etc. The species of grasses have been identified about more than 200 in the Gangetic plain with rich in medicinal plants. Its avifauna is among the richest in the country. The birds include pigeons, blue jay, peafowl, snipes and parrots. The U.P is rich in fauna such as wild boars, jungle cats, leopards, jackals, foxes, tigers, monitor lizards and some other species include mammals and reptiles. The state has one national park the Jim Corbett Park and about 12 wildlife sanctuaries to provide protection to the wildlife **(Table 5.3.17).** The Corbett National park is a major region of tourism, which covers in an area of about 324 Sq. Km of land. In the past years, there is decrease in no. of species in fauna with varieties. Fauna specie includes some tigers and wild buffalos found in along the banks of the Ganga river. The Indian antelope declared a protected species in the state Uttar Pradesh. Some medicinal plants are also found. The huge no. of fauna species include amphibians, fresh-water fish, reptiles, animals such as chinkara and crabs are found due to river Ganga and its tributaries. Some babool trees are are also found in abundance along the region. Gangetic plain gives support to a large variety of flora and fauna specie. Moist deciduous trees and Tropical dry deciduous forests grow in the upper Gangetic plain along the banks used for cultivation. Some tropical thorn forest mainly babool are scattered mostly in the south western regions of the state. These forests are generally found in areas, where low rainfall occurs (50–70 cm), a mean annual temperature of about 25-27 °C and low humidity. Some bird sanctuaries are also located in the state include Hastinapur Sanctuary, Chandra Prabha Sanctuary, Bakhira Sanctuary, National Chambal Sanctuary, Kaimoor Sanctuary and Okhla Sanctuary (**Fig 5.3.20).** Some species of reptiles are are found such as lizards, cobras, kraits and ghariyals etc. Mahaseer is the most common fish species is found. In the Uttar Pradesh state some endangered species are found such as lion in the Gangetic plain and rhinocerous in the Terai area. Some species are vulnerable due to poaching activities. In the belt of temperate mountainous forests, species of reptiles, insects, mammals and trees are found.

Protected areas in Uttar Pradesh

Uttar Pradesh	**Total No.**	**State Area Sq. Km**	**Area Sq. Km**	**Percent of Total state area**
1. National Park	1	240,928	490	0.20
2. Wildlife Ssnctuaries	23	240,928	5221.88	2.17

Table: 5.3.17

Fig: 5.3.20 Protected Areas in Uttar Pradesh State Source: Maps of India

5.3.8 PROTECTED AREAS IN UTTARAKHAND

The Uttarakhand state is commonly known for its biodiversity. Due to difference in geographic and climatic conditions, different types of forests are found in the region Himalayas and Terai plains. About 12 % of the total G.A is the protected areas which include 6 National Parks, 6 wildlife sanctuaries and 3 Conservation Reserves **(Table 5.3.18).** Uttarakhand state is rich in both flora and fauna species, which are protected by National parks and wildlife sanctuaries. The Jim Corbett National Park is the first National Park is located at the Ramnagar area in Nainital District. Some other protected areas are Valley of Flowers National Park and Nanda Devi National Park in Chamoli District, which are a World Heritage Sites. Rajaji National Park in Haridwar district, Govind Pashu Vihar National Park and Gangotri National Park in Uttarkashi area are the other protected regions in the state. There are about 102 mammals species, 600 Bird species, 19 amphibians species, 70 reptilian species and about 124 species of fishes are found. Some endangered species include Musk deer (*Moschus chrysogaster*), Guldar (*Panthera pardus*), tiger (*Panthera tigers*), Asian elephant (*Elephus maximus*), Snow leopard (*Panthera uncial*) and Monal (*Lophophorus impejanus*) etc.

Protected areas in Uttarakhand

Uttarakhand	**Total No.**	**State Area Sq. Km**	**Area Sq. Km**	**Percent of Total State Area**
1. National Park	6	53,483	4915.44	9.19
2. Wildlife Sanctuaries	7	53,483	2,688.64	5.03

Table: 5.3.18

5.3.9 FAUNA OF THE STUDY AREA ALONG THE CANAL

Fauna of the Enrouted and Command areas of the proposed S-Y link canal include some species of birds, mammals, reptiles and fishes shown in given tables **(Table 5.3.19; 5.3.20; 5.3.21; 5.3.22).**

- **List of Some Birds**

Several varieties of birds are found such as ducks, partridges and pigeons. The extinct species is pink headed and Green pigeons are becoming less in no. due to felling of fruits and berry trees.

List of Birds

S. No.	**Common Name**	**Scientific name**
1.	Common Peafowl	*Pavo cristatus linnaeus*
2.	Jungle Bush Quail	*Perducula asiatica*
3.	Common Green Pigeon	*Columba livia*
4.	Little Brown Dove	*Streptolepia senegaleninsis*
5.	Emerald Dove	*Chalophaps indica*
6.	Little Grebe	*Tachybaptus ruficollis*
7.	Brahmany Duck	*Tadorna ferruginea*
8.	Lasser Whistling Teal	*Dendrocygna Javanica*
9.	Mallard	*Anas Platyrhyncos*
10	Red Crested Pochard	*Netta rufina*
11.	Blue Rock Pigeon	*Columbia livia*
12.	Spotted Dove	*Streptolepia tranquebarica*
13.	Ring Dove	*Streptolepia decaocto*
14.	Comb Duck	*Sarkidiornis nelanotos*
15.	Scaup Duck	*Aythya marila*
16.	River Tern	*Sterna aurantia*
17.	Painted Stork	*Mycteria leucocephala*
18.	Open Bill Stork	*Anastomus oscitans*
19.	Lesser Spotted Eagle	*Aguila ponarina*
20.	Crested Hawk Eagle	*Spilornis cheela*
21.	Long – billed vulture	*Gyps indicus*
22.	White baked vulture	*Gyps bengalensis*
23.	Common Tern	*Sterna hirundo*
24.	Grey Heron	*Ardea alba*
25.	White breasted Kingfisher	*Halcyon smyrnensis*

Table: 5.3.19

- **List of Mammals**

S. No.	Common Name	Scientific name
1.	Monkey	*Macaca Mulatta*
2.	Common langur	*Presbytis entellus*
3.	Leopard	*Panthera pardus*
4.	Common Mongoose	*Herpestes edwarsii*
5.	Elephant	*Elephas maximus*
6.	Barking deer	*Muntiacus*
7.	Bharal	*Pseudois nayaur*
8.	Swamp Deer	*Rucervus duvaucelii*
9.	Tiger	*Panthera tigris*

Table: 5.3.20

- **List of Reptiles**

In rural areas different types of reptilian species are found such as Cobra, Krait, Rat and Snake etc. Some other reptiles found in the district are the Geeko, Chameleon, and Moniter lizard.

S. No	Reptiles	Scientific name
1.	Cobra	*Naja naja*
2.	Marsh Crocodile	*Crocodilus palustris*
3.	Ghariyal	*Ghavialis gangeticus*
4.	Monitor Lizard	*Varanus bengalensis*
5.	King Cobra	*Ophiophagus hannah*
6.	Garden Lizard	*Calotes versacolor*

Table: 5.3.21

- **List of Fishes**

Some fish species are also found in the rivers, ponds, springs and reservoirs such as Mangur (Clarius batrachus), Tengra (Mystas seenghala), Parhan (Wallagonia attu), Rohu (Labeo rohita), saul (Ophiocephelus) and nain (cirrhina mrigala) etc.

S. No	Fishes	Scientific name
1.	Chilwa	*Cheela argentia*
2.	Rohu	*Labeo rohita*
3.	Mahaseer	*Barbus putitora*
4.	Saul	*Channa marulius*
5.	Katla	*Catla catla*

Table: 5.3.22

5.3.10 IMPACT OF PROPOSED SHARDA- YAMUNA LINK CANAL ON FOREST AND NON-FOREST AREA OF ENROUTED DISTRICTS IN UTTAR-PRADESH AND UTTARAKHAND STATE (Table 5.3.23).

5.3.10.1 Enrouted Districts in Uttarakhand State

i. Champawat and Nainital Districts

Champawat and Nainital districts have more Open and Dense Forest Area. The Total forest in Champawat and Nainital is 4261 Sq.Km; Total G.A of U.K is 53,483 Sq.Km. Approx 7.96 % of forest area covered by Champawat and Nainital out of the total G.A of U.K. The open forest area in Champawat and Nainital districts can be converted into densely forest area, after the construction of the Link canal.

ii. Udham Singh Nagar and Haridwar Districts

Maximum Non-forest area covered by Udham Singh Nagar and Haridwar Districts are of about 1996 Sq. Km and 1745 Sq.Km The total Non-forest area in the districts is about 3741 Sq. Km out of total G.A Uttarakhand state (53,483 Sq. Km) which is about 6.99%.

iii. Nainital District

In the total Geographical Area is 4251 Sq. Km, out of which it has 3074 Sq. Km (approx 72.37 %) is the Forest part and 1177 Sq. Km (approx 27.68 %) is Non Forest part. Forest part of Nainital district may also benefit after the construction of the link canal. It helps in increasing biodiversity and maintains the ecological balance**.**

Command and Enrouted Districts in Uttarakhand

In both Enrouted and Command Areas of proposed Sharda-Yamuna Link Canal maximum Forest area of about 1187 Sq. Km and 3074 Sq. Km covered by Champawat and Nainital**.**

5.3.10.2 Enrouted Districts in Uttar pradesh

Bijnor and Muzzaffarnagar districts are the Enrouted areas of the proposed link canal of Uttar Pradesh. Among Bijnor and Muzzaffarnagar districts, Bijnor has highest Forest cover of about (417 Sq. Km). It has both Forest Area and Non-Forest area more than Muzzaffarnagar district (41 Sq. Km). After the construction of the link canal, forest area can be converted into densely forest area and Non- Forest area into the forest part.

Command Districts in Uttar Pradesh

i. Forest Area

Jyotiba Phule Nagar and Rampur districts have more Forest area than other command districts like Moradabad, Bareilly, Bijnor and Badaun in Uttar Pradesh.

ii. Non-Forest Area

All districts of command areas like Moradabad, Jyotiba Phule Nagar, Bijnor, Rampur, Bareilly, Badaun and Moradabed has less Forest Area which is Open Forest Area positively benefited by the proposed Sharda Yamuna Link Canal.

In Both Command and Enrouted Districts in Uttar Pradesh

In both Command and Enrouted Areas, Bijnor and Rampur Districts have both types of Open forest and Dense Forest is present. But in comparison to both the maximum dense forest is covered by Bijnor than Rampur, both these districts will moderately benefited by Proposed Sharda-Yamuna Link Canal. Minimum impact will be on the forest area of Bijnor than in Rampur Districts. Overall in Enrouted and Command areas, Badaun has Non-Forest area (5124 Sq. Km.) and Bijnor has highest Forest area (417 Sq. km). The state Uttarakhand has about 6 National Parks and 7 Wildlife Sanctuaries and about 3 Conservation Reserves **(Table 5.3.20).**

Forest and Non-Forest Area of Enrouted Districts in Uttar-Pradesh and Uttarakhand State

S. No	Districts	Total G.A (Sq. Km)	Very Dense Forest (Sq. Km)	Moderate Dense Forest (Sq.Km)	Open Forest Area (Sq.Km)	Total Forest Area (Sq.Km)	% Forest Area	Non-Forest Area (Sq.Km)	% of Non-Forest Area
1.	**Bijnor**	4561	42	228	147	**417**	9.14	**4144**	90.85
2.	**Muzzafarnagar**	4008	0	14	27	**41**	1.02	**3967**	98.97
3.	**Champawat**	1,766	337	576	274	**1,187**	67.21	**579**	32.78
4.	**Nainital**	4,251	605	1,899	570	**3,074**	72.37	**1177**	27.68
5.	**Haridwar**	2,360	25	333	257	**615**	26.06	**1745**	73.94
6.	**Udham Singh Nagar**	2,542	175	236	135	**5,46**	21.48	**1996**	78.52

Table: 5.3.23

- ✓ **Impact of Proposed Sharda- Yamuna Link Canal on forest area of Enrouted Areas (Table 5.3.23), (Fig 5.3.21;22).**

The total forest area in the Enrouted areas of U.P is 458 Sq. Km and the total forest area in Enrouted areas of state U.K is 5,422 Sq. Km. The total forest area in Enrouted areas of U.P and U.K is 5,880 Sq. Km. The entire 384 Km stretch of proposed Sharda- Yamuna Link Canal is likely to transverse 112 Km through forest area. Impact of proposed Sharda- Yamuna Link Canal on forest area of Enrouted areas is 5,768 Sq .Km, which is of about 1.9 % of total forest area of U.P and U.K. Proposed Sharda- Yamuna Link Canal will cover of about 1.9 % of forest area out of total forest area of U.P and U.K.

- ✓ **Impact of Proposed Sharda- Yamuna Link Canal on Non-forest area of Enrouted Areas (Table 5.3.23).**

Total Geographical area of U.P and U.K is 2, 94,412 Sq. Km. The forest area of Enrouted areas of U.P and U.K. after the construction of proposed Sharda- Yamuna Link Canal will be 5,768 Sq. Km, so the non-forest area will be 2,88,644 Sq .Km. which is of approx 98.04 % of Total Geographical area of U.P and U.K.

- ✓ **Impact of Proposed Sharda- Yamuna Link Canal on Geographical area of U.P and U.K**

Total Geographical area of U.P and U.K is 2, 94,412 Sq. Km. Impact of proposed Sharda- Yamuna Link Canal on Total Geographical area of U.P and U.K is 294399 Sq. Km, which is of approx 0.03 % of total Geographical area of U.P and U.K. About 0.03 % of Geographical area out of the total Geographical area of U.P and U.K. will be covered by the link canal.

- ✓ **Impact of Proposed Sharda- Yamuna Link Canal on Total forest area of U.P and U.K**

Total forest area of U.P is 14,349 Sq. Km. Total forest area of U.K is 24,508 Sq. Km. Total forest area of U.P and U.K. is 38,857 Sq. Km. Impact of proposed Sharda- Yamuna Link Canal on total forest area of U.P and U.K. is 38,745 Sq. Km. About 38,745 Sq. Km of forest area out of total forest area of U.P and U.K. will remain, which is of approx 0.2 % of total forest area of U.P and U.K.

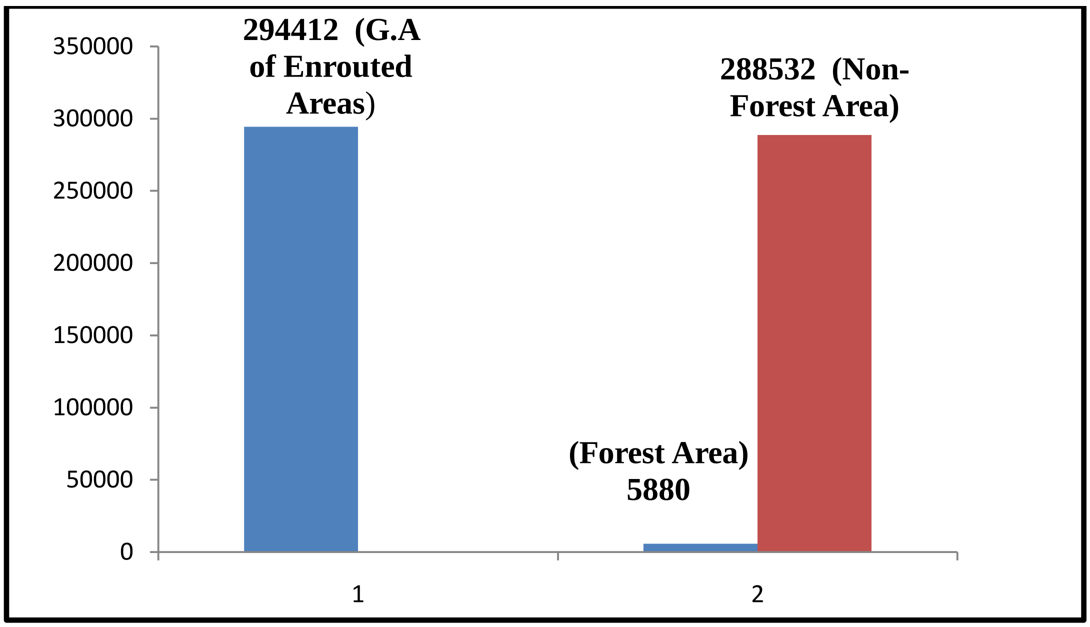


Fig: 5.3.21 Forest and Non-Forest Area of Enrouted areas before construction of Link Canal

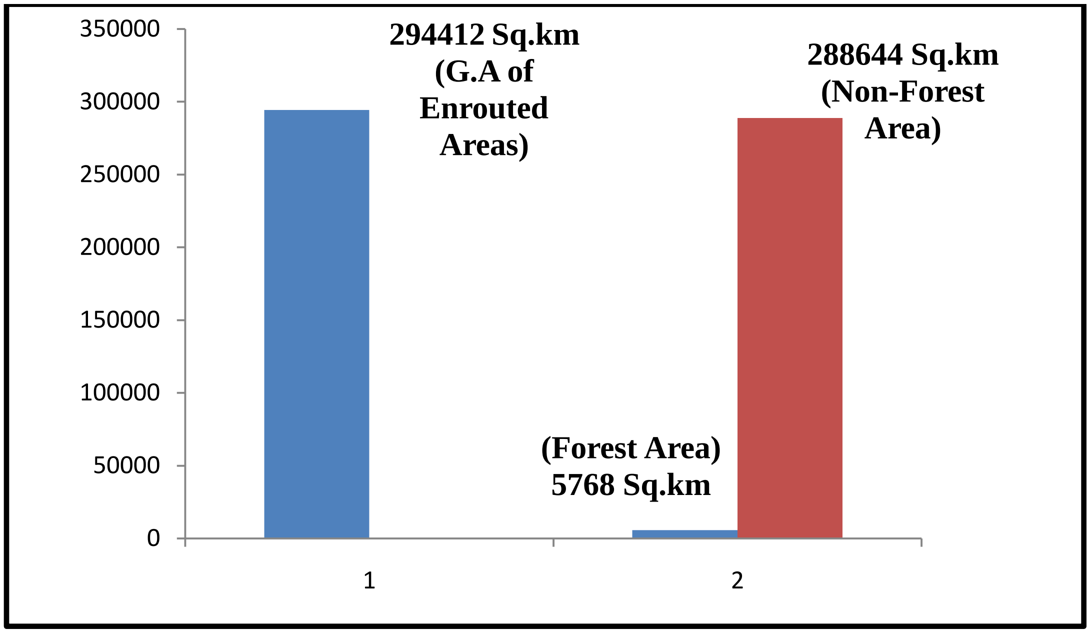


Fig: 5.3.22 Forest and Non-Forest Area of Enrouted areas after construction of Link Canal

This proposed link canal will more helpful for U.P than U.K, because in comparison to U.K, U.P has more open forest area and less densely forest area.

In U.P all the districts of Enrouted and command areas will be benefited but maximum positive benefit to Bijnor and Muzzaffarnagar because these are enrooted areas and less benefit to all the command areas of proposed Sharda – Yamuna Link Canal.

5.3.11 IMPACT OF PROPOSED LINK CANAL ON WILDLIFE RESERVES

"The canal alignment does not pass through any Wildlife Sanctuary or Biosphere reserve, but the nearest wildlife reserve is Jim Corbett National park which is a Tiger Reserve".

The minimum lining of the link canal from Jim Corbett National Park is about 1 Km at Kuankhera village in Nainital district of Uttarakhand, However there is possibility of migration of animals within the forests in the area **(Fig 5.3.23 ; 5.3.27).**

5.3.11.1 Jim Corbett National Park

The Jim Corbett National Park is a National Park of an IUCN category II. It is located in Ramanagar in Nainital district of Uttarakhand in India (**Fig 5.3.24). *It was established in 1936, which is the oldest National park in India*** as Hailey National park and in 1956; it was renamed abolishment of National Park. ***The National park is located in the two districts Nainital and Pauri in the hills of Uttarakhad state in India*** **(Fig 5.3.25).** Its geographical region lies in between the Himalayas and the terai region. It covers an area of about 521 Sq.Km. The elevation of the N.P ranges from 1,300 feets (400m) to 4,00 feets (1,200 m). The climate is temperate type in the park. The temparature differs from 5 °C to30 ° C in the winter season and generally do not rise above 40 °C in summers. Rainfall ranges from low to heavy during the monsoons seasons. The rainy season mostly from July to September during the monsoon seasons. The Corbett National Park consists of wet, dry, plain and mountainous, forests which attract different plant and animal species. It covers of about 488 species of plants and animals. Approx. 10% of the region consists of grassland species, tree species about 110 %, species of mammals 50%, species of birds and 25% species of reptiles. The most common fauna species of the Corbett N.P. are the Bengal Tigers and Asiatic Elephant and avifauna is the another one of the richest bird species. In every season, more than 70,000 tourists come to the park from India and other countries.

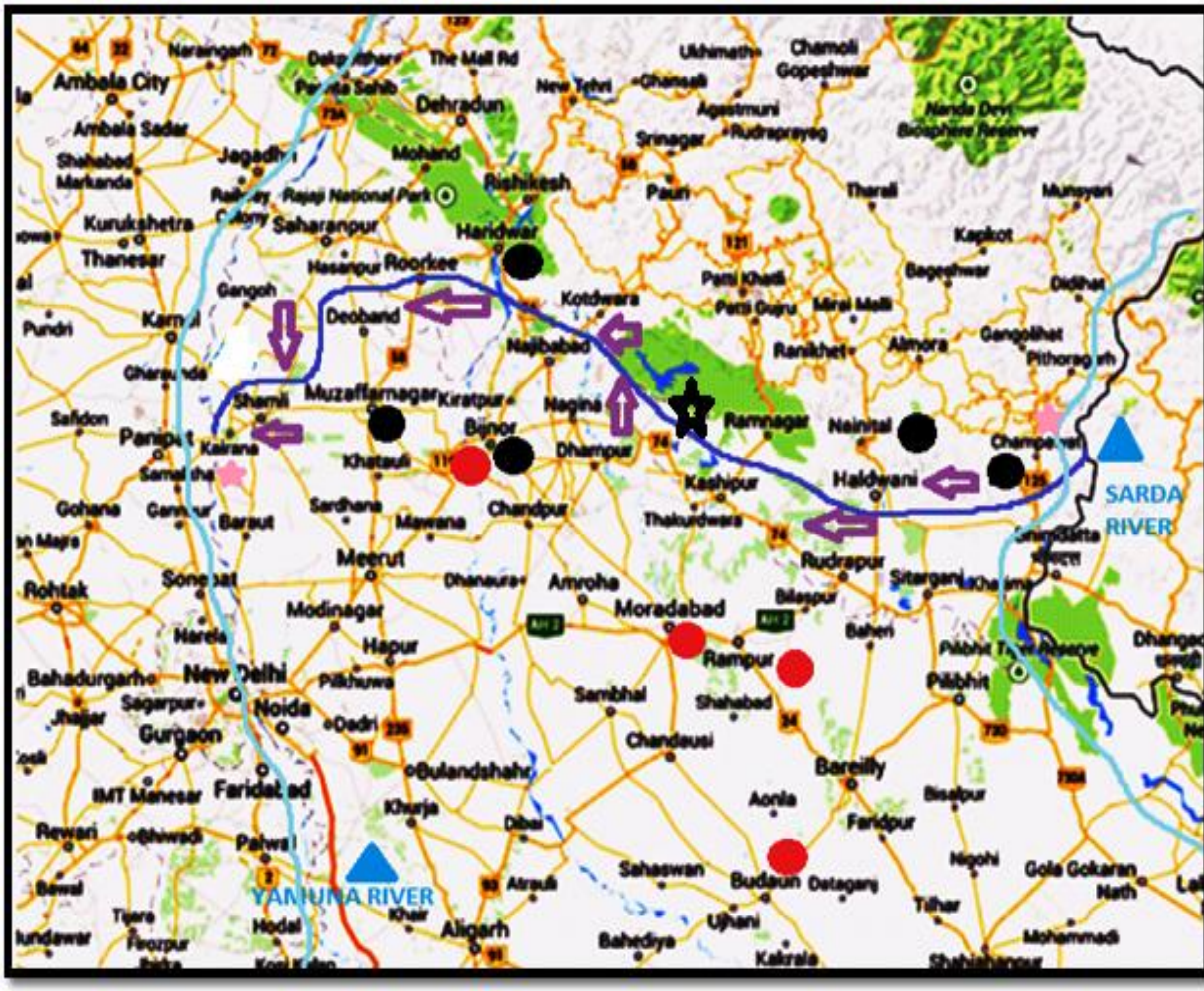


Fig: 5.3.23 Jim Corbett National Park (location Map) Source: Google

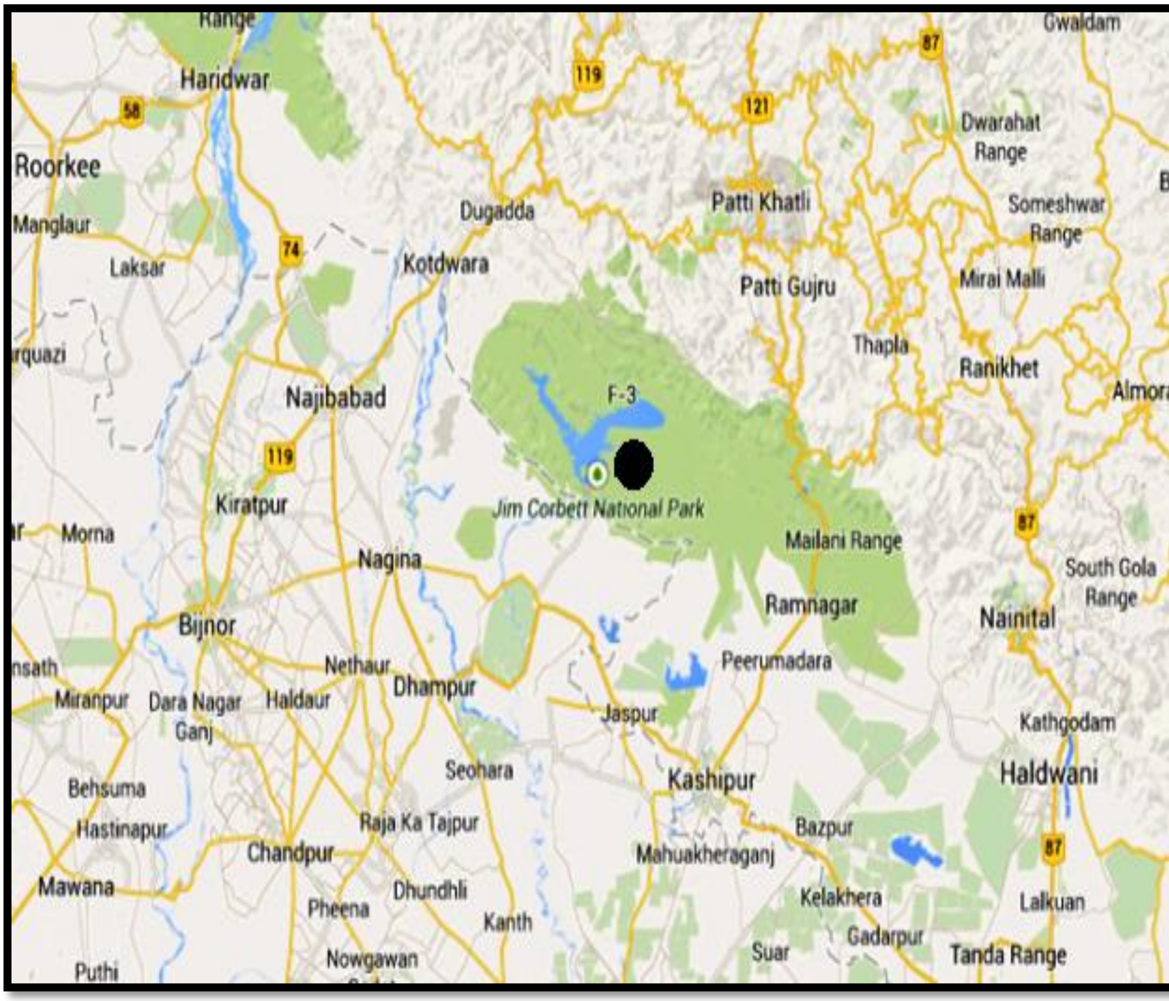


Fig: 5.3.24 Jim Corbett National Park (Satellite Map) Source: Google

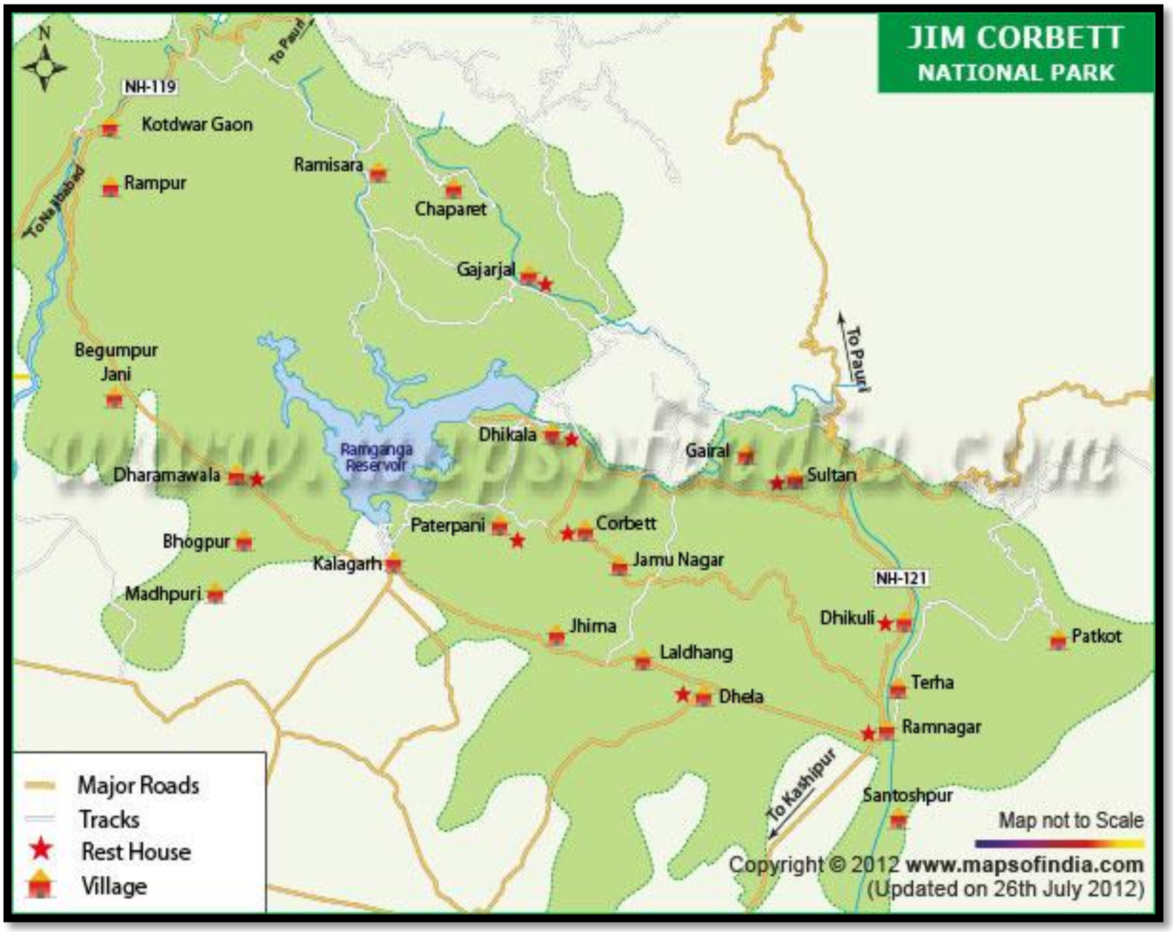


Fig: 5.3.25 Jim Corbett National Park Source: www.maps of india.com

5.3.11.1.1 Flora of Jim Corbett National Park

The Jim Corbett National Park contains about 488 different species of plants. The forests range from pure Sal to deciduous mixed forests. About more than 600 species of the different habitat are found such as trees, shrubs, herbs, bamboos, grasses climbers and ferns.

- **Trees**

About 73 per cent of the park is almost covered by the dense moist deciduous forest. The mostly found trees are such as Sal and Khair and some other trees species are spread such as Jamun (*Syzygium cumini*), Bel (*Aegle marmalos)*, Kusum (*Schleichera oleosa)*, Tendu (*Diospyros tomentosa*), Kanju (*Holoptelia integrifolia*), Mahua (*Madhuca indica*) and Bakli (*Anogeissus latifolia*) etc. Some other tree species which do not occurs naturally and planted artificially include Jacaranda (*Jacaranda mimosaefolia*), Silver Oak (*Gravillea robusta*), Bottle (*Callistemon viminalis*), Chir pine (*Pinis roxburghi*) etc. Some palms include Khajur (Phoenix), *Wallachia densiflora* which are rare palms. Some flowering trees include are Kachnaar (*Bauhinia variegata*), (*Bombax ceiba*) (*Butea monoaperma*) and Amaltas (*Cassia fistula*) etc.

- **Bamboo**

Bamboo forest is present in some parts of Jim Corbett National Park having thich stems and shiny stem covering.

- **Shrubs**

Several species of Shrubs are found such as Ber (*Zyzyphus*), Maror phalli (*Helicteres isora*), Karaunda (*Carissa*) and Jhau (*Tamarix dioica*) etc.

- **Herbs**

Some herbs species of Pea and Aster include families like Solanum species *Drymaria diandra*, Bhilmora (*Rumex hastatus*) and Indigofera Clover.

- **Grasses**

Grasses is another largest group of the plant species found in Corbett National Park. They occupy different habitats, especially chaurs. Some other species are Kansi (*Saccharum*) and Khus Khus (*Cymbopogon flexuosus*) etc.

- **Climbers**

Some climbers are found in the park are such as *Milletia auriculata*, *Cryopteris buchanani*, *Porana paniculata*, *Clenatis gouriana* and *Bauhinia vahlii.*

- **Epiphytes and orchids**

Epiphytes and orchids species like *Dendrophthoe falcate*, *Scurrula cordifolia*, *Vanda testacea* and *Cuscuta reflexa*.

- **Wetland vegetation**

Generally grows in marshy areas of the Jim Corbett National Park such as *Polygonum*, *Veronica*, *Hypericum* and *Ranunculus* etc.

- **Non-flowering plants**

Some non- flowering plants are also found such as ferns, mosses and lichens. Some ferns are Equisetum *Adiantum*, *Ophioglossum reticulatum*. Many kinds of fungi such as lichens grow on the trunks of mature trees in all over the Corbett.

5.3.11.1.2 Fauna of Jim Corbett National Park

Fauna of Corbett include a greater diversity of wildlife such as King Cobra, wild boar elephant, tiger chital, deer, gharial, common musk shrew, Indian Pangolin etc. The Jim Corbett National park covered with around 600 bird species, 33 reptile species, 7 amphibian species and 36 species of dragonflies.

- **Birds**

More than 586 species of birds are present like Koel, Woodpecker, Babblers, Indian Robin, and Pigeons. Some other birds include great headed fishing eagle, little fortail, red jungle fowl, blossom headed parakeet, owls and nightjars etc.

- **Fishes**

Mahasheer is a very large no. of fish species are found in Jim Corbett National park.

- **Mammals**

The canal passes through the forest area which comprises of mammals like Leopard, Monkey, Indian Fox, Jackal, Wild Dog, and Asiatic Elephant. Other include barking deer, sambar deer, hog deer, Indian elephants can be seen in Corbett National Park.

(a) **Tigers**

1. The tiger is the wildest animal of India.
2. It’s the carnivore which is a critically endangered species in Asia. India is a home of wild tigers in the world.

3. Some species of Bengal tiger found in the Corbett National Park.

(b) **Leopard**

1. Leopards are generally found in the hilly regions but in some low land jungles also.
2. Corbett National Park is habitat for Leopards.

(c) **Cat**

Some species of small cats are found in the Corbett park include jungle cat and leopard cat.

- **Reptiles**

Reptile species such as the India python is also found in the Corbett reserve which is very dangerous species.

"As the proposed link canal will not cross through any wildlife reserve or any protected area, but it will be lined near Jim Corbett National park. So the biodiversity of Jim Corbett National park may affect".

5.3.11.2 Positive Impacts on Wildlife

i. Jim Corbett National park which would be present near the link canal may positively benefited by the proposed S-Y link canal. After the construction of proposed link, the environment near canal will get changed.

ii. Increasing in water availability, improving soil fertility, migration of more species, new habitation of species which may increase the both diversity of flora and fauna of the national park by improving their quality and quantity.

iii. The Corbett National Park is present in Terai-Bhabar region, which is a good protected area for critically endangered Bengal tigers. The species of these tigers may benefited by increasing favourable environments.

iv. Due to increase availability of water in Ramganga River the forest diversity attracts many wild elephants, leopards and tigers.

v. Ramganga reservoir will be formed in Ramganga River which will help in increasing in water quantity. Species such as crocodiles, gharials can be saved from the breeding programs.

vi. Fishery and aqua culture will have better scope in the area due to development of link canal and barrage.

vii. Development of fisheries can create source of income generation to local people.

5.3.11.3 Negative Impacts on Wildlife

i. The link canal show negative impact during its the construction time such as disturbance in wildlife habitation, restriction in movement, obstruction of migratory path. Canal is likely to interrupt the migratory path of Elephants and cause hindrance in movement of wildlife in the area **(Fig 5.3.26).**

ii. The construction work of the link canal may cause deforestation of the area so, flora of the region also be disturbed

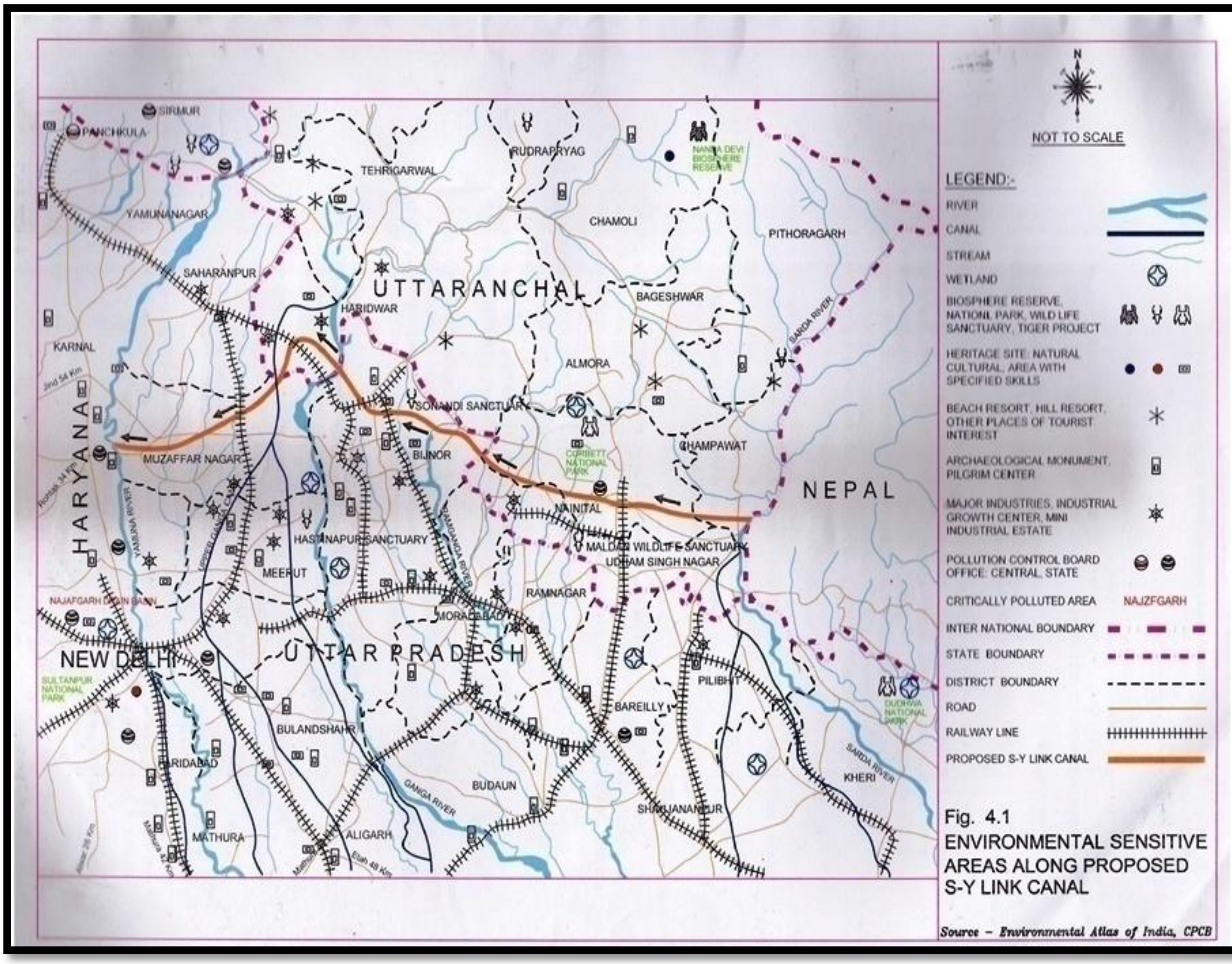


Fig: 5.3.26 Environmental sensitive areas along the lining of the canal Source: NWDA

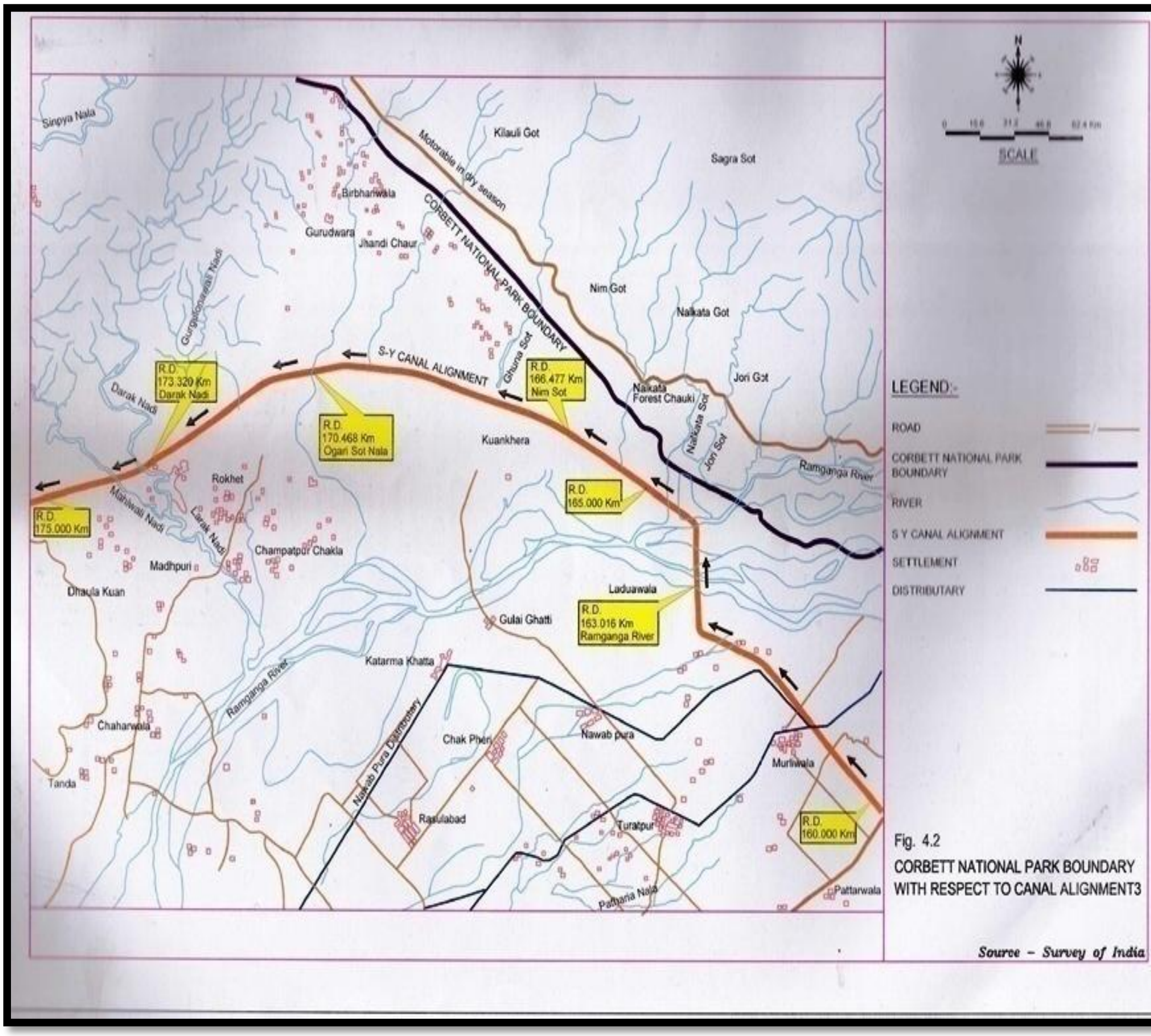


Fig: 5.3.27 Location of Jim Corbett National Park near lining of the canal

Source: NWDA

5.4 SOCIO ECONOMIC STATUS OF THE PROPOSED SHARDA YAMUNA LINK

This section describes the Socio-Economic profile of the Enrouted and Command districts of S-Y link. A study was done with respect to household conditions, demography and health status which reveal the Socio-Economic Conditions of the project area. An EIA Descriptive Checklist method was applied to know the Socio-Economic Impacts of the Proposed S-Y link canal.

5.4.1 SOCIO- ECONOMIC STATUS

Socio- Economic status refers to the social and economic factor. It is a field of economic activity that affects the social processes and focuses on the relationship between social behaviour and economic, to examine the changes to society or the economy. It refers to a relationship between person and activity, occupational status and industry. The aim of Socio- Economic study is based on the socio-economic surveys of households and villages, including groups and interviews.

The proposed S-Y Link canal traverses a length of 384 Km through Uttarakhand and Uttar Pradesh States.

5.4.2 SOCIO- ECONOMIC STATUS OF UTTAR PRADESH AND UTTARAKHAND STATE

The Indian Census 2011, referred as the seventh census operation after Indian independence. According to the Indian Census 2011, India consists of 28 states and seven union territories. Uttar Pradesh is the most populated state with a population of about

19.96 crores. Among Socio-Economic Status of U.P and U.K states, U.P has more geographical area than U.K. On the basis of population census 2011, the total population including urban and rural area of U.P is also more. In case of the literacy rate, the state U.K has more literacy rate (**Table 5.4.1).**

State	Population	%	Males	Females	Sex Ratio	Literacy	Rural Population	Urban Population	Area in Sq. Km.	Density in Sq. Km
Uttar Pradesh	199,812,341	16.5	104,480,510	95,331,831	930	67.68	131,658,339	34,539,582	240,928	828
Uttarakhand	10,086,292	0.83	5,137,773	4,948,519	963	78.82	6,310,275	2,179,074	53,483	189
India	**1,210,726,932**	**100**	**623,724,248**	**586,469,174**	**943**	**73.00**	**833,087,662**	**377,105,760**	**3,287,240**	**382**

Table: 5.4.1 Source: Indian Census 2011

5.4.2.1 SOCIO-ECONOMIC STATUS OF UTTARAKHAND STATE

The alignment of the proposed S-Y link canal will traverse though Champawat, Nainital, Udham Singh Nagar and Haridwar districts of Uttarakhand state and the Command area are lies in Udham Singh Nagar. The Socio- Economic details of canal alignment state and districts are given below.

The beautiful state of Uttarakhand is formerly known as Uttaranchal referred to as the Land of the gods. It is also a tourist destination. The state is cover over an area of about 53,000 Sq. Km and it is one of the smallest state of the country. The density of population is about 189 per Sq. Km. Uttarakhand state consists of the population of Hindus, Muslim, Sikhs and Christians **(Table 5.4.2).**

5.4.2.1.1 Uttarakhand State Population

According to the Census data 2011, the population in Uttarakhand state is approx 10 million and it is among the most populated states in India. Total population of Uttarakhand state is about 10,086,292 out of which males and females are 5,137,773 and 4,948,519 in numbers.

5.4.2.1.2 Uttarakhand State Population Growth Rate

The population of Uttarakhand forms 0.83 % of India in year 2011. The total population growth is about 19 % which is more than the national growth rate of about 17 %.

5.4.2.1.3 Uttarakhand State Literacy Rate

As per 2011 population census, the literacy rate of Uttarakhand is approx 78.82 %. The total literates in Uttarakhand state are about 6,880,953.

5.4.2.1.4 Uttarakhand State Density

The total G.A of Uttarakhand state is 53,483 Sq. Km. The density of population in Uttarakhand state is 189 per Sq. Km.

5.4.2.1.5 Uttarakhand State Sex Ratio

The Sex ratio in Uttarakhand state is 963 for each 1000 males, which is below national average of 940 as per census 2011.

Socio-Economic Status of Uttarakhand State

S. No.	**Description**	**2011**
1.	Approximate population	1.01 Crores
2.	Actual Population	10,086,292
3.	Males	5,137,773
4.	Females	4,948,519
5.	Population Growth	18.81 %
6.	Percentage of total population	0.83 %
7.	Sex Ratio	963
8.	Child Sex Ratio	890
9.	Density/ Sq. Km	189
10.	Density/mi^2	488
11.	Area Km^2	53,483
12.	Area mi^2	20,650
13.	Total Child Population (0-6 Age)	1,355,814
14.	Male Population (0-6 Age)	717,799
15.	Female Population (0-6 Age)	638,615
16.	Literacy	78.82 %

17.	Male Literacy	87.40 %
18.	Female literacy	67.06 %
19.	Total Literates	6,880,935
20.	Male Literates	3,863,708
21.	Female Literates	3017245

Table: 5.4.2 Source: Census 2011

5.4.2.1.6 Uttarakhand State Urban Population

Out of the total population of Uttarakhand state, approx (30.23 %) 3,049,338 of the people live in urban regions, out of which 1,618,731 are males and while 1,43,0607 are females. In the last 10 years the urban population has increased by 30.23 %. The sex ratio in urban regions of the Uttarakhand state is 884 females per 1,000 males. The total children in urban areas are approx. 365,038. Among children 868 are girls per 1000 boys. About 11.97 % of children are present out of the total population in urban region. Average literacy rate in the state is 84.45 %, out of which literate males are 89.05 %, while literacy in females is about 68.96 %. In urban region the total literates are 2,266,903 **(Table 5.4.3).**

5.4.2.1.7 Uttarakhand State Rural Population

Total rural population in the state Uttarakhand is 7,036,954, which is around 69.77 %. Male and female population is 3,519,042 and 3,517,912 respectively. The recorded population growth rate is 69.77 %. The child population is about 14.08 % out of the total rural population. The total child population in the rural areas is 990,776 among which female sex ratio is 899 girls per 1000 boys. The literacy rate for males and females is 86.62 % and the total literates in rural areas are 4,614,050 **(Table 5.4.3).**

Urban and Rural Population in Uttarakhand State

S. No.	Description	Rural	Urban
1.	Population %	69.77 %	30.23 %
2.	Total population	7,036,954	3,049,338
3.	Male Population	3,519,042	1,618,731
4.	Female Population	3,517,912	1,430,607
5.	Population Growth	11.52 %	39.94 %
6.	Sex Ratio	1000	884
7.	Child Sex Ratio (0-6 age)	899	868
8.	Child Population (0-6 age)	9,90,776	3,65,038
9.	Child Percentage (0-6 age)	14.08 %	11.97 %
10.	Literates	4,614,050	2,266,903
11.	Average Literacy	76.31 %	84.45 %
12.	Male Literacy	86.62 %	89.05 %
13.	Female Literacy	66.16 %	68.96 %

Table: 5.4.3 Source: Census 2011

5.4.2.1.8 SOCIO-ECONOMIC STATUS OF ENROUTED DISTRICTS OF S-Y LINK IN UTTARAKHAND STATE

5.4.2.1.8.1 Socio-Economic Status of Champawat District

As per census 2011, the total population of Champawat district is 2, 59,648, out of which males and females are 1, 31,125 and 1, 28,523 respectively. The Population growth rate of Champawat district is (15.63 %). The density of Champawat district is 147 people per Sq. Km. The total literates in Champawat district are 177,726 and average literacy rate of Champawat district is 7,983, out of which males and females literacy is 91.61 % and 68.05 %. Sex Ratio in Champawat district is 980 per 1,000 males. Child sex ratio is 873 girls per 1,000 boys. The total children in Champawat district is 14.26 %. The total children under age of 0-6 are 37,028. Out of the total 37,028 males and females children are 19,766 and 17,262 **(Table 5.4.4).**

Socio-Economic Status of Champawat District

S. No.	**Description**	**2011**
1.	Actual Population	259,648
2.	Male	1,31,125
3.	Female	1,28,523
4.	Population Growth	15.63 %
5.	Area Sq. Km	1,766
6.	Density/Km^2	147
7.	Proportion to Uttarakhand Population	2.57 %
8.	Sex Ratio (Per 1000)	980
9.	Child Sex Ratio (0-6 Age)	873
10.	Average Literacy	79.83 %
11.	Male Literacy	91.61 %
12.	Female Literacy	68.05 %
13.	Total Child Population (0-6 Age)	37,028
14.	Male Population (0-6 Age)	19,766
15.	Female Population (0-6 Age)	17,262
16.	Literates	177,726
17.	Male Literates	102,015
18.	Female Literates	75,711
19.	Child Proportion (0-6 Age)	14.26 %
20.	Boys Proportion (0-6 Age)	15.07 %
21.	Girls Proportion (0-6 Age)	13.43 %

Table: 5.4.4 Source: Census 2011

5.4.2.1.8.2 Socio-Economic Status of Nainital District

Nainital is another district of Uttarakhand state, which has a population of about 9, 54,605. Males and females are 4, 93,666 and 4, 60,939 in numbers. The Population growth rate of the district is 25.13 %. The density of Nainital district is 225 people per

Sq. Km having geographical area is 4,251 Sq. Km. The literacy rate of Nainital district is (83.88%) 696,500, out of which male and female literacy is (90.07 %) 385,779 and (77.29%) 310,721. Sex ratio in the district is 934 per 1,000 male sex ratio which is 902 are girls per 1,000 boys. The total child population is 1, 24,272 out of which male and female population is 65,337 and 58,935. Child sex ratio is 902 **(Table 5.4.5).**

Socio-Economic Status of Nainital District

S. No.	**Description**	**2011**
1.	Actual Population	9,54,605
2.	Males	4,93,666
3.	Females	4,60,939
4.	Population Growth	25.13 %
5.	Area Sq. Km	4,251
6.	Density/ Sq. Km	225
7.	Proportion to Uttarakhand Population	9.46 %
8.	Sex Ratio per 1000	934
9.	Child Sex Ratio (0-6 Age)	902
10.	Average Literacy	83.88 %
11.	Male Literacy	90. 07 %
12.	Female Literacy	77. 29 %
13.	Total Child Population (0-6 Age)	1,24,272
14.	Male Population (0-6 Age)	65,337
15.	Female Population (0-6 Age)	58,935
16.	Literates	6,96,500
17.	Male Literates	3,85,779
18.	Female Literates	3,10,721
19.	Child Proportion (0-6 Age)	13.02 %
20.	Boys Proportion (0-6 Age)	13.24 %
21.	Girls Proportion (0-6 Age)	12.79 %

Table: 5.4.5 Source: Census 2011

5.4.2.1.8.3 Socio-Economic Status of Udham Singh Nagar District

The total population of Udham Singh Nagar district is 1,648,902, out of which males and females are 8, 58,783 and 7, 90,119. The Population Growth rate of district is 33.45 %. The density of Udham Singh Nagar district is 6,49 people per Sq. Km having a geographical area of about 2,542 Sq. Km. Average literacy rate of Udham Singh Nagar district is 73.10 %. Male and female literacy are 81.09 % and 64.45 % respectively. Total literates in Udham Singh Nagar district are 1,037,839 out of which males and females are 5, 98,525 and 4, 39,314. The Sex Ratio in Udham Singh Nagar is 920 per 1,000 males while child sex ratio is 899 girls per 1,000 boys. The total population of children is 2, 29,162. Out of which males and females are 120,687 and 108,475. Child sex ratio as is 899 **(Table 5.4.6).**

Socio-Economic Status of Udham Singh Nagar District

S. No.	**Description**	**2011**
1.	Actual Population	1,648,902
2.	Male	8,58,783
3.	Female	7,90,119
4.	Population Growth	33.45 %
5.	Area Sq.km	2,542
6.	Density/ Sq.km	649
7.	Proportion to Uttarakhand Population	16.35 %
8.	Sex Ratio (per 1000)	920
9.	Child Sex Ratio (0-6 Age)	899
10.	Average Literacy	73.10 %
11.	Male literacy	81.09 %
12.	Female Literacy	64.45 %
13.	Total Child Population (0-6 Age)	2,29,162
14.	Male Population (0-6 Age)	1,20,687
15.	Female Population (0-6 Age)	1,08,475

16.	Literates	1,037,839
17.	Male Literates	5,98,525
18.	Female Literates	4,39,314
19.	Child Proportion (0-6 Age)	13.90 %
20.	Boys Proportion (0-6 Age)	14.05 %
21.	Girls Proportion (0-6 Age)	13.73 %

Table: 5.4.6 Source: Census 2011

5.4.2.1.8.4 Socio-Economic Status of Haridwar District

The population in Haridwar district is 1,890,422, among which males and females are 1,005,295 and 885,127. The district growth rate is 30.63 %. As per census 2011, the density of Haridwar district is 801 people per Sq. Km. The geographical area of the district is 2,360 Sq. Km. Average literacy rate of Haridwar is 1,178,354 (73.43%). Male and female literacy are (81.04 %) 691,411 and (64.79 %) 486,943 respectively. The Sex Ratio in the district is 880 per 1,000 male. Child Sex ratio is 877 girls per 1,000 boys. The total population of children is 2, 85,693. Out of the total population of children male and female population are 152,173 and 133,520 respectively **(Table 5.4.7).**

Socio-Economic Status of Haridwar District

S. No.	Description	2011
1.	Actual Population	1,890,422
2.	Male	1,005,295
3.	Female	8,85,127
4.	Population Growth	30.63 %
5.	Area Sq.km	2,360
6.	Density/ Sq.km	801
7.	Proportion to Uttarakhand Population	18.74 %
8.	Sex Ratio (per 1000)	880
9.	Child Sex Ratio (0-6 Age)	877
10..	Average Literacy	73.43 %

11.	Male literacy	81.04 %
12.	Female Literacy	64.79 %
13.	Total Child Population (0-6 Age)	2,85,693
14.	Male Population (0-6 Age)	1,52,173
15.	Female Population (0-6 Age)	1,33,520
16.	Literates	1,178,354
17.	Male Literates	691,411
18.	Female Literates	486,943
19.	Child Proportion (0-6 Age)	15.11 %
20.	Boys Proportion (0-6 Age)	15.14 %
21.	Girls Proportion (0-6 Age)	15.08 %

Table: 5.4.7 Source: Census 2011

5.4.2.2 SOCIO- ECONOMIC STATUS OF UTTAR PRADESH STATE

The canal alignment of the proposed S-Y link canal will traverse though Bijnor and Muzaffarnagar districts of Uttar Pradesh state and the command areas lies in Bareilly, Rampur, Moradabad, Badaun, Bijnor and Jyotiba Phule Nagar districts of state Uttar Pradesh. The Socio- Economic details of districts of canal alignment in Uttar Pradesh state and are given below.

Uttar Pradesh is one of the populated states in India located in the north part of the country. States such as Rajasthan, Madhya Pradesh, Bihar and Haryana surrounded the state Uttar Pradesh. It is an oldest state bordered with New Delhi along with the state Uttarakhand. On the basis of Uttar Pradesh Census 2011, the population of the state is about 190 million having population growth rate of about 20 % which is the highest growth rate. The state has many places for tourism, strategic and cultural significance. Most of the educational institutions are situated in the state. In terms of economy the

Uttar Pradesh is the second state in the country and agriculture is the main occupation of the country. The density of the population state is about 800 people per Sq. Km, which is a major concern. The literacy rate in the state is about 70 %, which is below the national average of 74 %.The sex ratio is about 900 **(Table 5.4.8).**

5.4.2.2.1 Uttar Pradesh Population

Uttar Pradesh has a population of about 19.98 crores. The total population of the state is 199,812,341, out of which males and females are 104,480,510 and 95,331,831 in numbers.

5.4.2.2.2 Uttar Pradesh Population Growth Rate

The total population growth is the state is 20.23 % which forms 16.50 % of India.

5.4.2.2.3 Uttar Pradesh Literacy Rate

The literacy rate in the state is (67.68 %) 114,397,555, out of which male literacy is (77.28 %) 68,234,964 and female literacy is (51.36 %) 46,162,591.

5.4.2.2.4 Uttar Pradesh Density

The geographical area of the Uttar Pradesh state is about 2, 40, 928 Sq. Km. The Density of Uttar Pradesh state is 829 per Sq.km which is higher than the average density 3. 82 per Sq. Km.

5.4.2.2.5 Uttar Pradesh Sex Ratio

As per census 2011, Sex ratio in the state is 912 per 1,000 males, which is below national average of 940.

Socio- Economic Status of Uttar Pradesh State

S. No.	Description	2011
1.	Approximate population	19.98 Crores
2.	Actual Population	199,812,341
3.	Males	104,480,510
4.	Females	95,331,831
5.	Population Growth	20.23 %
6.	Percentage of total population	16.50 %
7.	Sex Ratio	912
8.	Child Sex Ratio	902
9.	Density/ Sq. Km	829
11.	Density/mi^2	2,40,928
13.	Area Km^2	30,791,331
14.	Male Population (0-6 Age)	16,185,581
15.	Female Population (0-6 Age)	14,605,750
16.	Literacy	67.68 %
17.	Male Literacy	77.28 %
18.	Female literacy	51.36 %
19.	Total Literates	114,397,555
20.	Male Literates	68,234,964
21.	Female Literates	46,162,591

Table: 5.4.8 Source: Census 2011

5.4.2.2.6 Uttar Pradesh Urban Population

Out of the total population of Uttar Pradesh, about 22.27 % of people live in urban regions which are 44,495,063. Out of which males are 23,487,515 and females are 21,007,548. The urban population in the past years has increase by 27.27 %. In respect of sex ratio, the females are 894 per 1000 males. Among child 885 are girls per 100 boys. The total children are living in urban areas are 5,750,748, out of the total population in the region which is 12.92 %. The total literates in the urban region of the state is about 75.14 % among which males and females literacy is 80.45 % and 60.96 % **(Table 5.4.9**).

5.4.2.2.7 Uttar Pradesh Rural Population

Out of the total population of the state, approx.77.73 % of the people live in rural areas. And males and females are 80,992,995 and 74,324,283. The total population of children in Uttar Pradesh are 25,040,583, which live in rural areas. The female sex ratio per 1,000 males is 918 while 906 girls are per 1000 boys. Child population forms 16.12 %. The total literates in rural areas of Uttar Pradesh are 85,284,680. In which male and female literacy is 76.33 % and 48.48 %. The average literacy rate is about 65.46 %.

Urban and Rural Population in Uttar Pradesh State

S. No.	**Description**	**Rural**	**Urban**
1.	Population	77.73 %	22.27 %
2.	Total Population	155,317,278	44,495,063
3.	Male Population	80,992,995	23,487,515
4.	Female Population	74,324,283	21,007,548
5.	Population Growth	17.97 %	28.82 %
6.	Sex Ratio	918	894
7.	Child Sex Ratio (0-6 age)	906	885
8.	Child Population (0-6 age)	25,040,583	5,750,748
9.	Child Percentage (0-6 age)	16.12 %	12.92 %
10.	Literates	85,284,680	29,112,875
11.	Average Literacy	65.46 %	75.14 %
12.	Male Literacy	76.33 %	80.45 %
13.	Female Literacy	48.48 %	60.96 %

Table: 5.4.9 Source: Census 2011

5.4.2.2.8 SOCIO-ECONOMIC STATUS OF ENROUTED DISTRICTS OF S-Y LINK IN UTTAR PRADESH STATE

5.4.2.2.8.1 Socio-Economic Status of Bijnor District

The total population of Bijnor district is 3,682,713, out of which males and females are 1,921,215 and 1,761,498. The district population growth rate is 17.60 %. The district population density is 8, 07 people per Sq. Km and the geographical area is 4,561 Sq. km. The average literacy rate is (68.48 %) 2,135,393, out of which male and female literacy is (76.56%) 1,241,471 and (59.72%) 893,922 respectively. The sex ratio in the district is 917 per 1,000 males. Children sex ratio is 883 girls per 1,000 boys. The total population of children is 5, 64,230. Of the total children 564,230 male and female children are 299,659 and 264,571 respectively. Sex ratio of children is 883 **(Table 5.4.10).**

Socio-Economic Status of Bijnor District

S. No.	**Description**	**2011**
1.	Actual Population	3,682,713
2.	Male	1,921,215
3.	Female	1,761,498
4.	Population Growth	17.60 %
5.	Area Sq. Km	4,561
6.	Density/Km^2	807
7.	Proportion to Uttar Pradesh Population	1.84 %
8.	Sex Ratio (Per 1000)	917
9.	Child Sex Ratio (0-6 Age)	883
10.	Average Literacy	68.48 %
11.	Male Literacy	76.56 %
12.	Female Literacy	59.72 %
13.	Total Child Population (0-6 Age)	5,64,230
14.	Male Population (0-6 Age)	2,99,659
15.	Female Population (0-6 Age)	264,571

16.	Literates	2,135,393
17.	Male Literates	1,241,471
18.	Female Literates	893,922
19.	Child Proportion (0-6 Age)	15.32 %
20.	Boys Proportion (0-6 Age)	15.60 %
21.	Girls Proportion (0-6 Age)	15.02 %

Table: 5.4.10 Source: Census 2011

5.4.2.2.8.2 Socio-Economic Status of Rampur District

The total population in Rampur district is 2,335,819, out of which males and females are 1,223,889 and 1,111,930 respectively. Population growth rate is 21.42 %. The density of the district is 987 people per Sq. Km. 987 people per Sq. Km. The G.A of the district is 2,367 Sq. Km. Average literacy rate is 53.34 %. Literacy in male and female are 61.49 % and 44.44 %. The sex ration in Rampur district is 909 per 1,000 males. The child sex ratio is 924 girls per 1,000 boys and the total child population is approx. 3, 79,227, out of which male and female child population are 197,151 and 182,076 **(Table 5.4.11).**

Socio-Economic Status of Rampur District

S. No.	Description	2011
1.	Actual Population	2,335,819
2.	Male	1,223,889
3.	Female	1,111,930
4.	Population Growth	21.42 %
5.	Area Sq. Km	2,367
6.	Density/Km^2	987
7.	Proportion to Uttar Pradesh Population	1.17 %
8.	Sex Ratio (Per 1000)	909
9.	Child Sex Ratio (0-6 Age)	924
10.	Average Literacy	53.34 %
11.	Male Literacy	61.40 %

12.	Female Literacy	44.44 %
13.	Total Child Population (0-6 Age)	3,79, 227
14.	Male Population (0-6 Age)	1,97,151
15.	Female Population (0-6 Age)	1,82,076
16.	Literates	1,043,666
17.	Male Literates	6,30,408
18.	Female Literates	413,258
19.	Child Proportion (0-6 Age)	16.24 %
20.	Boys Proportion (0-6 Age)	16.11 %
21.	Girls Proportion (0-6 Age)	16.37 %

Table: 5.4.11 Source: Census 2011

5.4.2.2.8.3 Socio-Economic Status of Jyotiba Phule Nagar

The total population in the Jyotiba Phule Nagar district is 1,840,221, out of which males and females are 9, 63,449 and 8, 76,772. The population growth rate is 22.76 %. The density of the district is 818 people per Sq. Km. The geographical area are 2,249 Sq. Km. Average literacy rate is (63.84 %) 983,110. Males 600,541 and females 382,569 literacy are (74.54 %) and (52.10 %). Sex ratio in Jyotiba Phule Nagar is 910 per 1,000 male. The child sex ratio is 903 girls per 1,000 boys. The total child population is 3, 00,231, out of which male and female children are 157,737 and 142,494 (**Table 5.4.12).**

Socio-Economic Status of Jyotiba Phule Nagar District

S. No.	**Description**	**2011**
1.	Actual Population	1,840,221
2.	Male	9,63,449
3.	Female	8,76,772
4.	Population Growth	22.76%
5.	Area Sq. Km	2,249
6.	Density/Km^2	818
7.	Proportion to Uttar Pradesh Population	0.92 %

8.	Sex Ratio (Per 1000)	910
9.	Child Sex Ratio (0-6 Age)	903
10.	Average Literacy	63.84 %
11.	Male Literacy	74.54 %
12.	Female Literacy	52.10 %
13.	Total Child Population (0-6 Age)	3,00,231
14.	Male Population (0-6 Age)	1,57,737
15.	Female Population (0-6 Age)	1,42,494
16.	Literates	9,83,110
17.	Male Literates	6,00,541
18.	Female Literates	3,82,569
19.	Child Proportion (0-6 Age)	16.31 %
20.	Boys Proportion (0-6 Age)	16.37 %
21.	Girls Proportion (0-6 Age)	16.25 %

Table: 5.4.12 Source: Census 2011

5.4.2.2.8.4 Socio-Economic Status of Moradabad District

As per census 2011, the total population of district Moradabad is 4,772,006, out of which males and female are 2,503,186 and 2,268,820. The Population growth rate of the district is 25.22 %. The density is 1,283 people per Sq. Km. The G.A of Moradabad district is 3,718 Sq. Km. The total literates in Moradabad district are 2,263,848, out of which males and females are 1,357,435 (64.83 %) and 906,413 (47.86%) respectively. Average literacy rate of Moradabad district is 56.77 %. Sex ratio is 906 per 1,000 males. The child sex ratio is 916 girls per 1,000 boys. The total children in the district are 784, 219, male and female children are 409,325 and 374,894 **(Table 5.4.13).**

Socio-Economic Status of Moradabad District

S. No.	Description	2011
1.	Actual Population	4,772,006
2.	Male	2,503,186
3.	Female	2,268,820
4.	Population Growth	25.22 %
5.	Area Sq. Km	3,718
6.	Density/Km^2	1,283
7.	Proportion to Uttar Pradesh Population	2.39 %
8.	Sex Ratio (per 1000)	906
9.	Child Sex Ratio (0-6 Age)	916
10.	Average Literacy	56.77 %
11.	Male Literacy	64.83 %
12.	Female Literacy	47.86 %
13.	Total Child Population (0-6 Age)	784,219
14.	Male Population (0-6 Age)	409,325
15.	Female Population (0-6 Age)	374,894
16.	Literates	2,263,848
17.	Male Literates	1,357,435
18.	Female Literates	906,413
19.	Child Proportion (0-6 Age)	16.43 %
20.	Boys Proportion (0-6 Age)	16.35 %
21.	Girls Proportion (0-6 Age)	16.52 %

Table: 5.4.13 Source: Census 2011

5.4.2.2.8.5 Socio-Economic Status of Bareilly District

Bareilly district has population of 4,448,359, out of which males and females are 2,357,665 and 2,090,694 respectively. Population growth rate is 22.93 %. The density of Bareilly district is 1,080 people per Sq. Km. Bareilly district has geographical area of about 4,120 Sq. Km. The average literacy rate of district Bareilly is 58.49 %. Male and female literacy are 67.50 % and 48.30 % respectively. Total literates in Bareilly district are approx 2,191,759 out of which males and females are 1,342,697 and 849,062. Sex ratio in Bareilly is 887 per 1,000 males. The average sex ratio in India is 940. The children sex ratio is 903 girls per 1,000 boys **(Table 5.4.14).**

Socio-Economic Status of Bareilly District

S. No.	**Description**	**2011**
1.	Actual Population	4,448,359
2.	Male	2,357,665
3.	Female	2,090,694
4.	Population Growth	22.93 %
5.	Area Sq. Km	4,120
6.	Density/Km^2	1,080
7.	Proportion to Uttar Pradesh Population	2.23%
8.	Sex Ratio (per 1000)	887
9.	Child Sex Ratio (0-6 Age)	903
10.	Average Literacy	58.49 %
11.	Male Literacy	67.50 %
12.	Female Literacy	48.30 %
13.	Total Child Population (0-6 Age)	7,01,416
14.	Male Population (0-6 Age)	3,68,591
15.	Female Population (0-6 Age)	3,32,825
16.	Literates	2,191,759
17.	Male Literates	1,342,697
18.	Female Literates	849,062
19.	Child Proportion (0-6 Age)	15.77 %
20.	Boys Proportion (0-6 Age)	15.63 %
21.	Girls Proportion (0-6 Age)	15.92 %

Table: 5.4.14 Source: Census 2011

5.4.2.2.8.6 Socio-Economic Status of Muzaffarnagar District

The total population of Muzaffarnagar district is 4,143,512, among which males and females are 2,193,434 and 1,950,078 respectively. Population growth rate is 16.94 %. The density of Muzaffarnagar district is 1,034 people per Sq. Km. The geographical area of Muzaffarnagar district is 4,008 Sq. Km. Average literacy rate of Muzaffarnagar is

69.12 %. The total literates in Muzaffarnagar district are 2,417,339, out of which of which male and female literates are 1,448,528 and 968,811 which is 78.44 % and 58.69 % respectively. Sex Ratio in Muzaffarnagar district is 889 per 1,000 males. Child sex ratio is 863 girls per 1,000 boys **(Table 5.4.15).**

Socio-Economic Status of Muzaffarnagar District

S. No.	Description	2011
1.	Actual Population	4,143,512
2.	Male	2,193,434
3.	Female	1,950,078
4.	Population Growth	16.94 %
5.	Area Sq. Km	4,008
6.	Density/Km^2	1,034
7.	Proportion to Uttar Pradesh Population	2.07 %
8.	Sex Ratio (per 1000)	889
9.	Child Sex Ratio (0-6 Age)	863
10.	Average Literacy	69.12 %
11.	Male Literacy	78.44 %
12.	Female Literacy	58.69 %
13.	Total Child Population (0-6 Age)	646,062
14.	Male Population (0-6 Age)	346,805
15.	Female Population (0-6 Age)	299,257
16.	Literates	2,417,339
17.	Male Literates	1,448,528
18.	Female Literates	968,811
19.	Child Proportion (0-6 Age)	15.59 %
20.	Boys Proportion (0-6 Age)	15.81 %
21.	Girls Proportion (0-6 Age)	15.35 %

Table: 5.4.15 Source: Census 2011

5.4.2.2.8.7 Socio-Economic Status of Badaun District

Badaun has a population of 3,681,896 and total males and females are 1,967,759 and 1,714,137. The population growth rate is 19.95 %. The density of Badaun district is 712 people per Sq. Km. Average literacy rate of Badaun is 51.29 %, male and female literacy are 60.98 % and 40.09 % respectively. Total literates in Badaun district are 1,547,477, among which males and females are 986,501 and 560,976. Sex Ratio in Badaun is 871 per 1,000 male. The child sex ratio is 899 girls per 1,000 boys **(Table 5.4.16)**

Socio-Economic Status of Badaun District

S.No.	**Description**	**2011**
1.	Actual Population	3,681,896
2.	Male	1,967,759
3.	Female	1,714,137
4.	Population Growth	19.95 %
5.	Area Sq. Km	5,168
6.	Density/Km^2	712
7.	Proportion to Uttar Pradesh Population	1.84 %
8.	Sex Ratio (per 1000)	871
9.	Child Sex Ratio (0-6 Age)	899
10.	Average Literacy	51.29 %
11.	Male Literacy	60.98 %
12.	Female Literacy	40.09 %
13.	Total Child Population (0-6 Age)	664,909
14.	Male Population (0-6 Age)	350,112
15.	Female Population (0-6 Age)	314,797
16.	Literates	1,547,477
17.	Male Literates	986,501
18.	Female Literates	560,976
19.	Child Proportion (0-6 Age)	18.06 %
20.	Boys Proportion (0-6 Age)	17.79 %

Table: 5.4.16 Source: Census 2011

Among the Enrouted areas of proposed S-Y Link, population and literacy rate of Muzzafarnagar district is more than other Enrouted districts and in Command areas,

Moradabad district is more populated and the literacy level of the Moradabad district is also very high.

The identification of Impacts of the proposed S-Y link on Environment and Socio Economic Status of the Enrouted and Command areas is determined on the basis of Field Survey and EIA Descriptive Checklist Method.

5.4.3 ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment is a tool for calculating the positive and negative impacts of any developmental activity on environment. It is the process to know the environmental causes of any developmental activity (positive or negative). It is the method of evaluation of expected environmental beneficial and harmful impacts of any proposed developmental activity or a project. It is related to Socio- Economic, cultural and human health impacts. The EIA process may apply at a starting stage in project planning and design to find the adverse impacts and to minimize the harmful effects on environment.

5.4.3.1 Stages in EIA

The stages involve in EIA process is first screening to know about any project or developmental activity which requires EIA process. Scoping method is for the identification of environmental impacts, whether harmful of beneficial. Further stages in EIA method are assessment and evaluation of environmental impacts, reporting in form of Environmental Impact Statement (EIS) or an EIA report, monitoring of impacts, decision making and environmental auditing.

5.4.3.2 EIA Checklist Method

Checklist is a classification of information’s for identifying the environmental impacts of any developmental activity or project. It is a list of environmental parameters for the identification of impacts, during early stages of any developmental activity**.** It helps in thinking about possible environmental management plan with mitigation actions.

Four types of EIA Checklist are:

5.4.3.2.1 Simple Checklist

It is a list of environmental components with no guide lines. (Yes for present impact, No for absent and – for Unknown impact)

5.4.3.2.2 Descriptive Checklist

It is information regarding environmental parameters and guidelines on management, about the description of Environmental Parameters & Impacts.

5.4.3.2.3 Scaling Checklist

It is same like as descriptive checklist method, which carries additional information on subject scaling of each environmental components.

5.4.3.2.4 Questionnaire Checklist

It is a set of questions regarding environmental parameters need to be answered for the impact identification by asking questions from the local people.

5.4.4 SOCIO ECONOMIC STATUS OF THE ENROUTED AND COMMAND AREAS ON THE BASIS OF FIELD SURVEY

A field visit was done during October to November 2014 in Haridwar district, which is the Enrouted area, Moradabad district which is the Command area and Bijnor district (Najibabad and Noorpur), which is both Enrouted and Command area of the S-Y Link. Certain environmental components were selected such as Literacy rate education, Electrical availability or supply, Water availability, Water quality, Agriculture, Occupation, Family income, Important landmark, Spoil generation, Industry, Climate, Religious monument, Flood status, Drainage system and Water collection, Tourism, Seepage and Percolation of water, Traffic, Air quality, Construction development, Soil, Fishery, Public health status and Medical facilities to know the possible Socio-Economic impacts of S-Y link on Enrouted and Command areas.

Five sites of each Enrouted and Command district were selected for collecting the Socio-Economic information.

5.4.4.1 HARIDWAR (Enrouted Area)

Five visited sites are:

1. Mayapur Chowki
2. Ranipur
3. Kankhal Area
4. Harkipauri
5. Kotwali Nagar

On the basis of field survey, in all the five sites of Haridwar district such as (Mayapur Chowki, Ranipur, Kankhal Area, Harkipauri and Kotwali Nagar) the literacy rate is medium and education status is from 10^{th} to Graduation. Electrical & Water availability is high (above 20 hrs) in all the sites except Kankhal area. There is proper availability of water and good water quality in all the locations. The medium of drinking water is mainly ground water. In Ranipur area the ground water quality is quite low due to presence of sand & impurities. There is no agriculture in all the areas except Harkipauri which is present nearby river Ganga. Occupation and family income is medium in all the areas of Haridwar district which is mainly depend or Hotels and Religions work. In Mayapur Chowki the important landmark is bus stand. In Ranipur area there is land mark is Bhagat Singh Chowk and Chandra Charya Chowk. Daksha temple is the land mark of Kankhal area and Mansa Devi Temple is the land mark of Harkipauri area. Kotwali Nagar is situated near Harkipauri region. There is a huge amount of waste generation in all the sites of Haridwar district as it is a tourist place. A spoil generation is more near bus stand, railway station and in Harkipauri area which is the main tourist place. In Kankhal area, the spoil generation is also more as it is very crowded place. In Mayapur chouki, Bharta Heavy Electrical Limited Industry is present. Sidkul industry is present in Kankhal area. In view of climate, it is dominating in all the sites both type of dominating climates are present summer and winter. Chanda Devi temple is a religious monument located in Mayapur Chowki of Haridwar district. In Kankhal area, Dakshwa temple is a religious monument and Mansa Devi temple in Harkipauri area. A no. of small temples is situated in Kotwali Nagar. During rainy season, sometimes water level of river Ganga raises and flood occurs in laksar area in Haridwar district. There is a proper drainage or water collection system due to presence of canals. In tourism, maximum tourists come in tourist season (between 15 April-15 July) and average throughout the year). All the sites of

Haridwar district are congested and traffic is very high. Air quality is more in all the districts. Bus station and railway station is present in Mayapur Chowki. After 2001, construction and developmental work is in progress. Soil quality is very fertile in all the locations. Fishery production is generally occurs in Vikas bhawan of Mayapur Chowki and sometimes near Ganga River in Harkipauri area. In view of public health status and medical facilities, there is good facility of Hospitals in all the locations of Haridwar districts (**Table 5.4.17).**

5.4.4.2 MORADABAD (Command Area)

Some sites visited are:

1. Station Road
2. Kath Road Hartala
3. Karula
4. Pital Nagar Bus Stand
5. Buddh Bazaar

In Moradabad district, the literacy rate and education is medium in all the sites such as (Station road, Kath road Hartala, Karula, Pital Nagar Bus stand and Buddh Bazaar). Most of the people are graduate and education level, literacy is good. Electricity supply is good in all the sites, which is above 20 hours. Water availability and water quality is medium in all the locations due sometimes sand come in water. Agriculture occurs only in Kath road Hartala area and in small areas of Buddh bazaar. Occupation level belongs to private, laborer & business in all the areas. Imperial tiraha is the land mark in Station Road, Akbar ka Kila in Kath road Hartala, Jankipur Temple in Karula, Prabhat market in

Pital Nagar bus stand and Geeta Gyan Temple in Buddh Bazaar are the land marks. Spoil generation is medium due to proper management of waste in all the sites, but in Buddh bazar waste generation is little more due to presence of small temples. Moradabad is a place of Brass, Steel, Iron, Bronze and Copper work. Climate is dominating in all the sites. Several types of temple are present in all the locations of Moradabad district. In view of flood status, it came about 6-7 years ago in station road region and 1 year ago near Jama masjid in the site Pital Nagar bus stand. Water Drainage system is good in all the sites, sometimes water collects during the rainy season. Tourism is average throughout the year in all the areas. Seepage and percolation of water in the soil is average in all the locations. Moradabad district is very congested area so; the traffic and air quality is very high. There is regular construction and development work is going on. Soil is fertile in all the locations except in site Karula. No fishery production in all the areas. Public health & medical facilities are good in all the locations due to presence of more Hospitals (**Table 5.4.18).**

5.4.4.3 BIJNOR (Command Area)

Some sites visited are:

1. Jatan
2. Sotiyan
3. Awas Vikas Colony
4. Ghasiawala Area
5. Barrage Colony

In all the sites of district Bijnor (Jatan, Sotiyan, Awas Vikas Colony, Ghasiawala Area and Barrage Colony), the education level is medium. Maximum people are educated. Electrical supply is very low, which is below 10 hours. Water availability & quality is medium due to presence of sand in the ground water. Agriculture of sugarcane, wheat & mustard is occurs in some places. Occupation is medium, mainly based on small business such as cloth, furniture etc. Labour work and private work is also a way of occupation. Shiv Chowk temple in Sotiyan area, Indira park in Awas vikas colony and Ghasiawala area are the landmarks. The spoil generation status is medium in all the sites, sometimes generation of spoil is more in Awas vikas colony, as it is a residential area. Sugarcane mill is present in area of Jatan and rest of the areas has small industries. Dominating type of climate is present in all the locations. In case of religious monument, Shiv Chowk temple is present in Sotiyan and Masjid is present in Ghasiawala area. Generally no flood comes, but according to local people, some years ago flood came near masjid in Ghasiawala area Drainage system is good in all the sites, but during rainy season, sometimes water collection occurs. Seepage and percolation of water is good in all the areas. Traffic is medium in all the regions except in Sotiyan region due to more emissions of dust smoke. Air quality of the Sotiyan area is also high. There is no such any big developmental or construction work in all the areas of the district Moradabad. Soil is fertile in nature and there is no fish production in all the regions except in Awas Vikas Colony (**Table 5.4.19).** The details of the Socio Economic status are given below in following tables:

SURVEY CARRIED OUT DURING SEPTEMBER 2014 TO OCTOBER 2014

SOCIO-ECONOMIC STATUS OF HARIDWAR (COMMAND AREA) ON THE BASIS OF FIELD VISIT

S. No	Environmental Components	Mayapur Chowki	Ranipur	Kankhal Area	Harkipauri	Kotwali Nagar	Average Impact	Impact of S-Y Link
1.	**Literacy Rate and Education**	Medium(10 th- 12th)	High Graduation	Medium Graduation	Medium Graduation	Medium Graduation	Medium Graduation	-
2.	**Electrical Availability or Supply**	High(About 20 Hrs)	High(About 20 Hrs)	Low(below 18 hrs)	High (Above20 Hrs)	High (Above20 Hrs)	High (Above 20 Hrs)	May increase
3.	**Water Availability**	Proper availability of water	Proper availability of water	Proper availability of water	Proper availability of water	Proper availability of water	Good availability of water	Water Availability may increase
4.	**Water Quality**	Water quality is good for drinking	Water quality is medium, Sometimes sand, impurities	Water quality is medium, mostly use of ground water	Water quality is good	Quality of water is good	Water quality is good	During construction phase of the S-Y link canal water quality may affected
5.	**Agriculture**	No Agricultural area	No Agricultural area	No Agricultural area	Agricultural area near river Ganga	No Agricultural area	No Agricultural area	Agriculture may increase
6.	**Occupation and Family income**	Occupation and Family income is High,	Occupation and Family income is	Occupation and Family income is	Occupation and Family income is medium,	Occupation and Family income is medium	Occupation and Family income is medium	Occupation and Family income may Increase during

		Commercial area/Hotel	medium, Commercial area	high, Commercial Area	Religious type of Occupation	Commercial Area		construction work.
7.	**Important Landmark**	Bus Stand	Bhagat Singh Chowk/ Chandra Charya Chowk	Daksha Temple	Mansa Devi Temple	Harkipauri	-	No impact of S-Y Link canal on Landmark
8.	**Spoil Generation**	Waste generation is more due to Bus, Railway station.	Waste generation is medium due to proper management	Waste generation is high due to crowded place	Waste generation is high near River Ganga	Waste generation is medium	More generation of waste	Waste will generate during the construction work
9.	**Industry**	Bharat Heavy Electrical Limited	No	Sidkul	No	No	Yes	Productivity of an area may rise
10.	**Climate**	Both type of climates are present, dominating	Dominating	Dominating	Dominating	Dominating	Dominating	-
11.	**Religious Monument**	Chandi Devi Temple	No	Dakshwa Temple	Mansa Devi	Temples near River Ganga	-	Construction of new Temples
12.	**Flood status**	No flood comes, but sometimes in Laksar area	No flood	Flooded	During rainy season sometimes water level of	No	Sometimes Flood occurs	During construction

					River Ganga rises.			
13.	**Drainage System or Water collection**	Good Drainage System, No water collection	Good drainage system due to presence of canals	No proper drainage System	Good drainage System, No water collection	Good drainage System No water collection	Good Drainage System No water collection	Drainage System May affect during the construction time
14.	**Tourism**	Maximum Tourist comes between 15 April to 15 July	Average Tourism Throughout the year	Maximum during the tourist season	Maximum during the tourist season	Maximum during the tourist season	Maximum during the tourist season	Tourism may increase due to increase in diversity
15.	**Seepage, Percolation or Absorption of water**	Average absorption of water in soil	Good absorption of water in soil	Good absorption of water in soil	No absorption of water in soil	Average absorption of water in soil	Good Seepage and Percolation of water	During construction Seepage and Absorption of water may occurs
16.	**Traffic**	Traffic is high during the tourist season	Traffic is medium	Traffic is high as it is congested area	Traffic is high as it is congested area	Traffic is high as it is congested area	Traffic high due to congested area	Traffic may affect during construction phase
17.	**Air Quality**	Air quality is high due to bus station and railway station	Air quality is high due to More traffic	Air quality is medium due to congested area	Air quality is maximum during tourist season	Air quality is medium	Air quality is high due to more traffic	During construction time
18.	**Construction and**	After 2001 construction is in	Not any construction	No any construction	No any construction	Not any Development and	No Development and construction	During Development and

	Development	progress	and development	and development	and development	construction		construction of S-Y Link
19.	**Soil**	Soil is fertile	Soil is fertile	Soil is fertile	Soil is fertile	Fertile Soil	Fertile Soil	Increase in fertility
20.	**Fishery**	Near Vikas Bhawan	Yes	No	Yes near Ganga River	No	Yes	Increase Fishery production
21.	**Public Health Status and Medical facilities**	Presence of more Hospitals	Presence of more Hospitals	Presence of more Hospitals	Presence of more Hospitals	Presence of more Hospitals	Presence of more Hospitals	No significant Impact

Table: 5.4.17 Source: Based on survey carried out during September 2014 to October 201

SOCIO-ECONOMIC STATUS OF MORADABAD (COMMAND AREA) ON THE BASIS OF FIELD VISIT

S. No	Environmental Components	Station Road	Kath Road Hartala	Karula	Pital Nagar Bus Stand	Buddh Bazaar	Average Impact	Impact of S-Y Link
1.	**Literacy Rate and Education**	Literacy Rate and Education is medium, 10^{th}-BA	Literacy Rate and Education is medium, 8^{th}-BS.c	Literacy Rate and Education is low, 8^{th}-12th	Literacy Rate and Education is Low, 6^{th}-12^{th}	Literacy Rate and Education is Low, 1^{st}-8^{th}	Literacy Rate and Education is medium	No impact on literacy rate
2.	**Electrical Availability and Supply**	Electrical Availability and Supply is high14-20 hrs	Electrical Availability and Supply is high20 hrs	Electrical Availability and Supply is Low, 8-10 hrs	Electrical Availability and Supply is Normal 16-17 hrs, but in summers 4-5	Electrical Availability and Supply is Low 8^{th}-10^{nth}	Electrical Availability and Supply is above 20 hrs	Electrical Availability and Supply may increase
3.	**Water Availability**	Water availability is medium	Water availability is medium	Water availability is medium and Ground Water is mostly used	Water availability is medium, sometimes sand come in ground water	Water availability is medium	Water availability is medium	Water availability will increase after the construction of the link canal.
4.	**Water Quality**	Water quality is medium but sometimes sand comes in drinking water	Water quality is medium but sometimes sand comes in drinking water	Water quality is medium but sometimes sand comes in drinking water	Water quality is medium but sometimes sand comes in drinking water	Water quality is medium but sometimes sand comes drinking water	Water quality is medium but sometimes sand present in drinking water	During construction of link canal Water quality may affect
5.	**Agriculture**	No Agriculture area	Yes agriculture in some places	No Agriculture area	No Agriculture area	Agriculture area in small	No Agriculture area	Agriculture area may increase

						places		
6.	**Occupation and Family income**	Occupation and Family income is average, private and self business.	Occupation and Family income is average, private and self business.	Occupation and Family income is average, private and self business.	Occupation and Family income is low, self business such as auto.	Occupation and Family income is low, self business, Labour	Occupation and Family income is average, private and self business.	Occupation and Family income is average, private and self business, which may increase during the construction work.
7.	**Important Landmark**	Imperial Tiraha	Akbar kaKila	Jankipur Temple	Prabhat Market	GeetaGyan Temple	-	No significant Impact
8.	**Spoil Generation**	Waste generation is medium due to proper management	Waste generation is medium due to proper management	Waste generation is medium due to proper management	Waste generation is medium due to proper management	Waste generation is medium, sometimes near temple	Waste generation is medium due to proper management	Waste generation may occurs during the construction work.
9.	**Industry**	No Industrial area	Colour, Brass, Bronze and snacks industries are present	Brass industries	Brass, Al, Iron and Steel industries	Brass industries	Yes industries are location in all the sites	After construction of the S-Y Link Productivity may rise
10.	**Climate**	Both type of climates are present,	Dominating	Dominating	Dominating	Dominating	Dominating	No significant Impact

		dominating						
11.	**Religious Monument**	Shiv Temple and Devi Temple	Shiv temple Dhap Temple	Jankipur Temple	Bajrang, Shani and ChaurasiGanta Temple	GeetaGyan, Durga, Hanuman	Yes temples are present in all the sites	New Temples may construct after the link construction
12.	**Flood Status**	Generally no flood comes, but about 6- 7 years ago some area was flooded	5yrs ago some area was flooded	No flood comes	1 yrs ago near Jama Masjid	No flood	Sometimes flood occurs	During construction flood condition may arise nearby area
13.	**Drainage System or Water collection**	Drainage System and water collection during rainy season	Generally no drainage system and water collection but sometimes	Generally no drainage system and water collection but sometimes	Generally no drainage system and water collection but sometimes	Generally no drainage system and water collection but sometimes	No drainage system and water collection	drainage system and water collection may be during the construction time of the link canal
14.	**Tourism**	Tourism is medium	Generally no tourism, but sometimes	Generally no tourism, but sometimes	Generally no tourism, but sometimes	Generally no tourism, but sometimes	Maximum tourism during the tourist season	Tourism may increase due to increase in flora and fauna diversity
15.	**Seepage and Percolation and Absorption of water**	Average absorption of water in soil	Average absorption of water in soil	Average absorption of water in soil	Average absorption of water in soil	Average absorption of water in soil	Seepage and percolation of water in soil is good	Average seepage and absorption of water in soil during

								construction of the link.
16.	**Traffic**	Traffic is high	Traffic is high Polluted, smoke, dust	Traffic is high, congested area	Traffic is high, congested area	Traffic is high, congested area	Traffic is high, congested area	Traffic and congested area may happens during the link construction
17.	**Air Quality**	Air Quality is high	Air Quality is high due to more traffic	Air Quality is medium due to congested area	Air Quality is Maximum	Air Quality is medium	Air Quality is high due to more traffic	Air Quality is high during construction time
18.	**Construction And Development**	No Construction and development	No Construction and development	Yes, No Construction and development buildings	Yes Construction and development buildings and bridges	Yes Construction and development buildings and bridges	No Construction and development	Construction and development may increase during construction time of the link canal.
19.	**Soil**	Soil is fertile	Soil is fertile	Soil is not fertile	Soil is fertile	Soil is fertile	Soil is fertile	Soil fertility may increase during and after construction of the link canal
20.	**Fishery**	No Fishery	No Fishery	Yes Fishery in some places	No Fishery	No Fishery	yes Fishery	Increase Fishery production

21.	**Public Health Status and Medical facilities**	Public Health Status and Medical facilities is good due to presence of more hospitals	Public Health Status and Medical facilities is good due to presence of more hospitals	Public Health Status and Medical facilities is good due to presence of more hospitals	Public Health Status and Medical facilities is good due to presence of more hospitals	Public Health Status and Medical facilities is good due to presence of more hospitals	Public Health Status and Medical facilities is good due to presence of more hospitals	No significant Impact

Table: 5.4.18 Source: Based on survey carried out during September 2014 to October 2014

SOCIO-ECONOMIC STATUS OF BIJNOR (COMMAND AREA) ON THE BASIS OF FIELD VISIT

S. No	Environmental Components	Jatan	Sotiyan	Awas Vikas Colony	Ghasiawala Area	Barrage Colony	Average Impact	Impact of S-Y Link
1.	**Literacy Rate Education**	Literacy Rate and Education is medium, Graduation	Literacy Rate and Education is medium, 8th -Grad.	Literacy Rate and Education is low, below 5	Literacy Rate and Education is very low	Literacy Rate and Education is medium12th -Grad.	Literacy Rate and Education is medium	No significant Impact
2.	**Electrical Availability and supply**	Electrical Availability and Supply is Low below 4 hrs	Electrical Availability and Supply is below Low 4 hrs	Electrical Availability and Supply is below Low 4 hrs	Electrical Availability and Supply is below 10 Hrs	Good Electrical Availability and Supply 10-15 hours	Electrical Availability and Supply is below Low 4-15 hours	Electrical Availability and Supply may increase
3.	**Water Availability**	Water availability is medium	Water availability is medium	Water availability is medium	Water availability is medium, sometime sand comes	Water availability is medium	Water availability is medium	May increase
4.	**Water Quality**	Water quality is medium but sometimes sand is present in drinking water	Water quality is medium but sometimes sand is present in drinking water	Water quality is medium but sometimes sand is present in drinking water	Water quality is medium but sometimes sand is present in drinking water	Water quality is medium but sometimes sand is present in drinking water	Water quality is medium but sometimes sand is present in drinking water	During construction of link canal water quality of nearby area may affect

5.	**Agriculture**	Yes agriculture in some places, Sugarcane	No agriculture	No agriculture	Yes agriculture in some places, wheat, mustard	No agriculture	Agriculture in some places	Agriculture may increase due to increase in water availability
6.	**Occupation and Family income**	Occupation and Family income is low, farmers	Occupation and Family income is average, private, self business, shop, cloth	Occupation and Family income is average, shops, cloth	Occupation and Family income is Low, labour	Occupation and Family income is low, business, private	Occupation and Family income is medium	Occupation and Family income may increase during construction work
7.	**Important Landmark**	No	Shiv Chowk Temple	Indira Park	Maszid	No	Yes	No significant Impact
8.	**Spoil Generation**	No Waste generation due to proper management	Waste generation is medium	Waste generation is due to Residential Area	Waste generation is medium due to proper management Medium	Waste generation is medium due to proper management	Waste generation is medium due to proper management	Waste generation may increase during the construction work of the link canal
9.	**Industry**	Yes Industrial area Sugarcane Mill	No Industrial area	No Industrial area	Industrial area including small Industries Crops	No Industrial area	Yes Industrial area	After construction of the S-Y Link Productivity may rise
10.	**Climate**	Both type of climates are present, dominating	Dominating	Dominating	Dominating	Dominating	both	No significant Impact

11.	**Religious Monument**	No	Shiv Chowk Temple	No	Masjid	No	Yes	New temples may construct after the link construction
12.	**Flood status**	Generally no flood comes	Generally no flood comes	Generally no flood comes	Sometimes flood comes near Masjid	Generally no flood comes	Sometimes flood comes	Flood situation may arise during construction time
13.	**Drainage System or Water collection**	Drainage System and water collection during rainy season	No drainage and collection of water	No, sometimes drainage System and water collection during rainy season	Yes, drainage system and water collection during rainy season due to household waste	Drainage System and water collection during rainy season	No drainage system and water collection	Drainage System and water collection may be during construction time
14.	**Tourism**	No Tourism	No Tourism	No Tourism	No Tourism	No Tourism	No Tourism	Tourism may increase due to increase in biodiversity
15.	**Seepage and Percolation/ Absorption of water**	Average Seepage and Percolation absorption of water in soil	Average Seepage and Percolation absorption of water in soil, but not in rainy season	No Average absorption of water in soil	Yes Seepage and Percolation absorption of water in soil	Average seepage and percolation near residential area	Average seepage and percolation of water in soil.	Seepage and Percolation of water may affect during the construction time
16.	**Traffic**	No traffic	Traffic is high, congested area, pollution smoke, dust	Average traffic	Low traffic	Low traffic	Average traffic due to congested area	Traffic may increase during the construction of link

17.	**Air Quality**	Good air quality	Air quality is high due to more traffic	Air quality is medium residential area	Low Air quality	Medium Air quality	Medium Air quality	During the construction time air quality will decrease
18.	**Construction and Development**	No Construction and development	Yes Construction and development buildings	Yes, Construction and development buildings	No Construction and development buildings	Yes, Construction and development buildings and bridges	No Construction and development	Construction and development will increase due to construction of the link canal
19.	**Soil**	Soil is fertile	Soil is fertile	Soil is fertile	Soil is fertile	Soil is fertile, but no agriculture	Soil is fertile	Increase in fertility
20.	**Fishery**	No Fishery	No Fishery	Yes in some places	No Fishery	No Fishery	Yes	Increase Fishery production
21.	**Public Health Status and Medical facilities**	Public health status and Medical facilities is good due to presence of more hospitals	Public health status and Medical facilities is good due to presence of more hospitals	Public health status and Medical facilities is good due to presence of more hospitals	Public Health status and Medical Facilities is good due to presence of more hospitals	Public Health status and Medical facilities is good due to presence of more hospitals	Public Health status and Medical facilities is good due to presence of more hospitals	No significant Impact

Table: 5.4.19 Source: Based on survey carried out during September 2014 to October 2014

5.4.5 Impact of proposed S-Y Link on Socio-Economic Status of the Enrouted and Command Areas.

5.4.5.1 Positive Impacts of the S-Y Link

- **i.** Increase in water availability which may help to fulfill the water based requirements.
- **ii.** Increase in electrical availability due to rise in availability of water.
- **iii.** Agriculture may increase with proper availability of water.
- **iv.** Increase in employment opportunity, the project is expected to provide jobs to large number of job seekers through the adoption of labour intensive production, protection and processing technologies in agriculture.
- **v.** Change in occupation pattern and family income may increase during the construction time of S-Y link by rising job opportunities for the local people.
- **vi.** Reduction in out-migration from the project area- with the rise in employment opportunity of people within the project area, the need for out migration will be minimized. Even the landless and unemployed/underemployed persons will find jobs in the non-agricultural activities of their own villages.
- **vii.** The increase in demand for employment will push the wage rates high in the labour market. Land value will rise. Irrigated land value will raise depending upon location factors and related aspects such as nearness to peri/semi urban areas, development of markets and infrastructure facilities.

viii. Increase in household income. All these post project change will lead increase in the household income in project area, average income likely to increase by 20-30%.

ix. Industrial productivity is likely to increase with increase in quantity and quality of crop production, improving in crop varieties, cropping pattern etc.

x. Some new temples, religious monuments, complexes may increase for the local people.

xi. Fertility of soil will rise due to increase in water availability.

xii. Increase in biodiversity.

xiii. Tourism may increase near the S-Y canal area due to increase in biodiversity.

xiv. Besides the major benefit of the advantage of sustainability, the project will provide an affordable cost advantage while shifting from tube-well irrigation to canal irrigation, as the farmers finds that the privately operated tube well irrigation is very expensive, unlike the Government's highly subsidized tube-well irrigation schemes.

5.4.5.2 Some Adverse Impacts may rise during the construction duration of the S-Y Link

1. During the construction time, water quality of nearby region may decrease due to addition of some impurities in drinking ground water.
2. Spoil may generate from labour camps, waste materials raise the waste generation in the construction area.

3. Some nearby areas of S-Y link may get flooded during the water transfer.
4. Drainage system may affect due to water collection during construction work.
5. Seepage and percolation of water may occur; impurities may get percolated into ground water.
6. Traffic may increase during the construction time due to increase in congestion of vehicles.
7. Air quality may increase due to increase in traffic.
8. Construction and development in nearby areas leads to increase in urbanization due to rise in water availability by the S-Y Link canal.
9. Impact on Public Health- Possibility of diseases such as malaria may increase due the development of the canal, formation of humid condition or stagnation of water resulting in mosquito breeding.

5.5 THIS SECTION INVOLVES THE STUDY OF OTHER ENVIRONMENTAL FACTORS OF THE PROPOSED S-Y LINK WHICH MAY LIKELY TO EXIST DURING AND AFTER CONSTRUCTION PHASE

5.5.1 Impact on Historical and Cultural Monuments

No Historical and Cultural Monuments may be affected due to the construction of S-Y link canal.

Positive Impact

Due to project site enhancement of the area, strengthening of road, plantation along road and temple is likely to increase more visitors and more tourism.

Negative Impact

Historical and cultural monuments along the lining of the S-Y canal during the construction work may affect.

5.5.2 Impact on Spoil Generation

Spoil generation and its disposal can be a critical issue during the construction stage. Spoil generated under the project is likely to affect the Enrouted areas through which the canal traverses. Spoil generation and disposal near forest area will have significant negative impacts if not managed properly.

5.5.3 Impact of Proposed S-Y Link canal on Settlements

The link will cross through some settlements of Enrouted areas. During and after construction of the S-Y link canal, the settlements of mostly in sub-urban areas of the districts such as Haldwani, Bijnor, Roorkee, Muzzaffarnagar, Haridwar and Udham

Singh Nagar would affect **(Fig 5.5.1).** List of settlements likely to be affected is given in the table below **(Table 5.5.1).**

List of Settlements likely to be affected

Settlements	**District**	**State**	**No. of structures likely to be affected**
Barahani	U.S Nagar	Uttarakhand	5
Bhukampuri	U.S Nagar	Uttarakhand	4
Intawa	U.S Nagar	Uttarakhand	7
Pipalsana	U.S Nagar	Uttarakhand	2
Chandpur	U.S Nagar	Uttarakhand	6
Navalp Colony	U.S Nagar	Uttarakhand	10
Jagdiswala	U.S Nagar	Uttarakhand	15
Chattarpur	U.S Nagar	Uttarakhand	1
Aliganj	Bijnor	Uttarakhand	6
Fatuha	Haridwar	Uttarakhand	4
Ladhuaura	Haridwar	Uttarakhand	4
Bukampur	Haridwar	Uttarakhand	5
Total Structures likely to be affected			69

Table: 5.5.1 Source: Primary Survey Conducted by CES

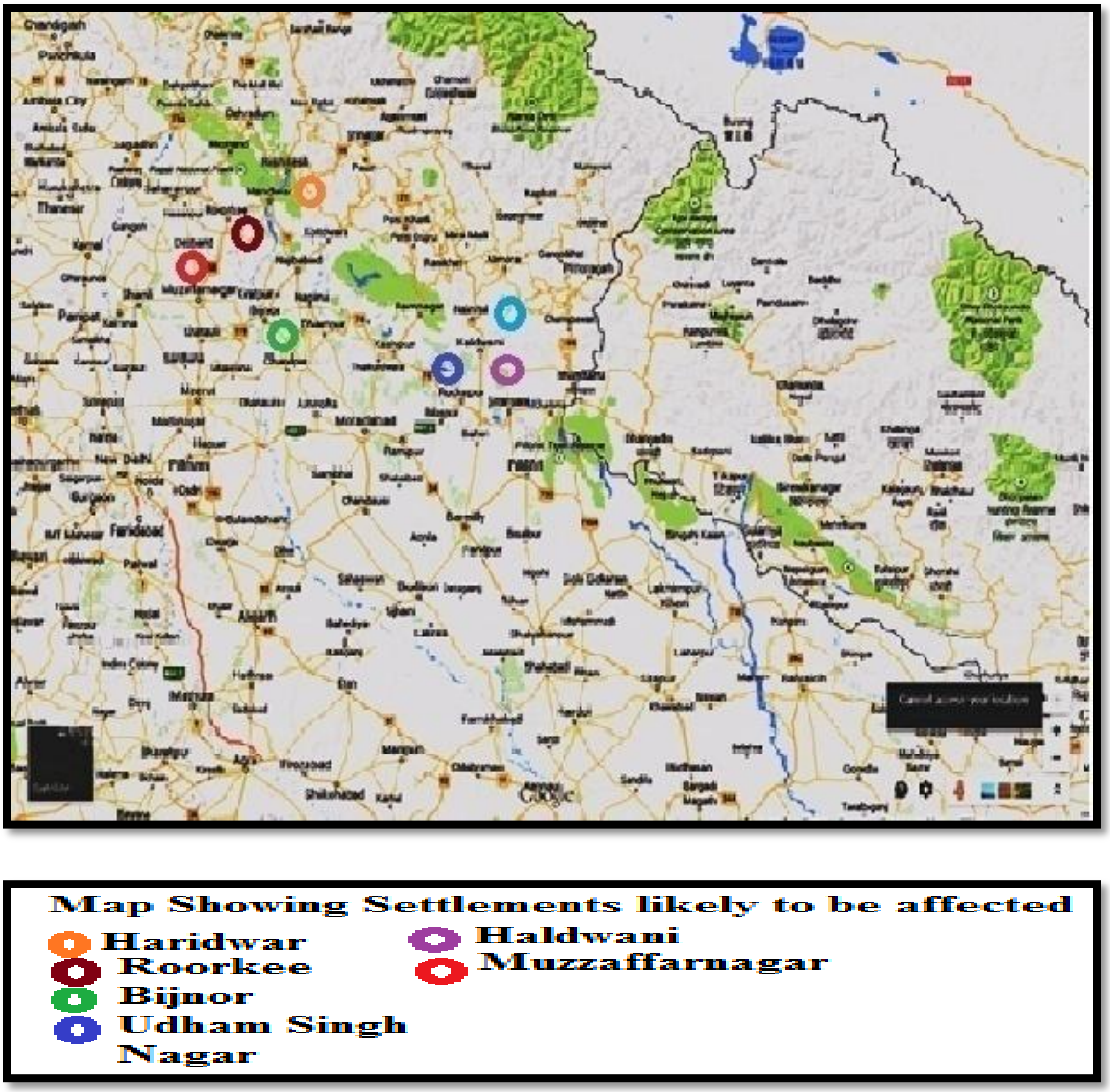


Fig: 5.5.1 Map of Settlements

5.5.4 Impact on Aquatic Life and Fisheries

Positive Impacts

Fishery and aqua culture will have better scope in the area due to development of the barrages and S-Y canal. The barrages have potential for development of fisheries and can create source of income generation to the local population. Aquatic life present in the upstream can easily flourish in other river in the downstream due to the S-Y link. This link will also help to enhance aquatic diversity. The canal linkage would help in cross migration of fish species and increase the fish population. The fisheries development will certainly enhance employment opportunity for local people.

Adverse Impacts

Some impact on downstream fish may take place due construction of barrages.

5.5.5 Impact on Flood and Drainage

The topography of the project area is covered in Gangetic plain. This zone is highly permeable and water table is found at shallow depth. Development of canal in the area is likely to raise the shallow water table. Water logging can be a matter of concern in the area. Some of the locations which are likely to be affected are:

- At Regional Distance, 144 to 155 Km near Pili dam, construction of canal is likely to affect the drainage problem between the Dam and proposed Canal.
- At Regional Distance, 129 Km to 136 Km near Tumaria Dam, the construction of canal may affect the drainage pattern of the area between dam and canal.
- Near Roorkee (Regional Distance 285 to 310 Km) water may be seeping into the ground. The S-Y canal will further contribute water to the ground which may cause water logging in the area.
- Other locations prone to water logging are Ghaumapur, Navalpur, Bhogpur, Bhukmpur- Jeetpur, Petapuri etc. **(Table 5.5.2).** Groundwater is at shallow depth prone to water logging. The streams and nallas in the beginning of the canal at regional distance are prone to flooding.

Locations prone to flooding

S. No	Village	District
1.	Ghaumapur	Nainital
2.	Navalpur	Udham Singh Nagar
3.	Bhogpur	Bijnor
4.	Bhukmpur- Jeetpur	Haridwar
5.	Petapuri	Haridwar
6.	Naagla Khurd	Haridwar
7.	Zabardastpur	Haridwar
8.	Jahalpur	Muzaffarnagar

Table: 5.5.2 Source: NWDA

5.5.6 Impact on Tourism and Water Sports Facilities

The proposed S-Y canal will traverse through forest, agricultural and settlement area providing various locations along the alignment.

Positive impacts

The cultural and religious monuments along the canal may be enhanced. The area where the canal passes near the Jim Corbett National Park and forest areas can be eco-tourist spot, providing wildlife watching towers etc. The barrage site at Sharda, Kosi, Ramganga and Ganga rivers can be developed as recreational centre providing water sports, boating facilities etc. Area along the stretch of canal, increase biodiversity of flora and fauna and forest area, development results into a famous tourist resort. Strengthening of road, plantation along road and temple, complex is likely to increase aesthetic value and more visitors are likely to visit the temple.

5.5.7 Impact on Air Quality

During construction time of the S-Y Link canal, the quality of air may be degraded due to the emission of vehicles, dust the people nearby area likely to have breathing problems. Some of the settlements which are vulnerable to air pollution during construction phase are given below in the **(Table 5.5.3).**

List of Settlements

S. No	Village	District
1.	Intwa	Nainital
2.	Gulzarpur (Regional Distance 114 Km- 115 Km)	Nainital
3.	Jagdishewal (Regional Distance 137.20 Km)	Nainital
4.	Jhadharpur (Regional Distance 300.05 Km)	Muzaffarnagar

Table: 5.5.3 Source: NWDA

5.5.8 Impact on Traffic

During construction period of the link canal, movement of construction vehicles and wok force are likely to increase the noise level. Some locations such as near urban areas or Ramnagar, Roorkee, Muzaffarnagar, Haldwani are busy routes. Possibilities of accident near construction the site mostly during night time. In forest area noise generated from construction activity may disturb wildlife in its resting feeding and breeding habit. Construction of canal near road side is likely to affect the traffic taking extra travelling time. Impact of noise level will be significant at the location where the canal traverses through settlement such as Intwa, Gulzarpur, Jagdishewal, Jhadharpur, Ghunsorpur, Ramnagar, Alipur, Jitinwala, Bukanpur, Alipur etc. All will be affected by noise produced due to their proximity to the canal alignment.

5.5.9 Impact on Construction / Labour Camps

During the construction time of the S-Y link, labour camps are also likely to come up near the water bodies disturb the wildlife, forest areas, utilize the forest resources such as felling trees for cooking, making huts etc pollute the surrounding land and water bodies. Some waste and sewage may also generate from labour camp is likely to be discharged in the water bodies etc.

5.5.10 Impact on Urban and Industrial Development

There is no allocation of water for industries in the command area along the S-Y link hence; the development of industries in the project area is not likely to take place. However irrigation of canal is likely to provide growth of agro-based industries such as rice mills, sugar mills, oil mills etc.

Positive Impact

Availability of water likely to accelerate the expansion of urban areas of Bijnor, Muzaffarnagar, Roorkee, Haldwani etc. Increase in agricultural yield and development of market for agriculture product.

Negative Impact

Increase in population due to urbanization. Settlement along the canal may disturb. Water quality may deteriorate due to the discharge of waste from domestic, municipal and industrial areas. Industrial effluent is likely to discharge.

5.5.11 Impact due to Barrage Construction on Flood Design Control

The project covers development of four barrages on Sharda River, Kosi River, Ramganga River and Ganga River. The submergence area at all the sites does not involve any submergence of forest, settlements and agricultural area.

(a). **Sharda Barrage**

The location of Sharda Barrage is Champawat district in Uttarakhand state. The discharge of water in Sharda River is 4986 × 10 ^{7} Cumec /yr. The barrage will design flood of about 16990 Cumec /yr. Impact of Sharda barrage on flood design control of Sharda River is 4985, 99, 83,010 Cumec /yr.

(b). **Kosi Barrage**

The location of Kosi Barrage is Nainital district in Uttarakhand state. The discharge of water in Kosi River is 220, 3 × 10^{8} Cumec /yr. The barrage will design flood of about 5184 Cumec /yr. Impact of Kosi barrage on flood design control of Kosi River is 22,029,99,94,816 Cumec /yr.

(c). **Ramganga Barrage**

The location of Ramganga Barrage is Bijnor district in Uttar Pradesh state. The discharge of water in Ramganga River is 15, 78 ×10^{7} Cumec /yr. The barrage will design flood is 7607 Cumec /yr. Impact of Ramganga barrage on flood design control of Ramganga river is 1577, 999, 2393 Cumec /yr.

(d) Ganga Barrage

The location of Ganga Barrage is Bijnor district in Uttar Pradesh state. The discharge of water in Ganga River is 3945 × 10^{8} Cumec /yr. The barrage will design flood is 1880 Cumec /yr. Impact of Ganga barrage on flood design control of Ganga river is 3944,999,98,120 Cumec /yr.

5.5.12 Impact on Water Use

Positive Impacts

During construction and after construction of the S-Y link, it will fulfil the water based requirements of the Enrouted and Command areas such as drinking, commercial, industrial and agriculture etc.

Negative Impact

The link canal will cross canals and rivers on the way, which are used for irrigation and drinking purpose may be temporarily affected. During the diversion of water, the canal is likely to have impact on the agricultural practices and hydro-power generation.

5.5.13 Impact on Water Quality

During the construction phase of the link canal, the water quality of the nearby area may deteriorate during construction phase. At the construction sites turbidity likely to increase and may have downstream impacts. The activities may arise such as surface water run-off from the construction sites, spillage, leakage from the construction tools and waste may be generated from the construction camps, all such factors may cause negative impact on quality of water in the Enrouted areas.

5.5.14 Impact on Availability of water in River Sharda and Yamuna

1. **Sharda River**

On the basis of recent status, the discharge of water in river Sharda is about 47,36,0409 Mm^3/yr. The S-Y Link canal will transfer water of about 11,680 Mm^3/yr into river Yamuna. The remaining water in river Sharda is may be 47,34,8729 Mm^3/yr. The quantity of water in river Sharda will decrease; impact will be moderate because water quantity in river Sharda is more.

2. Yamuna River

The discharge of water in river Yamuna is about 93,110 Mm^3/yr. The S-Y Link canal will transfer water of about 11,680 Mm^3/yr into river Yamuna. The remaining water in river Yamuna may be 10, 4739 Mm^3/yr. The quantity of water in river Yamuna will increase, impact will be positive.

5.5.15 Impact of Proposed Pancheshwar and Poornagiri Dam

The location of Pancheshwar and Poornagiri dam is Champawat district in Uttarakhand state. The Pancheshwar Dam will generate of about 45,526 Kwh of electricity and Poornagiri Dam will generate of about 83, 78,000 Kwh of electricity. Total generation of electricity of both dams will be 8382526 Kwh/yr. Electricity generation in Champawat District is 35, 5872 Kwh/yr. The Electricity of Champawat District will increase approx 87, 38,398 Kwh/yr. The Electricity of U.K will may also rise.

5.5.16 Impact on Environmental Enhancement

Environmental enhancement of the region would take place on account of the forestation programmes on the banks of the S-Y link canal, branch canals and distributaries.

SUMMARY

AND

CONCLUSIONS

6

SUMMARY AND CONCLUSIONS

Key findings of the research

The Case study of Proposed Sharda-Yamuna Link highlights the role of Large Scale Inter-Basin Water Transfer project in proper distribution of water and management of Flood and Drought problems in U.P and U.K states in India.

A National Perspective Plan was formed by Central Water Commission and Indian Ministry of Water Resources in 1980, under which about 30 "Inter- Basin Water Transfer Links" or "Interlinking of Rivers" proposed over 37 Indian rivers in respect of both Peninsular and Himalayan Rivers of the country. The interest shown by many researchers in the field of water resource management gave the concept of Large Scale Inter Basin Water Transfer projects in order to reduce the imbalances in the water availability between various regions by surplus water transfer from surplus regions to deficit regions.

Sharda-Yamuna Link (S-Y Link) is a Himalayan river development component and one of the proposed links of NPP in India. This link has been conceived for transferring estimated surplus water of approx 11,680 million cubic meters from Sharda River into Sharda-Yamuna link for use in water in water scarce areas of Rajasthan, Uttar Pradesh, Haryana and Gujarat. The S-Y link will fulfil the drinking, irrigation and industrial water requirements in acute water short and water scarce areas of western part of India. This link will also fulfil the other water requirements in its Enrouted areas through which the link crosses and surrounded Command areas. The canal alignment of the proposed Sharda-Yamuna link canal will passes through two states namely

Uttarakhand and Uttar Pradesh in India. It will traverse though Champawat, Nainital, Udham Singh Nagar and Haridwar districts in Uttarakahnd, which are the Enrouted areas and Bijnor, Muzaffarnagar districts, which are the Command areas in Uttar Pradesh state.

The key objectives of the of the S-Y Link canal project were to study the Description, Environmental, Ecological and Social Impacts of the Proposed Sharda-Yamuna Link Project on its Enrouted and Command regions.

S-Y link canal project comprises of three main components namely construction of Pancheshwar dam, Poonagiri dam for hydro power production and S-Y canal development. The canal will be trapezoidal section with 55.0 m bed width and 7.8 m full supply depth. The total length of the S-Y link canal is 384 Km. The average elevation of link canal varies from 240 to 280 m above means sea level. The S-Y link canal will take water from the right bank of the proposed barrage of about 5 Km downstream of proposed Poornagiri dam and 6 Km of existing Tanakpur barrage near Tanakpur town of Champawat district of Uttarakhand and outfalls into Yamuna near upstream of connecting U.P and Haryana in Kairana village of Muzaffarnagar district of Uttar Pradesh state. The available water from river Sharda will first store in the reservoir created by proposed Pancheshwar dam. Then the release of surplus water from this reservoir after generating the power will again store at proposed Poornagiri dam. The location of Poornagiri dam is at 58 Km distance of Pancheshwar dam. The designed discharge at head and tail of S-Y link canal will be 757.32 Cumecs and 605.77 Cumecs respectively. The full supply depth and bed slope is 7.8 m respectively for its entire length. Out of remaining 11,629 Mm^3 (Million cubic meters) of water available in river Yamuna, about 3054 Mm^3 of water will be available for industrial and domestic use. The remaining 8575 Mm^3 of water will be available for further diversion for providing irrigation to 10.27 Lakh hac in the water scarce areas of western regions and for the industrial and domestic water supply in Enrouted areas of the S-Y link. Besides various small tributaries, the S-Y link canal will cross important major rivers Kosi, Ramganga and Ganga. Barrages on each of these crossings are proposed to be constructed as level crossing. About 89 road bridges, 8 railways bridges and 2 canal escapes are proposed at suitable location along the entire stretch of link canal. The direct benefited En-route Command area of 2, 94,500 ha. S-Y link canal will provide 2.94 lakh ha annual irrigation in the areas of Uttar Pradesh and Uttarakhand state utilizing 1758 Mm^3 of water. The construction process work of the S-Y link canal is based on perfect construction and manpower planning. Many key types of machinery will be required for the construction work of Sharda-Yamuna link project along with good technical professionals. The duration is estimated for the construction work is approx 9 years.

Baseline Environmental Status is associated with the physical, biological components of environment. The Enrouted and Command areas of proposed S-Y Link are covered in U.P and U.K states. In view of **Physiography and Geology**, the entire S-Y link canal stretch including Enrouted and Command areas of U.P lies in Himalayan and Gangetic plane. U.P states lies in northern plane physiographic zone and U.K is situated in south part of Himalaya. Enrouted areas such as Champawat, Nainital, U.S. Nagar and Haridwar lies comes under greater Himalayan range and Command area U. S. Nagar is situated in Sivalik range of Himalaya region. The project site lies over sediments of Gangetic plain comprising sand, silt and clay with kankar in varied proportions. The S-Y link canal alignment passes through mainly bhabar and tarai plains from east to west and after that entire stretch up to regional distance 384 Km falls in alluvial plain. There will be no change in geology pattern of the Enrouted and Command districts.

With respect to **Soil**, the Enrouted and Command areas of the S-Y link canal covers in U.P and U.K states, which lies in Gangetic region. In U.K mountain soils are also present due to hilly region. Due to presence of Ganga River, alluvial types of soil are present which flooded soil. The soils in this plain are developed from alluvium deposited due to presence of rivers Ganga and Yamuna. The soils are generally very deep, highly productive and cultivated for wheat, rice and sugarcane crops. Canal alignment mainly passes through soils of old alluvium plain followed by soils of tarai and bhabar plain which is flood plain. Soil in command area is fertile and suitable for growing the crops. The soil of U.K is less productive, after construction of S-Y link canal the productivity of the crops may increase due to increase in water availability. The soil will be very productive and fertile. Productivity of agriculture of U.P and U.K region may rise. But during construction work of the canal and barrages by cleaning of vegetation, soil erosion may increase, which is negative aspect of the link canal. Soils of bhabar region and ravine plains near rivers and rivulets present in some patches along the alignment may show excessively drainage properties, severe seepage and erosion vulnerability.

In case of **Agriculture,** the maximum occupation of U.P and U.K states is agriculture, which lies in Indo-Gangetic plain in which river Ganga flows with its tributaries. In addition to agriculture, U.P is an industrial area. The predominant cropping pattern all along the canal alignment is observed as paddy and wheat in U.S Nagar, Haridwar and Bijnor districts and sugarcane crop in Muzaffarnagar district. S-Y canal alignment in Champawat and Nainital districts mainly pass through forest with minimal agriculture activity. U.K is an agricultural state due to presence of favourable climate, soil. Maximum population of the state is based on agriculture. The state is a good for the cultivation of wheat, rice, maize, bazra etc. S-Y Link will increase 2.94 lakh ha of agricultural area in Enrouted and Command areas of U.P and U.K. The total cultivated area of U.P and U.K will be 7, 84, 28,452.94 $\times 10^9$ Hectares. The S-Y Link canal will help in reducing the barren land by providing water. After the construction of the link canal, agriculture and other developmental activities may spread. Agriculture and irrigation will rise due to good water availability. The soil of the region is highly fertile and proposed link canal will increase the agriculture in U.P also. In U.P and U.K irrigation done by the canals and tube wells. The construction of the S-Y link canal may help in development of agricultural activities with proper availability of water such as the productivity of crops, intensity of crops, cropping pattern, more food grain production, agriculture labour, annual agriculture benefits and high yield varieties improved seeds.

In case of **Land use pattern** in U.P and U.K states, major crops grown are such as sugarcane, paddy, wheat etc. The entire stretch comes in Himalayan range which covers maximum forest area. The catchment area of Pancheshwar and Poornagiri dam covers in the reserve forest, protected forest, cultivated area and agricultural area. Due to construction work of the S-Y link canal there will be possibility of small change in land-use area in certain places. The land-use value will also rise by increasing tourist, agriculture, industries market places and settlements. Negative aspect of the link canal is that, it will require approx 256 Sq Km (25,699 ha) of agricultural area for the construction. Out of 384 Km length of S-Y canal alignment, 256.2 Km length of the canal covers agricultural land, 112 Km covers forest land and 15.8 Km length covers settlement, river beds & other land use. Initial stretch of about 100 Km, S-Y link canal alignment is covers through the forest area and remaining 12 Km forest is in intermittent patches.

With reference to **Climate and Rainfall Status**, In Uttar Pradesh state, it has humid subtropical climate (warmer summers) and some areas are semi arid regions. In Uttarakhand state, it has mountainous and humid subtropical type of climate is present. Monsoon occurs from June to September month and in winter rain occurs occasionally. Rainfall shows high regional variation from east to west along canal alignment. According to recent annual rainfall status in India, based on Indian Meteorological Department, the average annual rainfall in U.P is (100-120 cm) and in U.K is (120-400 cm), which is more than other states. On the basis of current data, during monsoons and rainy season, U.P faced normal rainfall of about 66.9 mm in east and 65.6 mm in western part, while in U.K, 107.4 mm of rainfall occurs, which is normal. During winters, U.P faced from excess rainfall which is about 18.2 mm in western region and 16.8 mm in eastern part and in U.K about 52.1 mm of rainfall occurs which is normal. Both U.P and U.K states faced from excess rainfall which is (46.6 mm and 8.9 mm) in western U.P and 7.2 mm in eastern U.P. Due to variations in rainfall and climate western, central and north eastern regions in India faced with drought and flood. Several districts of Uttarakhand have faced heavy rainfall in last year’s. On the basis of Indian Meteorological Department, last five years rainfall data shows that Enrouted and Command areas of the S-Y link canal in U.P and U.K faced excess rainfall during monsoon seasons. There will be no such impact of S-Y link on the climate and rainfall status of the Enrouted and Command areas. S-Y link will provide an equal distribution of water in states U.P and U.K due to surplus water transfer. The link will helpful in maintaining the water balance and minimizing the risk of flood in U.P and U.K regions by proper distribution of water. Surplus amount of water during the monsoons will be available to the drought affected regions.

As we see the **Surface Hydrology** status of U.P and U.K, the states are fulfil of major rivers and their tributaries such as river Ganga and Yamuna. All the Enrouted and Command areas of the S-Y link covered in Sharda, Ramganga, Yamuna and Ganga basin. S-Y link alignment including Enrouted and Command area falls mainly is Sharda, Ramganga and Yamuna sub-basins of Ganga basin and having well-drained properties. Among the perennial rivers Sharda, Kosi, Ramganga, Ganga and Yamuna are the main rivers coming across the proposed S-Y link alignment. All Command areas fall in Ganga-Ramganga region except Rampur, which is located in Kosi- Gola region. River Ganga, Ramganga a tributary of Ganga itself and their tributaries drain the major part of command areas belonging to Moradabad and J.P. Nagar district. Due to major rivers and their tributaries water balance is irregular. During monsoons the heavy flood situation arises. So, the S-Y Link canal will help in maintaining water balance and provide the surplus water to deficit regions also.

Statistics shows that **Ground Water** constitutes major source of irrigation in all project block along canal alignment as well as in its en-route command area. Over exploitation of ground water, has led to decline in water levels. Bareilly, Badaun, J.P. Nagar and Moradabad districts have ground water shortage. Water levels are observed at deep level (ranging 10 to20 m below ground level) during pre and post monsoon period except at shallow level in tarai area during post-monsoon period. Rampur and U.S. Nagar being located in tarai zone, show good potential for further ground water development. Condition in Muzaffanagar and Bijnor districts is not as much alarming as compared to other districts of command area. Proposed S-Y Link will help in maintaining the ground water level in Enrouted and Command areas. S-Y link canal can be a source of drinking water and irrigation. During summers, S-Y link canal will helpful for recharging ground water and increase the amount of water in canals. After recharging the ground water, the net annual ground water availability of Uttarakhand State will increase to 49,493.87 Mm^3 from 2,100 Mm^3 and in Uttarakhand State it may increase up to 49,493.87 Mm^3 from 2,100 Mm^3. Hence, overall canal alignment is passing through districts with good potential of ground water development area. In case of **Water Quality** of the study area, surface as well as ground water may slightly get deteriorated during the construction work of S-Y link. Some settlements also face from bad water quality along the canal cover.

The **Baseline Ecological Status** of the S-Y link canal describes the recent status of the ecosystem along the S-Y canal including study of flora, fauna, forest cover, wildlife, vegetation along the canal alignment, protected areas in Enrouted and Command areas of U.P and U.K states and Impact of proposed S-Y Link canal on forest and non-forest area of Enrouted districts and wildlife reserves. The S-Y link canal will cross through Himalayas and Gangetic plain of U.K and U.P states in India. Himalaya is the highest mountain in the world, which was formed about millions of years ago having extreme cold climate and rich in diversity of flora and fauna. Indo-Gangetic Plain is a northern plain. It is a plain of river Ganga, Brahmputra and Indus and their tributaries.

The plain was formed by mountainous streams. It is a plain of rivers flowing in the regions. Climate of U.P and U.K states is very warmer in summers and some western parts are drought affected. Soils are very fertile, alluvial due to the plain of flowing major rivers and their tributaries. Vegetation in the plain varies due to variations in rainfall status. The Gangetic plain is a plain of large diversity of flora and fauna. U.K is rich in forest diversity. Dry temperate, grasslands and wet temperate types of forest are present. In U.P, tropical thorn and dry deciduous forest are present.

According to India State of Forest Report, U.K state has more forest cover (26.38 %) than in U.P (3.39 %) state. Among the Enrouted areas in U.K state of the S-Y link canal, Champawat (1187 Sq. Km) and Nainital (3074 Sq. Km) districts has both types open and dense forests. While in Haridwar (615 Sq. Km) district, it has more open forest area, Among the Command area U.S Nagar (5.46 Sq. Km) has more open forest area. Nainital district has more forest cover (3074 Sq. Km) among all the Enrouted and Command areas of U.K state. Among the Enrouted areas of S-Y link canal in U.P. state, Bijnor (417 Sq. Km) district has both open and dense forest area and Muzzafarnagar (41 Sq. Km) district has open forest area. While in Command areas Moradabad (26 Sq. Km), J.P. Nagar (86 Sq. Km), Bijnor (417 Sq. Km), Bareilly (44 Sq. Km) and Badaun (44 Sq. Km), have open forest area and Rampur district has both open and dense forest areas. Among all the Enrouted and Command districts in U.P state, Bijnor district has maximum forest (417 Sq. Km) cover. Different types of forest along the S-Y link canal (384 Km) are such as Sal, mixed forest etc. It is covered by more diversity of fauna. Various medical and aromatic plants are also present along the link. Proposed S-Y Link canal is likely to transverse about 112 Km through forest area, which is approx 1.9 % out of the total forest area of U.P and U.K state and about 0.3% of the geographical area will be covered by the link canal out of the total (G.A) geographical area of U.P and U.K state. Approx (0.2 %) of the forest area may covered by the S-Y link out of the total forest area of U.P and U.P state. Due to the construction work of the link some forest area of about 112 Km may be covered, but after construction the link canal, the forest area in Enrouted and Command areas may rise due to the water availability. The proposed S-Y link will help in increasing more forest cover in U.P than U.K state. U.P has more non-forest area.

U.P state has one National Park (N.P) and 23 wildlife sanctuaries and U.K state has about 6 National Parks and 7 wildlife sanctuaries are present which is rich in diversity of flora and fauna. The proposed S-Y canal will not cross through any wildlife sanctuary and N.P, but the nearest N.P is Jim Corbett. It is situated approx 1 Km at a distance from the link canal, which is located at Kaunkhera village in Nainital district of U.K state. During the construction time, some disturbances may create, but after the construction of link canal diversity of flora and fauna may increase due to increase in water availability, there would be more migration, more habitation etc. The S-Y link will be more helpful endangered species for their survival. EIA is an effective tool for study of environmental impacts of any project activity. EIA techniques can help to protect the environment and mitigate the negative impacts.

With respect to the **Socio-Economic Status**, among the Enrouted and Command areas of the S-Y link canal Haridwar, Moradabad and Bijnor districts were visited during (October to November 2014) to know the Socio-Economic Status. Bijnor is both Enrouted and Command area. Five local sites of each Enrouted and Commend districts were visited. The study on recent Socio- Economic conditions was done on the basis of EIA Checklist Method and to know the Socio Economic Impacts of the S-Y link canal. The field survey was done with pre-prepared questionnaires and checklist. Interview was taken with discussion from several group of people include literates, illiterates, labours, employers youngsters etc. Certain environmental components were selected such as literacy rate and education, electrical availability or supply, water availability, water quality, agriculture, occupation and family income, important landmark, spoil generation, industry, climate, religious monument, flood status, drainage system and water collection, tourism, seepage and percolation (absorption of water), traffic, air quality, construction development, soil, fishery, public health status and medical facilities to know the possible environmental and socio economic impacts of S-Y Link canal on its Enrouted and Command areas.

In **Haridwar district,** the visited sites are Mayapur Chowki, Ranipur, Kankhal Area, Harkipauri and Kotwali Nagar. The literacy rate is medium; there will be no impact of the S-Y Link canal on literacy rate. Electrical and water availability may increase, Water quality may affected during the construction of the canal. Agriculture, industries, occupation, family income may rise during construction and after construction of the S-Y link canal. There are important landmarks in all the sites. Climate of the areas is dominating; there will be no significant impact of the link canal. Spoil generation, flood status and drainage system may be affected during the construction time. Sometimes in rainy season, flood comes in laksar area due to which water level rise in river Ganga. Tourism is maximum during the tourist season likely to increase and increase in quality of religious monuments, temples. Traffic, air quality seepage and percolation of water construction development may affected by the S-Y Link during the construction time. Soil fertility and fishery production may rise due to increase in water availability. There will be no significant impact of S-Y link on public health status and medical facilities.

In **Moradabad district**, which is the command area, the visited sites are Station Road, Kath Road Hartala, Karula, Pital Nagar Bus Stand and Buddha Bazaar. No impact of the S-Y link canal on literacy rate of all the sites. Electrical availability is good in all the sites (above 20 hrs), water supply is medium, but sometimes sand present in ground water. There will be increase in water and electrical availability due to presence of link canal but water quality may decrease during the construction time. There is no agriculture in all the sites the link canal, but the agriculture may raise due to good water availability. Occupation and family income is average in all the sites depends on private sectors, business work; labour work, which may increase during the construction. Industrial sector is likely to increase the productivity due to increase in water availability. No impact will affect landmark, climate of the region. Traffic congestion, seepage, percolation of water, air quality, drainage system, flood and spoil generation may occur during the construction time of the S-Y link canal. Soil fertility, fishery production and tourism may increase after the S-Y Link canal construction.

In **Bijnor district**, the sites visited are Jatan, Sotiyan, Awas Vikas Colony, Ghasiawala Area and Barrage Colony. Literacy rate is average in all the sites. Water quantity, agriculture and electrical availability are very low in all the sites. S-Y link may increase the water, electrical availability and agriculture of the areas. Industries, occupation and family income may increase during and after the construction work. Water quality is medium in all the areas, sometimes sand comes in drinking water. Water quality, traffic, air quality, drainage system, spoils generation and construction development may increase during the construction of the link canal. Soil quality, fishery production and tourism may rise after the construction of the link canal.

"Overall in the Enrouted and command areas, Enrouted areas will be more benefited by the construction of proposed Sharda-Yamuna link canal, as the alignment crosses the areas. Water availability, electrical availability, fishery, industries, tourism, soil, fertility, agriculture, occupation, family income and religious monuments are likely to increase during and after the construction phase of S-Y Link".

Some adverse impacts may arise such as air quality, water quality, traffic, drainage, seepage, percolation of water, construction and development of the regions, but such adverse impacts occurs only during the construction work of S-Y Link, after the construction, there will be no significant impacts. On the basis of Socio-Economic survey, beneficial impacts of proposed S-Y link are found to be more than the adverse impacts on environment. The adverse impacts can be minimize during the construction time with a proper Environmental Management Plan.

It is necessary to know the expected adverse impacts of S-Y link project to mitigate the harmful Environmental, Ecological and Social impacts of the link canal on its Enrouted and Command areas. Impacts during the construction phase are of temporary nature and can be managed with better housekeeping and construction practices.

CONCLUSION

The Case Study is based on the recent Environmental, Ecological and Social aspects of proposed Sharda-Yamuna (S-Y) Inter-Basin Water Transfer Link to know the expected beneficial and adverse impacts with mitigation measures.

A study was done on one of the Himalayan river development component projects proposed Sharda- Yamuna link of the National Perspective Plan in India. Many regions in the country are facing with floods and nearly maximum parts of the country are water scarce due to irregularity in rainfall pattern. In 1980, a National Perspective Plan (NPP) was formed by the Indian Ministry of Water Resources and Central Water Commission for water resources development and proposed Large Scale Inter-Basin Water Transfer proposals for transfer of water from surplus regions to water scarce regions to minimise the water problems Flood and Drought in India. Proposed Sharda- Yamuna link project is aimed to make available water to the acute water short and drought prone western states Haryana, Rajasthan and Gujarat of the country. The surplus water of river Sharda will transverse to river Yamuna and further towards western regions of India to decrease the twin water problems Flood and Drought in India. This water transfer project consist of districts which are lies on the way are Enrouted areas and cover the surrounded districts are as Command areas in Uttar Pradesh and Uttarakhand State in India. Enrouted areas are Champawat, Nainital, Udham Singh Nagar and Haridwar districts in Uttarakhand State and Bijnor, Muzaffarnagar districts in Uttar Pradesh state in India. Command districts are Bareilly, Rampur, Moradabad, Badaun, Udham Singh Nagar and Bijnor districts in Uttar Pradesh. Along with flood and drought control, the S-Y link canal would cover all the water requirements of Enrouted and Command areas of U.P and U.K in India

Objectives of the case study were to study the Environmental, Ecological and Social Impacts of Proposed Sharda-Yamuna link. An EIA checklist method was applied to know the Socio-Economic status of the Enrouted and Command areas of the S-Y link. Potential Positive and Negative Impacts were assessed due to project location, design, construction, operation phase. Appropriate measures are also suggested to regulate the adverse impacts and to focus positive impacts. Key findings under positive and negative impacts during post project scenario have screened and described in following section.

The annually transfer of the surplus water in river Yamuna by the S-Y link will approx 11,680 Mm^3/Yr. On the basis of current amount of water in river Yamuna, the water availability may increase up to 1, 04739 Mm^3/yr in river Yamuna, which helps in decreasing drought in the surrounded areas. And in river Sharda the remaining water will be 47,34,8729 Mm^3/yr from 47,36,0409 Mm^3/yr which may help in decrease in flood in its surrounding areas in U.P and U.K states. Water requirements of the local people such as drinking water, water for commercial purposes will also fulfil by the S-Y link during and after the construction phase. With increase in proper availability of water and development of the surrounding areas, more industries may likely to set up. Increase the productivity with quality and quantity, fishery production will also increase, which are likely to enhance the employment opportunities in Enrouted and Command areas. Sharda, Kosi, Ramganga and Ganga barrages are proposed to control the flood during the surplus water transfer by the S-Y link canal. With respect to per capita income of U.P and U.K.

states, during and after construction phase the proposed link is expected to increase the per capita income of about 25-30% due to increase in employment. On the basis of current per capita income status, the per capita income of U.P may rise from 33,269 Rs to 41,586 Rs and in U.K it will rise from 92,607 Rs to 11,5758 Rs.

With respect to the Socio-Economic Status, on the basis of recent field survey of Enrouted and Command areas and EIA Checklist method, it can expect that the S-Y link canal will increase the Water availability, Electricity Production, Agriculture, Occupation pattern, Employment, Industries, Religious monuments, Tourism, Soil fertility and Fishery etc. Due to increase in water quantity. The Electricity available in the Champawat District of U.K state is 35, 5872 Kwh/yr. The proposed Pancheshwar and Poornagiri dam will generate of approx 83, 82,526 Kw/yr of electricity in the Champawat District. The Electricity of Champawat District may increase up to 87, 38,398 Kwh/yr. The electricity generation in U.K state may also rise.

Due to development of the nearby area of the S-Y link canal, historical and cultural monuments, forest, settlements and agricultural area, tourism and water sports facilities are also likely to increase. After construction of the S-Y link several a forestation programmes on the bank of the canal may take place, which may help in environment enhancement. Increase in biodiversity, flora, fauna of the region may attract several tourists in the surrounding regions of the S-Y link. The area where the S-Y link canal place near the Jim Corbett National Park, which can be converted into eco-tourist spot, picnic spot for watching wildlife, biodiversity. Soil fertility in the surrounding areas of the S-Y link will also increase due to increasing in amount of water, due to which agricultural productivity and agricultural area will also rise. The S-Y link canal may increase of about 2.94 lakh ha of agriculture area in Enrouted and Command areas of U.P and U.K states. On the basis of current agriculture status, the cultivation of area will increase up to 7, 84, 28,452.94×10^9 ha. The land use value will also rise. Surface and Ground water level will rise during and after the construction of the link due to the ground water recharge by the link canal. The total ground water availability in U.P and U.K is 72,280 Mm^3. It is expected that about 72,998.83 Mm^3 of the ground water availability will rise in U.P and U.K states. There will be no significant change in physiography and geology in the nearby locations of the surrounded areas of the S-Y link. After the construction work, the wildlife includes both diversity of flora and fauna will increase and new habitation may take place. The S-Y link canal may also help in protection of endangered species such as bengal tigers etc.

Along with Flood and Drought control, the S-Y link canal would cover all the water requirements of Enrouted and Command areas of U.P and U.K in India.

Overall the **Positive Impacts** includes management of water crisis, sustainable use of water for future, Irrigation Benefits like increase in crop productivity, recharging of ground water by canal water, increase in intensity of irrigation, improvement in cropping pattern & agriculture practices. Some other benefits include Infrastructure facility improvement, employment generation, tourism development, navigational benefits, increase in water availability for drinking and industrial purposes, agro based industries, fishery development, household income, food production and power generation etc.

With respect to the **Adverse impacts** of the S-Y link canal, the project covers in U.P and U.K states, which have mountain and flooded types of soil is present, so soil erosion may occur during the construction phase of the link canal and barrages. Wildlife may get disturbs during the construction work of the link canal; restriction in their movement may take place. In case of agriculture, approx 256 Sq. Km of area will be covered by the S-Y link project, which may increase deforestation. Air and water quality may get deteriorated during the construction time due to release of dust and emissions from the vehicle. Some settlements in the Enrouted area may affect and likely to have breathing problems. The forest area in Enrouted area may decrease, the link covers of about 112 Sq. Km of forest area. On the basis of current status of forest, the forest area will decrease from 5,880 Sq. Km to 5,768 Sq. Km and about 0.03% of the geographical area will be covered by the S-Y link canal. In case of Socio-Economic status, the water quality of the surrounded area may decrease, spoil generation may increase, flood status may arise, drainage and water collection problem, seepage and percolation of water may take place, traffic may affected, air quality may disturbs and urbanization will increase in the Enrouted and Command areas. Overall the Negative Impacts include forest area and wildlife destruction, agricultural area and settlements are affected, drainage problem, land use, seepage percolation of water and spoil generation.

Significant adverse Environment and Social issues may arise; most of the impacts are temporary, reversible and localized. With the significant beneficial and adverse Environment and Social issues, the preliminary management plans are discussed to minimize and manage the adverse impacts during and after construction of the S-Y link canal.

However, the adverse impacts are short term in nature and are occurs only during operation phase of the S-Y link. Environmental monitoring is required for to measure the environmental Parameters due to the construction activities and monitoring of adverse impacts may be conducted during the construction time of the link project. The study on strategies and management plans were done to regulate the adverse impacts of the S-Y link on environment. During construction of the barrages, dams and link alignment, the adverse impacts on water quality, air quality, soil, forest, flora, fauna, socio-economic conditions, agriculture etc. may cause, which cannot be avoided hence, some appropriate mitigation measures are suggested to minimise adverse impacts with proper planning. Now, the various efforts should be made at Govt., NGO and individual levels to decrease the flood and drought in India and conserve the precious water for future. With proper management plan, it is necessary to educate the public about environment and its sustainability. Mitigation measures should be for the social aspects. Some mitigation measures for Soil, Land-use, Agriculture Sector, Agricultural Land, Ground Water, Seepage and Percolation, Flood and Drainage problem, Water use, Traffic, Noise Pollution, Air Quality, Spoil Generation, Barrage Construction, Forest Area, Tourism, Socio-Economic Status, Electricity, Historical and Cultural Monuments, Occupational hazards and Public Safety and Settlements were studied to control the harmful impacts of S-Y link during and after the construction phase.

“The overall case Study of proposed S-Y Link concluded that it is an effective flood and drought management plan in U.P and U.K states in India. The link will also fulfil other water based requirements of its Enrouted and Command areas.

ENVIRONMENTAL MANAGEMENT PLAN

7 ENVIRONMENTAL MANAGEMENT PLAN

This section numerates the set of compensatory measures to mitigate and manage the adverse impacts of proposed S-Y Link.

Environmental Management Plan is to identify the expected harmful environmental impacts and focus the positive impacts of the S-Y Link Project. The development and construction work of the S-Y link canal including excavation, construction of barrages, dams etc. are likely to cause some adverse impacts on water quality, air quality, soil, forest, flora, fauna, socio-economic conditions and agriculture.

Adverse impacts may arise only during the construction phase, which can be managed by the proper planning activities.

7.1 Some Suggested Strategies and Recommendations for Environmental Management Plan are as follows:

Centers for sustainable human settlement, education and environmental awareness must be established in urban and as well as in rural areas. Central and State Government must set up centers to carry out research and developmental programmes related to Sustainable development of Environment. EIA is a necessary method for environmental management of any developmental activity. There is a need to educate the public about environment and its sustainability. The quality of life and requirements of the people including their views should keep in focus.

7.1.1 Mitigation Measures for Underlain Geology and Physiography

No such impact may arise on Geology and Physiography of the baseline environmental status of the proposed S-Y link canal due to the construction work.

7.1.2 Mitigation Measures for Soil

i. Canal bank protection measures are required to control the soil erosion problem of the banks. Suitable measures include bio-engineering techniques such as plantation, check dams etc.

ii. Training work on river to be conducted in upstream of rivers and streams.

iii. During the borrowing of an area for the canal construction work, ecological sensitivity of the area needs to be concern.

iv. Construction work of the S-Y link should not be done in rainy season; there may be possible chances of soil erosion.

v. Surplus spoil generated from the construction work of canal can be utilized for rehabilitation of degraded brick, kilns near Roorkee- Laksar area.

vi. Plantation may be undertaken at site along with construction activity

7.1.3 Mitigation Measures for Land-use

i. Crop rotation process should be encouraged for proper water balance in the area

ii. Awareness program for farmers should be place.

iii. Water distribution may be prioritized to the areas which do not fall under any scheme in the command area.

7.1.4 Mitigation Measures for Agriculture Sector

i. The maintenance of water quality in the Enrouted areas of the S-Y link canal need to priority.

ii. Bridges may be provided along agriculture fields near the link canal to avoid agriculture runoff.

iii. Discharge of domestic, municipal, agricultural and industrial waste into canal should not be in nearby area of the link canal.

iv. Job opportunities and employments should provide to small farmers, laborers and landless needy persons under the project.

v. Organic farming should be preferred, a proper space should be provided to grow food producing plants using sustainable methods such as organic farming, this will not only good for the diet of local people but also helps in improving the biodiversity of the region of the link canal.

7.1.5 Mitigation Measures for Ground Water

i. During the demand for irrigation, the farmers in command area may go for conjunctive use of surface and groundwater in order to meet both the criteria of economic maximization and sustainability.

ii. Ground water monitoring during the construction phase.

iii. The distribution of water may be planned in consideration with population growth and urbanization of the project area.

iv. Discharge of waste in water should be strictly prohibited and regular inspection of canal may be undertaken.

v. Ground water fluctuations should be observed periodically, to control water logging problem in nearby area of the canal.

7.1.6 Mitigation Measures for Seepage and Percolation

i. Soil from cutting section available from various reaches may be used for filling nearby sections.

ii. Proper seepage control measures should be taken in the permeable section.

iii. Plantation of tree species such as Eucalyptus, Bamboo and grass species etc. are suggesting along canal.

7.1.7 Mitigation Measures for Flood and Drainage

i. The Sharda –Yamuna link canal may cause minimal impact on the flood status of the area through which it traverse.

ii. During the alignment the seepage of water may be occurs.

iii. There should not be a problem of water logging in the area.

iv. Proper drainage system should be provided to avoid any problem due to construction of the canal.

v. River training work need to provide, the flow of water could be channelized near the canal to protect agriculture and settlement land from erosion and flooding.

vi. Cross drainage structures at Rivers & Streams are suggested considering the topography and bed level of the canal.

vii. Plantation should be done in the area prone to water logging along the canal.

7.1.8 Mitigation Measures for Water use

- **i.** Construction of the canal should not affect the hydro-power generation and irrigation requirements from other sources while crossing rivers and canals.
- **ii.** Use of water should be in a sustainable way to meet the drinking water requirement of acute water shortage towns and villages from the S-Y link.

7.1.9 Mitigation Measures for Traffic

- **i.** The effect on traffic congestion will be temporary and only during the construction time. However traffic management plan is required to be framed and diversion routes to be marked before starting construction activity.
- **ii.** The information regarding diversion routes should be provided through local Newspaper and Television channels to the local people.
- **iii.** Appropriate signs and flags are required to place at the construction sites and diversion routes.
- **iv.** Proper lighting is required to provide at all the crossing locations during night time.
- **v.** After completion of the construction work at crossing sites, development of green belt should be there to enhancement and maintenance measures.

7.1.10 Mitigation Measures for Noise Pollution

All vehicles, equipments and machineries during the construction work should be fitted by silencers to keep maintain noise within the permissible limit and to avoid noise pollution.

7.1.11 Mitigation Measures for Air Quality

- **i.** Mask is required during the plantation activity, construction work to prevent breathing problems.
- **ii.** Construction vehicles such as trucks carrying soil, sand, stone and other construction materials should be covered to avoid dust spreading.
- **iii.** Low emission construction tools should be used.
- **iv.** Checking of air quality should be done at regular time intervals at the construction sites.
- **v.** Some air pollution tolerant plants such as Banyan tree (*Ficus benghalensis*), Peepal (*Ficus religiosa*) should be planted in deforested areas with proper planning and care.

7.1.12 Mitigation Measures for Spoil Generation

- **i.** Generated spoil from the cutting sections need to be utilized in filling sections.
- **ii.** The excavation material can also be utilized for the construction of the link canal.
- **iii.** Periodic sprinkling of water should provide to avoid spreading of dust.
- **iv.** Borrow area rehabilitation should be taken under the project.
- **v.** Instead of land filling of the waste, recycling of solid waste is good process to avoid pollution of ground water, soil and flooding.

7.1.13 Mitigation Measures for Barrage Construction

- **i.** The barrage sites should be away from the settlement area and submergence of settlement area and forest land should not likely to be involved.
- **ii.** Plantation should be carry around barrage sites to prevent water logging.

iii. Enhancement measures such as development of cycle tracks, toe and paths, parks, water sports etc. likely to be explored for optimum use of site.

iv. Construction of Kosi barrage on River Kosi should be reviewed; level crossing may be avoided so that water quality is not affected due to mixing of water from two sources.

7.1.14 Mitigation Measures for the Forest Area

i. The alignment of the canal has been selected judiciously considering the topography, slope, social setup and ecological aspects. Except Bijnor and Muzaffarnagar in U.P the districts of Uttarakhand comprise of good forest cover Nainital 72.37 %, Champawat 67.21 %, Haridwar 72.37 % and Udham Singh Nagar 26.06 %.

ii. Compensatory forestation program should be carried to compensate the loss of forest area.

iii. Greenbelt development may be undertaken as a part of enhancement measure in the settlement area and plantation along then S-Y Link canal banks.

iv. Forest clearance is necessary from the State Forest Department before felling trees initiating any activity in the forest area.

v. Uttarakhand and Uttar Pradesh water, land and tree rule, 2004 should be followed.

7.1.15 Mitigation Measures for the Wildlife Reserves

i. Poaching should not be done in the forest areas; it may be informed that no handling or fishing should be at site of the work to maintain the value and sensitivity of the wildlife resources.

ii. Protected line of the S-Y link in excavated section is required to keep animals safely out.

iii. Facility should be provided in the forest area for wild animals for drinking water.

iv. Specially designed bridges, structures, sloping cover and tunnels can be provided in the forest area with over the canal with plants on both sides for their migratory paths so, that elephants & other wildlife can safely cross the canal. The facility should be finalized in consultation with Wildlife Department.

v. An efficient work strategy should be follow to limit damage of sensitive ecosystem.

vi. Construction work of the link canal may be restricted during monsoon period.

vii. Acts related to the wildlife such as Forest Act and Wildlife Act should be strictly followed.

viii. Awareness programs on conservation of wildlife are required to place.

ix. It is essential to undertake separate focus on Endangered and Threatened species in the project area for their conservation.

7.1.16 Mitigation Measures for Tourism

i. Water quality of the canal requires to be strictly maintained.

ii. Discharge of any waste into the canal should be strictly banned.

iii. Environmental sensitivity, safety measures and Environmental law should be placed at eco-tourist site.

iv. Hunting and fishing is required to ban.

v. Violation of the Forest and wildlife Act may be subjected to the law.

vi. Plantation may be undertaken along the canal alignment, barrages and at the tourist sites.

vii. Cycle tracks with green belts can be developed along canal to enhance the aesthetic value.

7.1.17 Mitigation Measures for Socio-Economic Status

i. The canal and surroundings should be cleaned to avoid mosquito breeding. No water stagnant pools may allow forming near the canal and command area.

ii. Supplies of medicine to the public health center to ensure the water borne diseases in the canal alignment and command area for at least 5 years.

iii. Displaced people for the project should be resettled at suitable locations.

iv. Preference should be given to local labors for unskilled work during the construction period.

v. Public consultation is required.

vi. Child labour should be prohibited.

7.1.18 Mitigation Measures for Electricity

The use of electricity should be charged in a reasonable limit, this kind of way is helpful for electricity misuse.

7.1.19 Mitigation Measures for the Historical and Cultural Monuments

i. Possibilities of canal alignment modification may be explored with respect to social concern.

ii. Religious structures may be relocated only after public concern.

iii. Any archeological, historical site, coins, pottery, status etc. of archeological importance discovered during the excavation work may be immediately communicated to Archeological Survey of India (ASI).

7.1.20 Mitigation Measures for the Settlements

i. All the settlements falling in the canal should be verified form the village Panchayat.

ii. Help concern should be provided to Project Affected Persons (PAPs) as per the national R&R policy.

iii. Mitigation measures should be for the social aspects.

7.1.21 Mitigation Measures for Occupational hazards and Public Safety

i. Safety instructions should be given to the local people of the surrounding area.

ii. Light should be provided all along the S-Y link especially at the crossing points.

iii. Siren and alert system should be providing to the construction vehicles to avoid any collision.

iv. Regular health check up programs and camps, first aid facility should be providing at the construction site.

v. Ambulance facility should be there for immediately medical treatment.

vi. Safety measures such as helmet, gloves and ear plugs should be apply.

vii. International standard of safety norms should be followed at work site.

viii. Awareness program should be done for health improvement.

RESETTLEMENT AND REHABILTATION PLAN

8 RESETTLEMENT AND REHABILTATION PLAN

The Resettlement and Rehabilitation (R&R) Plan is necessary to restore the Social and Economic aspects of living of the Project Affected Persons.

Resettlement includes Project Affected Persons *(PAPs)* shifted to new settlements and it is related to the developmental strategy for the people considering Socio-Economic conditions to improve their quality of life.

8.1 Land Acquisition Act

The land acquisition for construction of the major and medium projects should be carried out under the Land Acquisition Act 2007 in India.

8.2 Rehabilitation Policies

The main policies of rehabilitation are as follows:

- Identification of displacement of the project affected people.
- To consider the special needs of tribals.
- To provide better facilities of living to the Project Affected Persons.
- Canal alignment should keep away from nearby settlements to avoid resettlement of households.
- Baseline Socio- Economic Status
- Villages along the canal, peoples and their socio-economic features should be focused for resettlement and rehabilitation plan.
- Affected people belonging to low poverty must be benefited.

- Financial support and agriculture land should be provided to the affected people.
- Affected families must be provided necessary self-employment projects to the resettlement areas.
- The project affected persons of scheduled caste should get reservation benefits at the resettlement zones.
- Help for house construction
- Allotment of land
- Shifting
- Infrastructural help include water supply, school, electric supply, proper sewer facilities and land for market etc. should be provided in the settlement area.

REFERENCES

9 REFERENCES

1. Amarasinghe, U. (2009). CPWF Project Number 48: Strategic Analysis of India's National River Linking Project, CGIAR Challenge Program on Water and Food Project Report series; www.waterandfood.org.
2. Amarasinghe, U. (2012).The National River Linking Project of India, Some Contentious Issues, Water Policy Research Highlight, IWMI-TATA, Water policy program, 16, pp: 1-11.
3. Amarasinghe, U. A., Shah, T., Turral, H. and Anand, B. K. (2007). India's water future to 2025- 2050, Business-as-usual scenario and deviation,. Colombo, Sri Lanka: International Water Management Institute, (IWMI Research Report 123), 47p.
4. Amarasinghe, U. A., Sharma B. R., Aloysius, N., Scott, C., Smakhtin, V., and Fraiture. C. D. (2005).Spatial Variation in Water Supply and Demand across River Basins in India. Research report 83, Colombo, Sri Lanka: International Water Management Institute.
5. Amarasinghe, U., Shah, T. and Malik, R.P.S. (2009). Indias water future , Scenarios and issues, Strategic analyses of the National River Linking Project of India Series I, Colombo, International Water Management Institute.
6. Ayalasomayajula, S., Saran, S., Srivastav, S.K. and Murthy, Y.V.N. Krishna.(2014). Geospatial Modeling approach for Interlinking of rivers-A Case study of Vamsadhara and Nagavali river systems in Srikakulam, Andhra Pradesh, Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP).
7. Bandyopadhyay, J. (2005). A Scientific Analysis of the Justifications Extended for the Proposed Interlinking of Rivers in India, Breakthrough, 11, (2), pp: 3-19.

8. Bandyopadhyaya, J. and Perveen, S. (2003). The Interlinking of Indian Rivers: Some Questions on the Scientific, Economic and Environmental Dimensions of the Proposal Paper presented at Seminar on Interlinking Indian Rivers: Bane or Boon? at IISWBM, Kolkata 17 June 2003, SOAS Water Issues Study Group, Occasional Paper No. 60, 2.

9. Barbier, E.B. (2004).Water and Economic Growth, Economic Record, 80, (248) pp: 1–16.

10. Bhaduri, A., Amarasinghe, U.A. and Shah, T. (2007). Assessing the Irrigation Benefits of India’s River Linking: Case Study-Godavari Krishna Link, Mimeo (draft) and International Water Management Institute.

11. Bhattacharya, S. and Das, A. (2007). Vulnerability to Drought, Cyclones and Floods in India, Winrock International, India. pp: 1-39.

12. Boroujeni, H.S. and Saeedinia, M. (2013), Study on the impacts of inter-basin water transfer: Northern Karun, African Journal of Agricultural Research, Vol. 8 (18), pp. 1996-2002.

13. Canter, L.W. (1999). Environmental Impact Assessment, ©CRC Press LLC.

14. Central Water Commission. (1997). Sankosh: Feasibility Report, Govt. of India.

15. Chapagain, K. A., Hoekstra, A.Y. and Savenije, G.H.H. (2005). Saving water through global trade, UNESCO-IHE, Institute for Water Education, Value of Water Research Report Series No. 17.

16. Das, P. K. (2013). The Himalayan Tsunami- Cloudburst, Flash Flood & Death Toll: A Geographical Postmortem, IOSR Journal of Environmental Science, Toxicology and Food Technology, 7, (2), pp: 33-35.

17. Dass, A., Jethoo, A.S and Poonia M.P. (2012). Impact of Drought on Urban Water Supply: A Case Study of Jaipur City, International Journal of Engineering and Innovative Technology, 1 (3): pp 170-174.

18. De, U.S., Dube, R.K. and Rao, G.S. P. (2005). Extreme Weather Events over India in the last 100 years, Journal of Indian Geophysical Union, Vol.9, (3), pp: 173-187.

19. Elliott, J., Glotter, M., Best, N., Boote, K., Jones,J., Hatfield, J., Rozenweig, C., Smith, L.A. and Foster, I. (2013). Predicting agricultural impacts of large-scale drought, 2012 and the case for better modeling, Mathematics and Computer Science Division Preprint ANL/MCS-P4034-0213. Argonne National Laboratory, 2013, RDCEP Working Paper No. 13-01. Centre for Climate Change Economics and Policy Working Paper No. 13-01. Available at SSRN: http://ssrn.com/abstract= 2222269.

20. Fedra, K., Winkelbauer, L. and Pantulu, V.R. (1991). Expert Systems for Environmental Screening, An Application in the Lower Mekong Basin, International Institute for Applied Systems Analysis, Laxenburg, Austria, p:169.

21. Forman, R.T.T. (2014). Urban Ecology, Science of Cities, Cambridge University Press, Cambridge, UK.

22. Gaurang I., Joshi, S., Rana,C. and Shrimali, N.J. (2014). Peak Flood Probability Analysis for Tapi River, Indian Journal of Applied Research, Vol. 4, (1), pp: 187-192.

23. George, M M.C., Korgaonkar, P.D. Geetha, K. (2014). Interlinking of river basins, a review, International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development, Vol. 4, (2), pp : 33-46.

24. Glasson, J., Therivel, R., and Chadwick, A. (1994). Introduction to Environmental Impact Assessment, UCL Press, London.

25. Gore, P.G., Prasad, P. and Hatwar, H.R. (2010). Mapping of Drought Areas over India, Research Report No. 12, National Climate Centre Office of the Additional Director General of Meteorology Research, India Meteorological Department Pune - 411005.

26. Gourdji, S., Knowlton, C., and Platt, K. (2005). Indian Inter-linking of Rivers, A Preliminary Evaluation, A project submitted In partial fulfillment of the requirements For the degree of Master of Science Natural Resources and Environment at the University of Michigan.

27. Government of India. (1999). National Water Policy.

28. Government of India. (2002) National Water Policy.

29. Gross, J. (2002). The Severe Impact of Climate Change on Developing Countries, Climate Change, 96 Medicine & Global Survival, Vol. 7 (2), pp: 96-100.

30. Guhathakurta, P., Menon,P., Mazumdar, A.B and Sreejith, O.P.(2010). Changes in extreme rainfall events and flood risk in India during the last century, NCC Research Report, National Climate Centre office of the Additional Director General of Meteorology (Research) India Meteorological Department, Pune - 411 005.

31. Gullett, W. (1998). Environmental Impact Assessment and the precautionary principle: legislating caution in Environmental Protection, Australian Journal of Environmental Management, Vol. 5, (3), pp: 146-158.

32. Gupta, A.K., Nair, S. and Yunus, M. (2013). Uttarakhand Disaster 2013 - Floods and Landslides, Lessons of Ecology Not Yet Learnt, International Society of Environmental Botanist, Enviro News. Vol. 19 :(4).

33. Gupta, A.K., Nair, S.S., Wajih, S.A. and Dey, S. (2013). Flood Disaster Risk Management: Gorakhpur Case Study (Training Module). National Institute of Disaster Management, New Delhi and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Germany, p:116.

34. Gupta, A.K., Tyagi, P. and Sehgal, V. K. (2011). Drought disaster challenges and mitigation in India, strategic appraisal, Current Science, Vol. 100, (12), pp: 1795-1806.

35. Gupta, A.K., Tyagi,P. and Sehgal, V. K. (2011). Drought disaster challenges and mitigation in India, strategic appraisal, Current Science, Vol. 100, (12), pp: 1795-1806.

36. IWMI-TATA. (2012). Water Policy Research, The National River Linking Project of India.

37. Iyer, R. R. (2003). Water Perspectives, Issues and Concerns, Sage Publication, New Delhi.

38. Iyer, R. R. (2007). The National Water Scene, ORF Discourse No.2 Published by Observer Research Foundation, New Delhi, 2.

39. Iyer, R.R. (2012). River Linking Project A Disquieting Judgment, Economic & Political Weekly Vol. 47, (14), pp: 33-40.

40. Jain, A. (2014), Complacency, Compounding the urban water crisis, / Indian Journal of Public Administration, Vol. l, (1), pp: 105-116.

41. Jain, S.K. and Kumar,V. (2012). Trend analysis of rainfall and temperature data for India, Current Science, Vol. 102, (1), pp: 37-49.

42. Jain, S.K., Kumar,V. and Panigrahy .(2008). Some issues on Interlinking of Rivers in India, Current Science, 95, (6), pp: 728-735.

43. Joseph, S., Sahai, A.K., Sharmila, S. , Abhilash, S. , Borah, N., Pillai, P.A. , Chattopadhyay, R. and Kumar, A. (2013). Extended Range Prediction of Uttarakhand Heavy Rainfall Event by an Ensemble Prediction System based on CFSv2, Indian Institute of Tropical Meteorology , Earth System Science Organization, Ministry of Earth Sciences, Pune, India.

44. Joshi, N. M. (2013). National River Linking Project of India, Hydro Nepal, (12), pp: 13-19.

45. Kaya, T. and Kahraman.C. (2011). An Integrated Fuzzy AHP–ELECTRE Methodology for Environmental Impact Assessment, Expert Systems with Applications, 38, pp: 8553–8562,

46. Landfill, B.Q. (2012). EIA quality mark review checklist, Planning Application and Environmental Statement IEMA Quality Mark Checklist.

47. Mann, R.P. (2012). Geographical study on district Action Plan for Hill District Uttarkashi, Uttarakhand , International Journal of New Innovations in Engineering and Technology, Vol. 1, (2), pp:16-19.

48. Mehta, D. and Mehta, N.K. (2013). Interlink of Rivers in India: Issues and Challenges, Geo. Eco. Mari, Vol, 19, pp: 137-143.

49. Moreland, J.A. (1993). Drought, U.S. Geological Survey Water Fact Sheet, Open-File Report 93-642, p: 2.

50. Moron, A. B., Calvo, F.M. D., Ramos, J. M. M. and Almohano, M. P. P. (2009). AIEIA: Software for Fuzzy Environmental Impact Assessment. Expert Systems with Applications, Vol. 36, (5), pp: 9135–9149.

51. Nautiyal, H. and Bhandari, S.P. (2012)., District Disaster Management Action Plan For Hill District (Uttarakhand), International Journal of Scientific & Technology Research, Vol. 1, (7), 5-9.

52. NIDM. (2013). Proceedings of the National Workshop on Uttarakhand Disaster 2013, Lessons Learnt, National Institute of Disaster Management (Ministry of Home Affairs, Government of India) 5B, I.P. Estate, Mahatma Gandhi Marg , New Delhi-110002, www.nidm.gov.in.

53. Novek, J. (1993). Environmental Impact Assessment in practice, exploring the contradictions, Great Plains Research, A Journal of Natural and Social Sciences, Vol.3, (2), pp: 337-57.

54. NWDA. (2012), National Water Development Agency, Society under the Ministry of Water Resources, Govt. of India, 18-20, Community Centre, Saket, New Delhi-110017.

55. Ogola, Pacifica F. Achieng. (2007). Environmental Impact Assessmen, General Procedures, Unite Nations University, Geothermal Training Programme, Presented at Short Course II on Surface Exploration for Geothermal Resources, organized by UNU-GTP and Ken Gen, at Lake Naivasha, Kenya, 2-17.

56. Pai, D.S., Sridhar, L., Guhathakurta, P. and Hatwar, H.R. (2010). District-wise Drought Climatology Of The Southwest Monsoon Season over India Based on Standardized Precipitation Index, National Climate Centre Office of the Additional Director General of Meteorology Research, India Meteorological Department, Pune - 411005.

57. Pal, I., Singh, S. and Walia, A. (2012). Flood Management in Assam, India: A review of Brahmaputra Floods, International Journal of Scientific and Research Publications, Vol. 3, (10), pp: 1-5.

58. Pant,V. and Pande, R.K.(2012). Community Based Disaster Risk Analysis (CBDRA): Case Studies from Uttarakhand, India, Global Journal of Human Social science, Vol. 12, (4), pp-42-46.

59. Pata. (2012). Operational Research to Support Mainstreaming of Integrated Flood Management under Climate Change, Policy and Advisory Technical Assistance, Technical Assistant report, Project Number: 45017.

60. Poder, T. and Lukki, T. (2011). A critical review of checklist-based evaluation of environmental impact statements, Impact Assessment and Project Appraisal, 29, (1), pp: 27–36.

61. R.K. Sharma. (2006). Linking Indian Rivers, Current. Science, 90, (12) pp :15- 89.

62. Radhakrishna, B.P. (2003). Interlinking of rivers: Bane or a boon, Current Science, 84, (11), pp: 1390-1394.

63. Rao, B.S.P., Rao, P.H.V., Jaisankar .G., Amminedu. E., Satyakumar.M., and Rao. P.K. (2010).Interlinking of River Basins: A Mega Harvesting Plan-A Review, Journal of Indian Geophysics Union, 14, (1), pp: 31-46.

64. Rao, B.S.P., Srinivas, N., Rao, B., Rajesh, S. V. J. S. S. and Pernaidu, P. (2012). Geological and Environmental issues of the proposed link canal Inchampalli to Nagarjunasagar of Godavari to Krishna Rivers adopting remote sensing and geographical information system, Journal of Geology and Mining Research Vol. 4, (4), pp :75-85.

65. Rathore, B.M.S., Sud, R., Saxena, V., Rathore, L.S., Rathore, T.S., Subrahmanyam,V.G. and Roy, M.M. (2014). Drought Conditions and Management Strategies in India, Country Report prepared for the Regional Workshop for Asia-Pacific as part of the UN-Water Initiative on “Capacity Development to Support National Drought Management Policies” organized in Hanoi, Vietnam.

66. Rijsberman, R .F. (2006) .Water Scarcity: Fact or Fiction?, Agricultural Water Management, 80, (1), pp: 5-22.

67. Saleth. R.M. (2009). Water sector perspective plan in India, Potential contributions from demand management in irrigation, Strategic Analysis of the National River Linking Plan (NRLP) of India, Series 3, Promoting Irrigation Demand Management in India, Potentials Problems and Prospects, Colombo, Sri Lanka: International Water Management Institute, (eds), p-177.

68. Shah,T., Amrasinghe, U.A. and Cornick, P.G. (2006). India River Linking Project: The State of the Debate.

69. Sharma, M., Mishra, S. K. and Tyagi, S. (2013). The Impact of Torrential Rainfall in Kedarnath, Uttarakhand, India during June 2013, International Research Journal of Environment Sciences, Vol. 2,(9), pp: 34-37.

70. Shukla, A.C. and Asthana, V. (2005). Anatomy of Interlinking Rivers in India: A Decision in Doubt, ACDIS Occasional Paper, Research of the Program in Arms Control, Disarmament, and International Security University of Illinois at Urbana–Champaign.

71. Singh Pankaj and Chauhan. D. S. (2005). Interlinking of rivers In India, Down to Earth, A Publication of Center for Science and Environment, (CSE). Available at: http://works.bepress.com/pankaj_singh/1

72. Singh, S.R and Shrivastava, M.P. (2006). River Interlinking in India, The Dream and Reality, Deep and Deep Publications Pvt. Ltd, New Delhi.

73. Singh,O., Arya, P. and Chaudhary, B.S. (2013). On rising temperature trends at Dehradun in Doon valley of Uttarakhand, India, Journal of Earth Science, Vol. 122, (3), pp :613–622.

74. Sivanappan, R.K. (2012). Interlinking of Indian Rivers-Need and Importance, Journal of Indian Water Resources Society, Vol. 32, pp: 3-4.

75. Snaddon, C.D., Davis, B.R. and Wishart, M. (1999). A Global overview of inter-basin Water Transfer Schemes, with and appraisal of their Ecological, Socio-economic and Socio-political implications and recommendations for their management, Water Research Commission, Technology Transfer Report TT120/00. Pretoria, South Africa: Water Research Commission.

76. Sridhar, K.S. and Mathur, O.P. (2011). Pricing Urban Water a Marginal Cost Approach, India Infrastructure Report.

77. Thatte , C.D. and Pandit,C. (2006). Inter-linking of rivers, Current Science, 91, (3), pp: 260-261.

78. Thilagavathi, G., Tamilenthi,S., Ramu, C. and Baskaran, R. (2011). Application of GIS in Flood Hazard Zonation Studies in Papanasam Taluk, Thanjavur District, Tamilnadu, Advances in Applied Science Research, 2, (3), pp: 574-585.

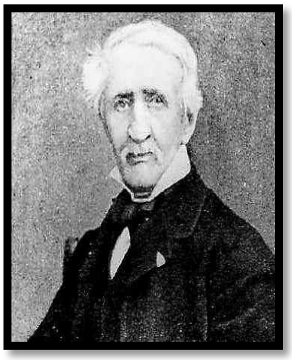
79. Urfi, A. J. (2004). Interlinking of Indian rivers, Current Science, Vol. 86, (4), pp: 498.

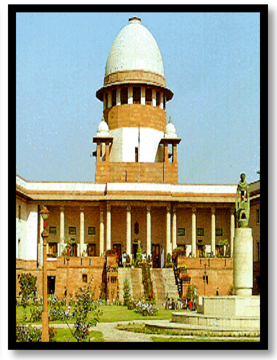
80. Valli, M., Sree, K.S. and Krishna, I.V.M. (2013). Analysis of Precipitation Concentration Index and Rainfall Prediction in various Agro-Climatic Zones of Andhra Pradesh, India, International Research Journal of Environment Sciences, Vol. 2, (5), pp: 53-61.

81. Zlatanovaa ,S., Ghawanab,T., Kaurb , A. and Neuvelc, J. M.M. (2014), Integrated flood disaster management and spatial information, Case studies of Netherlands and India, The International Archives of the Photogrammetric, Remote Sensing and Spatial Information Sciences, ISPRS Technical Commission VIII Symposium, Hyderabad, India, Vol. XL-8.

ANNEXURES

HISTORY OF INTERLINKING PLAN






S. No	Year	History
1.	**1972**	Ganga Cauvery Link proposed by Dr. K.L.Rao .
2.	**1974**	"Garland canal" proposal by captain Dastur .
3.	**1980**	Ministry of water resources framed the National perspective Plan (NPP).
4.	**1982**	The National Water Development Agency (NWDA) set up to carry out pre – feasibility studies.
5.	**1999**	A National Commission for Integrated Water Resources Development Plan (NCIWRDP) set up.
6.	**Aug 15, 2002**	President Abdul Kalam mentions the need for River Linking Project in his Independence Day speech.
7.	**Oct 2002**	Supreme Court recommends that the government formulate a Plan to link the major Indian rivers by the year 2012.
8.	**Dec 2002**	Government appointed a task force on interlinking of 37 Indian rivers led by Mr. Suresh Prabhu.

- **British Era**

1. The River-Linking Project has a long history. During the British raj, an Engineer Arthur Cotton proposed the Interlink plan to link the southern major

Indian rivers in **1839** in order to address water shortages and droughts in southeast India.

➢ **Post independence**

1. In the **1970s**, K.L. Rao, an eminent water engineer and former irrigation minister who later became water resources minister, proposed "National Water Grid "to link the Ganges and Cauvery rivers. But the plan was finally scrapped, as it was 'very costly. He was concerned about the water scarce condition in the South and flooding in the North India. He suggested that the Brahmaputra and Ganga basins are surplus in water areas and south and central part are water deficit. He proposed that surplus water should be diverted to drought.
2. In **1974**, A third plan, "Garland canal" proposal by the retired Captain Dastur to solve India's major water problems.
3. In **1980,** India's Ministry of Water Resources prepared a report entitled "National Perspectives for Water Resources Development". This report divided the water development plan in two parts – the Himalayan and Peninsular components.
4. In **1982**, the National Water Development Agency department was formed, which is a committee of nominated experts to carry out studies on the feasibility and water balance of the river linking program. NWDA has done many detailed studies, surveys and investigations over 30 years, from 1982 through 2013 in respect of reservoirs, canals and feasibility of inter-linking water resource management plan.

5. In **1999**, the river inter-linking idea was modified to intra-basin development as opposed to inter-basin water transfer. A National Commission for Integrated Water Resources Development Plan placed to review NWDA findings.

6. In **2002,** President Abdul Kalam gave a speech on the need for river linking in Independence Day.

7. **In Oct 2002,** The plan to link the major Indian rivers by the year 2012 recommended Supreme Court

8. **In Dec 2002,** Govt. appointed a task force on interlinking of major Indian rivers led by Mr. Suresh Prabhu.

9. **By 2004,** a different political Congress Party was opposite the project concept and plans, that the plan may be not valuable in terms of cost, environmental and ecological damage and water table.

10. In **Feb 2012,** Supreme Court forwards the interlinking of rivers to go-ahead to and ensures the government that the project is implemented expeditiously.

11. The central government of India, from **2005** through **2013**, placed several committees, reports, and financed a series of feasibility and impact studies on environmental law and standards.

12. Recently due to the increased water demand, these mega projects are coming into the national agenda and helpful for the water resource management in India.

13. The aim of the ILR that water should be diverted from ‘surplus’ rivers to ‘deficit’ rivers.

14. The government argues that, the Inter Basin Water Transfer (IBWT) or ILR is ‘one of the most effective ways to increase irrigation potential to increase food

grain production, mitigate floods and droughts, and reduce regional imbalance in the availability of water is from the surplus rivers to deficit areas.

BENEFITS OF NATIONAL PERSPECTIVE PLAN

Inter Basin Water Transfer Project of the National Perspective Plan could be effective project of flood and drought management, conservation and sustainable use of water

The likely benefits of the Proposed River Linking Plan are:

1. Mitigation of Drought
2. Flood Control
3. Management of water crisis
4. Domestic & Industrial Water Supply
5. Equal Distribution of water
6. Electricity Generation
7. Improve soil fertility
8. Irrigation Benefits
9. Employment Generation
10. Rise in Per Capita Income
11. Ecological Conservation
12. Fisheries Production
13. Pollution Control
14. Infrastructural Development (Urban and Industrial Development)
15. Socio – Economic Development
16. Sustainable use of water
17. Increase in water availability (Surface and Ground Water)
18. Tourism development
19. Food production
20. Water conservation ways such as rainwater harvesting, water reuse, watershed management Ground water recharging and regulating the exploitation of underground water resources.

PROPOSED SHARDA-YAMUNA LINK

EXPECTED IMPACTS

POSITIVE IMPACTS

1. Water Availability increase
2. Afforestation
3. Soil Fertility increase
4. Employment increase
5. Agriculture area increase
6. Reduce Flood
7. Electricity increase
8. Construction and Development increase
9. Ground Water Recharge increase

NEGATIVE IMPACTS

1. Water Quality Decrease
2. Construction and Development increase
3. Public Health Status and Medical facilities
4. Flood increase in nearby areas
5. Drainage System or Water collection Increase
6. Public Health Status and Medical facilities
7. Traffic increase

NO SIGNIFICANT IMPACTS

1. Geology and Physiography
2. Climate and Rainfall

10. Reduce Barren Land

11. Tourism Increase

12. Crop Productivity increase

13. Increase Irrigation increase

14. Water Balance in Ganga Basin

15. Drinking and Industrial Water increase

16. Occupation Pattern and Family income Increase

17. Spoil Generation Increase

18. Rise in Land Value increase

19. Industrial Productivity Increase

20. Public Health Status and Medical facilities

21. Fishery increase

22. Traffic increase

23. Seepage and Percolation Increase

24. Drainage System or Water collection Increase

25. Religious Monument increase

26. Important Landmark

27. Literacy Rate Education

SOME ISSUES OF ILR PROJECT MAY ARISE

1. Soil erosion, water logging problems during construction phase.
2. Landslide may occur due to Soil erosion in the region.
3. Deforestation or clearing of vegetation, flora and fauna diversity may disturb.
4. Forest area and Agricultural area, certain area covered by canal.
5. Wildlife disturbance.
6. Settlements, displacement of people living in the canal region.
7. Drainage problem.
8. Spoil generation, waste generation due to canal work.
9. Seepage and percolation in the area of loose gravel and pebbles with high water permeability.
10. Air Pollution may rise.
11. Water Pollution, water quality may affect during construction.
12. Some cultural monuments may be affected on the way.
13. Traffic may affect during construction work.
14. Noise level.
15. Aquatic fishes life may disturb in downstream flows.
16. Cost or losses

SOME QUESTIONS MAY ARISE ON ILR TO THINK….

1. Why should the ILR plan?
2. Will the ILR mitigate the drought and flood?
3. What will be the cost?
4. What may be the negative issues of the project?
5. What will be the benefits?
6. Any Environmental plan will be there?
7. Public opinion
8. About its feasibility and effectiveness?
9. ILR is possible or not?

PICTURES OF THE FIELD VISIT HARIDWAR DISTRICT (UTTARAKHAND STATE)

MAYAPUR CHOWKI AND KANKHAL AREA IN HARIDWAR DISTRICT (UTTARAKHAND STATE)

FOREST OF UTTARAKHAND STATE

PICTURES OF THE FIELD VISIT MORADABAD DISTRICT

(UTTAR PRADESH STATE)

AGRICULTURE IN UTTAR PRADESH STATE

SUGARCANE CROPS IN UTTAR PRADESH

PICTURES OF THE FIELD VISIT BIJNOR DISTRICT IN UTTARAKHAND STATE (VILLAGE NOORPUR)

PUBLICATIONS

PUBLICATIONS

1. Seminar on Environment, Education and Society Organised by Department of Environmental Science, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow held on 5 june 2013.

2. Symposium on "Building an ecologically Sustainable society" Organised by Babasaheb Bhimrao Ambedkar University, Lucknow (A Central Univesity) held on 16 August 2013.

ABSTRACTS AND POSTER PRESENTATION

1. **GLOBAL CLIMATE CHANGE**

   (National Seminar on Environmental Pollution: Problems and Perspective held on 19-20th Jan 2014, Organized by Department of Law, School for Legal Studies, BBAU, Lucknow).

2. **INTERLINKING OF RIVERS: AN ECOFRIENDLY APPROACH FOR WATER. RESOURCE MANAGEMENT**

   (International Conference on Environmental technology and Sustainable Development: challenges and remedies held on 21-23 Feb. 2014, Organized by Department of Environmental Science, BBAU, Lucknow).

3. **ROLE OF ECOFRIENDLY INDUSTRIES IN ENVIRONMENTAL MANAGEMENT**

(National workshop Innovation and Technology transfer to industries role of Universities, Held on 10-11 th March, 2014, Organized by Centre for Industry Institute Partnership Program, Babasaheb Bhimrao Ambedkar University (A central university), lucknow-226025 (U.P.), India.

4. **IMPORTANCE OF RIVER LINKING PROJECT: A CASE STUDY OF PROPOSED SHARDA- YAMUNA LINK**

2nd Lucknow Science Congress, held on 27-28 th march 2014, Babasaheb Bhimrao Ambedkar University (A central university), lucknow-226025 (U.P.), India.

5. **ROLE OF PROPOSED INTERLINKING OF RIVERS IN BIODIVERSITY CONSERVATION IN INDIA**

(International symposium on biodiversity: status, utilization and impact of challenging climatic conditions, held on 30-31 October 2014, organized by Babasaheb Bhimrao Ambedkar University (A central university), lucknow-226025 (U.P.), India. in collaboration with the Indian academy of environmental sciences, Haridwar, Uttarakhand).

6. **ROLE OF INTERLINKING OF RIVERS IN FLOOD AND DROUGHT MANAGEMENT**

National Seminar on Green Communication and Sustainable Development: Prospects and challenges, held on 28-29 th January 2015, organized by Department of Journalism & Mass Communication, Babasaheb Bhimrao Ambedkar University (A central university), lucknow-226025 (U.P.), India.

ORAL PRESENTATION

ROLE OF PROPOSED RIVER LINKING PROJECT IN REJUVENATION OF RIVER GOMTI: PROPOSED GANDAK - GANGA LINK, Gomti Yatra and National Seminar on Rejuvination of River Gomti: Past Present and Future (GY & NSRRG-2015), held on 9-11 May 2015, organized by Babasaheb Bhimrao Ambedkar University (A central university), lucknow-226025 (U.P.), India.

RESEARCH PAPERS

1. **Verma. A and Kumar. N. (2015), Interlinking of Rivers in India: Proposed Sharda- Yamuna Link, IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), Vol, 9, (2), pp: 28-35.**

2. **Verma. A and Kumar. N. (2015), Inter Basin Water Transfer of Rivers from Sharda to Yamuna using Construction Techniques, Indian Journal of Applied Research, Vol, 5, (2), pp: 252-254.**

3. Nath. P, Verma. A, Dhusia. N and More. N, (2012) Study on Impact of Natural Disasters and its Relationship with Rainfall Distribution in the State of Uttar Pradesh During 2006- 2010, International Conference on Sustainable Water Resource Development and Management, SWRDM (Accepted) Category No. 5, ISBN: 978-81-926964-0-9.

4. Kumar. D, Verma. A, Dhusia. N and More. N, (2013) Water Quality Assesment of River Gomti in Lucknow, Universal Journal of Environmental Research and Technology, Vol, 3, (3), pp: 337-344.

5. Verma. A, Rawat A. K and More N. (2014) Extent of Nitrate and Nitrite pollution in Ground Water of Rural Areas of Lucknow, U.P., India, Department of

Environmental Science, BBA (A Central) University Lucknow-226025, (U.P.), India, Current World Environment, An International Research Journal of Environmental Science, ISSN:0973-4929, Vol. 9 (1), pp: 114-122.

6. Verma. A, Kumari. M, Dhusia N. and More N. (2014) Phytoremediation Potential of Phragmites Karka for Arsenic Contaminated Soil and Water, International Organization of Scientific Research, Journal of Environmental Science, Toxicology and Food Technology, ISSN: 2319-2399, vol. 8, (1).

ARTICLE

Verma. A and Kumar. N. (2014) Role of proposed inter-basin water transfer projects in drought and flood management, department of environmental science, Babasaheb Bhimrao Ambedkar University (A central university), lucknow-226025 (U.P.), India. International Journal of Current Research, International Journal of Current Research Vol. 6, Issue, 07, pp. 7356-7357.

IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 9, Issue 2 Ver. II (Feb 2015), PP 28-35
www.iosrjournals.org

Interlinking of rivers in India: Proposed Sharda-Yamuna Link

Anjali Verma and Narendra Kumar
Department of Environmental Science, Babasaheb Bhimrao Ambedkar University
(A Central University), Lucknow-226025, (U.P.), India.

Abstract: *Currently, about a billion people around the world are facing major water problems drought and flood. The rainfall in the country is irregularly distributed in space and time causes drought and flood. An approach for effective management of droughts and floods at the national level; the Central Water Commission formulated National Perspective Plan (NPP) in the year, 1980 and developed a plan called "Interlinking of Rivers in India". The special feature of the National Perspective Plan is to provide proper distribution of water by transferring water from surplus basin to deficit basin. About 30 interlinking of rivers are proposed on 37 Indian rivers under NPP plan. Sharda to Yamuna Link is one of the proposed river inter links. The main concern of the paper is to study the proposed inter-basin water transfer Sharda – Yamuna Link including its size, area and location of the project. The enrouted and command areas of the link canal covers in the States of Uttarakhand and Uttar Pradesh in India. The purpose of S-Y link canal is to transfer the water from surplus Sharda River to deficit Yamuna River for use of water in drought prone western areas like Uttar Pradesh, Haryana, Rajasthan and Gujarat of the country. It could be one of the effective plans of flood and drought management and other water based activities for future.*

Key words: *Drought, Flood, River Interlinking, Sharda – Yamuna Link, Water Management*

I. Introduction

Water is an important element and one of the most essential natural resources [1]. Some researchers have estimated that by 2025 more than half of the world population will be facing water-based crisis and suggested that by 2030, in some developing regions of the world, water demand will exceed supply by 50%. Water resources are however limited due to developmental activities, industrialization, pollution, population, dropped rainfall levels, droughts, floods and other factors. Problem of water scarcity in Indian scenario discussed by [2]. In future, even more water will be needed to produce food because the Earth's population is forecast to rise to 9 billion by 2050. More than one-third of all counties face higher risks of water shortages by mid-century as a result of climate change in the developed countries which causes due to increasing pollution, population, industrialization, deforestation, urbanization and depleting natural resources. Climate change is affected by many things from natural processes or by human activities. Drought and Flood are natural disasters caused by climate change which are the major water concerns in the country happens due to heavy and low rainfall. The recent mega and complex disaster due to flash flood [3]. [4] Change in water supply and demand across river basins of India. Considering the future demands, conservation and management of water resources are very essential.

1.1 Flood and Drought

Floods are one of the most common natural hazards, occurs mostly due to heavy rainfall (Fig. 1.). Drought is a period when a region receives a deficiency in its water supply. It is a disaster when an area gets less amount of rain water (Fig. 2.). Some regions of the country are facing drought and some are flooded. Floods cause billions in damages every year. The study on causes of floods done by [5]. Flood prone areas in India are Punjab, Uttar Pradesh, Haryana, West Bengal, Odisha, Andhra, Kerala, Assam, Bihar and Gujarat. Drought regions in India are Rajasthan, Gujarat, Madhya Pradesh, Karnataka, Tamil Nadu, Haryana, Maharashtra and Andhra Pradesh.

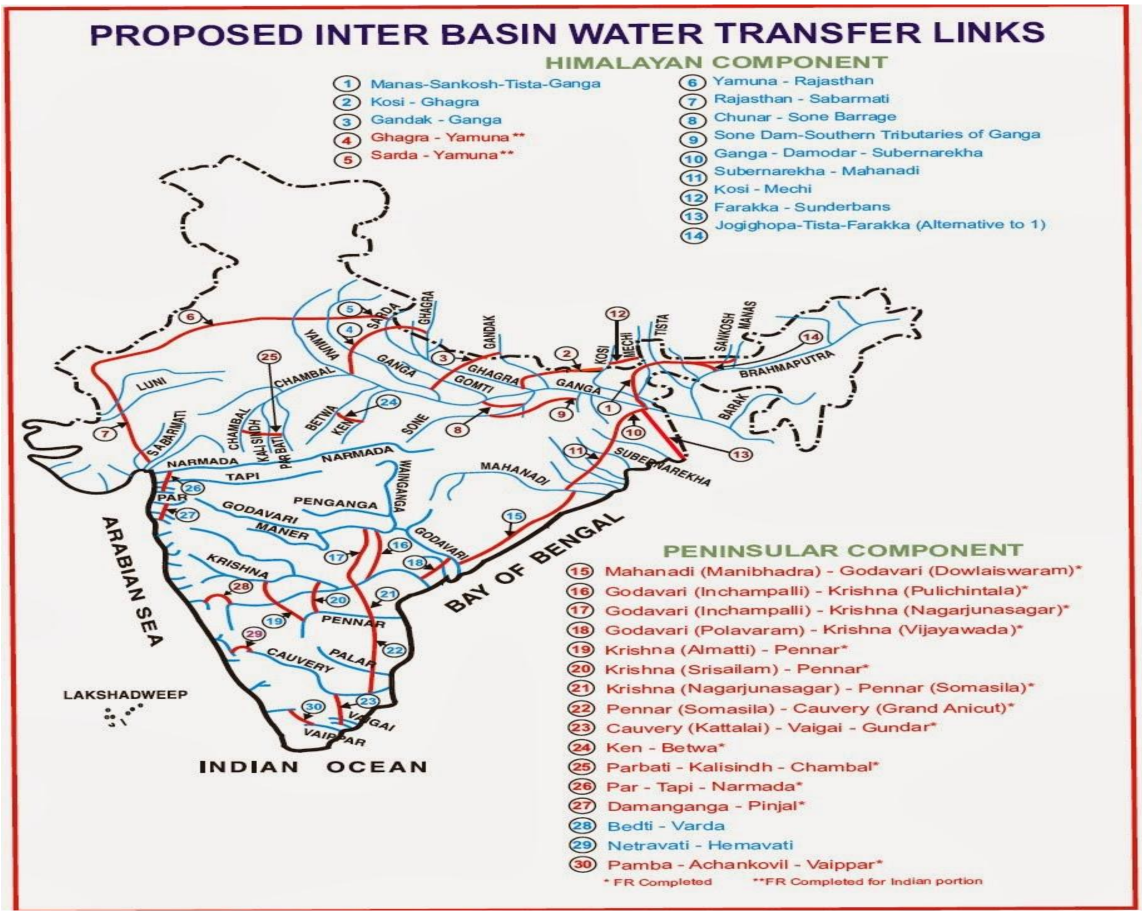
(Fig. 1.)

(Fig. 2.) (Google)

Fig 1 and **Fig 2** showing the regions affected by Floods and Drought.

1.2 National Perspective Plan (NPP) for Water Resources Development: "Inter-Linking of River's" (ILR)

A National Perspective Plan (NPP) was formulated in the year 1980, by Ministry of Water Resources and the Central Water Commission indentified a number of large scale Inter- Basin Water Transfer Links "Inter-Linking of River's" (ILR) to increase the availability of water by transferring from surplus water basins to deficit basins in India and also to manage the problems of flood and drought disasters. Inter-Linking of River (ILR) is a water conservation method to reduce the irregular distribution of water and for providing solution to minimize floods and droughts in India. Practices should be needed for water resource management [6] .Various practices have been made by the Indian Govt. for water management and conservation. To overcome the problems of flood and drought, National Water Development Agency (NWDA) has taken up massive project ILR which includes 30 major river link canals over 37 rivers throughout the country. National Perspective Plan (NPP) consists of two components Himalayan component and Peninsular component. The Himalayan component carries of 14 canal links and 16 links are proposed in the peninsular component (Fig. 3.). Interlinking system of Sharda-Yamuna is a part of the Himalayan Rivers Development Component of the National perspective plan. Planning of Interlinking of rivers for the mitigation of droughts and floods under national water policy by the Government of India [7].Study on proposed river link canal project has done by several researchers [8], [9], [10], [11], [12], [13]. Environmental impacts, issues and challenges of Inter- Linking of Rivers in India are discussed by [14].



(Fig.3.) Proposed Inter-Link of Rivers in India (NWDA)

1.3 Need of the Project

Water should be made available to water deficit river basins based on a national perspective, after fulfilling the water requirements of the enrouted and command areas. The surplus water should be transferred to the water needy areas. Need for proposed ILR to tackle the problem of droughts and floods to providing both water and security explained by [15] and [16]. The large scale project will helps in increase in water availability in different river basins. Study on proposed linking of rivers has done by several researchers including [17], [18], [19], [20], [21], [22], [23], [24], [25] and Central Water Commission [26]. Transfer of water from surplus basins to deficit basins to control floods and droughts studied by [27]. [28] Indian Government has approved the country's first river interlinking project on Ken–Betwa Rivers among the states of Uttar Pradesh and Madhya Pradesh. The key objective was to study about the description of proposed Sharda -Yamuna link project including its size, area, location.

II. Methodology

The research work has been done to carry out the studies on the descriptions and impacts of proposed Sharda-Yamuna Link Project. The related information has been collected from various state and central govt. water departments. Extensive review of literature was done to collect information and get a fair understanding of the kind of research.

III. Discussion

3.1 Proposed Sharda-Yamuna Link Canal

Sharda-Yamuna Link is an interdependent link for the diversion and utilizations of water to overcome the problems of drought and flood in Uttar Pradesh and Uttarakhand states in India.This plan is aimed to transfer of about 11,680 Mm^3 of surplus water from river Sharda to deficit river Yamuna and further towards west parts of India. Before falling into Yamuna River the water of Sharda river will be utilize to fulfill all the water requirements of its command areas and transfer of water towards the drought prone western areas of India such as Haryana, Rajasthan and Gujarat. Sharda-Yamuna link project will locate in the States of Uttarakhand and Uttar Pradesh (Fig.4). The proposed link canal will cross through enrouted areas Champawat, Nainital, Udham Singh Nagar and Haridwar districts of Uttarakhand and Bijnor and Muzaffarnagar districts of Uttar Pradesh

(Table.2) in India. The command areas of the link canal would be Bareilly, Rampur, Moradabad, Badaun and Bijnor districts of Uttar Pradesh and Udham Singh Nagar district of Uttarakhand (Table.3).There will be development of Pancheshwar dam and Poornagiri dam for the generation of power during the construction work of link canal and also to provide domestic, irrigation facilities to drought prone western parts of the country. During the journey it will cross the major rivers viz. Sharda, Kosi, Ramganga and Ganga. Barrages on these crossings are also proposed for flood control and to be constructed at the time of level crossing which would be named as Sarda barrage, Kosi barrage, Ramganga barrage and Ganga barrage. The Sharda-Yamuna link canal and its proposed four barrages will locate in the Ganga basin. The total length of this link canal will be 384 Kms and full supply depth is 7.8 m. The proposed link canal will transfer water from Sharda river near Tanakpur town of Champawat district of Uttarakhand between proposed Poorangiri dam and Tanakpur barrage into the Yamuna River about 2.5 Km near Kairana village of Muzaffarnagar district of Uttar Pradesh. First the available water in the catchment of Sarda River will be stored in the reservoir of Pancheshwar dam, then the release of water from this reservoir after generating the power will again stored at proposed Poornagiri dam which is located of about 58 Km distance of Pancheshwar dam. The construction of Pancheshwar and Poornagiri dams would be across the Sharda river known as Mahakali in Nepal with having gross storage capacities of 11,355 Mm^3 and 3,680 Mm^3. (Table.1) The discharge of water at starting and ending of the link canal will be 757.32 cumec and 605.77 cumec and the transmission losses would be of 541 Mm^3. Annual electrical energy benefit may be of approx. 8378 Mkwh, Irrigation benefit 2.94 lakh hac and economic irrigation benefit shall be 1306.63 crore. Overall this proposed link – canal will pass through 2 states, 6 districts, 15 Tehsils and 170 villages. The Sharda to Yamuna Link would provide an additional irrigation benefits, generation of power, fisheries, salinity, economic development and employment potential in the enrouted and command areas. The inter-basin water transfer can be quicker and efficient plan for proper distribution of water in India. This plan is socially needed, technically feasible, economically viable and environmentally sustainable (Thatte).This link canal could be beneficial for fulfilling the water requirements of its command areas and drought prone western areas of India such as Haryana, Rajasthan Gujarat. The inter-basin water transfer can be quicker and efficient plan for proper distribution of water and to overcome the problem of floods and droughts in India.

3.2 Sailent Features of Proposed Sharda-Yamuna Link Canal

1.	River Basin	Sharda (Mahakali)
2.	States Passing	Uttar Pradesh and Uttarakhand
3.	District Traversed	Champawat, Nainital, Udhamsingh Nagar, Haridwar, Bijnor and Muzaffarnagar
4.	Basins Traversed	Sharda, Ramganga, Upper Ganga and Yamuna sub-basins of Ganga Basin
5.	En-routed, Command Districts	Moradabad, Jyotiba Phule Nagar, Rampur, Udham Singh Nagar, Badaun, Bareilly, Bijnor
6.	Off-take area	Sharda River, 10 km North East to Tanakpur town of Champawat district in Uttarakhand
7.	Out-fall area	Yamuna River in Kairana village of tehsil Kairana of Muzaffarnagar district in Uttar Pradesh
8.	Water available for transfer from Sharda river	11,680 Mm^3
9.	Transmission Loss	541 Mm^3
10.	Water utilization in the Enrouted of Sharda-Yamuna link	1758 Mm^3
11.	Full supply depth	7.8 m in depth
12.	Bed width	At head of canal55.00 m and At tail of the canal 44.50 m
13.	Velocity	1.363 m/s to 1.334 m/s.
14.	Flow	By gravity
15.	Length of Canal	384.0 Km
16.	Lining	Lined with Cement concrete all along the stretch (canal)
17.	Barrages	Sarda, Kosi, Ramganga, Ganga Barrage
18.	Dams	Poornagiri, Pancheshwar (For Hydro Power Generation)
19.	Annual electrical Energy	8378M Kwh
20.	Irrigation Benefit (Enrouted, Command)	2.94 Lakh hac
21.	Estimated Cost	35404.77 Crore
22.	Power	10785.53 Crore
23.	Economic Irrigation Benefit	1306.63 Crore
24.	Economic Power Benefit	1935.60 Crore

(Table.1.)

3.3 Enrouted and Command Areas of Proposed Sharda –Yamuna Link Canal

The location of the proposed Sharda-Yamuna link project covers in the states of Uttarakhand and Uttar Pradesh in India. (Fig.5).

3.3.1 Enrouted Areas

Enrouted areas are those through which proposed S-Y link canal will cross such as Champawat, Nainital, Udham Singh Nagar and Haridwar districts of Uttarakhand and Bijnor and Muzaffarnagar districts of Uttar Pradesh. Sharda-Yamuna Link has planned for transferring surplus water of river Sharda near tanakpur town of champawat district of Uttarakhand into the Yamuna River near kairana village of muzaffarnagar district of Uttar-Pradesh. Table 1:

Enrouted areas of proposed S-Y link canal are following:-

States	Districts	Town
Uttarakhand	Champawat	Poonagiri/Tanakpur
	Nainital	Haldwani
	Udam singh nagar	Bajpur
		Kashipur
		Jaspur
	Haridwar	Haridwar
		Roorkee
		Laksar
Uttar Pradesh	Bijnor	Dhampur
		Nagina
		Najibabad
	Muzaffarnagar	Muzaffarnagar
		Shyamli
		Kairana

Table 2: Source: NWDA (National Water Development Agency)

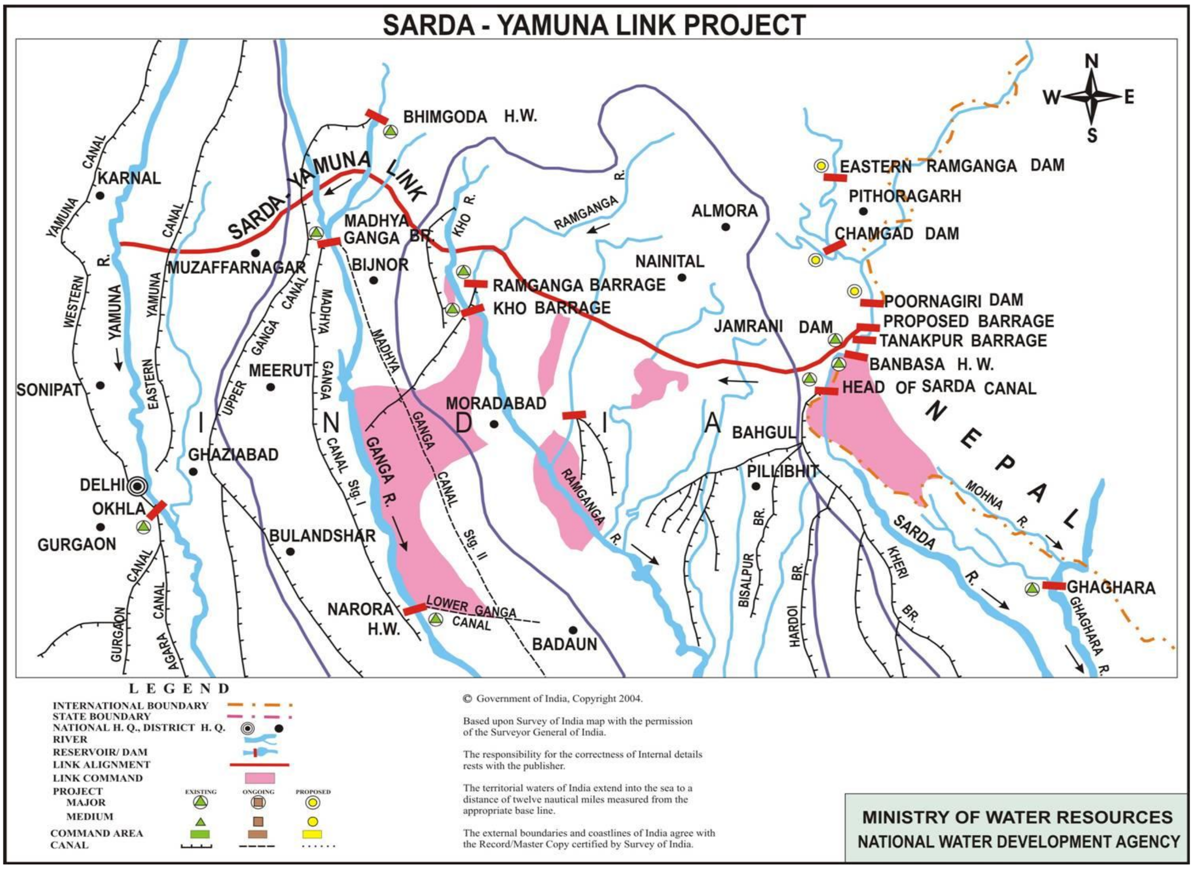
3.3.2 Command Areas

Command areas are the surrounded areas of proposed S-Y link canal. The command areas of the link canal lies in Bareilly, Rampur, Moradabad, Budaun, Bijnor and Jyotiba Phule Nagar districts of Uttar Pradesh and Udham Singh Nagar district of Uttarakhand.

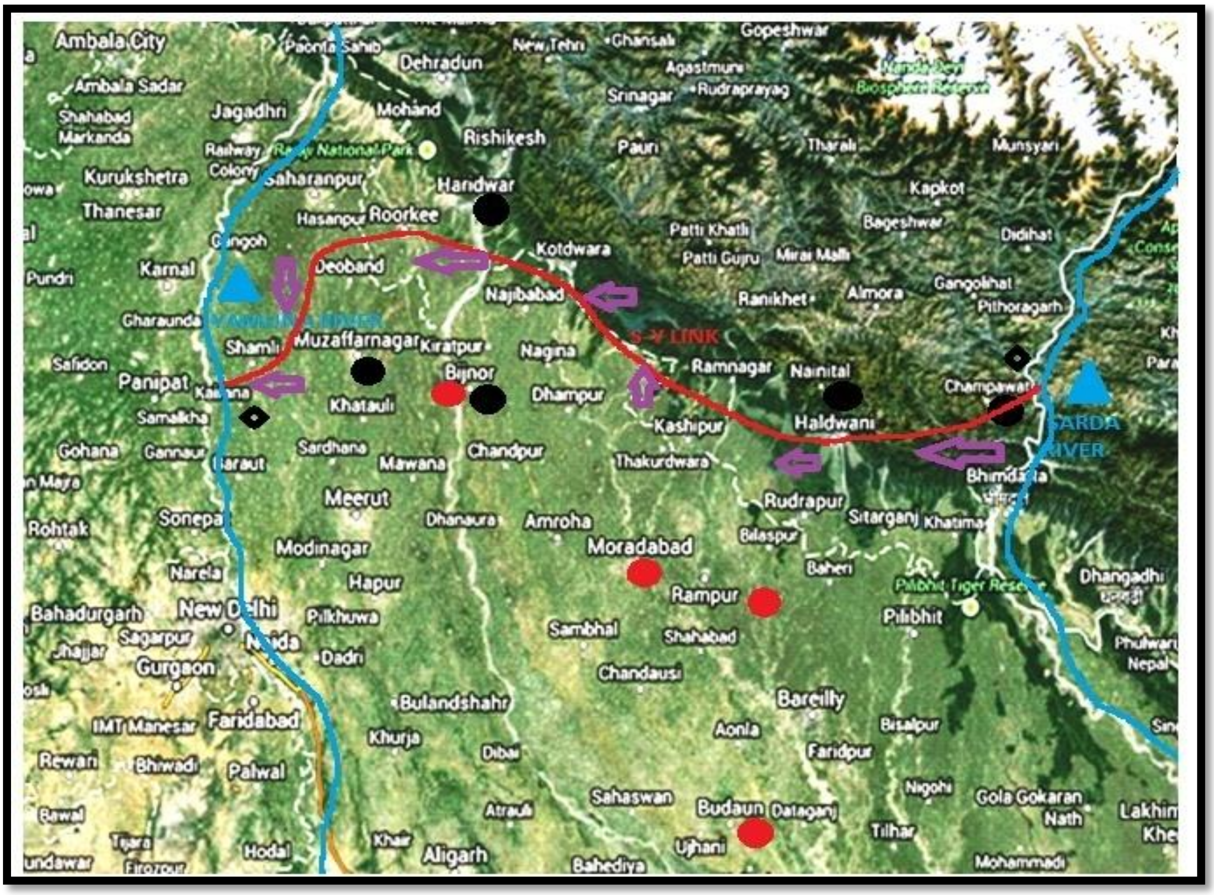
Command areas of proposed S-Y link canal are following:-

States	Districts	Town
1. Uttarakhand	Udham Singh Nagar	Kichha
		Kashipur
2. Uttar Pradesh	Moradabad	Moradabad
		Kanth
	Jyotiba Phule Nagar	Amroha
		Hasanpur
		Dhanaura
	Bijnor	Chandpur
		Dhampur
	Rampur	Swar
		Rampur
		Sahabad
	Bareilly	Meerganj
		Aonla
		Baheri
	Badaun	Sahswan
		Gunnaur
		Bisauli

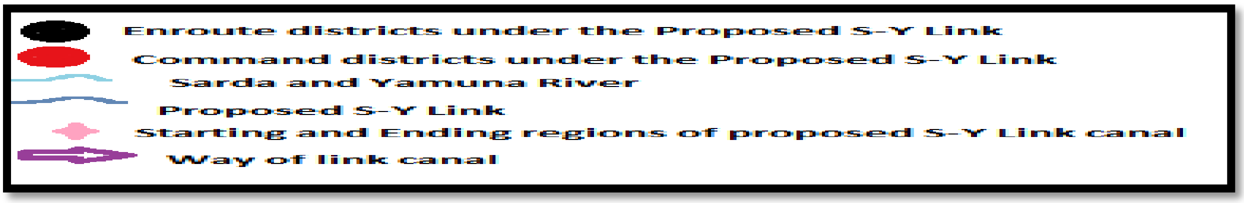
(Table.3.) Source: NWDA (National Water Development Agency)



(Fig.4.) Location of Proposed S-Y link canal project. Source: NWDA



(Fig.5.) Satellite Map of Enrouted and Command areas covered under Proposed S-Y link Canal.
(Google map)



IV. Conclusion

This paper highlights the description viz. size, area and location of proposed inter basin water transfer Sharda-Yamuna Link, which is a part of Himalayan river development component (Fig. 4.) and one of the proposed links of NPP (National Perspective Plan) to minimize the problem of flood and droughts in India. The Ministry of Water Resources and Central Water Commission formulated a National Perspective Plan (NPP) for Water Resources Development in 1980, considering large scale inter basin water transfer proposals for transfer of water from surplus regions to deficit regions. Sharda-Yamuna Link (S-Y Link) is aimed to make available of water to the acute water short and drought prone west part such as Haryana, Rajasthan, Gujarat of the country.

V. Acknowledgements

The authors acknowledge the Head, Department of Environmental sciences, Babasaheb Bhimrao Ambedkar (A Central University) Lucknow-226025 for providing facilities to this work. Financial support to Ms. Anjali Verma in the form of Ph. D fellowship is gratefully acknowledged.

VI. References

[1]. R. R. Iyer, Water Perspectives, Issues and Concerns, Sage Publication, New Delhi, 2003.
[2]. E.B. Barbier, 2004, 'Water and Economic Growth'. Economic Record 80, 1-16.
[3]. Gupta, Readings on Critical Issues and Concerns for NGOs, Activists and others concerned with Justice and Social Change Uttarakhand: Disaster as a Tragedy, 2013.
[4]. U.A. Amarasinghe and M.D. Kumar, Spatial Variation in Water Supply and Demand across River Basins in India. Research report 83, Colombo, Sri Lanka: International Water Management Institute, 2005.

[5]. H. Nautiyal, S.P. Bhandari, District Disaster Management Action Plan For Hill District Uttarkashi, Uttarakhand , International Journal of Scientific & Technology Research, (1),7, 2012, 5 – 9.

[6]. K.C. Sheshikumar, 2005, Practical steps needed for water resource management, Current. Science, 88, (11), 1715.

[7]. Government of India, National Water Policy, 2002

[8]. M. Gopalkrishnan, D.A. Mohile, A.D. Gupta, L.N. Kuberan and R.S.A. Kulkarni, An Integrated Water Assessment Model for Supporting Indian Water Policy, 2006.

[9]. S.K. Sinha, A.K. Sinha and S. Chandra, Interlinking of Rivers- Issues and Challenges, In Volume I – Water for Life with Special Reference to Interlinking of Rivers, Proceedings of the Eleventh National Water Convention of India, New Delhi: National Water Development Agency, 2005.

[10]. R. Rijsberman, Frank, Water Scarcity: Fact or Fiction? Agricultural Water Management, 80, 2006 , 1-3, 5-22.

[11]. B. Hornby, Water Policy Has Changed - Attitudes will Follow Denver Post, Colorado, USA,1993,

[12]. R. Ramaswamy, Iyer, The National Water Scene, ORF Discourse No.2 Published by Observer Research Foundation, New Delhi, 2, 2007.

[13]. B.P. Radhakrishna, Interlinking of rivers: Bane or a boon, Current Science, 84 (11), 2003, 1390-1394.

[14]. D. Mehta and N.K. Mehta, Interlink of Rivers in India: Issues and Challenges, Geo. Eco. Marina, 2013, 137-143.

[15]. J. Bandyopadhyay, A Scientific Analysis of the Justifications Extended for The Proposed Interlinking of Rivers in India, Breakthrough, (11), 2, 2005.

[16]. T., Shah, U. Amarasinghe., and P.M.C. Cornick, Mc River Linking Project: The State of the Debate, 2006.

[17]. B. Mallik and S. Perveen, 'A Scientific and Economic Assessment of the River Link Project in India' in proceedings of the Workshop on Interlinking of Rivers: Doable and Desirable? , Kolkata: West Bengal Academy of Science and Technology, 2004.

[18]. A. Aggarwal, "Interlinking of India's Rivers- A reality check", 2004.

[19]. D .Goel, Interlinking of Rivers, 2005.

[20]. B. Sivaraman, "Interlinking of rivers in India" ,2003.

[21]. R.K. Sharma, Linking Indian Rivers, Current. Science, 90, (12), 2006, 15- 89.

[22]. R. M. Saleth, 'Water Pricing Potential and Problems', 2007.

[23]. C.D. Thatte and C. Pandit, Inter-linking of rivers, Current. Science, 91,(3), 2006,260-261.

[24]. A. Mahmood and A. Kundu, Demographic Projections for India 2006-2051: Regional variations, Draft prepared for the IWMI-CPWF project on "Strategic Analysis of National River Linking Project of India, 2006.

[25]. C.D, Snaddon, B.R. Davis and M. Wishart. A Global overview of inter-basin Water Transfer Schemes, with and appraisal of their Ecological, Socio-economic and Socio-political implications and recommendations for their management, Water Research Commission, Technology Transfer Report TT120/00. Pretoria, South Africa: Water Research Commission, 1999.

[26]. Central Water Commission, Sankosh: Feasibility Report, Govt of India, 1997.

[27]. Nair. R and Radhakrishna. M.D, Interlinking of rivers for Mitigation of Droughts. In Volume I – Water for Life with Special Reference to Interlinking of Rivers. Proceedings of the Eleventh National Water Convention of India, May 11 2005, New Delhi: National Water Development Agency, 2005.

[28]. B.S.P, Rao, Vasudeva. R. P.H.V , G. Jaisankar , E. Amminedu, M. Satyakumar and & P.K. Rao, Interlinking of River Basins: A Mega Harvesting Plan-A Review, Journal of Indian Geophysics Union, 14,(1), 2010, 31.

RESEARCH PAPER | Environmental Science | Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

Inter Basin Water Transfer of Rivers from Sharda to Yamuna using Construction Techniques

KEYWORDS: Inter Basin Water Transfer, Sharda-Yamuna Link Canal and Construction techniques

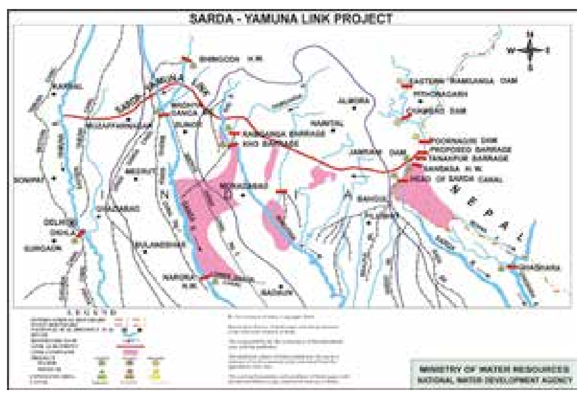
Anjali Verma	Dr.Narendra Kumar
Department of Environmental Science, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow- 226025 (U.P.), India.	Assistant Professor, Department of Environmental Science, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow- 226025 (U.P.), India.

ABSTRACT *This paper focuses on the construction techniques of the proposed Inter basin water transfer Sharda and Yamuna link canal; one of the proposed Inter Basin Water Transfer Links of National Perspective Plan (NPP). The Sharda-Yamuna link canal has been proposed to transfer water from river Sharda to River Yamuna by S-Y link canal of about 11,680 million m3. Surplus water will transfer from river Sharda near Tanakpur town of Champawat district of state Uttaranchal into the Yamuna River near Kairana village of Muzaffarnagar district of Uttar-Pradesh state in India. The construction techniques of the proposed Sharda-Yamuna Link canal include construction of Poornagiri and Pancheshwar dams, construction of barrages for flood management viz. Sharda, Kosi, Ramganga, Ganga, construction of power houses, construction of 384.0 km long main canal, branch canals and distributaries.*

Water is vital for all known forms of life; it affects directly or indirectly. About 71% of the Earth's surface is covered by water, out of which 1.7% in form of glaciers of Antarctica and Greenland and about 0.001% of water is present in form of vapour. Less than 0.3% water is present in form of freshwater in rivers, lakes. So far, however, life cannot exist without water. It is being suggested that by 2030 in some developing regions of the world, the water demand will exceed supply by 50%.Water also allows for things like weather which is also responsible for survival of life on Earth. Rainfall is one of the important elements. There are great regional and temporal variations in the distribution of rainfall. Variations in rainfall affects from heavy to scanty on different parts of India. Due to seasonal variability in rainfall drought and flood occurs. Maximum amount of rainfall about 80% of the annual rainfall is received in the four rainy months of June to September. Over 200 cm of heavy rainfall causes flood. Some regions of heavy rainfall are Western Ghats, Sub-Himalayan areas in North East, Meghalaya Hills. Assam, West Bengal, West Coast and Southern slopes of eastern Himalayas. Whereas drought areas are Southern Parts of Gujarat, East Tamil Nadu, North-eastern Peninsular, Western Ghats, eastern Maharashtra, Madhya Pradesh, Orissa, Haryana, Maharashtra, Andhra Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Karnataka and Tamil Nadu. Indian Ministry of Water resources planned Inter basin water transfer of rivers to regulate the major flood and drought water problems by transfer surplus water from surplus places to the deficit areas in India. 30 Inter basin water transfer links are proposed on 37 Indian rivers. These proposed water transfer links could helpful for proper distribution of water in India.

SARDA -YAMUNA LINK PROJECT

S-Y Link canal is one of the proposed links of the Himalayan part of National Perspective Plan (NPP). This link is proposed to transfer water from surplus river Sharda to deficit river Yamuna and shall helpful in flood and drought situations in India. The proposed link canal will take water from Sharda river which is near Tanakpur town of Champawat district of Uttaranchal state and transfer into the Yamuna river of about 2.5 km near Kairana village of Muzaffarnagar District of Uttar Pradesh.



Location of proposed S-Y link canal project. Source: NWDA (National Water Development Agency)

ENROUTED AND COMMAND LOCATIONS OF THE PROJECT

Proposed Sharda Yamuna Link will transverse through Uttarakhand and Uttar Pradesh states in India. It will fulfill the water needs of the command areas and enrouted areas. The enrouted areas are Champawat, Nainital, Udham Singh Nagar and Haridwar districts in Uttarakhand and Muzaffarnagar, Bijnor districts in Uttar Pradesh state in India. The command areas are Udham Singh Nagar district in Uttarakhand and Moradabad, Jyotiba Phule Nagar, Bijnor, Rampur, Bareilly and Badaun districts in Uttar Pradesh State. The transfer of surplus water will be from river Sharda to deficit river Yamuna, further the flow of water will be towards the western parts of the India. This link will also fulfill the water demands of other drought prone regions of Haryana, Rajasthan and Gujarat.

BARRAGES

Before falling into river Yamuna, Sharda and Yamuna link canal will cross major important rivers viz. Sharda, Kosi, Ramganga and Ganga during the journey. Hence, four barrages namely Sharda, Kosi, Ramganga, Ganga are also proposed on these rivers to control flood.

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

PANCHESHWAR DAM AND POORNAGIRI DAM

Pancheshwar dam and Poornagiri dams are proposed for the generation of power during the construction of the link canal. The water available in the catchment of Sharda River will be first stored in the reservoir of Pancheshwar dam followed by water release from this reservoir after generating the water will be stored at proposed Poornagiri dam; about 58 km Pancheshwar dam.

DESCRIPTION OF PROPOSED SARDA -YAMUNA LINK PROJECT VIZ. SIZE, AREA

This project is being considered for the transfer of surplus water of about 11,680 Mm^3 from Sharda river to water deficit Yamuna river to manage the flood and drought in India. The river basin of the link canal is Sharda basin, length of this link canal is 384 km and full supply depth is 7.8 m. The discharge of water at starting and ending of the link canal will be 757.32 cumec and 605.77 cumec and the transmission losses of water would be of 541 Mm^3. Flow of link canal would be by gravity with a velocity of 1.363 m/s to 1.334 m/s. About 1758 Mm^3 of water of S-Y link canal will be utilized to irrigate en-routed areas of Uttar Pradesh and Uttarakand states. Some benefits may be like irrigation benefit of approx 2.94 lakh hac, generation of annual electricity of about 8378M kwh. The estimated cost of the link canal is about 35404.77 Crore.

LITERATURE REVIEW

The purpose of Inter linking of rivers is to provide equal distribution of rainfall and manage drought and flood water problems in India by transferring the surplus water from surplus areas to deficit areas Shah et. al.,2006 .Inter linking of rivers could help to mitigate the Flood and Drought by large scale water transfer Rao et. al., 2010.Feasibility studies is being done by National Water Development Agency about River Linking projects in India (NWDA, 2006).Water balance should be maintained by transferring surplus water towards deficit regions (Bandyopadhyay, 2005).Study on water transfer from water rich parts to deficit done by (Singh and Srivastava , 2006).Study on Inter basin water transfer of rivers has done by several researchers, scientists such as (Mahmood and Kundu, 2006), (Sharma, 2006), Gopalkrishnan et. al .,2006, (Saleth, 2007), (Sinha et. al., 2005,(Hornby,1993), (Iyer ,2007) and (Rijsberman, 2006) etc. Description on NRLP (National River Linking Project given by (Joshi, 2013), which is undertaken by IWMI (The International Water Management Institute) and CPWF (Challenge Programme for Water and Food). Inter-Linking of Rivers in India, its environmental issues and challenges are focused by (Mehta and Mehta, 2013).River link canal project is useful for Economic, Environmental feasible and Irrigation purposes (Bandyopadhyay and Perveen, 2003). From political point of view NRLP (National River Linking Project) is technically feasible and justifiable (IWMI-TATA, 2012).

CONSTRUCTION PLANNING

The duration considered for the construction of Sharda-Yamuna link canal is approx 9 years. The construction planning is divided into investigation of pre-construction phase, design preparations, management of organization, tools, machinery, materials arrangements like cement, steel, completing formalities of land acquisition for projects, construction of camps, quarries, land approach roads, branch canal, distributaries and minors etc.

MANPOWER PLANNING

Technical Professionals are required for the construction and maintenance of the Sharda-Yamuna link project like Technical Directors, Administrative Directors, Finance Directors, Public Relation Officers and Labour welfare Officers. Chief Engineers will design the work of canal and canal structures from RD (Regional Distance) 0.00 km to 100.00 km, 100.0 km to 225.0 km and 225.00 km to 384 km. Superintending Engineers will see the design of Pancheshwar and Poornagiri Dams, Barrages & Power houses. Some other professionals will also involve like Civil, Electrical, Mechanical Draftsmans, Ferro printers, Tracers, Photo copiers, Laboratory assistants for quality control laboratory, medical professional's for dispensary in the project area, Administrative Managers / Officers, Accounts Officers, Accountants, Skilled and semi-skilled labours, Work charged staff, daily wages staff, Contractor's and so many other workers.

TOOLS FOR THE SHARDA-YAMUNA LINK PROJECT

The main tools of construction work for the entire project are classified as Core drilling machine, Vibratory compactors, Sheep foot rollers, Diesel Road roller, Crawler tractor, Concrete Mixer, Concrete Vibrator, Trucks (Dumper), Tipper, Water tanker, Diesel Pump, Stone crusher, Concrete batching plant, diesel Jeep / Van, Mini bus, ambulance, small crane, gravity dams, spill channels, power house, water pools, approach tunnel to power house, branch canals, distributaries and excavation of earth work for four barrages etc.

Table No: 1- Key machineries required for the construction of Sharda-Yamuna link project.

S.No	Name of Tools
1	Core drilling machine
2	Vibratory compactors
3	Sheep foot rollers
4	Diesel Road roller
5	Crawler tractor
6	Concrete Mixer
7	Concrete Vibrator
8	Trucks (Dumper)
9	Tipper
10	Water tanker
11	Diesel Pump
12	Stone crusher
13	Concrete batching plant
14	Diesel Jeep / Van
15	Mini bus
16	Ambulance
17	Small crane

CONCLUSION

Indian Ministry of Water Resources proposed Interlinking of Rivers for water resource management. Sharda Yamuna Link is one of the proposed links. The construction work of the Sharda Yamuna link canal is based on perfect construction and manpower planning. Many key types of machinery will be required for the construction work of Sharda-Yamuna link project along with good technical professionals. The duration considered for the construction work is approx 9 years. This large scale water transfer Sharda Yamuna link project could be one of the efficient ways to mitigate the major water problems Flood and Drought in India.

Volume : 5 | Issue : 2 | Feb 2015 | ISSN - 2249-555X

REFERENCE Bandyopadhyay, J., 2005 : A Scientific Analysis of the Justifications Extended for the Proposed Interlinking of Rivers in India, Breakthrough,11,2.| (2) Bandyopadhyaya, J., & Perveen, S., 2003: The Interlinking of Indian Rivers: Some Questions on the Scientific, Economic and Environmental Dimensions of the Proposal Paper presented at Seminar on Interlinking Indian Rivers: Bane or Boon? at IISWBM, Kolkata 17 June 2003, SOAS Water Issues Study Group, Occasional Paper No 60. 2.| (3) Gopalkrishnan, M., Mohile, D.A., Gupta, A.D., Kuberan, L.N. ,& Kulkarni, R.S.A., 2006: An Integrated Water Assessment Model for Supporting Indian Water Policy. | | (4) Hornby, B., 1993 :Water Policy Has Changed - Attitudes will Follow Denver Post, Colorado, USA. | (5) IWMI-TATA, Water Policy Research, (2012): The National River Linking Project of India. | (6) Iyer Ramaswamy, R., 2007: The National Water Scene, ORF Discourse No.2 Published by Observer Research Foundation, New Delhi, 2. |(7) Jain.S.K., Kumar.V., & Panigrahy (2008) :Some issues on Inter Linking of Rivers in India, Current Science, 95,6, 728-735. | (8) Joshi.N.M., (2013): National River Linking Project of India, Hydro. Nepal, 12, 13-19. |(9) Mahmood, A., & Kundu, A., 2006; Demographic Projections for India 2006-2051: Regional variations, Draft prepared for the IWMI-CPWF project on "Strategic Analysis of National River Linking Project of India. | (10) Mehta.D., & Mehta.N.K., (2013): Interlink of Rivers in India: Issues andChallenges,Geo.Eco.Mari, pp. 137-143. | (11) Narseen J., Sara F., Zobeyer., A.T.M.H., & Md.Rashedul I., 2003: A direction to resolve water conflict in Ganges-Bhrahmputra Basin. Jour. of .app. hyd, 16,4A, 59- 65. |(12) National Water Development Agency, 2006: NWDA National Water Development Agency., Feasibility Reports of River Linking proposals for 14 links and other information, "The Need". | (13) Rao, B.S.P., Vasudeva Rao, P.H.V. , Jaisankar .G., Amminedu. E., Satyakumar.M., & Rao. P.K.,2010: Interlinking of River Basins: A Mega Harvesting Plan-A Review, Journal of Indian Geophysics Union, 14,(1), 31. | (14) Rijsberman, R .Frank. 2006: Water Scarcity: Fact or Fiction? Agricultural Water Management, 80, 1-3, 5-22. |(15) Saleth, R. M., 2007:'Water Pricing Potential and Problems'. | (16) Shah,T., et al ., 2006:River Linking Project: The State of the Debate. | (17) Sharma, R.K., 2006: Linking Indian rivers, Curent. Science, 90, (12), 1589. | (18) Singh, & Shrivastava, R.S., M.P., 2006: River Interlinking in India: The Dream and Reality. | (19) Sinha , S.K., Sinha, A.K., & Chandra ,S., 2005: Interlinking of Rivers-Issues and Challenges, In Volume I – Water for Life with Special Reference to Interlinking of Rivers, Proceedings of the Eleventh National Water Convention of India ,New Delhi: National Water Development Agency. |

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 6, Issue, 07, pp.7356-7357, July, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

REVIEW ARTICLE

ROLE OF PROPOSED INTER-BASIN WATER TRANSFER PROJECTS IN DROUGHT AND FLOOD MANAGEMENT

*Anjali Verma and Dr. Narendra Kumar

Department of Environmental Science, School for Environmental Science, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.), India (226025)

ARTICLE INFO

Article History:
Received 15th April, 2014
Received in revised form
19th May, 2014
Accepted 18th June, 2014
Published online 20th July, 2014

Key words:
Monsoon,
Flood, Drought,
Interlinking of Rivers.

ABSTRACT

Monsoon is an annually recurring weather phenomenon due to variations in precipitation. Some regions in India receive very large monsoon precipitation causing floods and some parts are facing water scarcity problems due to low precipitation resulting in droughts condition. Almost half of the world's population lives in areas affected by the monsoons of Asia and most of these people are farmers, so the coming and goings of the monsoon are vital to their livelihood to grow food to feed them. Ministry of Water Resources and the Central Water Commission formulated a number of inter-basin water transfer links under a National Perspective Plan (NPP) in 1980, to overcome the problems of flood and drought. The purpose of the inter-basin water transfer links is to transfer surplus water from surplus regions to deficit regions which will help in minimizing the problem of flood and drought in India.

Copyright © 2014 Anjali Verma and Dr. Narendra Kumar. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Lack of competent management of the available water resources resulting in water crises, which is effecting billions of people and deteriorating the environment. Monsoon is a seasonal change in atmospheric circulation and precipitation, which occurs when the temperature on land is significantly warmer or cooler than the temperature of the ocean. The major monsoon systems of the world consist of the West African and Asia-Australian monsoons. The Indian Monsoon Current refers to the seasonally varying ocean current found in the tropical regions of the Northern Ocean. Usually, the term monsoon is used to refer the rainy phase, but it is also a dry phase. The distribution of precipitation in India is characterized by a large regional variation WWC, (2000). Drought and Floods are two major water problems of the country. Flood and Drought condition generally happens due to low and high precipitation. It is an overflow of water that submerges land which is usually dry and one of the most destructive forces in nature. Flood and drought happens due to changing weather patterns. In India flood prone areas are West Bengal, Orissa, Andhra, Kerala, Assam, Bihar, Gujarat, Uttar Pradesh, Haryana and Punjab. Whereas drought is a deficiency in water supply that affects water availability and water quality. In India large parts of Haryana, Maharashtra, Andhra Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Karnataka and Tamil Nadu are not only deficit in rainfall but also subject to large variations, resulting in frequent droughts Rao, *et al.* (2010). Many researchers gave the concept of Inter-Basin water transfer to continuously meet the water requirements and future water demand. Primarily, Inter-Basin water transfer concept was given by Rao and Dastur in 1970s Bandyopadhyaya, and Perveen (2003). Ultimately as a consequence of variations in different river basins and to mitigate the major problems of flood and drought, a National Perspective Plan (NPP) was formulated by the Ministry of Water Resources in the year 1980 and The National Water Development Agency (NWDA) was set up in 1982, to carry out studies on water resource management. NWDA has proposed several inter-basin transfer schemes named "Interlinking of rivers (ILR) "which is referred to as 'inter-basin transfers'; and it means water transfer from 'surplus' areas to 'deficit 'areas. The NWDA of India has identified 30 Himalayan and peninsular rivers for such inter-basin water transfers and proposed about14 links for the Himalayan Rivers and 16 links for the peninsular rivers under the proposed ILR project. ILR is a welcome step for our nation, a good concept for increasing water availability, which will helps in reducing the problem of water scarcity in different river basins. It is a very ambitious plan of GOI Government of India to meet the objectives of transferring surplus water from northern rivers to water deficit regions of southern and western part of India to tackle the twin problem of flood and drought to ensure Sustainable Flood plain Management. Inter-linking of rivers may solve the water related problems of the country like ways to conserve water such as rainwater harvesting, water

Corresponding author: Anjali Verma
Department of Environmental Science, School for Environmental Science, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.), India. (226025

reuse, watershed management and regulating the exploitation of underground water resources. Some other benefits may be agricultural benefits, generation of electricity and deforestation along river banks, ecological conservation and social acceptance.

REFERENCES

Bandyopadhyaya, J. and Perveen, S. 2003. The Interlinking of Indian Rivers: Some Questions on the Scientific, Economic and Environmental Dimensions of the Proposal Paper presented at Seminar on Interlinking Indian Rivers: Bane or Boon? at IISWBM, Kolkata 17 June 2003, SOAS Water Issues Study Group, Occasional Paper No 60, 2.

Rao, P. B.S., *et al.* 2010. Interlinking of River Basins: A Mega Harvesting Plan-A Review, *Journal of Indian Geophysics Union*, 14,(1), 31 46.

World Water Council, 2000. A water scarce world; vision for water, life and the environment. Marseille: World Water Council.

****