

Climate change and Disasters : Issues and concern of Proposed Sharda –Yamuna Link

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ABSTRACT

Climate is a measure of changes in meteorological variables. Sudden changes arise due to increasing deforestation, pollution, population, depletion of natural resources, global warming and industrialization etc. Uneven monsoon and irregular rainfall distribution causes great variations in climatic conditions which cause disasters; drought and flood. During monsoon season, flood occurs in several river basins of U.P and U.K states. According to Indian Meteorological Department, the average annual rainfall in U.P and U.K is more than other states; 100-120 cm and 120-400 cm respectively. Uttarakhand is among one of the highest rainfall states of India. Sharda river; a tributary of river Ganga overflows many times, causes flood in surrounded regions. Sharda-Yamuna link (S-Y) is one of the proposed links of National Perspective Plan to minimize flood in U.P and U.K states and drought in western parts such as Haryana, Rajasthan, and Gujarat of the country. Excess water will be transferred through S-Y link towards the drought regions of India. Approx 11,680 m³ of surplus water is estimated to transfer from river Sharda to river Yamuna to avoid flood in U.P and U.K states. The lining of the link passes through two states Uttarakhand and Uttar Pradesh. The S-Y may also help in maintaining the water balance in its Enrouted and Command regions. This paper highlights the climate change, flood and drought disaster issues and role of proposed Sharda-Yamuna link.

1. INTRODUCTION

1.1. Climate change in relation to Flood and Drought

Climate change is the overall change in environment. Gross (2002) described the current state of health impacts of global warming, climate, vulnerability and indirect consequences of climate change etc. Bhattacharya and Das (2007) focused on three climate extremes such as repeatedly drought, floods and cyclones in India. India is prone to natural disasters such as droughts, cyclones, floods, landslides and earthquakes (Ayalasomayajula *et al.*, 2014). Amarsinghe (2012) focused on flood and drought disasters in India. Drought and Flood are the major water concerns happen due to improper rainfall water distribution. The study on causes of flood was done by Nautiyal and Bhandari (2012). Dass *et al.* (2012) discussed the impact of drought in Rajasthan, one of the severe drought affected states. Drought affects the scarcity of drinking water. Possible mitigation plans and many others issues related with great disaster flood in Uttarakhand and the geographical causes were focused by Das (2013). Elliott *et al.* (2013) discussed the agricultural impacts of drought which not only affects the regions of India but other countries also. Drought

condition generally occurs due low rainfall for a very long time. It causes water scarcity in the river basins. Some regions of Rajasthan, Bundelkhand, Karnataka, Orissa, Chhattisgarh, Punjab and Haryana states in India are the examples of severe drought. 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 duration.

1.2. Improper Rainfall Distribution in North India (U.P and U.K States)

In India, several parts have faced improper rainfall distribution, which varies from heavy to low. Due to irregular fluctuations in rainfall and climate change during the monsoon season, some parts of the northern region are facing acute drought and some are flooded. 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 such as Bihar, Jharkhand faced drought. The average annual precipitation is 11,871 mm. According to Indian Meteorological Department (IMD), the maximum rainfall occurs in the months of June to September in the country.

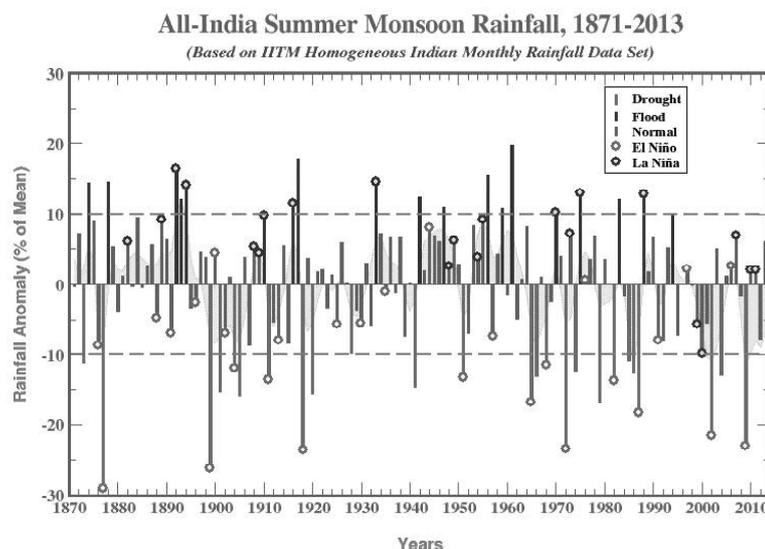


Fig. 1. All-India Summer Monsoon (June-September) Rainfall (AISMR Anomalies during (1871-2013) (Source: India Meteorological Department)

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. Study on the temperature changes in Dehradun city in doon valley of Uttarakhand state in India was done by Singh *et al.* (2013). Several districts of Uttarakhand state including Uttarkashi, Chamoli and Rudrapur were faced with heavy rainfall. The study on the devastation caused by flood in the Brahmaputra basin was done by Pal *et al.* (2012). 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). Problem and potential of water pricing are increasing day by day (Sridhar and Mathur, 2011). Flood happened in Kedarnath valley in Uttarakhand due to heavy rainfall (Sharma *et al.* 2013). 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. Mann (2012) carried out studies on disaster management of Uttarakashi district, which is the most sensitive zone of the Himalaya. Rising sea levels, development and other factors increase the flood situations (Thilagavathi *et al.*, 2011). Different states in India such as Rajasthan, Gujarat, Tamil Nadu, Orissa and Bihar etc are facing droughts and floods due to hydrological ignorance (Gaurang *et al.*, 2014). Jain (2014) discussed the problem of water scarcity in Indian scenario. Jain and Kumar (2012) explained the trends of rainfall and temperature all over India. 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). Practices should be needed for the water resource management.

1.3. 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. Pant and Pande (2012) explained different disasters, their impacts in Uttarakhand state in India and disaster management through disaster risk analysis and case studies. The impacts of drought, its management, data management and monitoring were described by Gupta *et al.* (2011). Flood is a major problem, which causes lots of damage each year (Pata, 2012). Zlatanova *et al.* (2014) focused on the need of flood management in India. The study on management of drought, its prevention, mitigation and preparedness was done by Rahore *et al.* (2014). Valli *et al.* (2013) studied the rainfall pattern with its Precipitation Concentration Index in several climatic parts in the state Andhra Pradesh.

1.4. National Perspective Plan (NPP)

The inter basin water transfer plan has a long history. 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 (Sangwan, 2016). About 30 large scale Inter- Basin Water Transfer Links are proposed under this plan in 1980 by the Central Water



Fig. 2. Rainfall Variation in U.P and U.K States (Source: Irrigation Department U.P)

Commission and Indian Ministry of Water Resources to reduce water irregularity and to face the problem of flood and drought in respect of both Peninsular Rivers and Himalayan Rivers of the country. (Mehta and Mehta, 2013) focused on the environmental impacts, issues and challenges of Inter- Linking of Rivers in India.

1.5. Large Scale Inter-Basin Water Transfer or “Interlinking of Rivers” (ILR)

Interlinking of Rivers proposal is a mega water transfer project proposed by Indian Ministry of Water Resources for flood and drought management (Avadhut, *et al.* 2016). It is required to transfer the surplus water to deficit basins of the country for proper water distribution, sustainable use of water and control of flood and drought (Urfi, 2004). The purpose of the large-scale project is to divert the surplus water towards the places which are water deficit. (Boroujeni and Saeedinia, 2013) highlighted the importance of the

diversion of surplus water from one river basin to other or sub basin through available natural drain from the catchment area of one reservoir to other. George *et al.* (2014) highlighted the concept of inter basin water transfer links with its impact on economic and ecological benefits

1.6. Proposed Sharda-Yamuna Link

Proposed Sharda-Yamuna link (S-Y) is a part of Himalayan river development component and one of the proposed river interlinks in India. The link is for transferring the surplus amount of water form Sharda river to water deficit Yamuna river and further towards drought prone 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 disasters in U.P and U.K states in India. Except flood and drought control, it will also help in increasing the water quantity in its Enrouted and Command regions for other useful purposes.

Table 1. Rainfall Status: Enrouted and Command regions (mm)

Years	May	June	July	August	September
Champawat District (mm)					
2009	0.0	205.4	462.1	790.4	186.8
2010	72.0	83.8	810.1	791.0	490.5
2011	104.0	369.0	584.7	656.5	175.5
2012	1.0	23.0	404.7	391.5	401.5
2013	12.0	537.0	391.5	215.5	76.0
Nainital District (mm)					
2009	51.4	62.6	226.2	493.7	301.0
2010	57.7	120.3	819.0	703.4	702.5
2011	64.1	334.2	551.6	656.1	250.9
2012	2.1	62.9	596.9	472.1	310.9
2013	15.2	741.0	482.1	411.7	136.0
Udham Singh Nagar District (mm)					
2009	0.0	0.0	119.1	201.3	112.6
2010	90.0	7.0	748.5	497.9	604.6
2011	74.6	116.8	517.7	699.3	209.9
2012	0.0	11.7	248.5	324.8	161.9
2013	1.1	412.8	329.8	279.8	70.4
Haridwar District (mm)					
2009	17.2	67.3	315.0	257.2	222.7
2010	35.3	39.9	551.0	283.2	456.1
2011	62.7	225.9	482.4	484.4	126.8
2012	0.5	34.8	171.7	514.5	186.9
2013	6.6	387.8	304.7	412.8	48.2
Bijnor District (mm)					
2009	16.8	43.6	99.3	262.3	230.0
2010	20.3	7.9	568.0	299.8	347.5
2011	52.2	154.5	188.0	368.1	62.2
2012	0.7	1.6	179.3	212.3	175.2
2013	0.0	208.1	219.3	383.6	63.3
Muzzafarnagar District (mm)					
2009	3.0	1.9	81.8	28.1	113.5
2010	9.0	17.1	189.5	186.1	146.3
2011	37.1	76.0	142.7	105.0	51.6
2012	1.1	0.0	191.3	217.7	48.4
2013	11.0	219.1	95.0	385.5	67.3

Years	May	June	July	August	September
Rampur District (mm)					
2009	0.0	2.7	66.1	160.5	95.7
2010	0.8	7.7	242.2	293.1	299.0
2011	29.3	107.9	130.5	221.1	49.5
2012	0.0	0.0	111.0	169.1	75.4
2013	0.0	151.5	224.8	226.1	53.2
Moradabad District (mm)					
2009	5.7	13.3	145.6	195.9	171.2
2010	45.7	18.7	555.1	450.9	436.1
2011	43.4	193.6	242.7	518.6	134.3
2012	1.1	4.2	190.4	288.6	137.2
2013	0.5	364.3	340.6	311.8	54.4
J. P. Nagar District (mm)					
2009	11.5	0.0	161.5	223.7	92.7
2010	7.0	1.5	564.3	295.3	397.3
2011	30.5	180.5	255.0	411.2	128.5
2012	0.0	2.0	260.1	296.4	70.4
2013	0.0	86.1	130.0	235.5	34.0
Bareilly District (mm)					
2009	8.6	44.1	174.5	384.9	159.8
2010	25.6	9.1	50.8	427.9	425.9
2011	37.5	141.1	369.7	432.3	166.7
2012	0.2	12.7	166.2	248.5	148.5
2013	8.1	371.1	428.8	244.6	90.7
Badaun District (mm)					
2009	16.0	0.0	154.6	296.2	102.5
2010	1.6	2.0	219.3	269.8	230.1
2011	30.8	162.9	253.2	198.8	72.4
2012	0.0	3.3	169.4	190.4	68.9
2013	0.4	166.7	190.5	117.2	75.0

(Source: India Meteorological Department)

2. STUDY AREA AND DATA COLLECTION

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

Badaun and Bijnor districts in Uttar Pradesh and Udham Singh Nagar district in Uttarakhand. Current Information is based on India Meteorological Department to study the climate change, flood and drought disaster issues.

3. RESULTS AND DISCUSSION

According to Indian Meteorological Department, during winters, U.P faced excess rainfall which is 18.2 mm in western

region and 16.8 mm in eastern part. In U.K, about 52.1 mm of rainfall occurs which is normal. 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 this is normal. During March month, both U.P and U.K states faced excess rainfall, which are 47.6 mm and 8.9 mm in western U.P and 7.2 mm in eastern U.P.

During October, both U.P and U.K states faced from drought, low rainfall due to the climate change, which is 41.4 mm in western U.P and 48.8 mm in eastern U.P. and in U.K state, the rainfall is 56.8 mm. 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 minimizing the risk of flood in U.P and U.K regions by proper distribution of water.

3.1. District wise Rainfall status for Last Five Years (mm): Enrouted and Command regions

On the basis of last five years rainfall data, it seems that Enrouted and Command areas of S-Y link such as in U.P (Bijnor, Muzaffarnagar, Rampur, Moradabad, J.P. Nagar, Bareilly and Badaun) and in U.K (Champawat, Nainital, Udham Singh Nagar and Haridwar) have faced excess rainfall during the monsoon seasons, the S-Y link will be helpful in maintaining water balance in such regions (Table 1).

3.2. Climate of Uttar Pradesh

The state Uttar Pradesh has a climate of extremes. The temperatures of the state range from 0 °C to 50 °C in various parts causes droughts and floods due to irregular rains. The state has humid subtropical climate (warmer summers) and some areas are the semi arid regions. The summer season is very hot; winters are cold and rainy season sometimes 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 to 2,000 mm in the east to 600 to 1,000 mm in the west. Rainfall variations occur due to the presence of Indo-Gangetic Plain, which is the plain of river Ganga and its tributaries.

3.3 Climate of Uttarakhand

Uttarakhand state is a region, which is covered by beautiful Himalayan peaks and glaciers, a part of the great Himalayan. The state gives rise to two important holy rivers Ganga and

Yamuna in India. The climate varies from tropical to severe cold depends on altitude. The state has mountainous and humid Subtropical climate. The climate of Uttarakhand is affected by tropical monsoons and seasonal variations in temperature.

3.4. Variation in the Rainfall

Rainfall in India is highly uneven, so the distribution of water is not proper. In some places heavy rainfall occurs during the normal monsoon time causes flood. The scarcity of water in river basins is increasing fast with rise in population. According to Indian Meteorological Department, the irregular distribution of rainfall in last year's, causes great variation in climatic conditions causes disasters drought, flood etc (Fig. 1).

3.5. Uneven rainfall distribution in North India (U.P and U.K)

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 due to the developmental activities. With the variations in temperature, rainfall flood and drought occurs in many areas of the north India (Fig. 2).

3.6. Rainfall distribution in Uttarakhand

Uttarakhand state is affected by the climate change. According to Uttarakhand Disaster Recovery Project 2013, heavy rains affect many regions of the state which is recorded of about 124.5 to 244.4 mm. This unprecedented rainfall resulted in increase in water levels and raises the flood situation in the river basins such as Mandakini, Alakananda, Bhagirathi caused extensive landslides at various locations such as Bageshwar, Chamoli, Pithoragarh, Rudraprayag.

3.7. Rainfall Distribution in Uttar Pradesh

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. In north India, several damages are caused by flood. The state U.P is situated in an Indo-Gangetic Plain, which is the plain of River Ganga and its tributaries. The summers are very hot; winters are so cold and rainy season is wet or very dry. If we see current map of variation in annual rainfall status in India (Fig.3), the average annual rainfall in U.P and U.K states is more than other states, which is in U.P (100-120 cm) and U.K (120-400 cm).

भारत मौसम विज्ञान विभाग INDIA METEOROLOGICAL DEPARTMENT

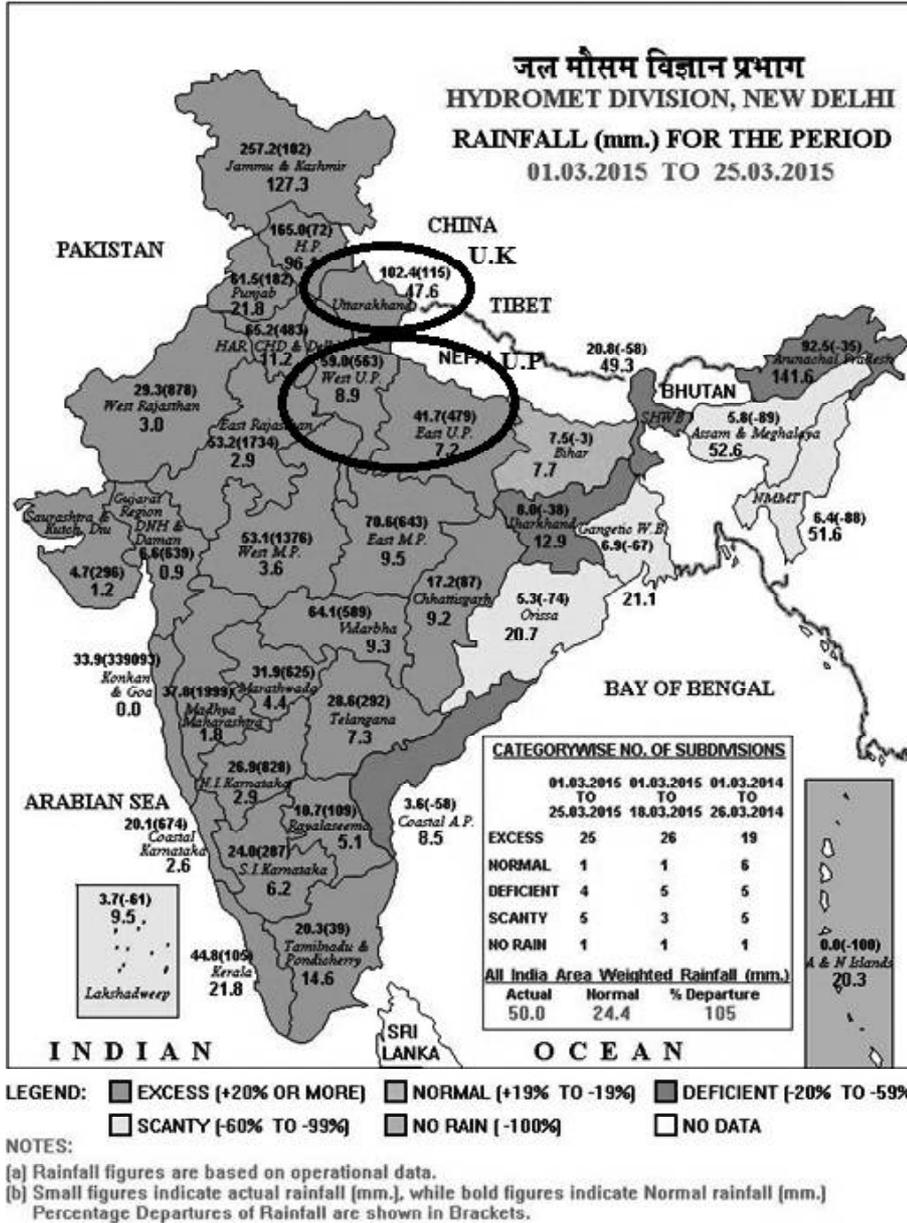


Fig. 3. Current Rainfall Status in India (March month) (Source: India Meteorological department)

4. CONCLUSION

It is beneficial to know the climatic conditions and rainfall status of U.P and U.K states and the role of proposed S-Y link in management of flood and drought disasters. The state Uttar Pradesh has a climate of extremes and humid subtropical climate and the Uttarakhand state is a part of

Great Himalayan. It has mountainous and humid subtropical type of climate is present. The climate of Uttarakhand and Uttar Pradesh affected by seasonal variations in temperature and tropical monsoons. On the basis of India Meteorological department, the average annual rainfall in U.P is 100-120 cm and U.K is 120-400 cm respectively, which is more than other

states. Irregular monsoon results flood and drought in northern region of India. S-Y link is an inter basin water transfer plan, which is for minimising the risk of flood in U.P and U.K. There will be no impact of the link canal on climatic conditions of U.P and U.K states due to construction, but the link may be helpful in managing flood and drought by surplus water transfer. Surplus water during monsoons will be transferred through the S-Y link towards the drought regions of India. The link will provide an equal distribution of water in the states.

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