

# BANGLADESH WATER DEVELOPMENT BOARD



## Morphological Changes of River Ganges over the Last Seven Years (2013 to 2019)



**August, 2020**

**Prepared & Published by:  
River Morphology Processing Branch  
BWDB, 72 Green Road, Dhaka.**

# **BANGLADESH WATER DEVELOPMENT BOARD**



## **Morphological Changes of River Ganges over the Last Seven Years (2013 to 2019)**

**August, 2020**

**Prepared & Published by:  
River Morphology Processing Branch  
BWDB, 72 Green Road, Dhaka.**

## ACKNOWLEDGEMENT

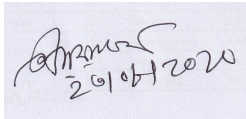
I express my heartfelt gratitude to Almighty Allah who has given me the opportunity to complete this report.

I express my honor and gratitude to Bidyut Kumar Saha, Superintending Engineer, Processing and Flood Forecasting Circle, BWDB, Dhaka for his support and guidance, which helped a lot to prepare this report.

I would like to express my thanks to Mr. Md. Mushfiqur Rahman, System Analyst, PFFC, BWDB, Dhaka for the support of providing water level data from BWDB archive.

I would like to express my thanks to my colleague Mr. Md Salehin Sharif, Assistant Engineer, River Morphology Processing Branch of BWDB for his co-operation in data analysis & checking.

I would like to give thanks to all Officers and Staffs of River Morphology Processing Branch, BWDB and all of them who actively participated in preparing this report. Furthermore, I hope that this attempt will encourage Engineers of BWDB and all other users, which will be significant for BWDB. Finally all are requested to come up with valuable suggestions for further improvement.



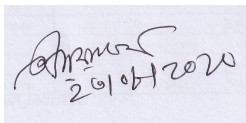
B. M. Abdul Momin  
Executive Engineer  
ID-771229001  
River Morphology Processing Branch  
BWDB, Green Road, Dhaka.  
rmpb.bwdb@gmail.com

## Preface

BWDB's Hydrology Division has an operational network of Hydro-Geological Stations covering Surface Water, Ground water, River Morphology and Processing & Flood Forecasting Circle. All these activities are organized by three Circles and one Directorate under Chief Engineer, Hydrology, BWDB, Dhaka. Processing and Flood Forecasting Circle, BWDB, Dhaka is one of those three circles. This circle has five divisions headed by four Executive Engineers, one Deputy Director. This circle is mandated and responsible for data validation, processing, quality control and database management. This circle is also responsible for flood forecasting and warning, data dissemination to various levels including media, historical data archiving and publishing report etc.

River Morphology Processing Branch is one of the branches under Processing and Flood Forecasting Circle which receives Morphological Survey Data from three morphology field division offices of River Morphology & Research Circle - Mapping Cell (Division), Dhaka, Morphology Division, Mymensingh and Morphology Division, Kushtia. After getting the hard copy and soft copy of data, this branch is responsible for data entry & archiving the all soft data in the data base server and preserving the hard copies. Quality, validation of the data along with preparing additional secondary information for different user groups are vital responsibility of River Morphology Processing Branch. Simultaneously the necessity to conduct research work to assess some trend analysis on the changes in morphology of rivers in Bangladesh has been felt. As such this branch has taken initiative to publish a report in this context which will continue in future.

This report "Morphological Changes of River Ganges over the Last Seven Years (2013 to 2019)" is to find out morphological changes in observed stations of the Ganges river for the year 2013 to 2019.

A handwritten signature in black ink, followed by the date "2019/07/20" written below it.

Executive Engineer  
ID-771229001  
River Morphology Processing Branch  
BWDB, Green Road, Dhaka.  
rmpb.bwdb@gmail.com

## Executive Summary

River Ganges is a transboundary river and one of the major rivers of South Asia. It plays a very important role in the overall socio economic development of the Bangladesh. It is an example of perennial and braided rivers in the world. It is highly susceptible to channel mitigation and avulsion. Bangladesh Water Development Board (BWDB) has been surveying river Ganges on a yearly basis over 126 km of the river at 6 km interval since 1965.

In this report, all 22 cross sections of last seven years (from 2013 to 2019) are individually superimposed to analyze channel characteristics, the trend of bed level change and variation of survey width of the river. Longitudinal profile of the river Ganges has been analyzed for finding the change in the reduced level of the thalweg. The Reduced Level of thalweg point varies from +4.19m to -17.35m during the period of 2013 to 2019. In 2013, the bed level at the cross section nearest to the upstream (RMG17 at Daulatour Upazilla, Kushtia District) is the highest (+2.52m). However, in 2014, 2015, 2017, 2018 and 2019, the highest bed level is found to be +4.19m, +0.8m, +0.81m, +3.29m and +3.52m at RMG17.1 at Daulatour Upazilla, Kushtia District. Except in 2016 the highest bed level is found to be +0.6m at RMG13.1 (30 km downstream to RMG17.1)

The lowest bed levels are found at different locations of the river in different years. In 2014 and 2015 the lowest bed levels (-12.68m, -11.78m respectively) are found at RMG13.1. In 2015, the lowest bed level (-17.35m) is found at RMG1. In 2016, 2017, 2018 and 2019 the lowest bed levels are -13m (at RMG2), -8.74m (at RMG11), -8.09m (at RMG2) and -17.26m (at RMG1.1).

The Surveyed width varies from 2.671km (at RMG13.1) to 15.475 km (at RMG17.1). The surveyed width has been found to be stable for all the cross sections over the last five years.

## Acronyms

BWDB	Bangladesh Water Development Board
CS	Cross Section
mPWD	meter Public Works Department
RL	Reduced Level
RMP	River Morphology Padma
SW	Surface Water

## Table of Contents

Preface .....	iv
Executive Summary.....	v
Acronyms .....	v
List of Tables.....	vi
List of Figures.....	vi
Chapter 1 Introduction.....	1
1.1 Background .....	1
1.2 Objective of the study .....	1
1.3 Sources of data.....	2
1.4 Hydrological Information of River Ganges.....	3
Chapter 2 Cross Sections of Ganges River.....	4
2.1 Superimposed Cross Sections of River Ganges .....	5
2.2 Long Profile of Ganges River .....	27
Conclusion.....	29
References .....	29

## List of Tables

Table 1. 1: Hydrological Network of BWDB.....	2
Table 1. 2: Hydrological Information of River Ganges.....	3
Table 2. 1: Reduced Levels of The lowest points and Survey Width of Ganges River.....	27

## List of Figures

Figure 2.1 : Location of bathymetric survey stations in river Ganges of BWDB.....	4
Figure 2.2 : Superimposed cross section of River Ganges over last seven years at CS#RMG1 .....	5
Figure 2.3 : Superimposed cross section of River Ganges over last seven years at CS#RMG1.1 .....	6
Figure 2.4 : Superimposed cross section of River Ganges over last seven years at CS#RMG2.....	7
Figure 2.5 : Superimposed cross section of River Ganges over last seven years at CS#RMG3.....	8
Figure 2.6 : Superimposed cross section of River Ganges over last seven years at CS#RMG4.....	9
Figure 2.7 : Superimposed cross section of River Ganges over last seven years at CS#RMG4.1.....	10
Figure 2.8 : Superimposed cross section of River Ganges over last seven years at CS#RMG5.....	11
Figure 2.9 : Superimposed cross section of River Ganges over last seven years at CS#RMG6.....	12
Figure 2.10: Superimposed cross section of River Ganges over last seven years at CS#RMG7.....	13
Figure 2.11: Superimposed cross section of River Ganges over last seven years at CS#RMG8.....	14
Figure 2.12: Superimposed cross section of River Ganges over last seven years at CS#RMG9.....	15
Figure 2.13: Superimposed cross section of River Ganges over last seven years at CS#RMG10.....	16
Figure 2.14: Superimposed cross section of river Ganges over last seven years at CS#RMG11 .....	17
Figure 2.15: Superimposed cross section of River Ganges over last seven years at CS#RMG12.....	18
Figure 2.16: Superimposed cross section of River Ganges over last seven years at CS#RMG12.1.....	19
Figure 2.17: Superimposed cross section of River Ganges over last seven years at CS#RMG13.....	20
Figure 2.18: Superimposed cross section of River Ganges over last seven years at CS#RMG13.1.....	21
Figure 2.19: Superimposed cross section of River Ganges over last seven years at CS#RMG14.....	22
Figure 2.20: Superimposed cross section of River Ganges over last seven years at CS#RMG15.....	23
Figure 2.21: Superimposed cross section of River Ganges over last seven years at CS#RMG16.....	24
Figure 2.22: Superimposed cross section of River Ganges over last seven years at CS#RMG17.....	25
Figure 2.23: Superimposed cross section of River Ganges over last seven years at CS#RMG17.1.....	26
Figure 2.24: Gradient changes in River Ganges .....	28

# Chapter 1

## Introduction

### 1.1 Background

Bangladesh is a land of rivers and the largest flat deltaic land in the world. The major rivers namely the Ganges, the Padma, the Brahmaputra-Jamuna, the Meghna with their numerous branches and tributaries play a significant role in supporting the lives and livelihoods of millions of people living in this country. Having a vast alluvial plain, it has one of the most fertile lands sloping southward from the Himalayas to the Bay of Bengal. Land formation and the delta development activities are going on in the south by deposition of these major river systems.

Being dynamic in nature these major rivers grasps about hectares of floodplain every year destroying and causing damages to valuable infrastructures and making thousands of people homeless. One of the major natural disasters of Bangladesh is the river bank erosion. The rate of river bank erosion and sediment deposition of these rivers varies with time.

River Ganges is one of the major rivers of Asia. It is a very important transboundary river. It is the flow combination of the two rivers namely the Alakananda and the Bhagirathi. The Ganges rises from the Gangotri glacier in the southern slopes of the Himalayas near Indo-China border. Ganges enters into Bangladesh territory at Panka, Narayanpur of Chapai Nobabganj District. Here it follows the Bangladesh-India border line for about 110 km. At Mahiskundi of Kustia district the Ganges enters fully within Bangladesh. The Ganges flows in the south east direction of the country and travels about 120 km. Then meets with Jamuna river at Aricha of the Manikganj district. The Ganges river after combining with Jamuna takes the name of the Padma River. The Ganges is a meandering river, the sinuosity of which varies over time. The platform of the river may change from meander to straight and then becomes braided due to changes in sediment.

### 1.2 Objective of the study

The main objective of this report is to analyze the superimposed cross sections of all the stations of the river Ganges for observing the existing trend, shifting characteristics and gaining a better understanding of the morphological changes.

### 1.3 Sources of data

Bangladesh Water Development Board (BWDB) Hydrology Division collects, processes and distributes the Hydrological Data of Bangladesh. BWDB maintains a strong hydrologic network throughout the country for the collection of different hydrological data. This network is shown in table 1.1.

Table 1. 1: Hydrological Network of BWDB

SL	Database	Type Code	Data Type Name	No of Stations
1	SW	NTWL	Non-Tidal SW Level	218
2	SW	TDWL	Tidal SW Level	126
3	SW	NTQ	Observed Discharge	111
4	SW	TDQ	Tidal Discharge	7
5	SW	SWQ	Surface Water Quality	22
6	SW	SA	Salinity	100
7	RM	CS	River Cross Section	1098
8	RM	SED	Sediment	26
9	CL	RF	Rainfall	243
10	CL	CL	Climatology	2
11	CL	EV	Evaporation	39
12	GW	GT	Weekly GW Table	1282
13	GW	GT Daily	Daily GW Table	20
14	GW	GQ	GW Quality	119

Source: BWDB Database



## 1.4 Hydrological Information of River Ganges

Hydrological information of river Ganges is shown below in Table 1.2.

Offtake	Gangotri, Satopanth and Khatling Glaciers at Himalayas, India.	
Outfall	The Padma River at Goalanda, Rajbari.	
Tributaries	Mahananda Lower (Nobabganj)	
Distributaries	Baral Upper; Mathabhanga; Hisna-Jhanja Ichamoti(Pabna); Gorai; Chandana-barasia.	
Branches	Nil	
Physical Description	Length	230 Km.
	Nature	Perennial and Braided
	Bed Level (off-take to outfall)	Varies from +4.19m to -17.35m
Discharge	Seasonal/Perennial	Perennial
	February-April	530 cumec
	July-September	70,868 cumec
	Tidal-Non tidal	Non-Tidal.
Existing Measurement Stations	Water Level Station	Panka(SW88A) Rampur Boalia (SW 88) Sarda (SW89) Hardinge Bridge (SW90) Talbaria (SW91) Sengram (SW 91.1) Mohendropur (SW91.2)
	Discharge Station	Hardinge Bridge (SW90)
	Sediment Transport Station	Hardinge Bridge (SW90) & Baroria (SW91.9L) Transit
	Salinity Stations	Nil
	Water Quality Stations	Rajshahi (SW 88), Hardinge Bridge (SW90)
	River Cross Sections	RMG1 to RMG 17.1 (22 Nos)

Table 1. 2: Hydrological Information of River Ganges

## Chapter 2

### Cross Sections of Ganges River

River Ganges has been surveyed on a yearly basis over 126km of the river since 1965 by Bangladesh Water Development Board (BWDB). There are 22 cross sections (from RMG 1 to RMG 17.1) at 6 km interval (Figure 2.1). In this report, cross sections of last seven years (from 2013 to 2019) of all stations are individually superimposed to analyze the change in channel characteristics of the river (Figure 2.2-2.23).

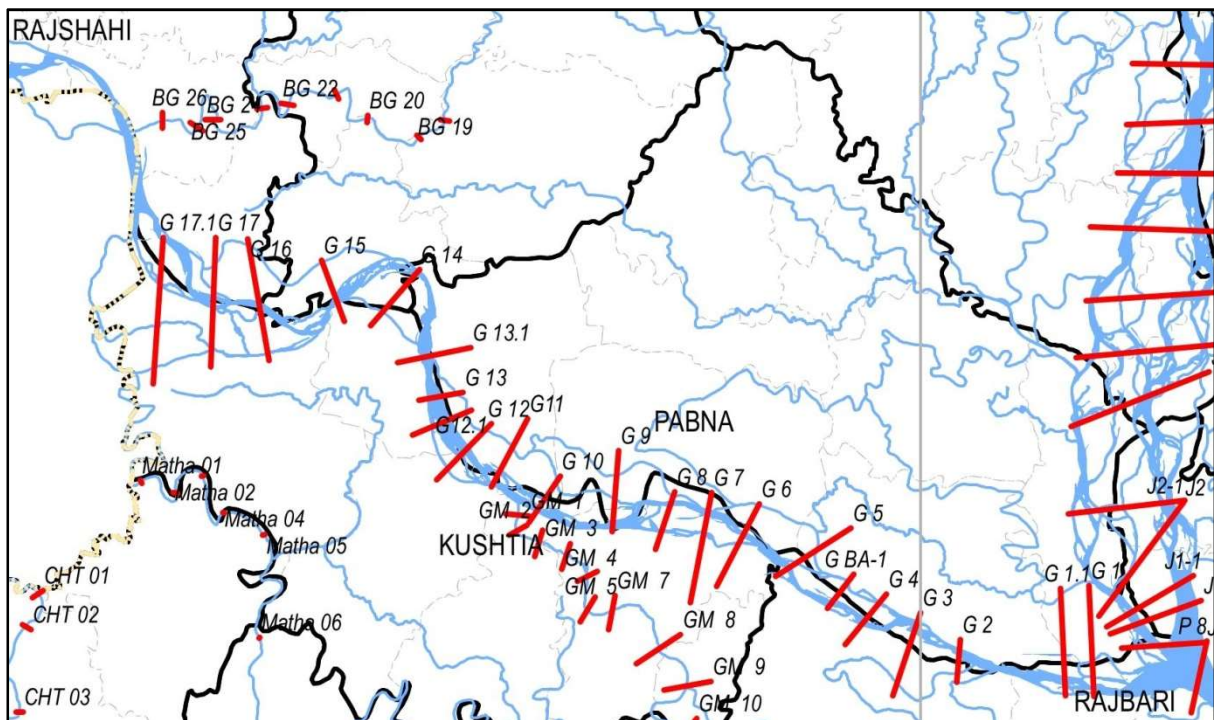


Figure 2.1: Location of bathymetric survey stations in river Ganges of BWDB.

## 2.1 Superimposed Cross Sections of River Ganges

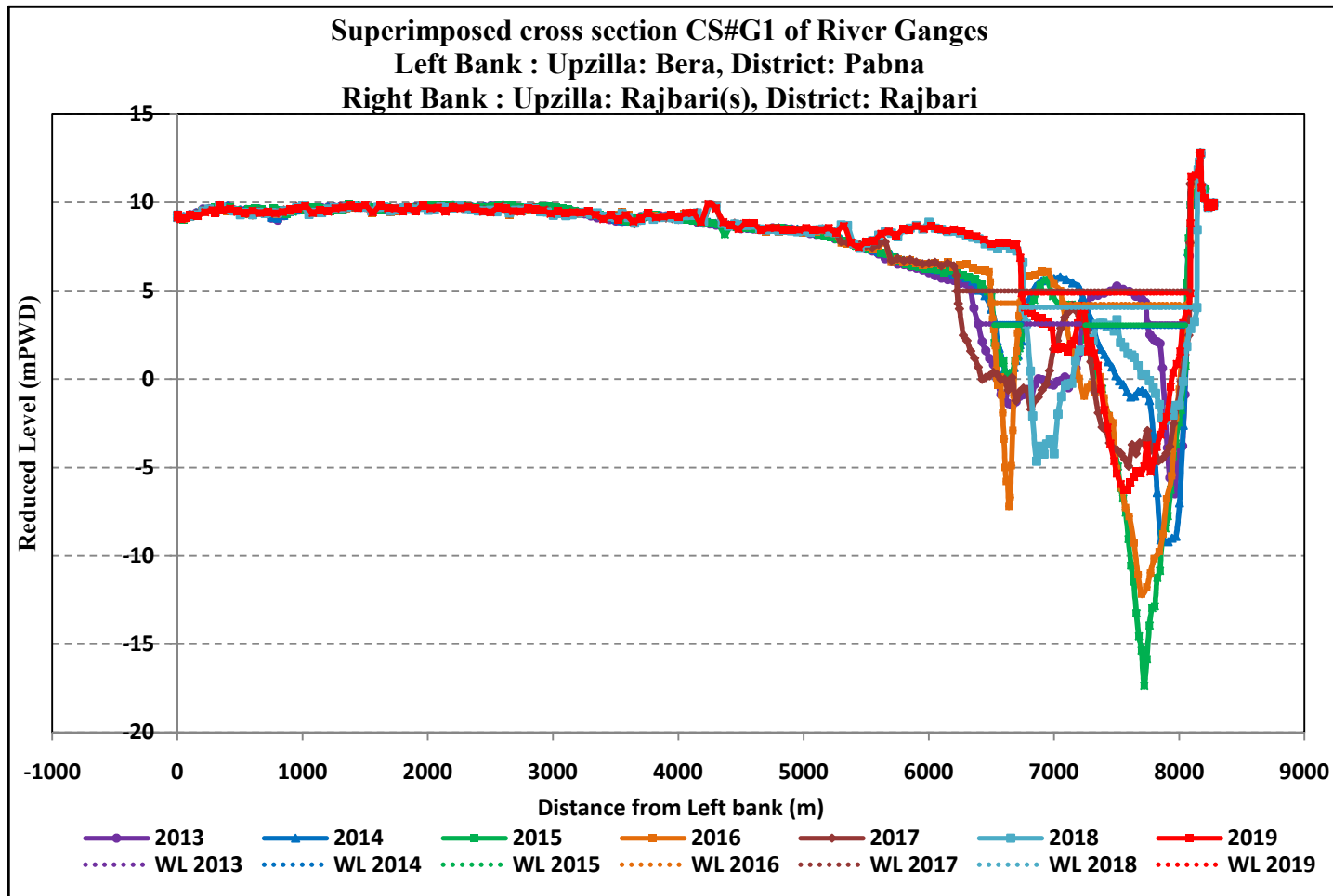


Figure 2.2: Superimposed cross section of River Ganges over last seven years at CS#RMG1

From figure 2.2 it can be seen that the Reduced Level (RL) of the lowest point at RMG1 of varies from -4.64m (2018) to -17.35m (2015), the surveyed width is 8.272km and water level varies from 2.98m (2014) to 4.98m (2017) during the period of 2013 to 2019.

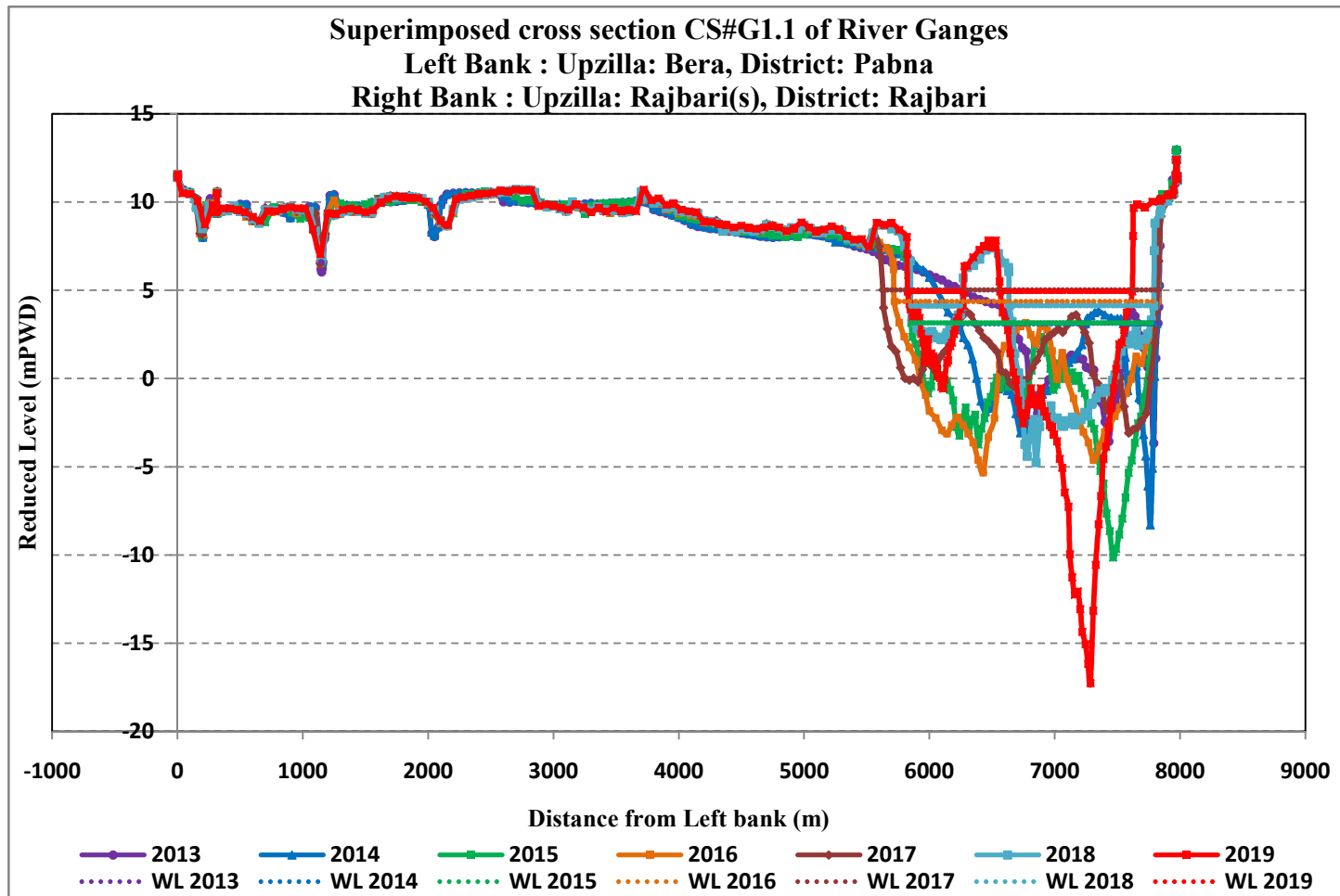


Figure 2.3: Superimposed cross section of River Ganges over last seven years at CS#RMG1.1

From figure 2.3 it can be seen that the Reduced Level (RL) of the lowest point at RMG1.1 varies from -3.09m (2017) to -17.26m (2019), the surveyed width is 7.98km and water level varies from 3.1m (2014) to 6.6m (2013) during the period of 2013 to 2019. It can be observed that scouring has occurred in the main channel in year 2019 compared to that of year 2013.

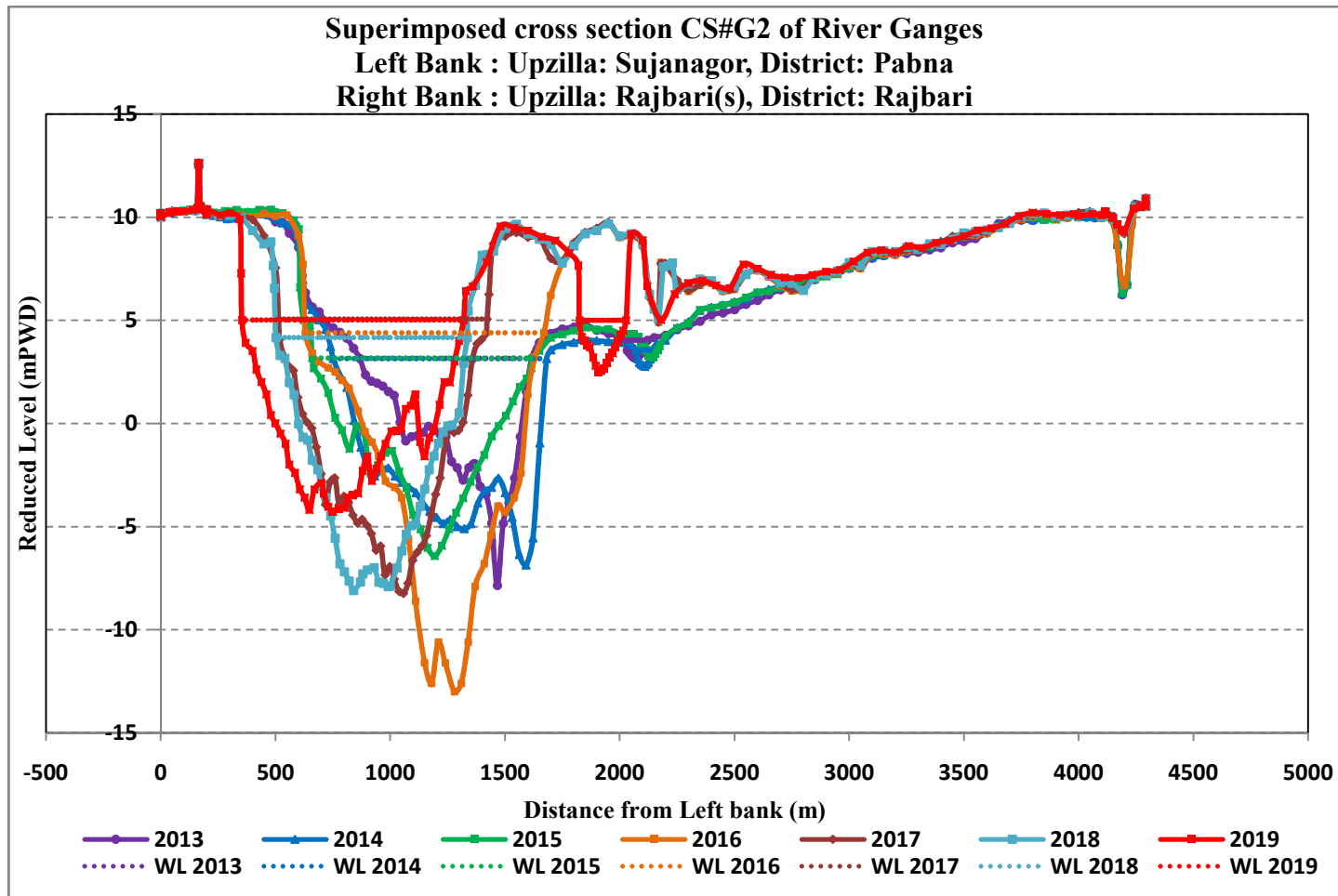


Figure 2.4: Superimposed cross section of River Ganges over last seven years at CS#RMG2

From figure 2.4 it can be seen that the Reduced Level (RL) of the lowest point at RMG2 varies from -4.29m (2019) to -13m (2016), the surveyed width is 4.293km and water level varies from 3.14m (2014) to 5.06m (2017) during the period of 2013 to 2019. It can be observed that scouring took place in the left bank in year 2019 and sediment deposition occurred in the main channel compared to that of in year 2013.

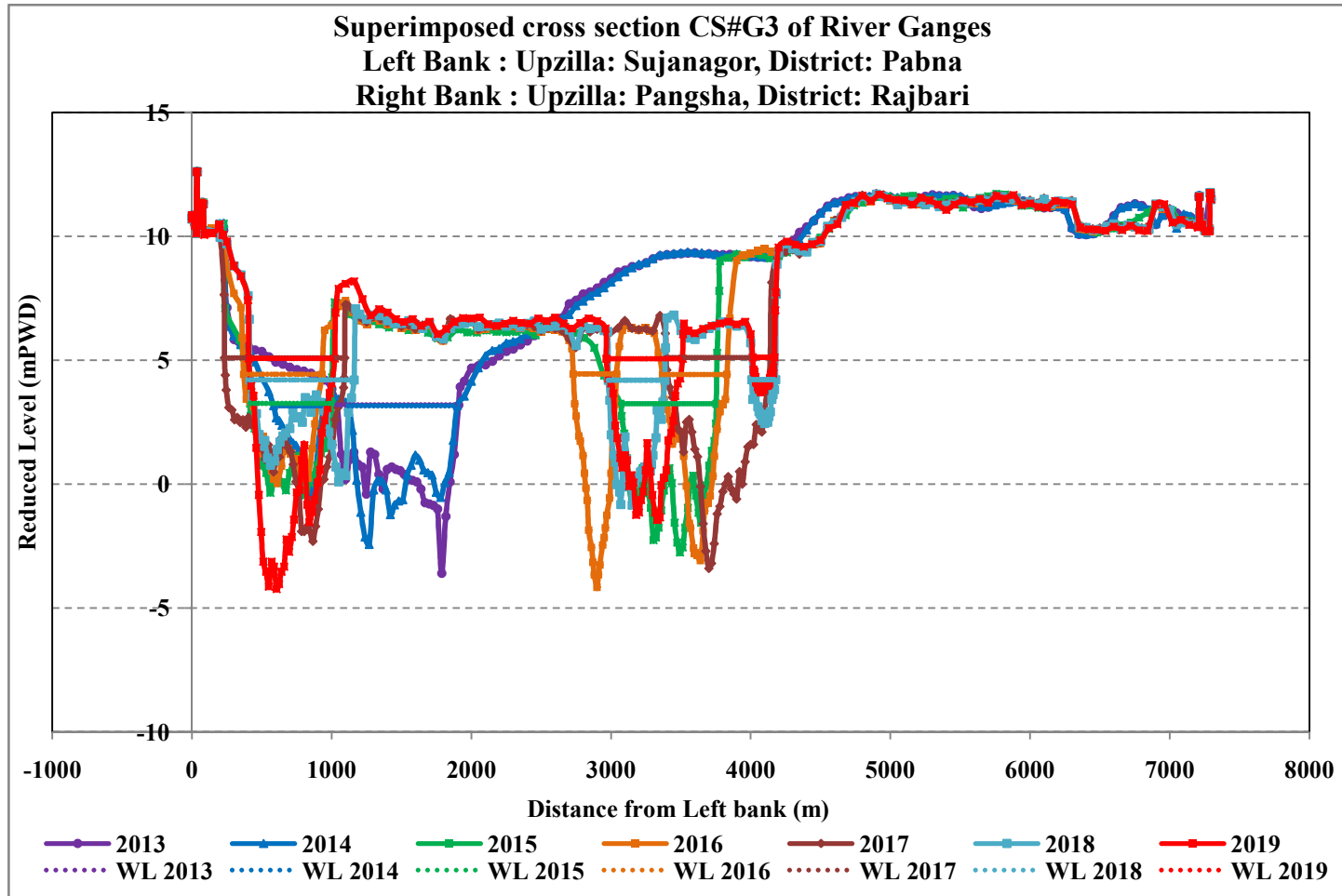


Figure 2.5: Superimposed cross section of River Ganges over last seven years at CS#RMG3

From figure 2.5 it can be seen that the Reduced Level (RL) of the lowest point at RMG3 varies from -2.44m (2014) to -4.23m (2019), surveyed width is 7.294km and water level varies from 3.16m (2014) to 5.12m (2019) during the period of 2013 to 2019. It is seen that scouring took place in the left bank and middle portion of the channel in recent years till 2019 than compared to that of in year 2013.

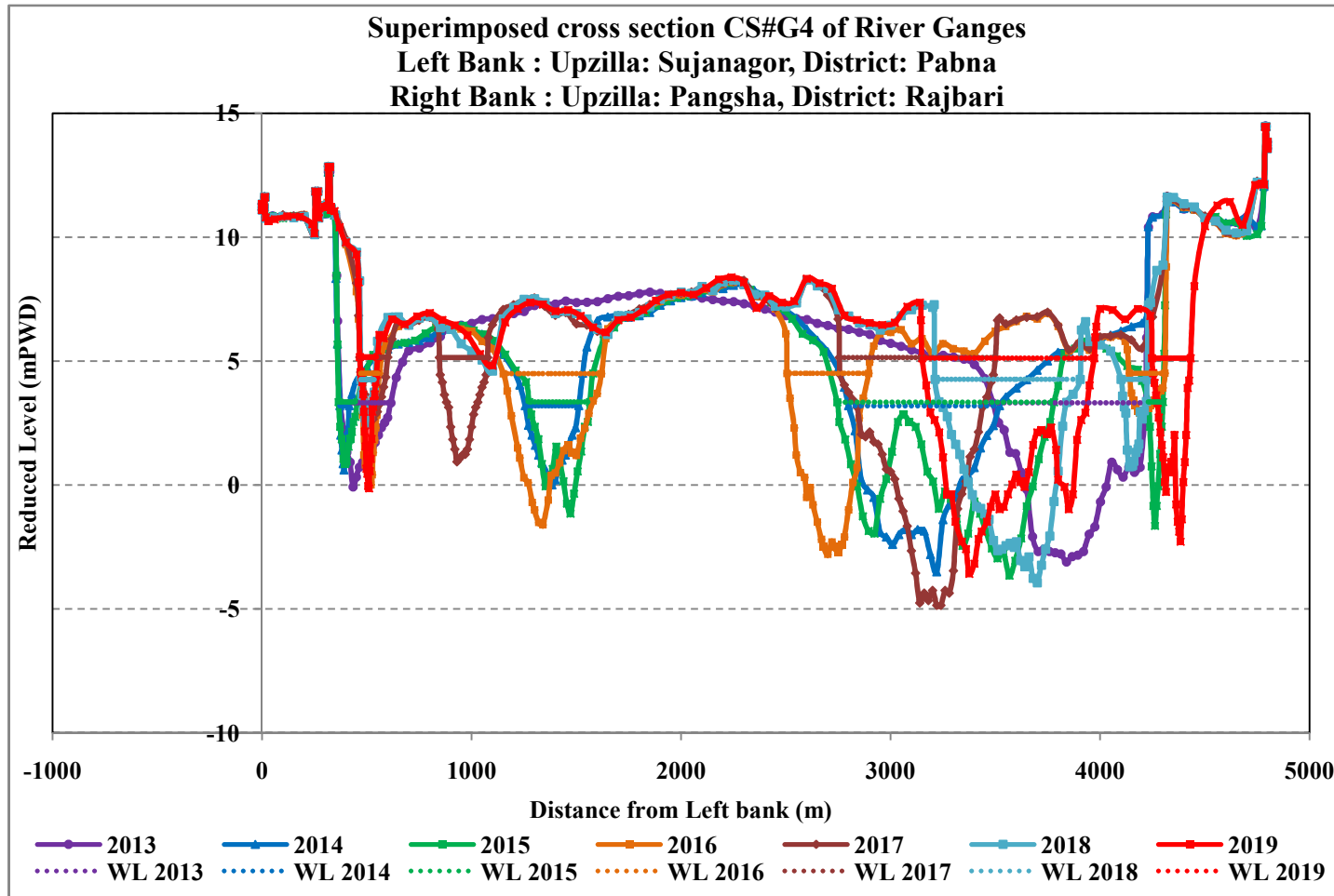


Figure 2.6: Superimposed cross section of River Ganges over last seven years at CS#RMG4

From figure 2.6 it can be seen that the Reduced Level (RL) of the lowest point at RMG4 varies from -2.8m (2016) to -4.86m (2017), the surveyed width is 4.7975km and water level varies from 3.19m (2014) to 5.16m (2019) during the period of 2013 to 2019. Observation can be made that scouring and deposition of sediment took place in different part of the cross section in different years.

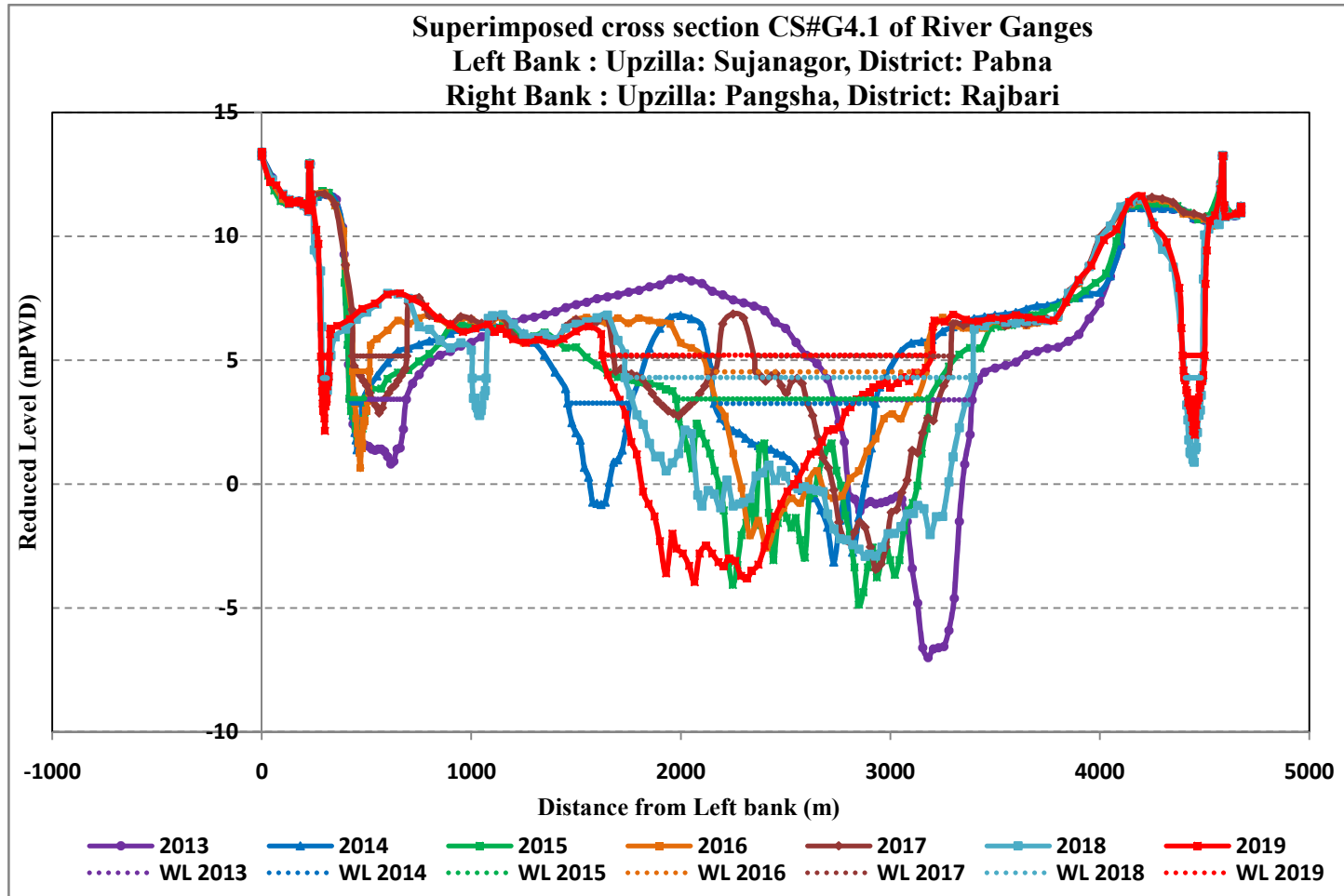


Figure 2.7: Superimposed cross section of River Ganges over last seven years at CS#RMG4.1

From figure 2.7 it can be seen that the Reduced Level (RL) of the lowest point at RMG4.1 varies from -2.57m (2016) to -7m (2013), the survey width has been found to be 4.674km and water level varies from 3.27m (2014) to 5.2m (2019) during the period of 2013 to 2019. It can be observed that the lowest point has shifted to the left in year 2019 compared to that of in year 2013.



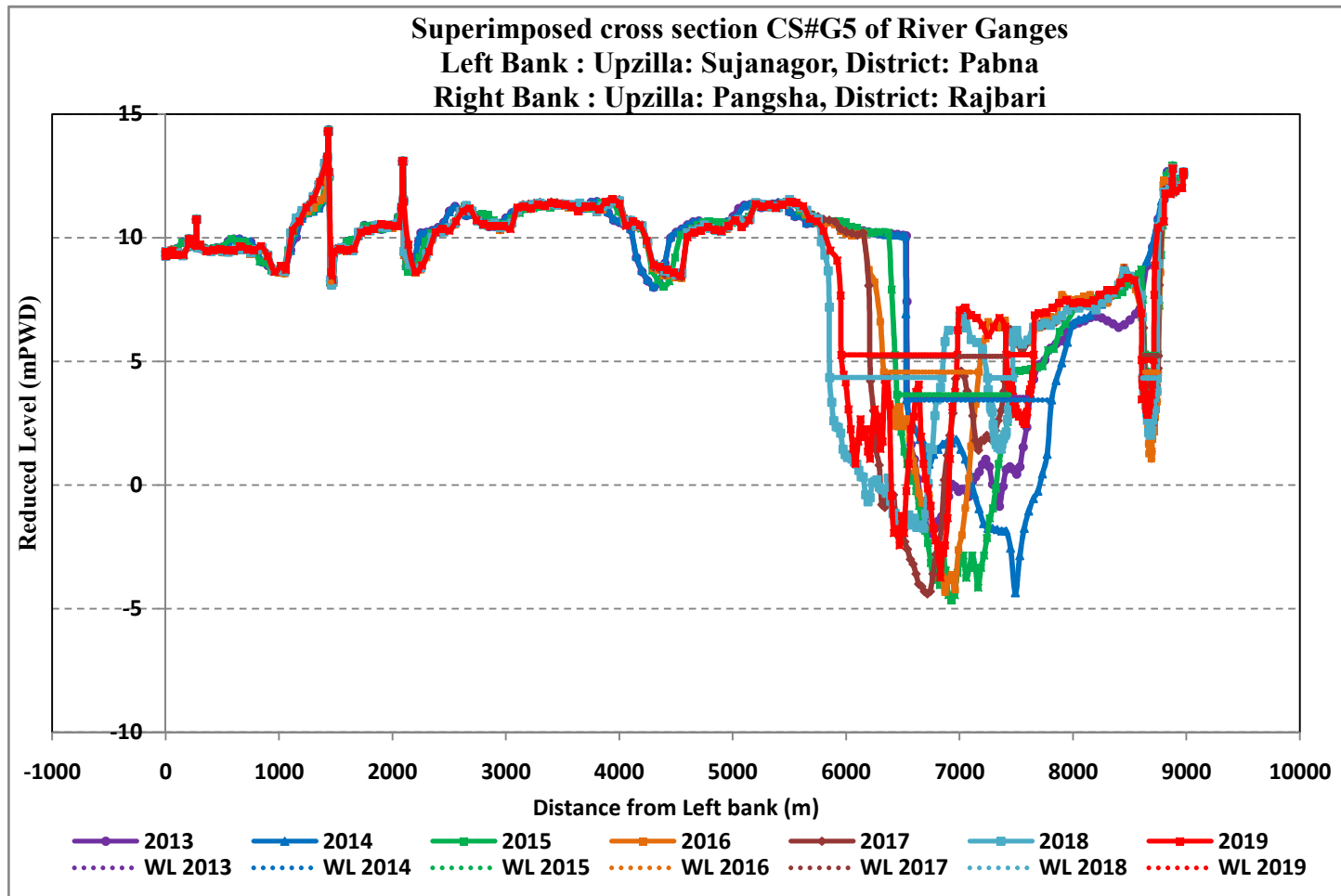


Figure 2.8: Superimposed cross section of River Ganges over last seven years at CS#RMG5

From figure 2.8 it can be seen that the Reduced Level (RL) of the lowest point at RMG5 of varies from -1.89m (2018) to -4.645m (2015), the surveyed width is 8.972km and water level varies from 3.44m (2014) to 5.285m (2015) during the period of 2013 to 2019.

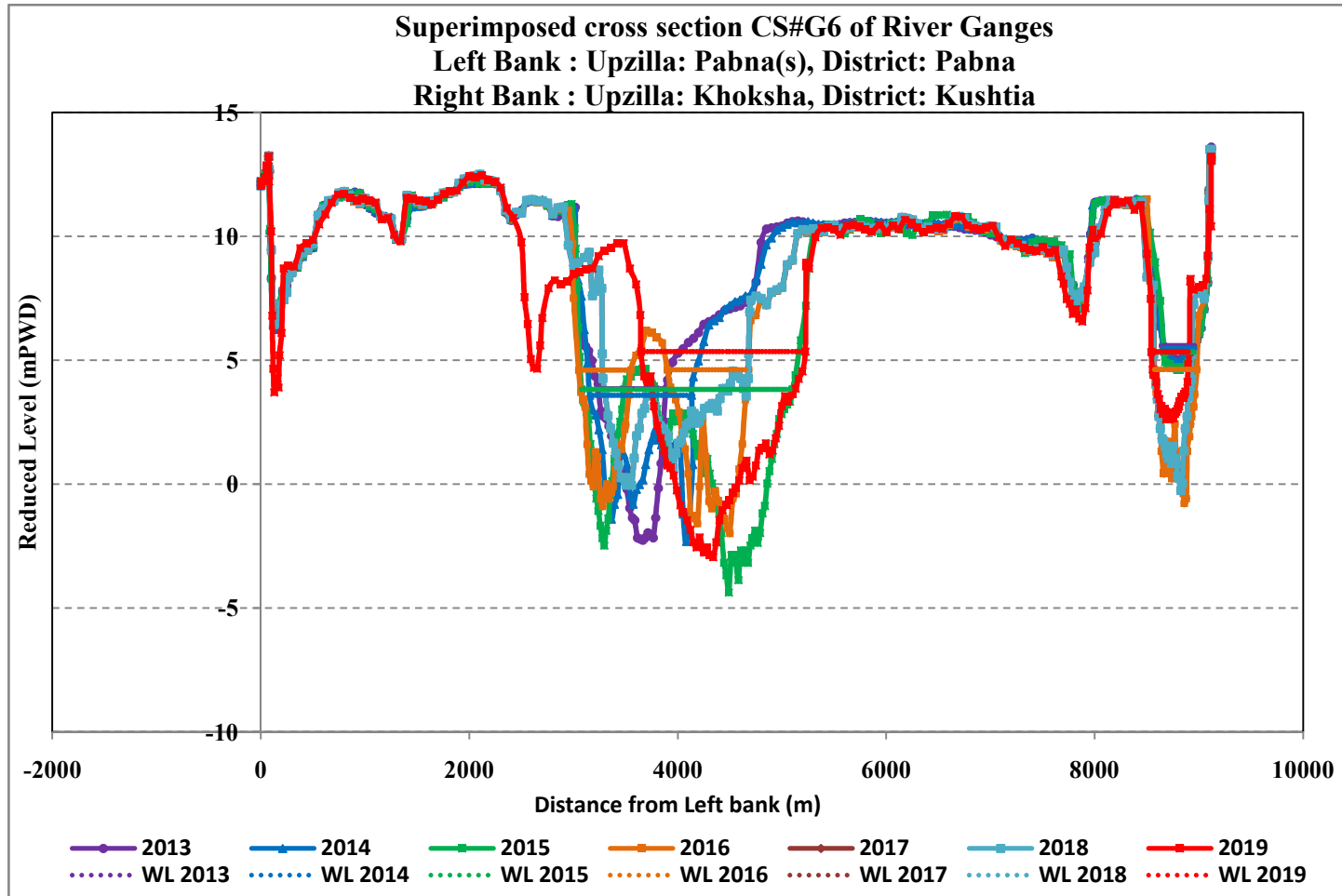


Figure 2.9: Superimposed cross section of River Ganges over last seven years at CS#RMG6

From figure 2.9 it can be seen that the Reduced Level (RL) of the lowest point at RMG6 varies from -0.26m (2018) to -4.375m (2015), the surveyed width is 9.118km and water level varies from 3.58m (2014) to 5.58m (2013) during the period of 2013 to 2019.

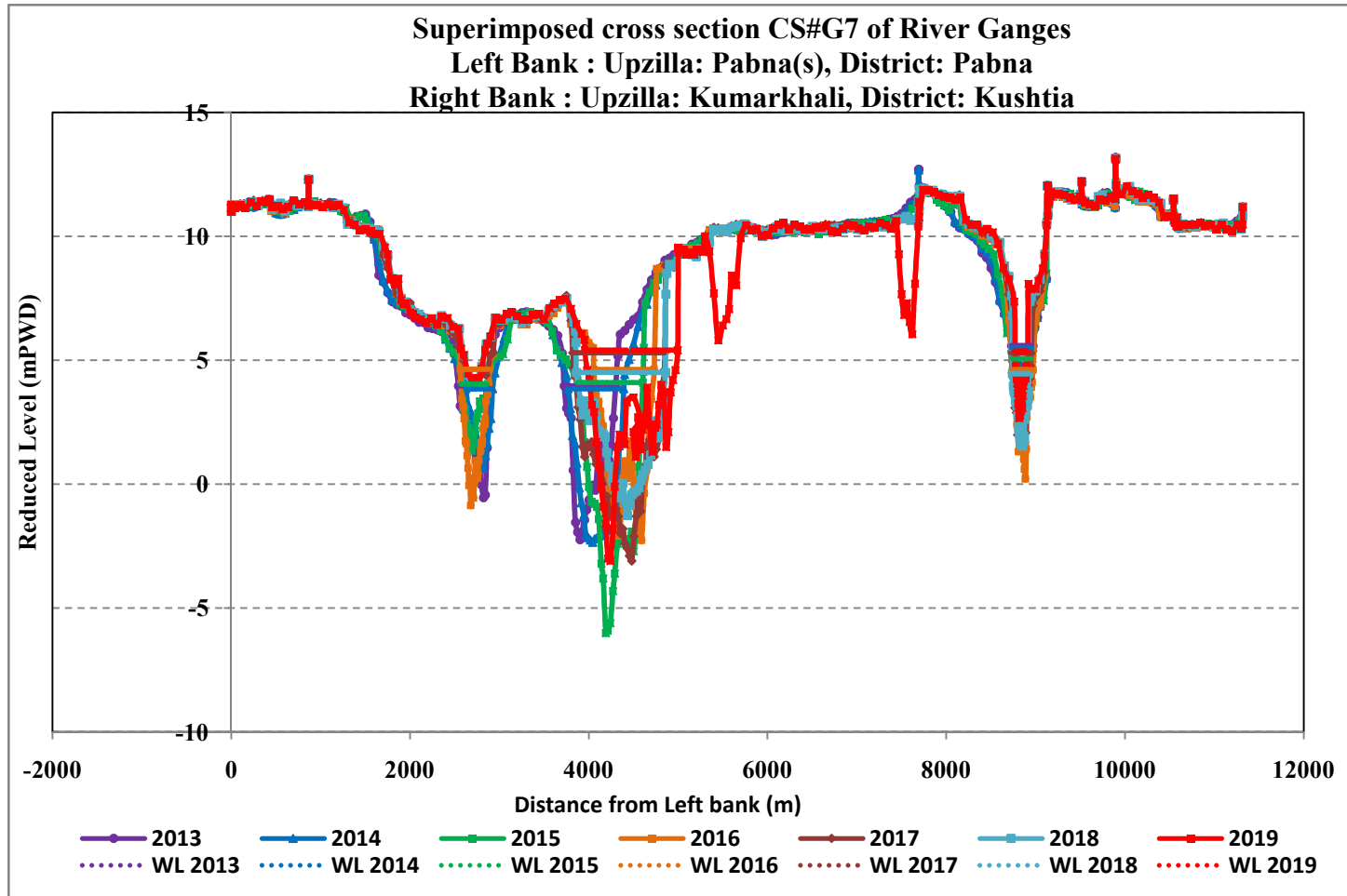


Figure 2.10: Superimposed cross section of River Ganges over last seven years at CS#RMG7

From figure 2.10 it can be seen that the Reduced Level (RL) of the lowest point at RMG7 varies from -1.26m (2018) to -6.01m (2015), the surveyed width is 11.316km and water level varies from 3.84m (2014) to 5.58m (2013) during the period of 2013 to 2019.

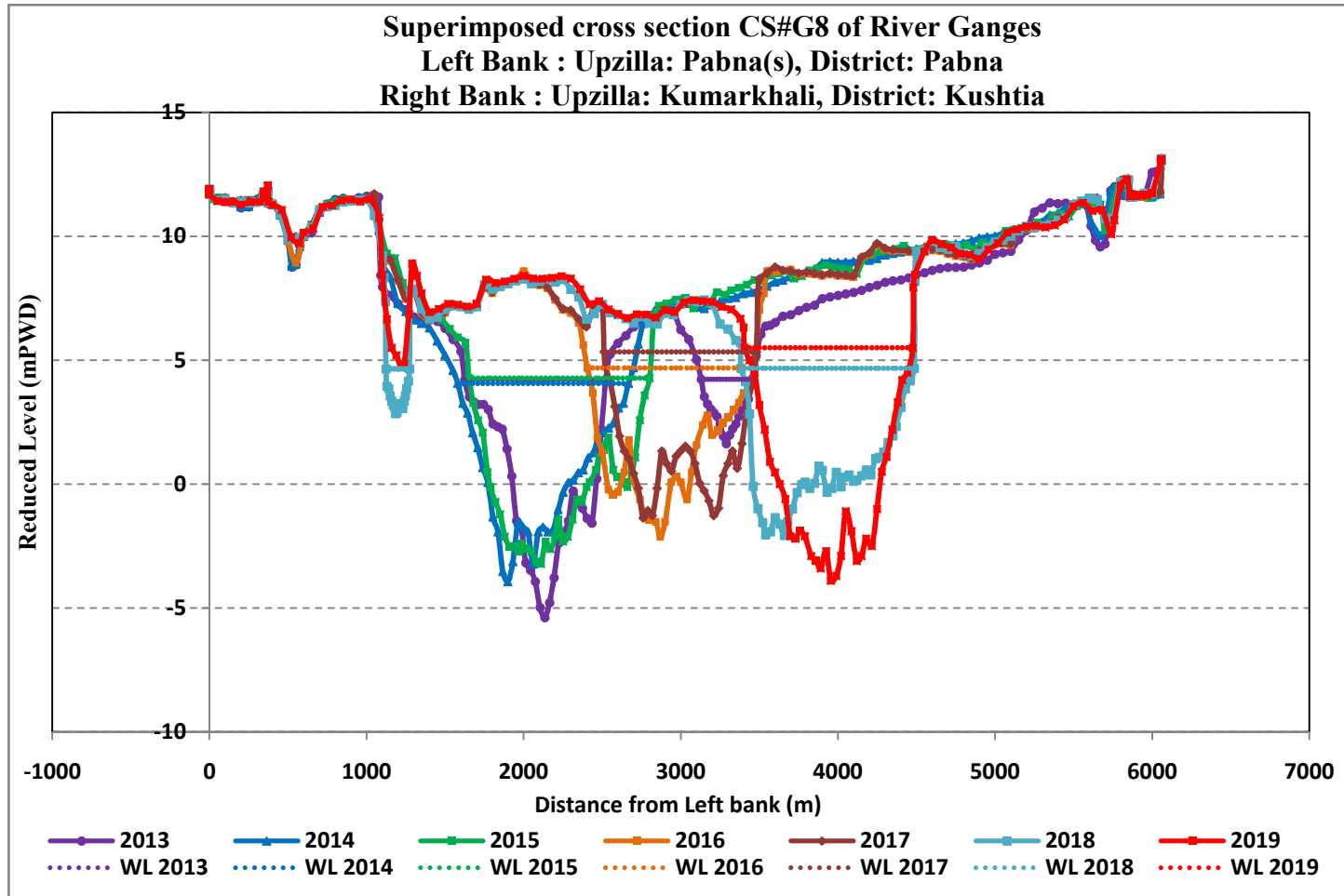


Figure 2.11: Superimposed cross section of River Ganges over last seven years at CS#RMG8

From figure 2.11 it can be seen that the Reduced Level (RL) of the lowest point at RMG8 of varies from -1.37m (2017) to -5.38m (2013), the surveyed width is 6.059km and water level varies from 4.06m (2014) to 5.5m (2019) during the period of 2013 to 2019. It can be observed that the lowest point has shifted to the right in year 2019 compared to that of in year 2013.

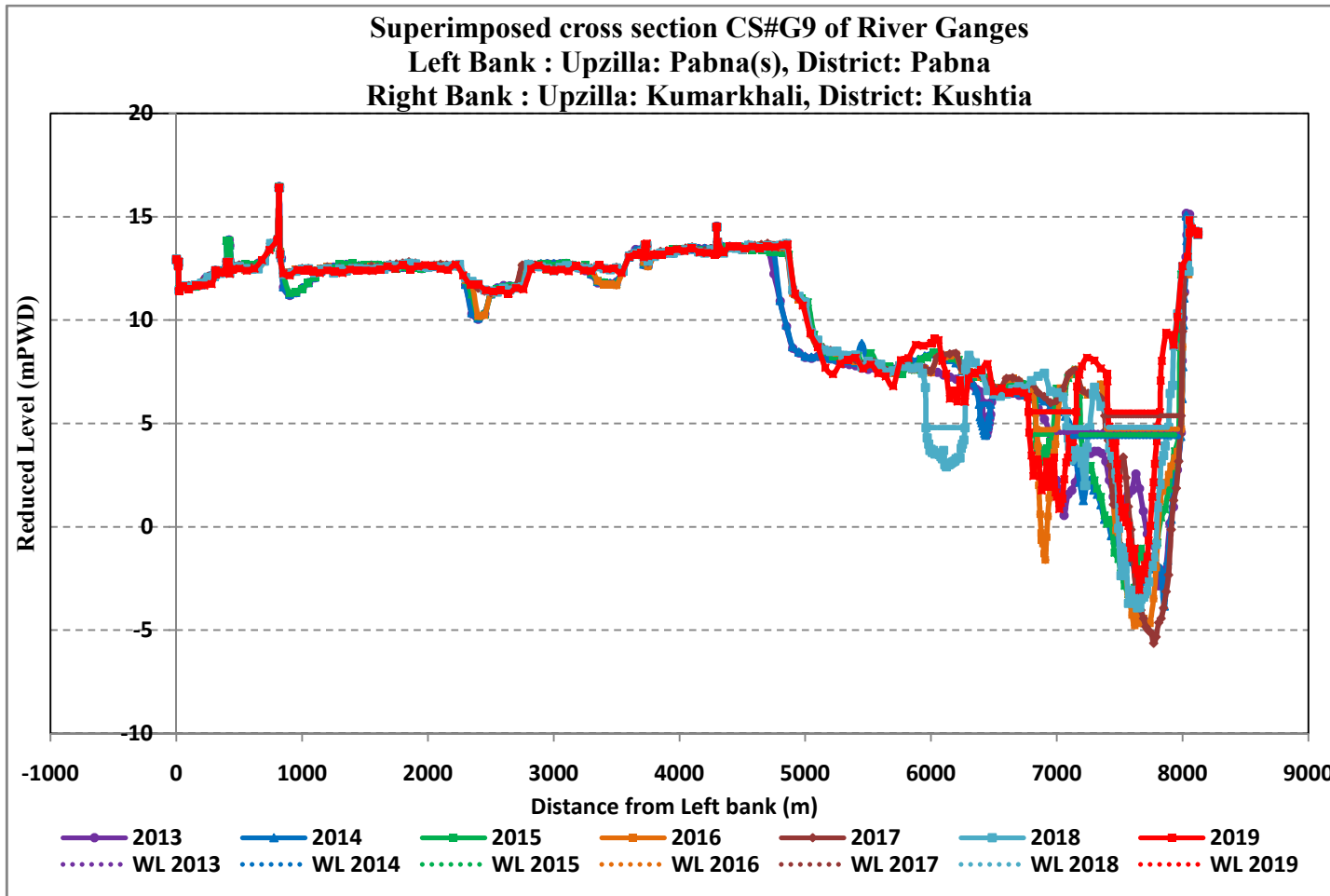


Figure 2.12: Superimposed cross section of River Ganges over last seven years at CS#RMG9

From figure 2.12 it can be seen that the Reduced Level (RL) of the lowest point at RMG9 varies from -2.84m (2013) to -5.63m (2017), the surveyed width is 8.122km and water level varies from 4.36m (2014) to 6.04m (2013) during the period of 2013 to 2019.

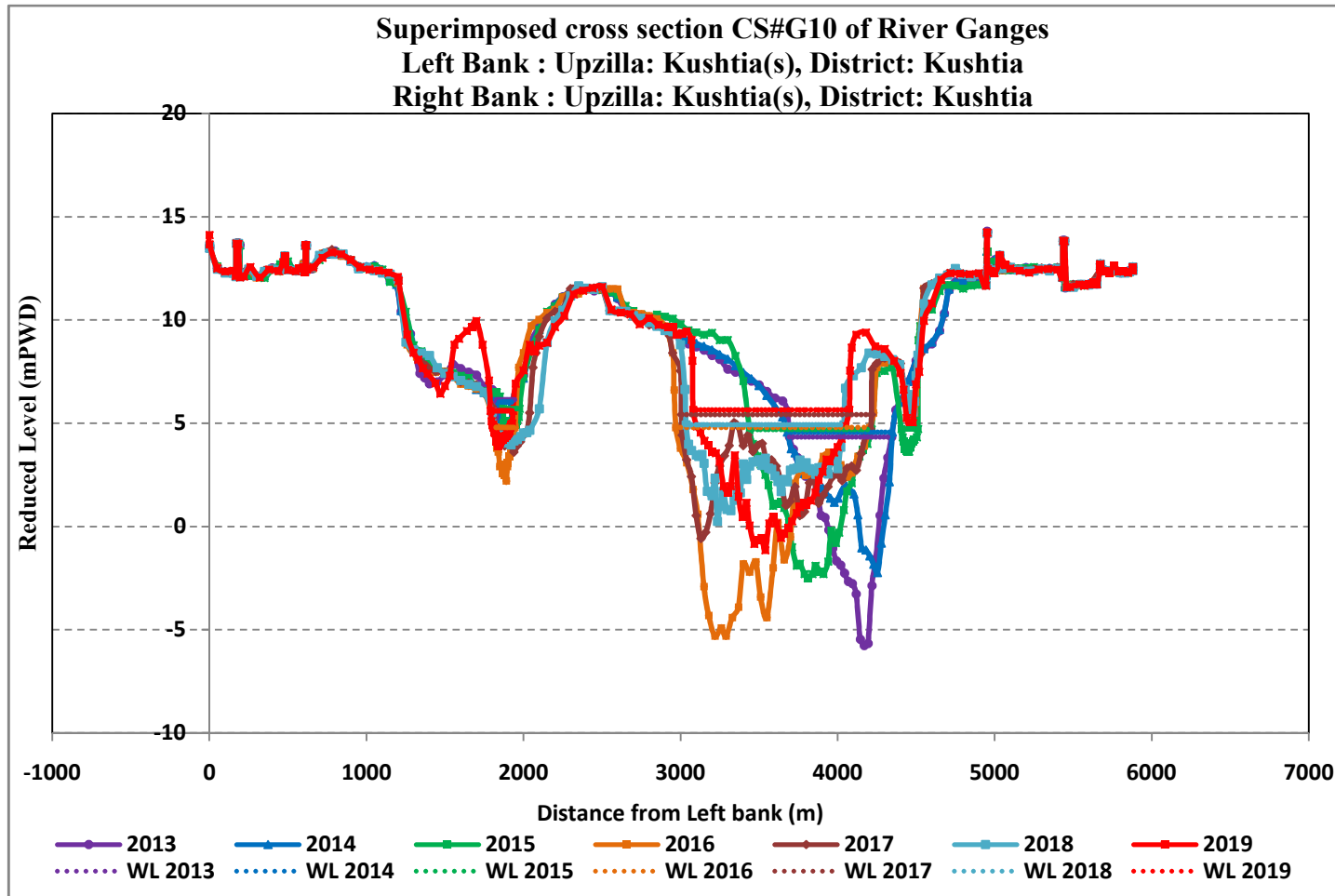


Figure 2.13: Superimposed cross section of River Ganges over last seven years at CS#RMG10

From figure 2.13 it can be seen that the Reduced Level (RL) of the lowest point at RMG10 of varies from 0.26m (2018) to -5.76m (2013), the surveyed width is 5.88km and water level varies from 4.34m (2013) to 6.14m (2013) during the period of 2013 to 2019.

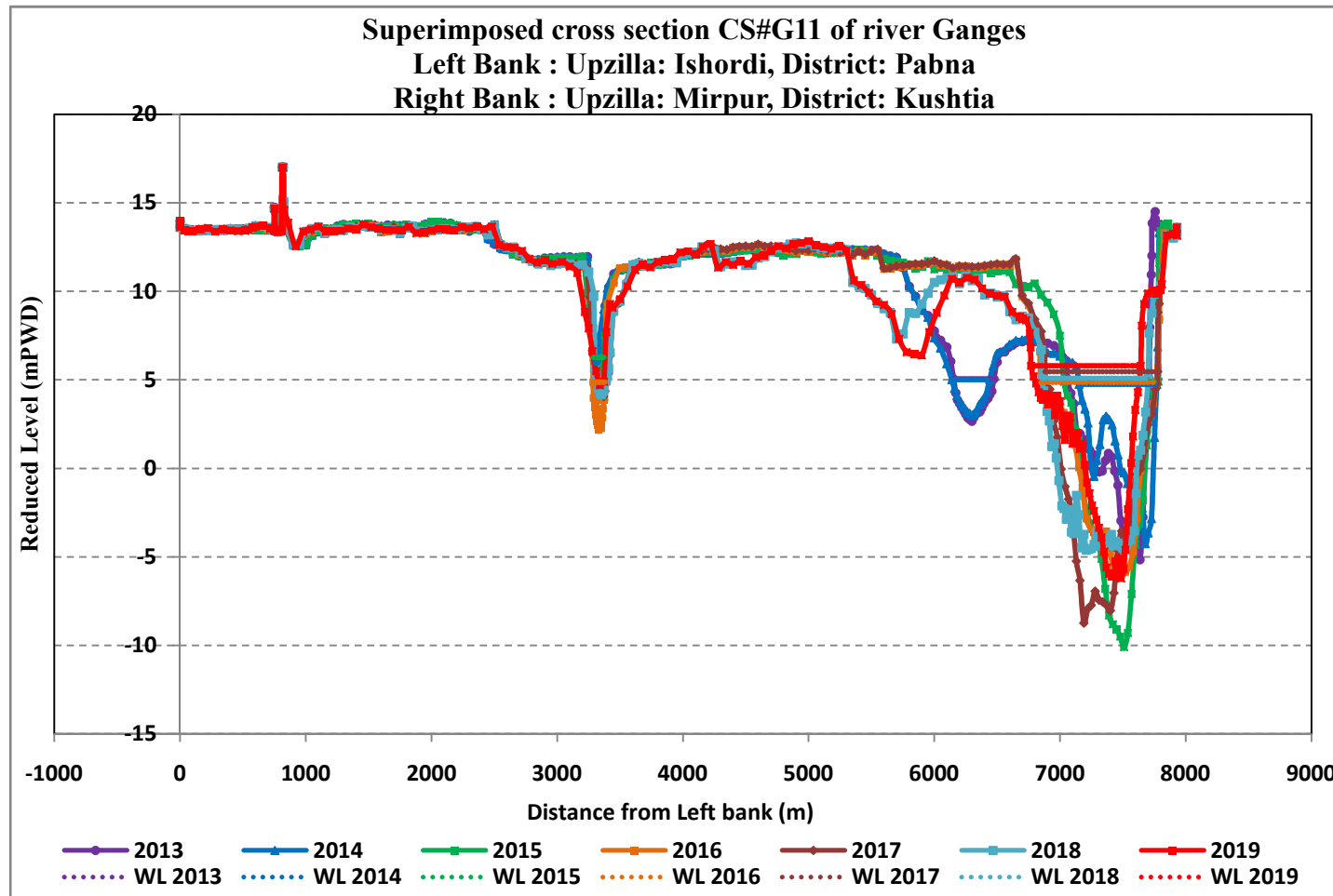


Figure 2.14: Superimposed cross section of river Ganges over last seven years at CS#RMG11

From figure 2.14 it can be seen that the Reduced Level (RL) of the lowest point at RMG11 of varies from -4.26m (2014) to -10.1m (2015), the surveyed width is 7.929km and water level varies from 4.74m (2014) to 6.26m (2015) during the period of 2013 to 2019.

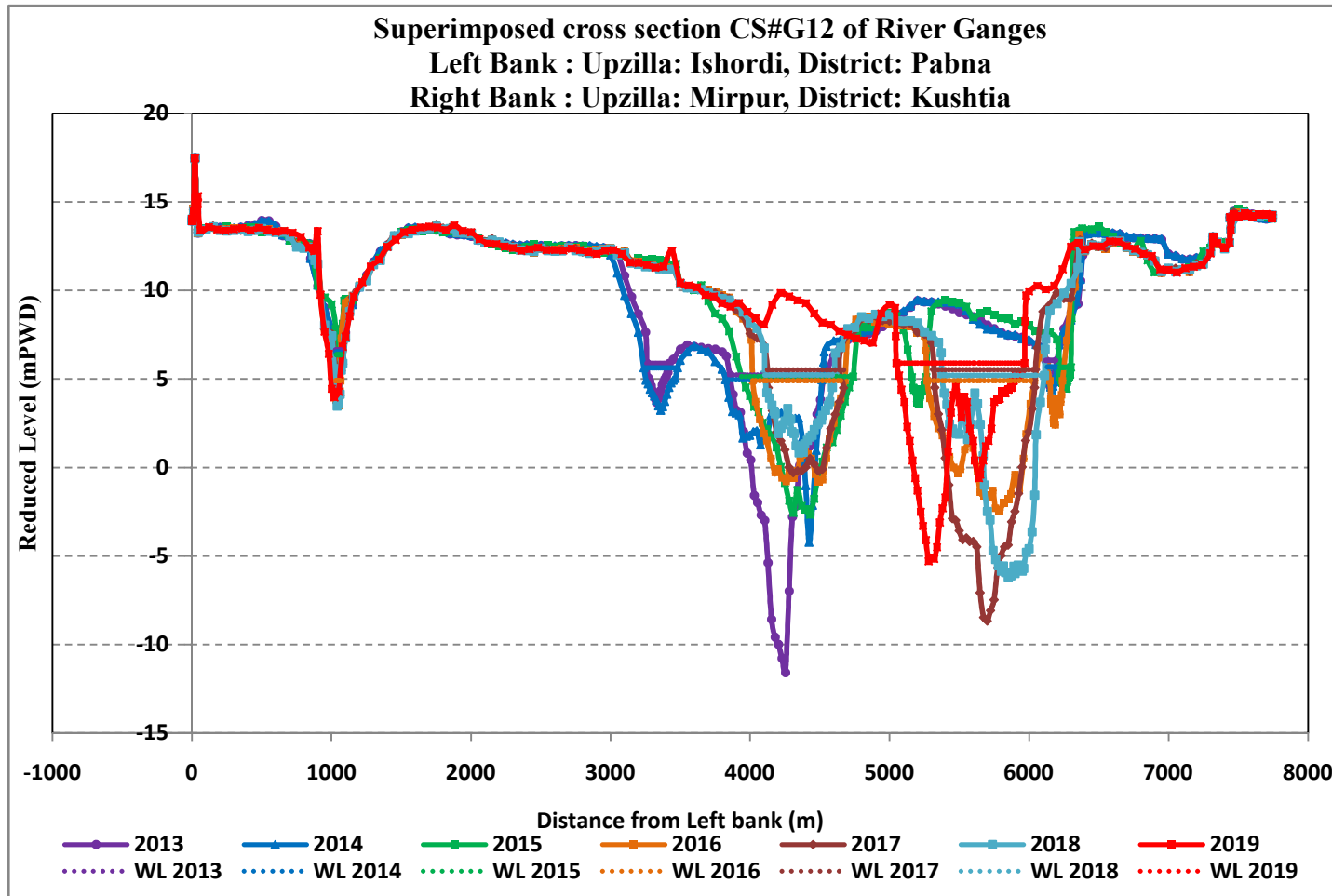


Figure 2.15: Superimposed cross section of River Ganges over last seven years at CS#RMG12

From figure 2.15 it can be seen that the Reduced Level (RL) of the lowest point at RMG12 varies from -2.4m (2016) to -11.58m (2013), the surveyed width is 7.744km and water level varies from 4.9m (2016) to 6.64m (2013) during the period of 2013 to 2019. It can be observed that the lowest point has shifted to the right in year 2019 compared to that of in year 2013.



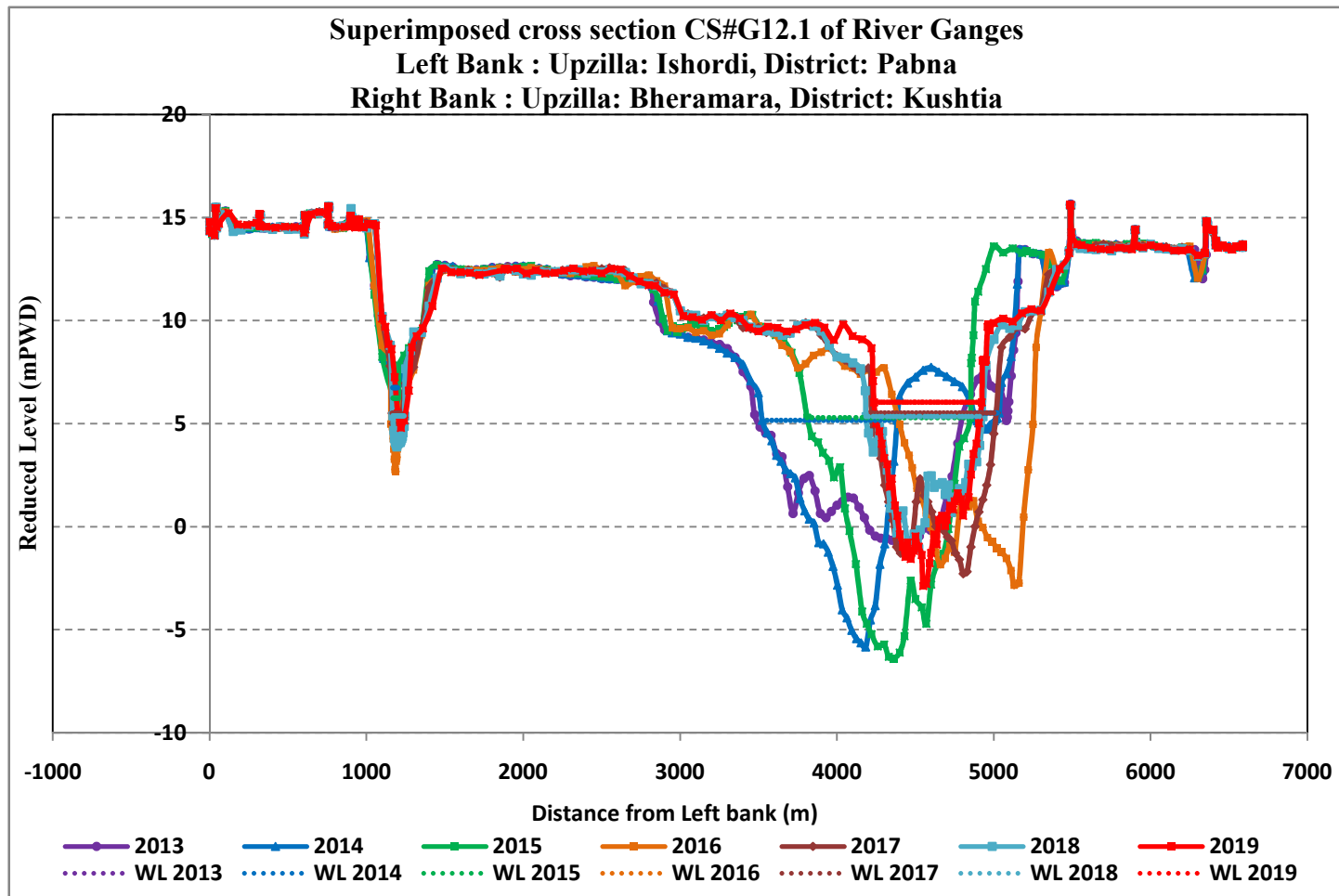


Figure 2.16: Superimposed cross section of River Ganges over last seven years at CS#RMG12.1

From figure 2.16 it can be seen that the Reduced Level (RL) of the lowest point at RMG12.1 of varies from -1.06m (2018) to -6.41m (2015), the surveyed width is 6.585km and water level varies from 5.16m (2014) to 6.74m (2014) during the period of 2013 to 2019.

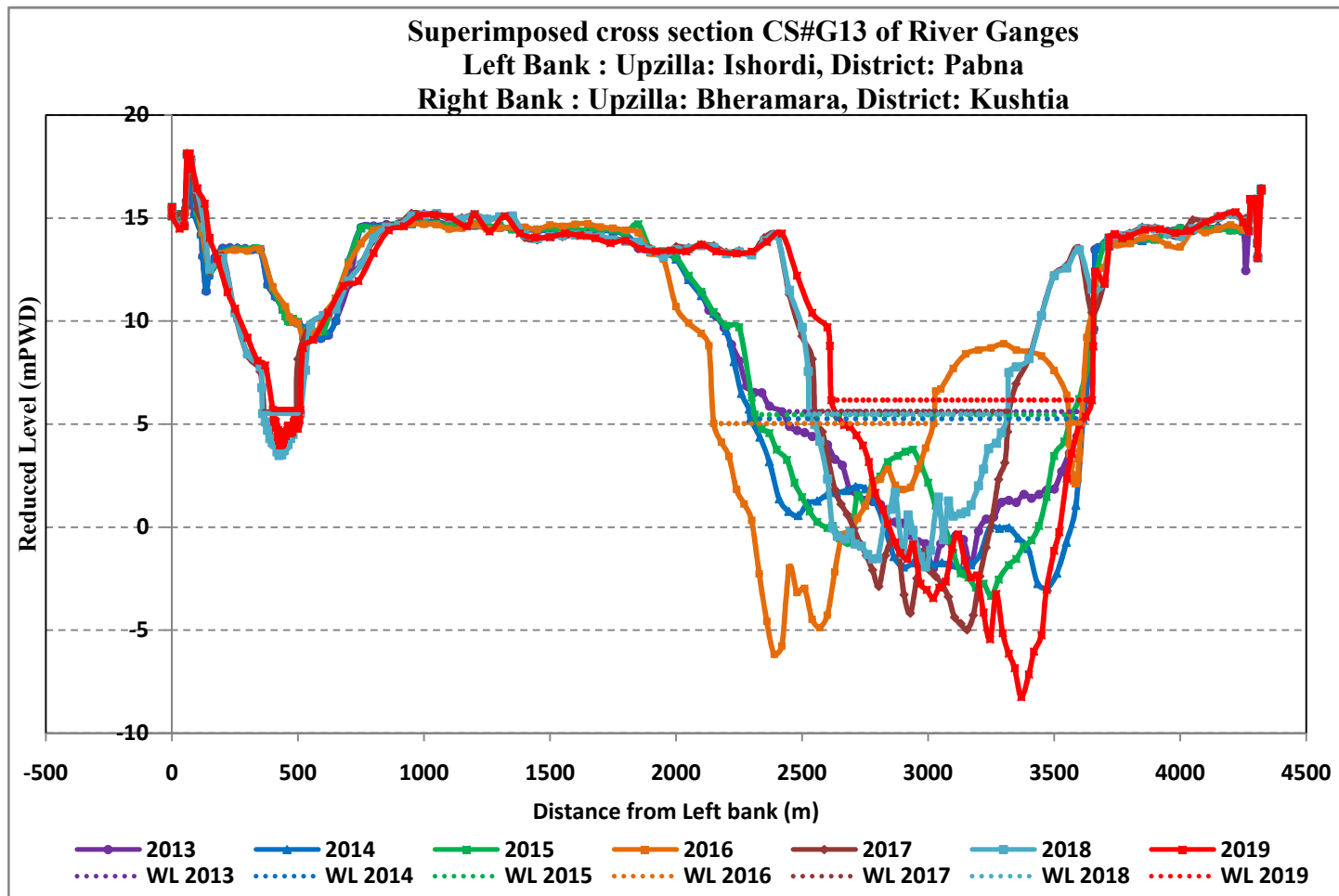


Figure 2.17: Superimposed cross section of River Ganges over last seven years at CS#RMG13

From figure 2.17 it can be seen that the Reduced Level (RL) of the lowest point at RMG13 varies from -1.92m (2018) to -8.24m (2019), the surveyed width is 4.3215km and water level varies from 5.03m (2016) to 6.16m (2019) during the period of 2013 to 2019.

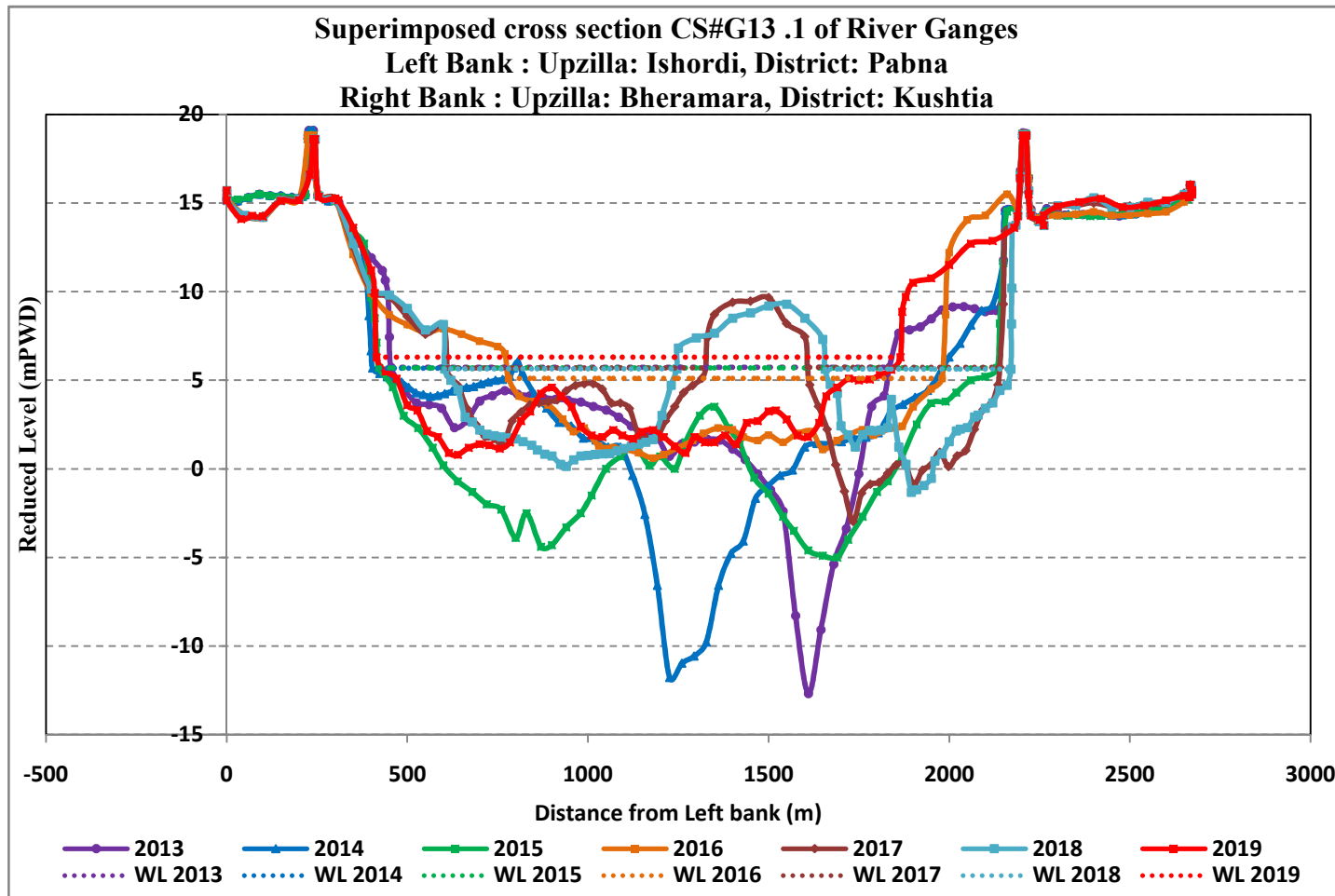


Figure 2.18: Superimposed cross section of River Ganges over last seven years at CS#RMG13.1

From figure 2.18 it can be seen that the Reduced Level (RL) of the lowest point at RMG13.1 of varies from 0.79m (2019) to -12.68m (2013), the surveyed width is 2.671km and water level varies from 5.1m (2016) to 6.29m (2019) during the period of 2013 to 2019. It can be observed that the lowest point has shifted upward in year 2019 compared to that of in year 2013 and 2014.

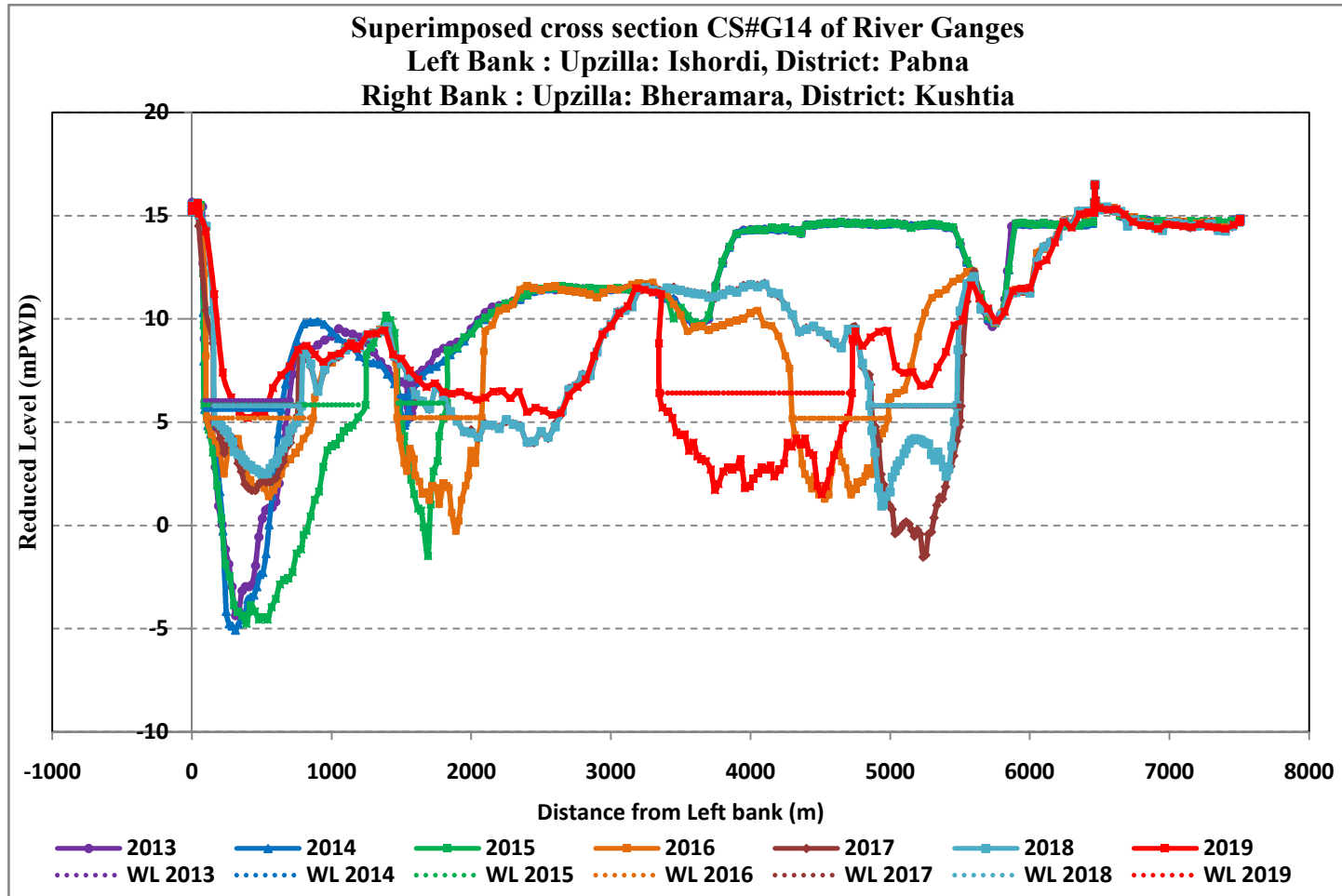


Figure 2.19: Superimposed cross section of River Ganges over last seven years at CS#RMG14

From figure 2.19 it can be seen that the Reduced Level (RL) of the lowest point at RMG 14 varies from 1.51m (2019) to -5.08m (2014), the surveyed width is 7.507km and water level varies from 5.18m (2016) to 6.84m (2013) during the period of 2013 to 2019. It can be observed that the lowest point has shifted to the right in year 2019 compared to that of in year 2013.

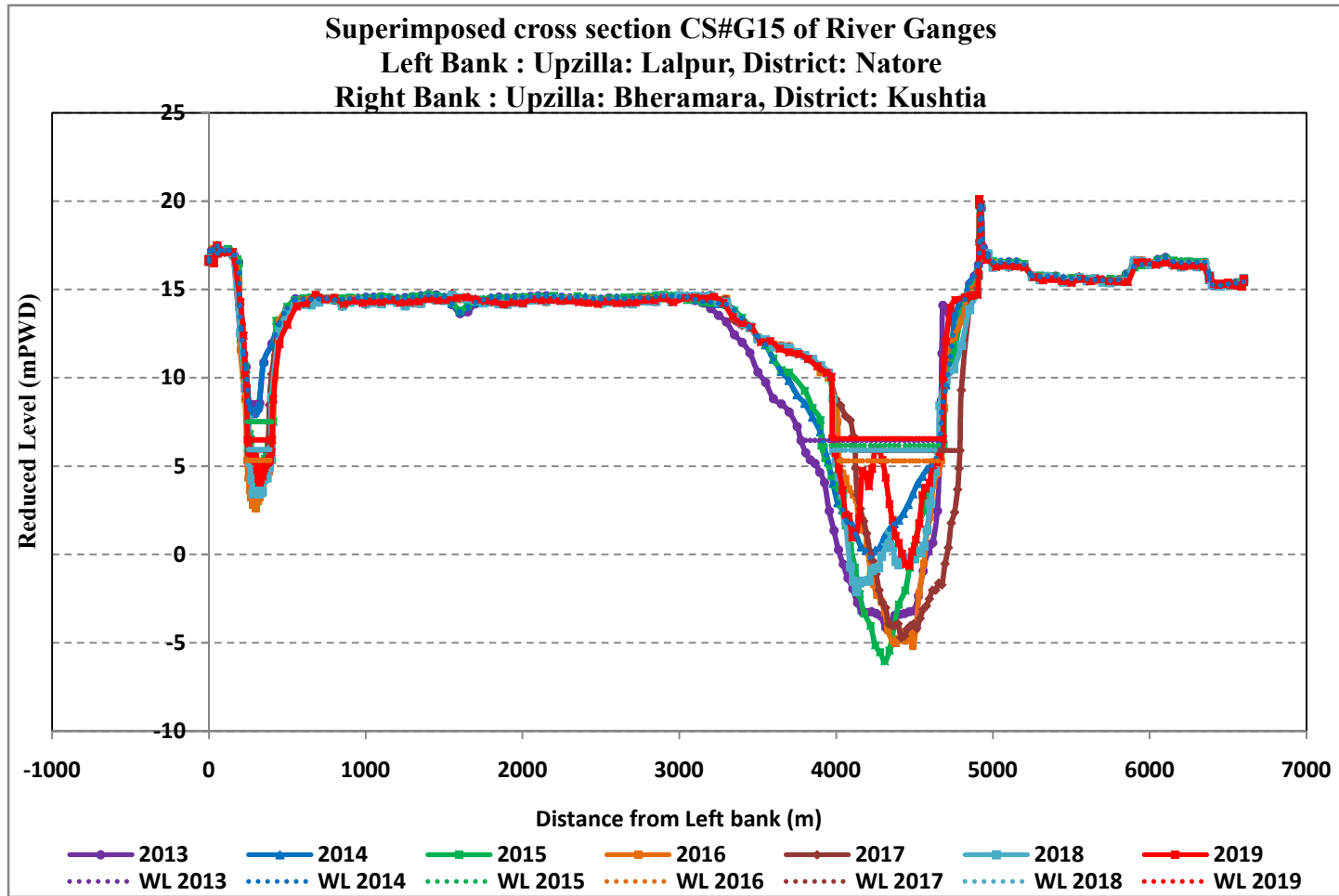


Figure 2.20: Superimposed cross section of River Ganges over last seven years at CS#RMG15

From figure 2.20 it can be seen that the Reduced Level (RL) of the lowest point at RMG 15 of varies from -0.18m (2014) to -6.04m (2015), the surveyed width is 6.599km and water level varies from 5.3m (2016) to 8.58m (2013) during the period of 2013 to 2019.

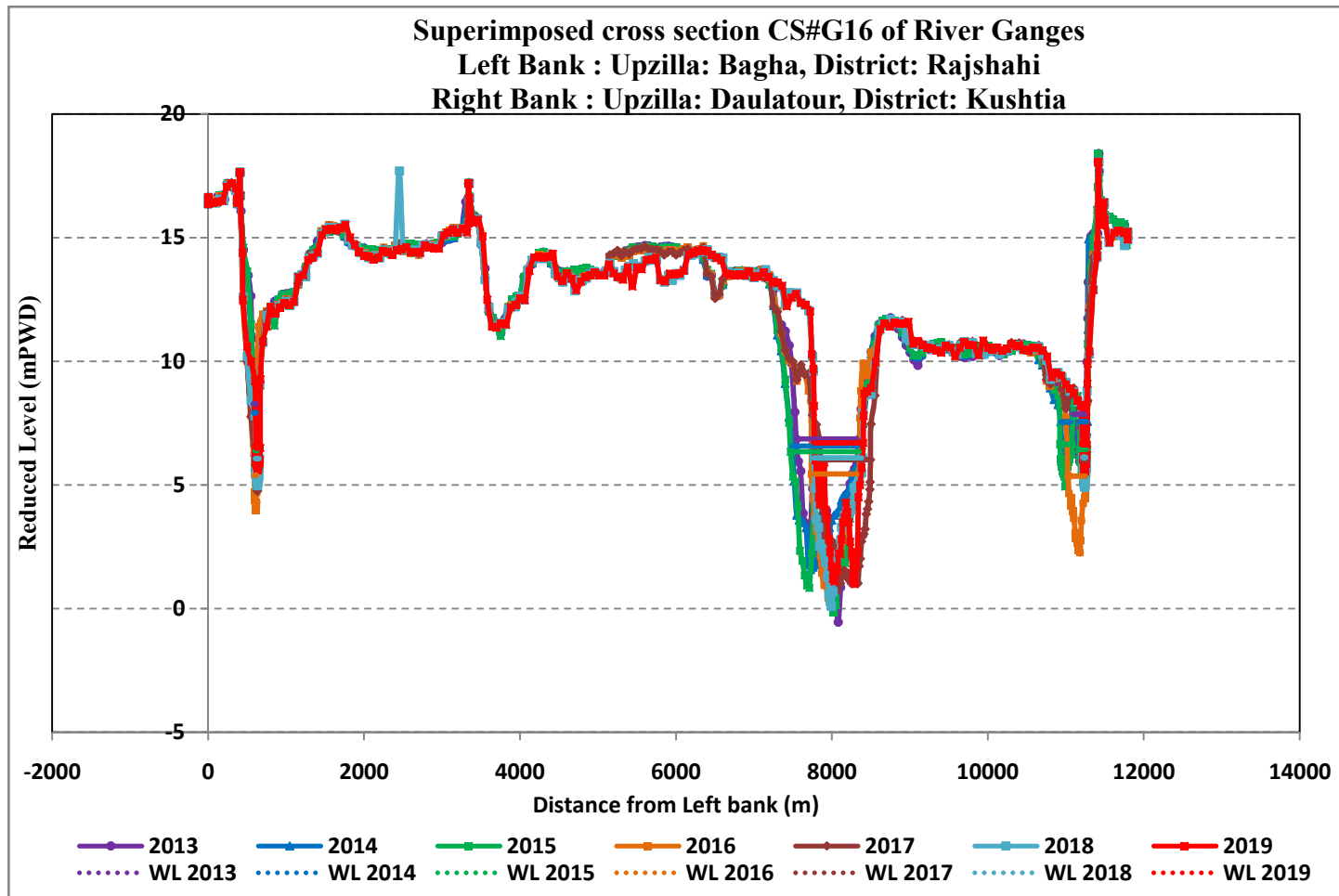


Figure 2.21: Superimposed cross section of River Ganges over last seven years at CS#RMG16

From figure 2.21 it can be seen that the Reduced Level (RL) of the lowest point at RMG 16 of varies from 1.57m (2014) to -0.54m (2013), the surveyed width is 11.792km and water level varies from 5.36m (2016) to 8.28m (2013) during the period of 2013 to 2019.

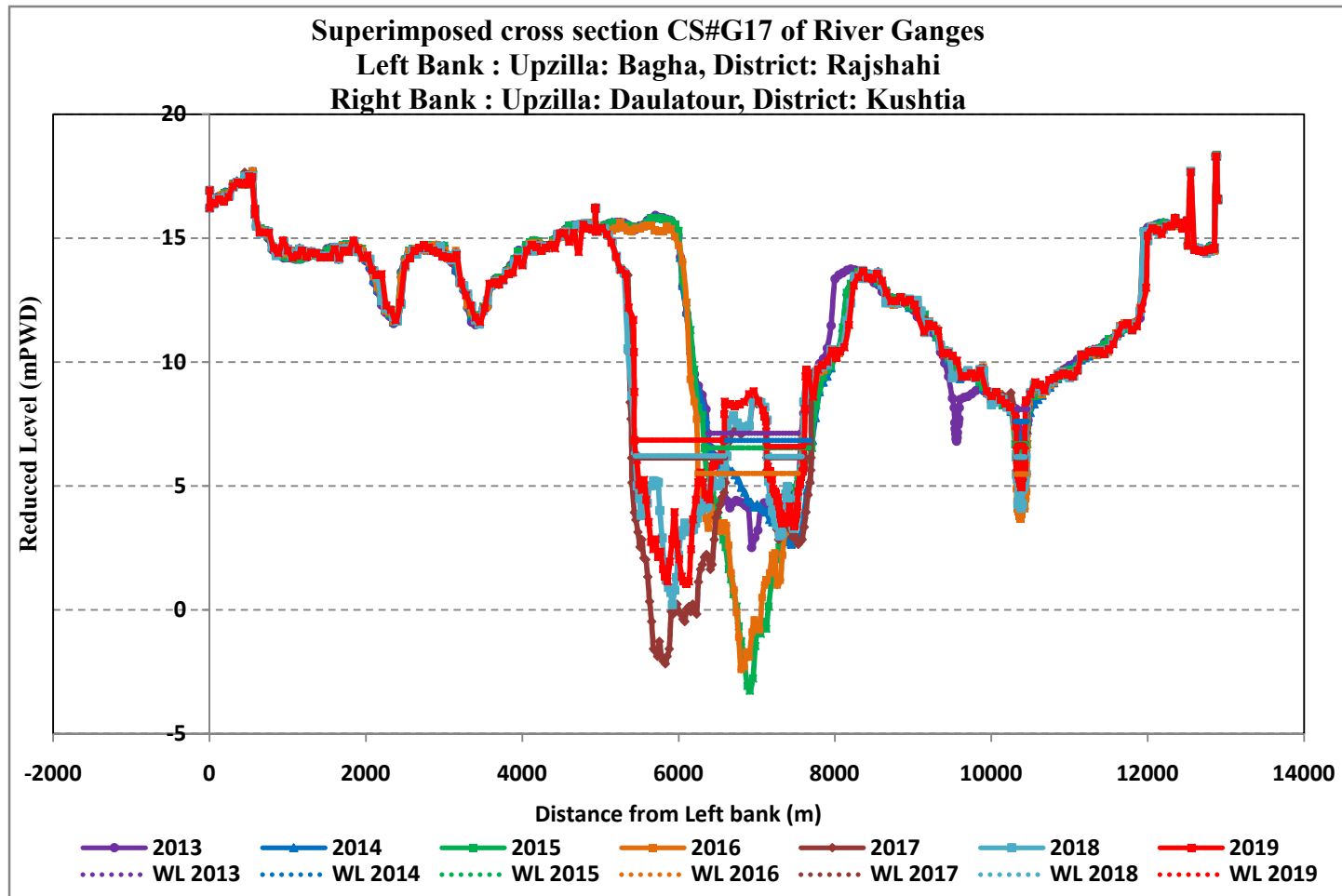


Figure 2.22: Superimposed cross section of River Ganges over last seven years at CS#RMG17

From figure 2.22 it can be seen that the Reduced Level (RL) of the lowest point at RMG 17 of varies from 2.64m (2014) to -3.26m (2015), the surveyed width is 12.895km and water level varies from 5.48m (2016) to 8.16m (2013) during the period of 2013 to 2019.

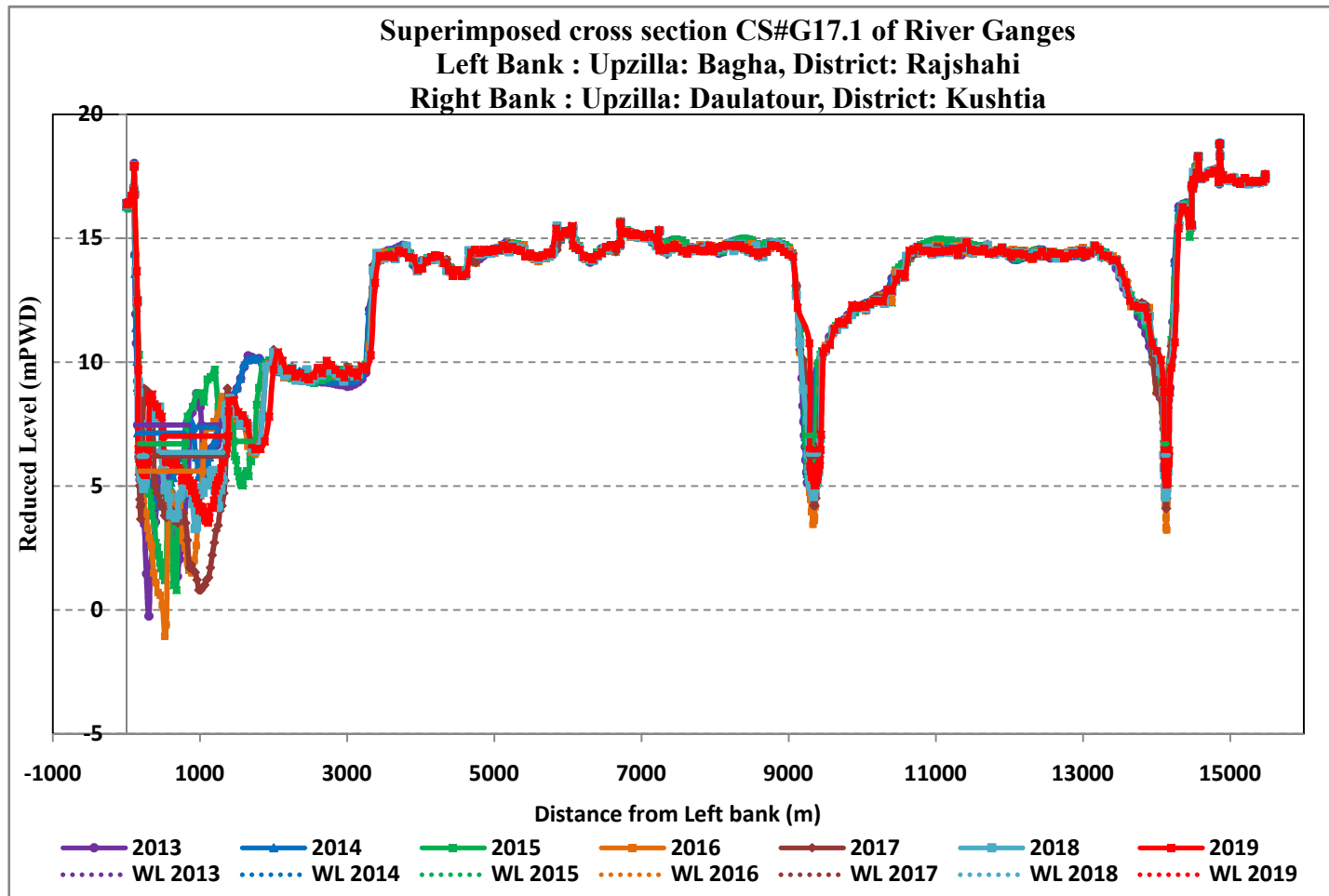


Figure 2.23: Superimposed cross section of River Ganges over last seven years at CS#RMG17.1

From figure 2.23 it can be seen that the Reduced Level (RL) of the lowest point at RMG17.1 varies from 4.19m (2014) to -1.06m (2016), the surveyed width is 15.475km and water level varies from 5.6m (2016) to 7.46m (2013) during the period of 2013 to 2019.



## 2.2 Long Profile of Ganges River

In order to find the changes in the reduced level of the lowest points, the longitudinal profile of the river Ganges has been analyzed. This is very important for determining the flow profile. The lowest points of the last seven years (from 2013 to 2019) of all 22 sections of river Ganges are shown in Table 2.1 and superimposed long profile is plotted in Figure 2.23.

Table 2.1: Reduced Levels of The lowest points and Survey Width of Ganges River.

CS ID/Year	Chainage in km	Bed Level (mPWD)							Survey Width (m)						
		2013	2014	2015	2016	2017	2018	2019	2013	2014	2015	2016	2017	2018	2019
RMG17.1	0	-0.24	4.19	0.8	-1.06	0.81	3.29	3.52	15475	15475	15475	15475	15475	15475	15475
RMG17	6	2.52	2.64	-3.26	-2.4	-2.17	0.21	1.05	12895	12895	12895	12895	12895	12895	12895
RMG16	12	-0.54	1.57	-0.16	0.44	0.72	0.09	1	11792	11792	11792	11792	11792	11792	11792
RMG15	18	-4.14	-0.18	-6.04	-5.2	-4.72	-2.09	-0.65	6599	6599	6599	6599	6599	6599	6599
RMG14	24	-4.36	-5.08	-4.76	-0.28	-1.53	0.95	1.51	7507	7507	7507	7507	7507	7507	7507
RMG13.1	30	-12.68	-11.78	-5	0.6	-2.97	-1.32	0.79	2671	2671	2671	2671	2671	2671	2671
RMG13	36	-2	-2.94	-3.34	-6.17	-4.98	-1.92	-8.24	4321.5	4321.5	4321.5	4321.5	4321.5	4321.5	4321.5
RMG12.1	42	-1.16	-5.84	-6.41	-2.84	-2.29	-1.06	-2.87	6585	6585	6585	6585	6585	6585	6585
RMG12	48	-11.58	-4.24	-2.67	-2.4	-8.68	-6.19	-5.3	7744	7744	7744	7744	7744	7744	7744
RMG11	54	-5.15	-4.26	-10.1	-5.85	-8.74	-4.62	-6.21	7855.5	7929	7929	7929	7929	7929	7929
RMG10	60	-5.76	-2.24	-2.5	-5.31	-0.58	0.26	-1.15	5880	5880	5880	5880	5880	5880	5880
RMG9	66	-2.84	-3.84	-3.35	-4.77	-5.63	-3.92	-3.05	8122	8122	8122	8122	8122	8122	8122
RMG8	72	-5.38	-3.94	-3.22	-2.12	-1.37	-2.07	-3.9	6059	6059	6059	6059	6059	6059	6059
RMG7	78	-2.24	-2.36	-6.01	-2.27	-3.1	-1.26	-3.1	11316	11316	11316	11316	11316	11316	11316
RMG6	84	-2.26	-2.32	-4.375	-1.99	-1.77	-0.26	-2.95	9118	9118	9118	9118	9118	9118	9118
RMG5	90	-1.96	-4.36	-4.645	-4.33	-4.4	-1.89	-3.74	8972	8972	8972	8972	8972	8972	8972
RMG4.1	96	-7	-3.15	-4.86	-2.57	-3.44	-2.91	-3.95	4674	4674	4674	4674	4674	4674	4674
RMG4	102	-3.1	-3.51	-3.658	-2.8	-4.86	-3.94	-3.58	4797.5	4797.5	4797.5	4797.5	4797.5	4797.5	4797.5
RMG3	108	-3.6	-2.44	-2.755	-4.16	-3.4	-0.84	-4.23	7294	7294	7294	7294	7294	7294	7294
RMG2	114	-7.84	-6.86	-6.425	-13	-8.24	-8.09	-4.29	4293	4293	4293	4293	4293	4293	4293
RMG1.1	120	-3.66	-8.3	-10.145	-5.34	-3.09	-4.75	-17.26	7980	7980	7980	7980	7980	7980	7980
RMG1	126	-6.48	-9.22	-17.35	-12.17	-4.92	-4.64	-6.26	8272	8272	8272	8272	8272	8272	8272

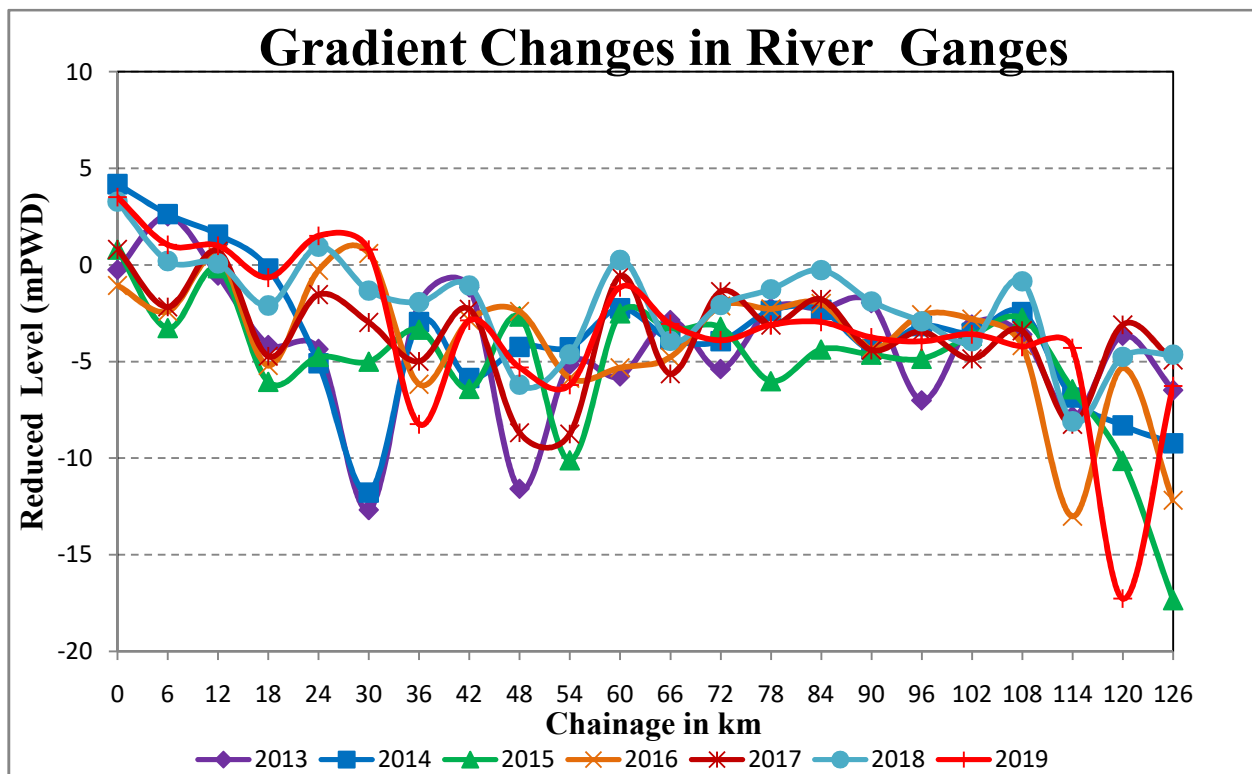


Figure 2.24: Gradient changes in River Ganges

In Figure 2.24, it is illustrated that the Reduced Levels of thalweg varies from +4.19m to -17.35m during the period of 2013 to 2019. In 2013, the bed level at the cross section nearest to the upstream (RMG17 at Daulatour Upazilla, Kushtia District) is the highest (+2.52m). However, in 2014, 2015, 2017, 2018 and 2019, the highest bed level is found to be +4.19m, +0.8m, +0.81m, +3.29m and +3.52m at RMG17.1 at Daulatour Upazilla, Kushtia District. Except in 2016 the highest bed level is found to be +0.6m at RMG13.1 (30 km downstream to RMG17.1)

The lowest bed levels are found at different locations of the river in different years. In 2013 and 2014 the lowest bed levels (-12.68m, -11.78m respectively) are found at RMG13.1. In 2015, the lowest bed level (-17.35m) is found at RMG1. In 2016, 2017, 2018 and 2019 the lowest bed levels are -13.00m (at RMG2), -8.74m (at RMG11), -8.09m (at RMG2) and -17.26m (at RMG1.1).

The Surveyed width varies from 2.671km (at RMG13.1) to 15.475 km (at RMG17.1). The surveyed width has been found to be stable for all the cross sections over the last five years.

## **Conclusion**

From the plotted superimposed cross sections it is observed that the shifting trends are significant in some stations (RMG4.1, RMG8 and RMG14). Erosion and deposition scenario also seen in these superimposed cross sections at different stations. In some stations deposition is much more than others (RMG 12, RMG13.1 and RMG15) in this study period. In some stations the main channel became very narrow and at the same time their RL of lowest bed level increased i.e depth of channel increased. It would help us to understand better, the changing morphology of the River Ganges if the another portion of the River Ganges that lies along the border line of Bangladesh-India could be surveyed to include in the list of periodical survey.

## **References**

- DATA BASE, BWDB
- BWDB, River Morphology Processing Branch, June 2013 “COPING WITH THE CHANGING MORPHOLOGY OF MAJOR RIVERS, BANGLADESH”