

RIVER NAVIGATION

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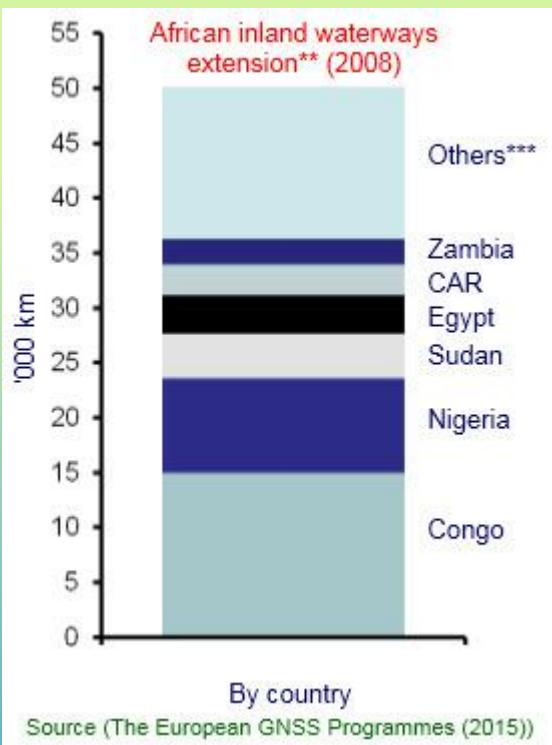
8- Conclusion

1- Introduction

1436 kilometer: Between Kosti and Juba. And between the fourth and third cataracts (287 km).

- River Navigation Department of the Ministry of Transport, Roads and Bridges, Sudan.
- Hydraulic Research Center (HRC), MoWRIE.

Assess river navigability along the reach Kosti- Khartoum- Berber.



2- Objectives

- ❑ Identify and mark the best navigation path (30 m width and 3 m depth) along the reaches under study.
- ❑ Identify and mark the location of obstacles in maps and tables.
- ❑ Determine the quantities of rock and sand to be removed along the proposed path.
- ❑ Quantify the impacts of Grand Ethiopian Renaissance Dam (GERD) on the river navigation depth.

3- Field work

264 X-sections from previous data(HRC & DIU)

332 in White Nile

328 in Main Nile

924 X-sections



Rubber boat and ADCP

Echo sounders



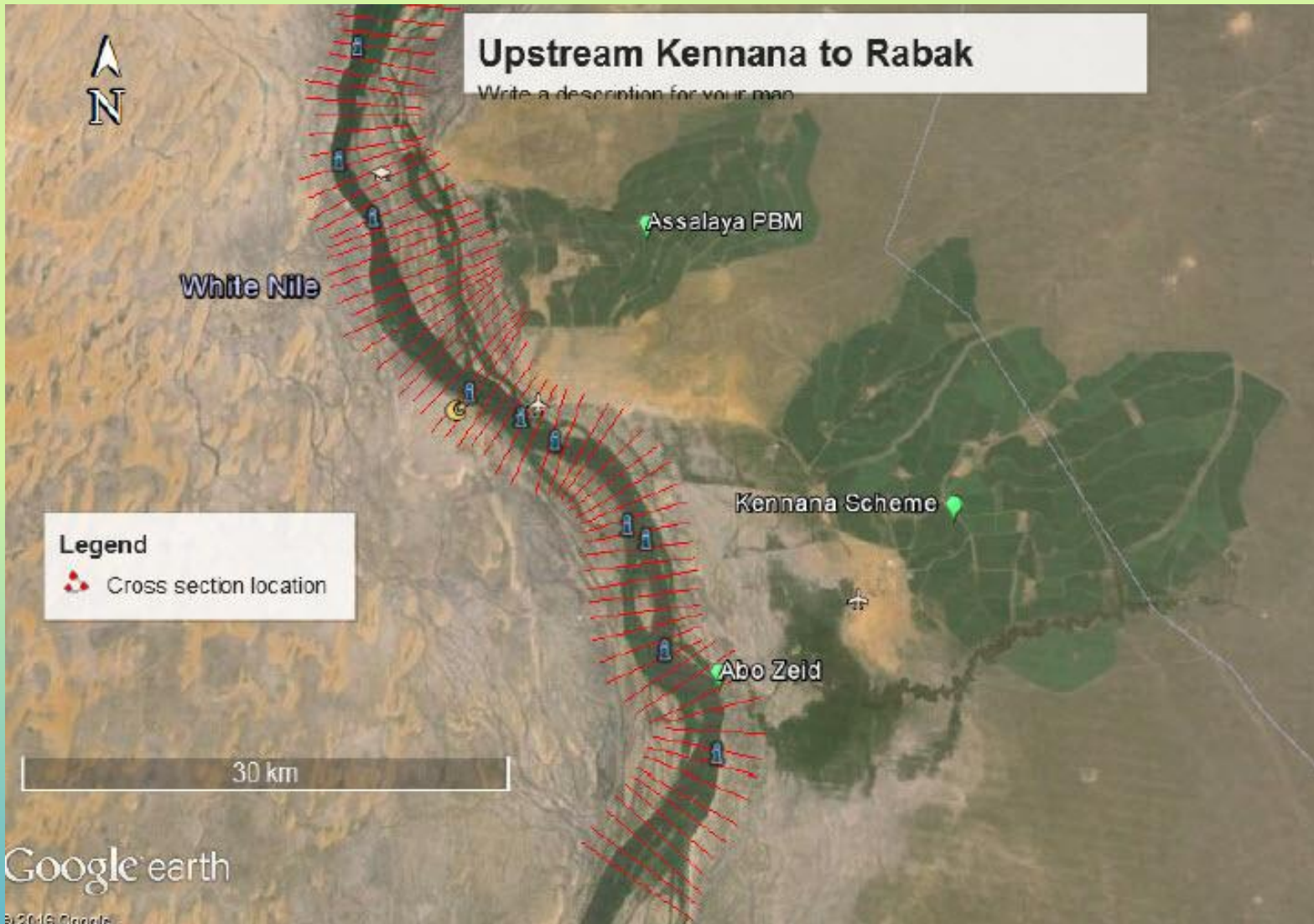
Total Station

Survey level

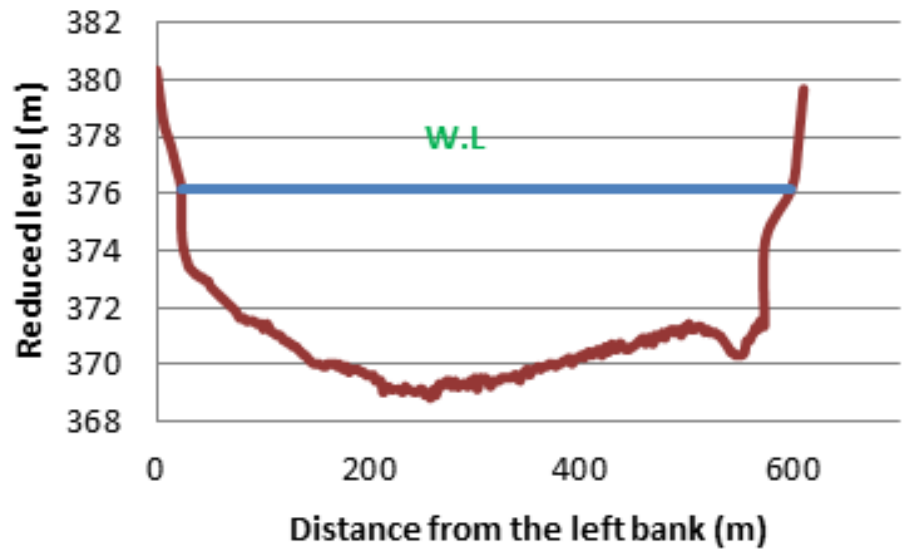
GPS-Garmin

3- Field work

X-sections

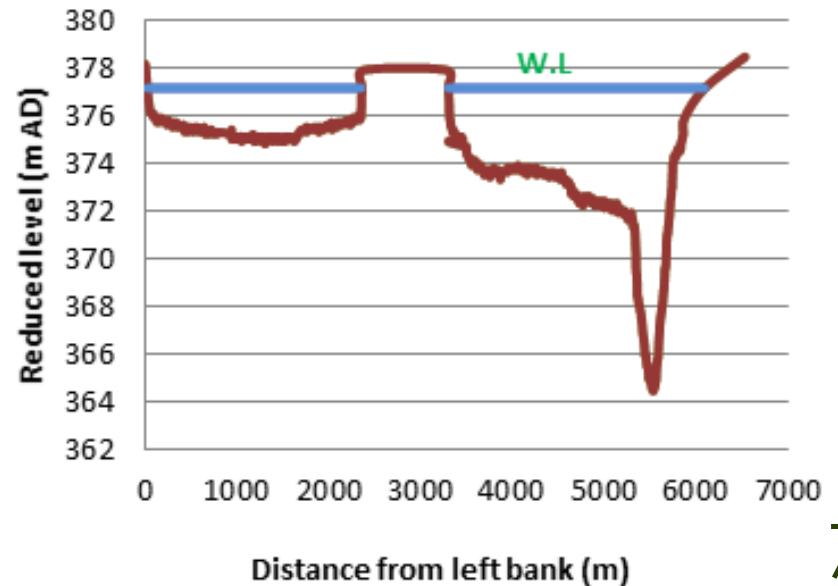


3- Field work (x-sections)

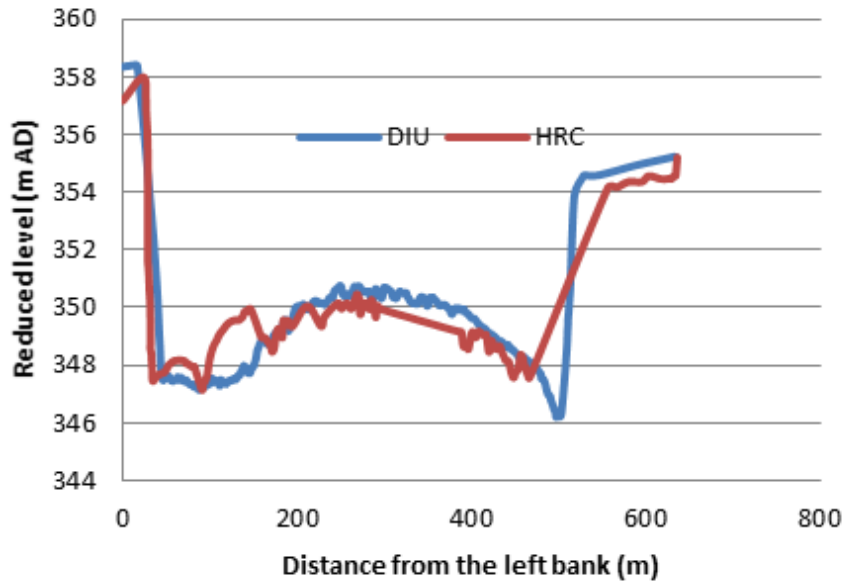


Main Nile near Shambat (328)

White Nile near Getaina (332)

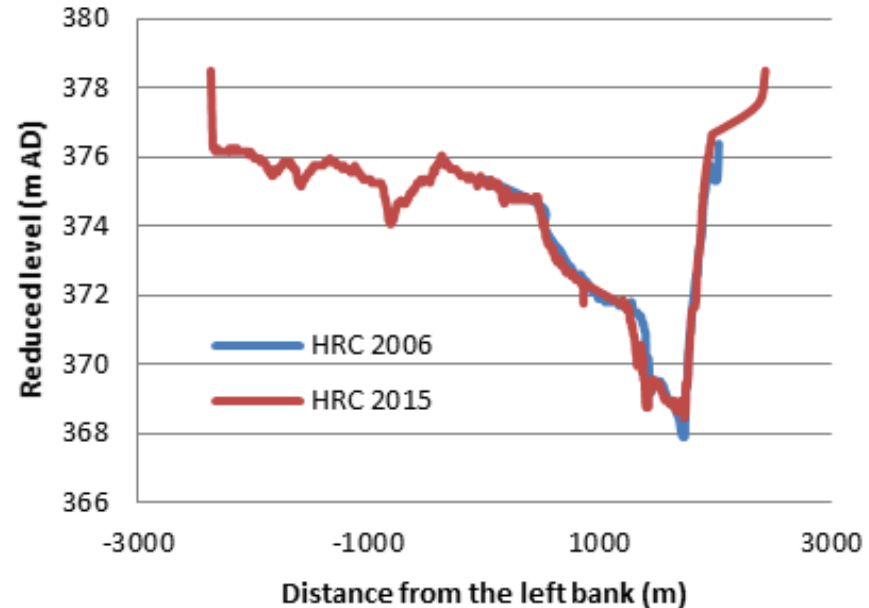


3- Field work (x-sections comparison)



Main Nile near Shendi

White Nile near Wad El Zaki



4- Hydrological analysis

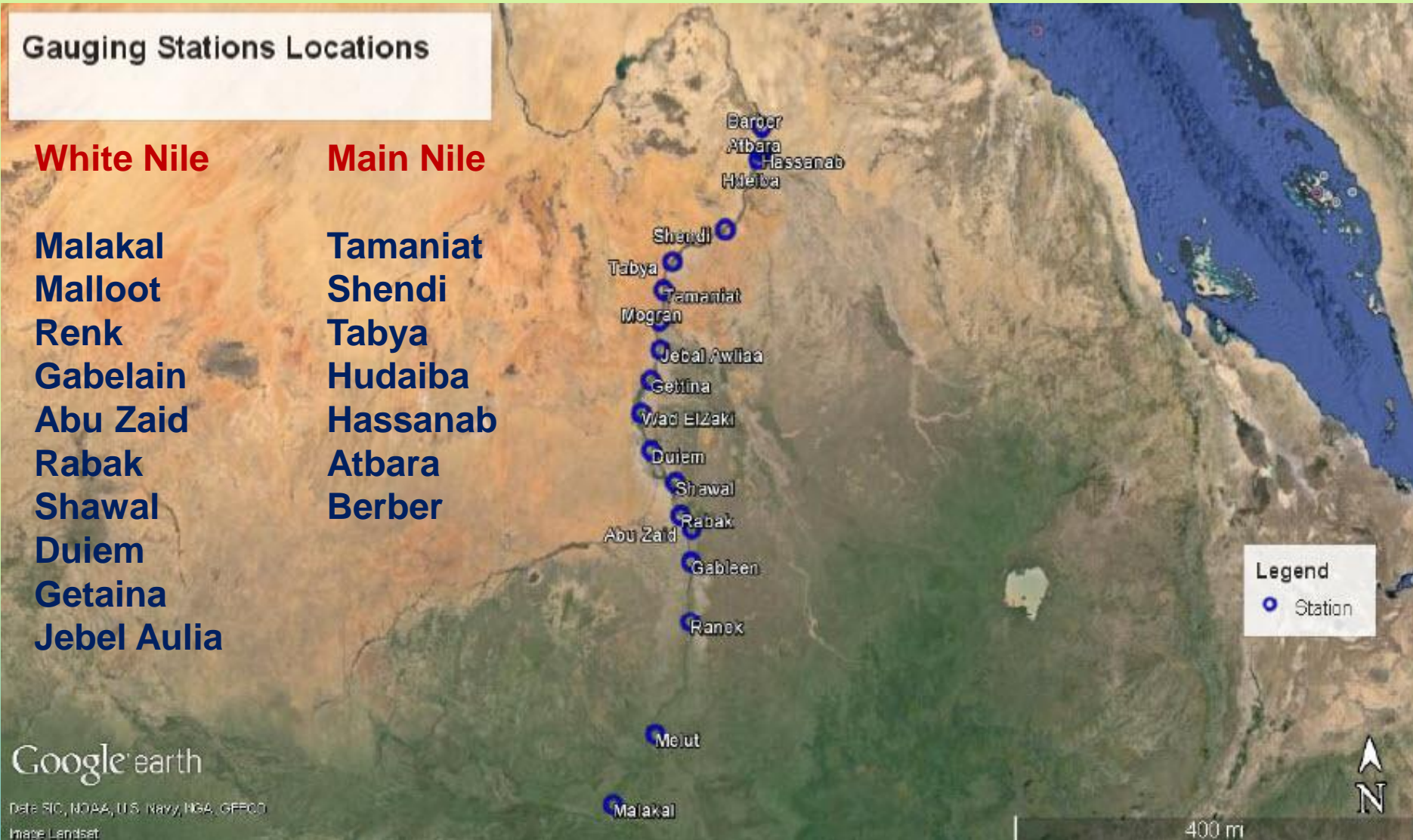
Gauging Stations Locations

White Nile

Malakal
Malloot
Renk
Gabelain
Abu Zaid
Rabak
Shawal
Duiem
Getaina
Jebel Aulia

Main Nile

Tamaniat
Shendi
Tabya
Hudaiba
Hassanab
Atbara
Berber



4- Hydrological analysis

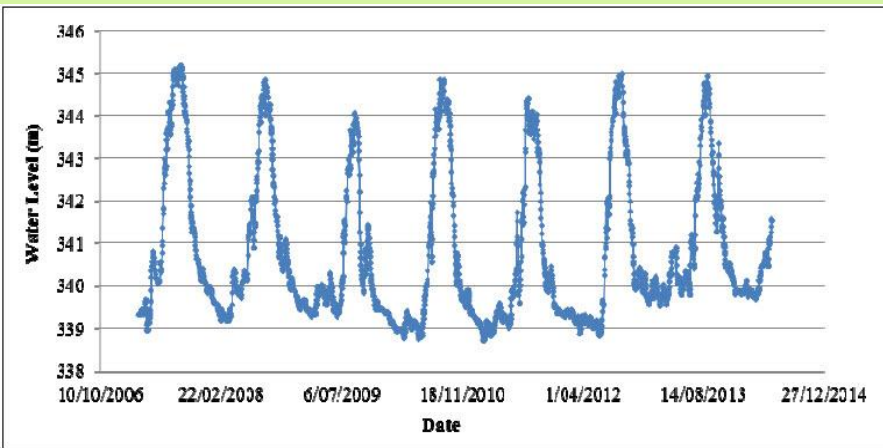


Fig. 3: Water Level Time Series for Barber Station.

Screening

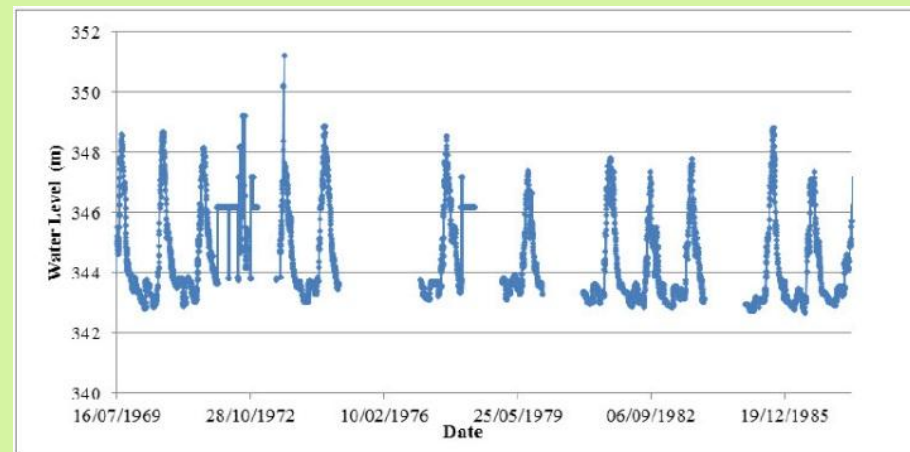


Fig. 4: Water Level Time Series for Atbara Station.

Filling missing data

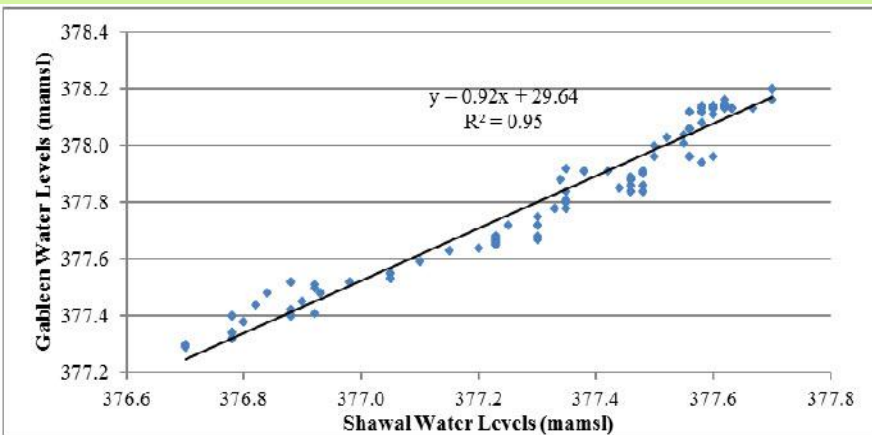
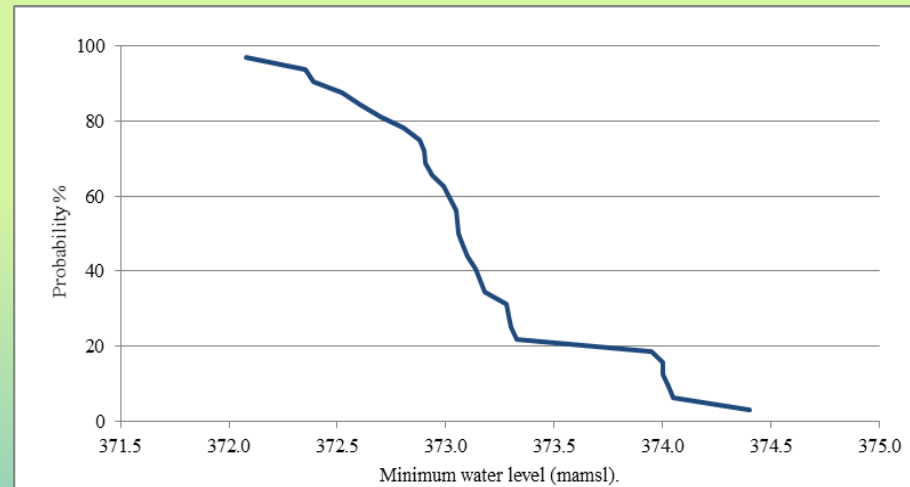


Fig. 5: Shawal and Gableen stations relation to fill the missing data

Correlation

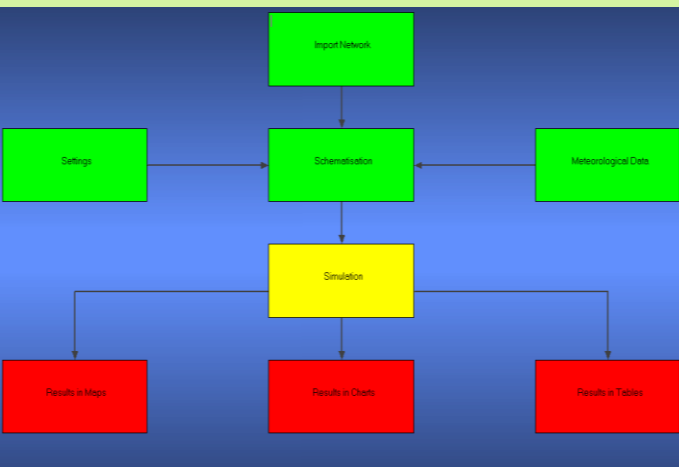
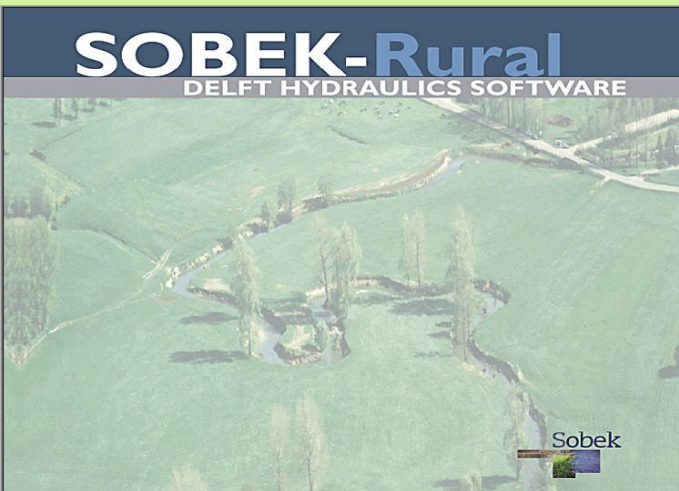


Frequency Duration Curve

4- Hydrological analysis

Station	Probability (%)	Hydrological Years			Average no. of days
		Dry	Average	Wet	
Tamaniat	80	368.78	369.59	369.70	292
	50	369.22	369.82	370.25	182
	20	371.03	371.81	372.49	73
Tabya	80	364.03	364.33	364.62	292
	50	364.44	364.76	365.17	182
	20	365.55	367.04	367.01	73
Shendi	80	352.74	353.20	353.81	292
	50	353.37	353.76	354.35	182
	20	355.73	356.80	356.76	73
Hudeiba	80	343.60	343.93	344.47	292
	50	343.90	344.32	344.89	182
	20	345.23	345.70	348.83	73
Hassanab	80	343.43	343.93	343.92	292
	50	343.96	343.96	344.70	182
	20	346.10	345.73	347.75	73
Atbara	80	343.05	343.52	343.93	292
	50	343.42	343.89	344.53	182
	20	345.03	346.47	347.24	73
Barber	80	339.05	339.19	339.75	292
	50	339.44	339.57	340.16	182
	20	341.03	341.63	343.03	73

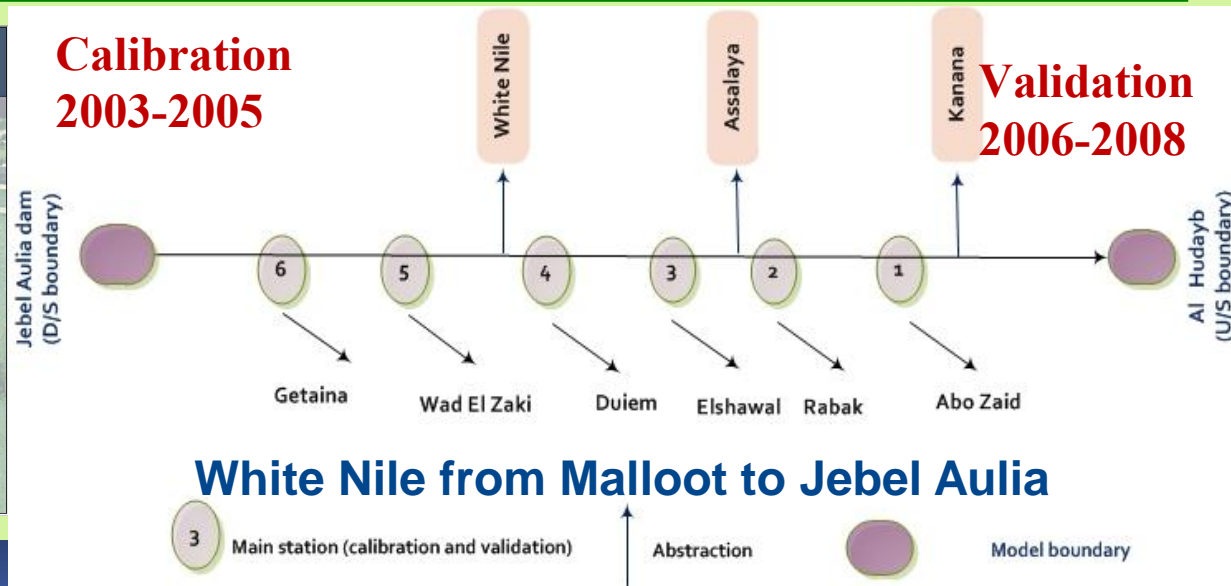
5- Modelling



one-dimensional open-channel Hydrodynamic numerical modeling

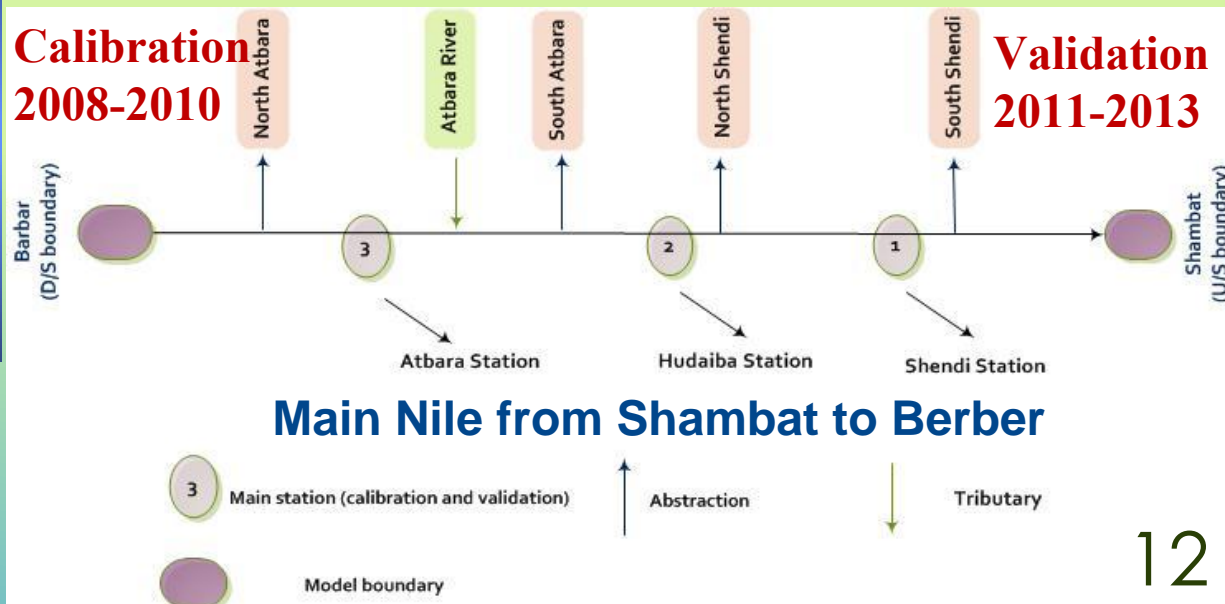
**Calibration
2003-2005**

**Validation
2006-2008**

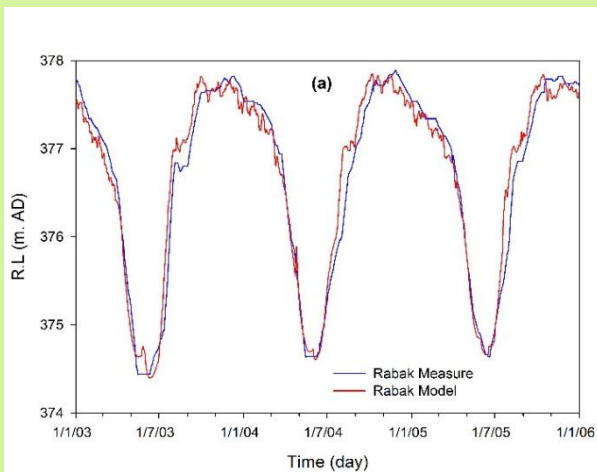


**Calibration
2008-2010**

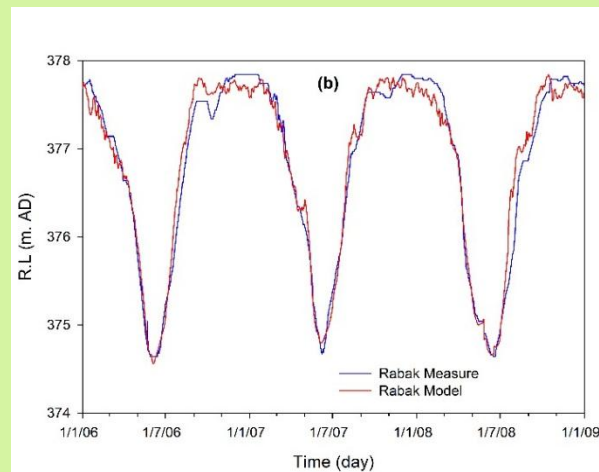
**Validation
2011-2013**



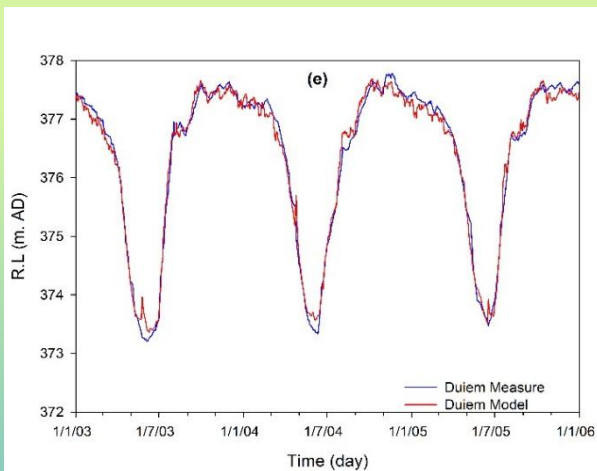
5- Modelling: calibration and validation



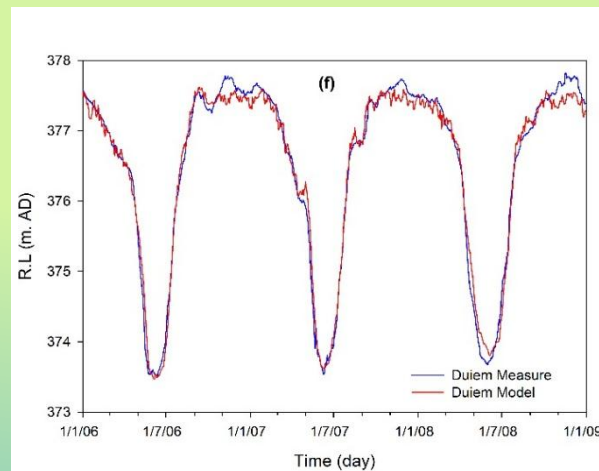
(a)



(b)



(c)



(d)

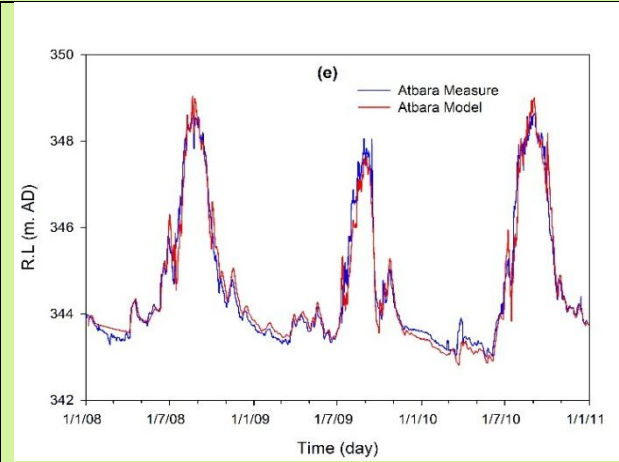
R^2 (0.95-0.99)
(0.98-0.99)

NSE (0.93-0.99)
(0.98-0.99)

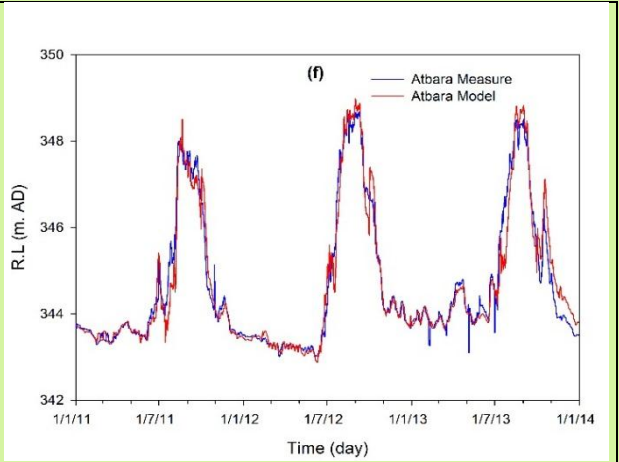
RMSE values are always less than 50% of SD

Rabak: (a) calibration and (b) validation and at El Dueim Station: (c) calibration and (d) validation

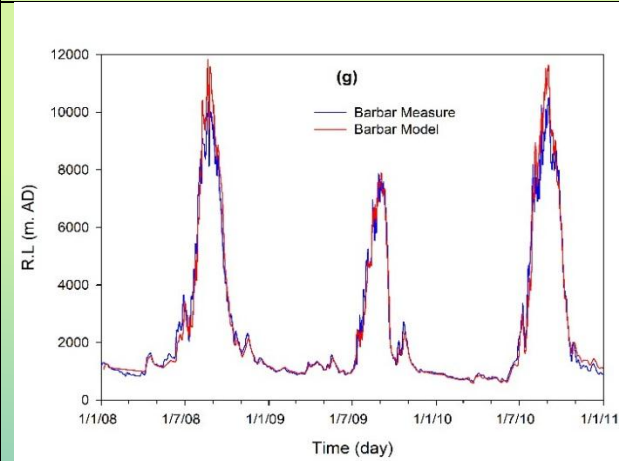
5- Modelling: calibration and validation...cont



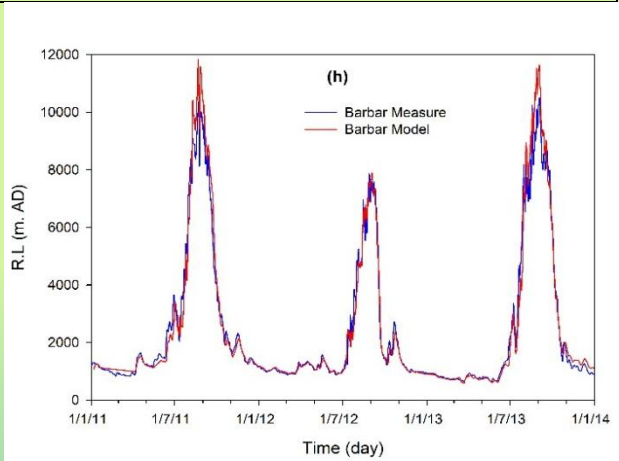
(a)



(b)



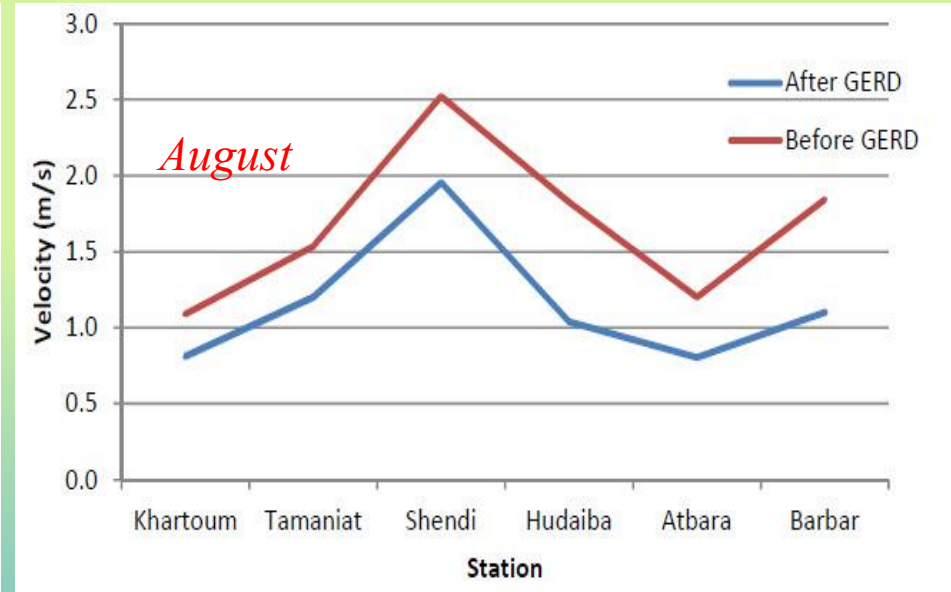
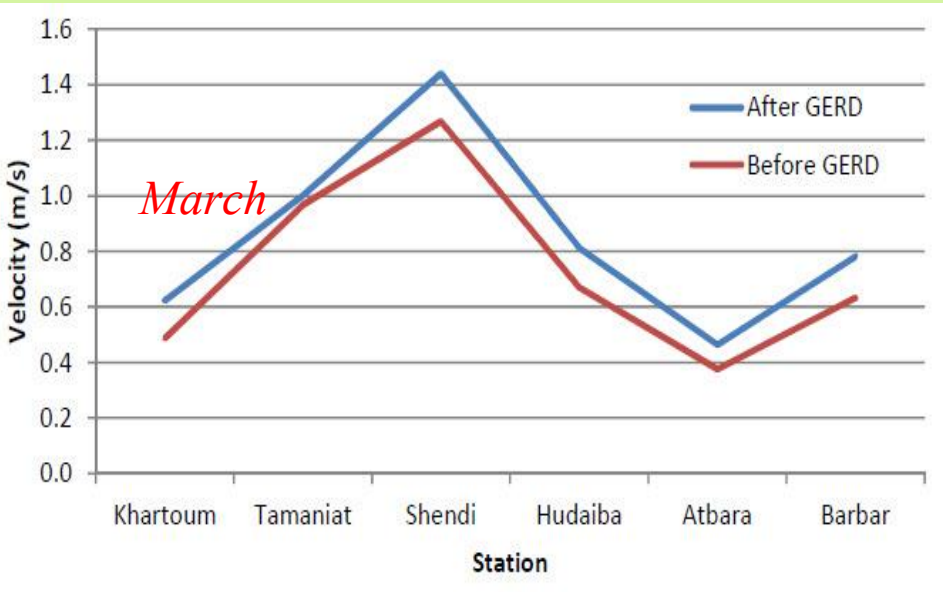
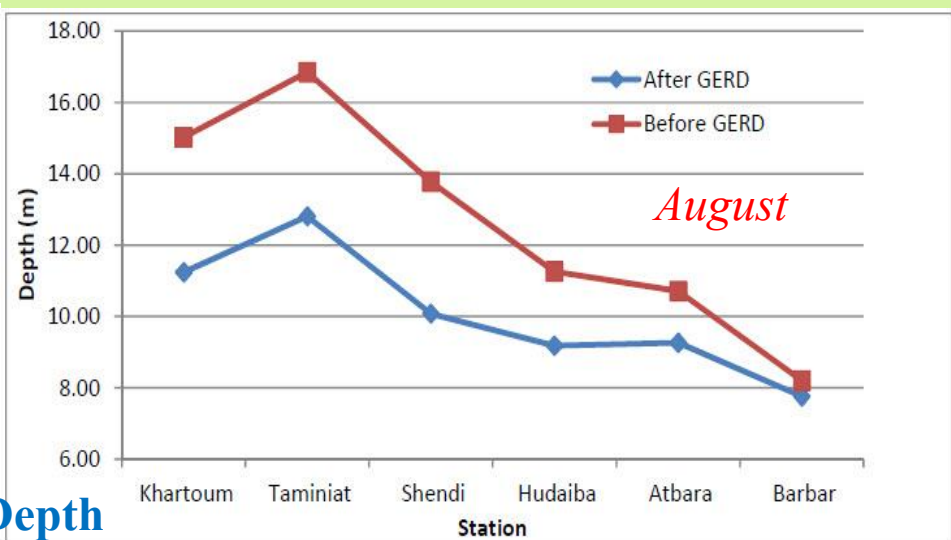
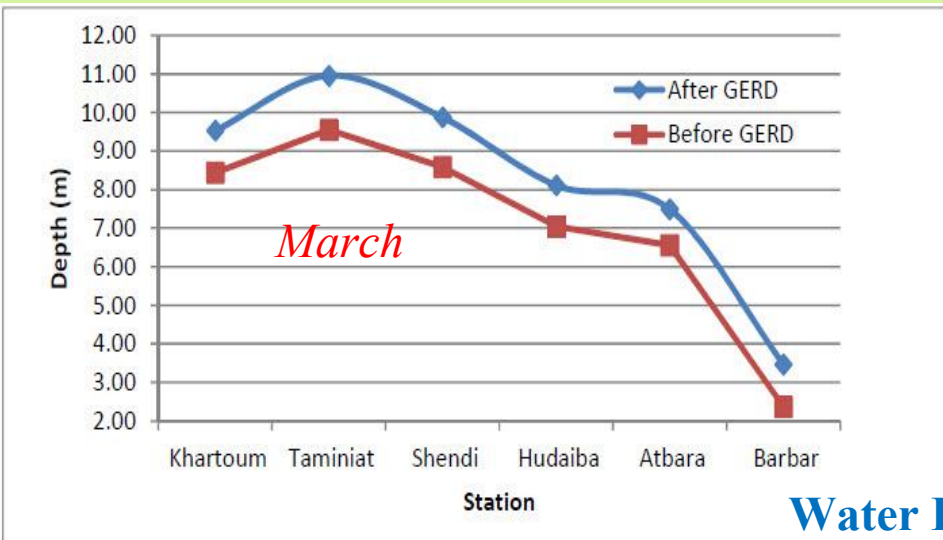
(c)



(d)

Atbara: (a) calibration and (b) validation and at Berber: (c) calibration and (d) validation

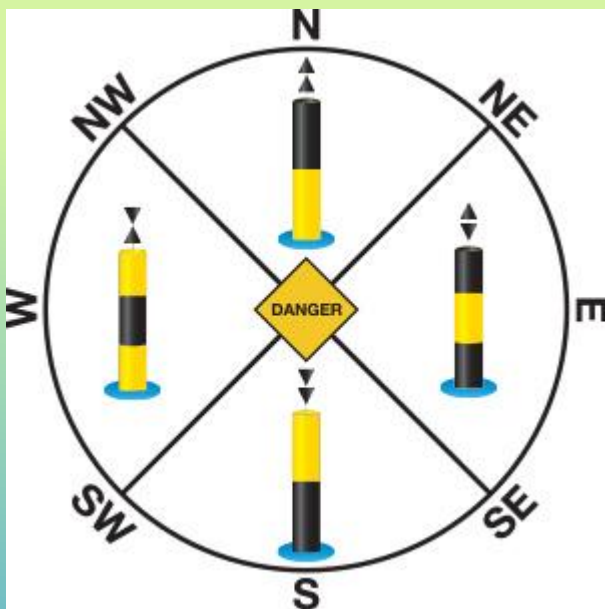
5- Modelling: GERD Impact



6- Navigation charts and signs

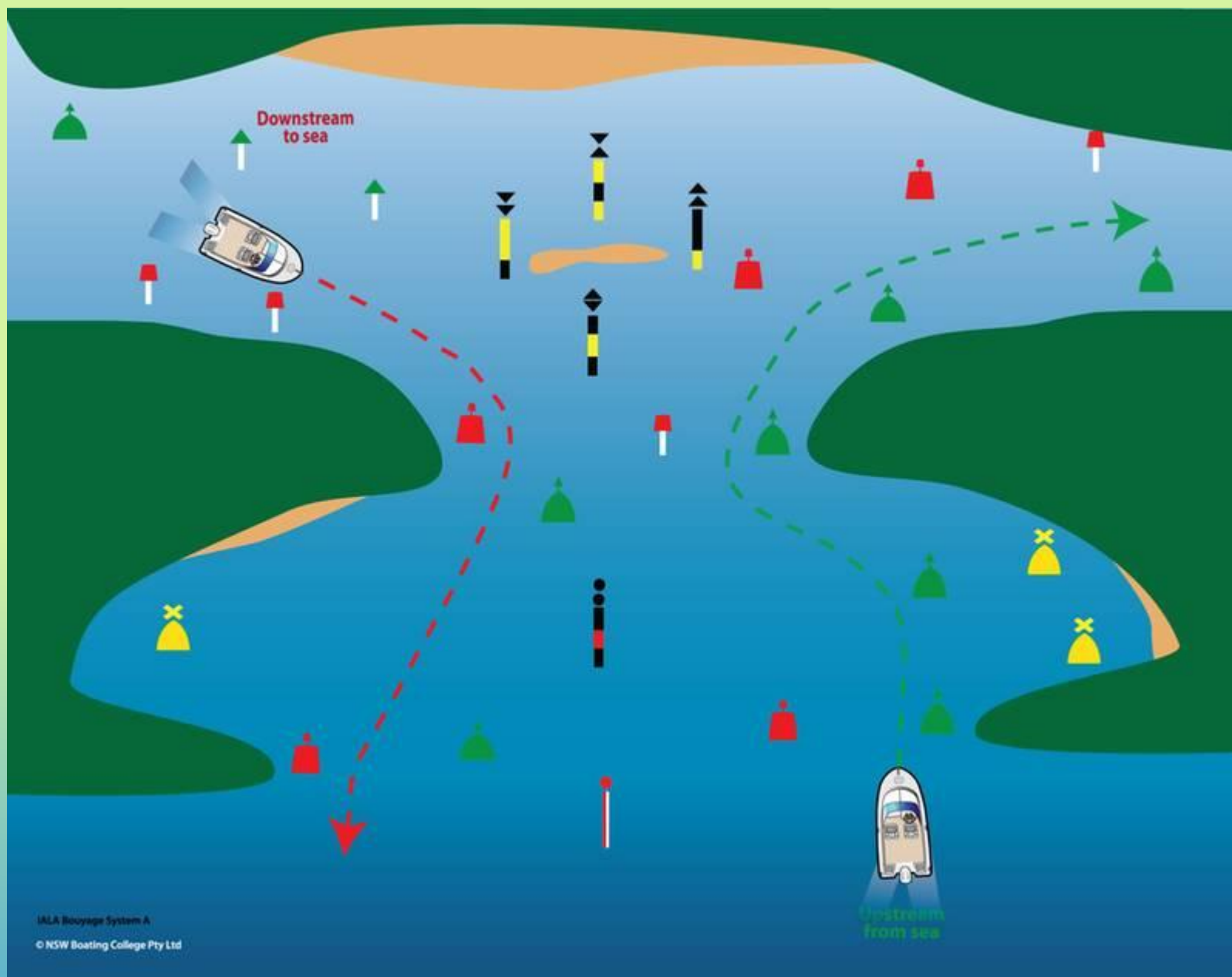


Safe path Buoys



Cardinal Buoys

6- Navigation charts and signs



6- Navigation charts and signs

bridges



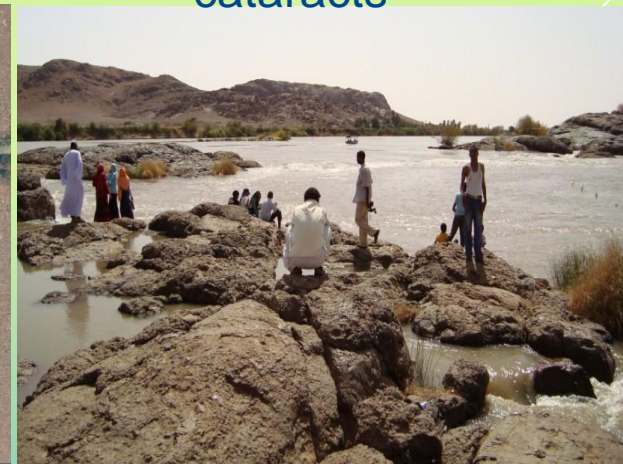
weeds



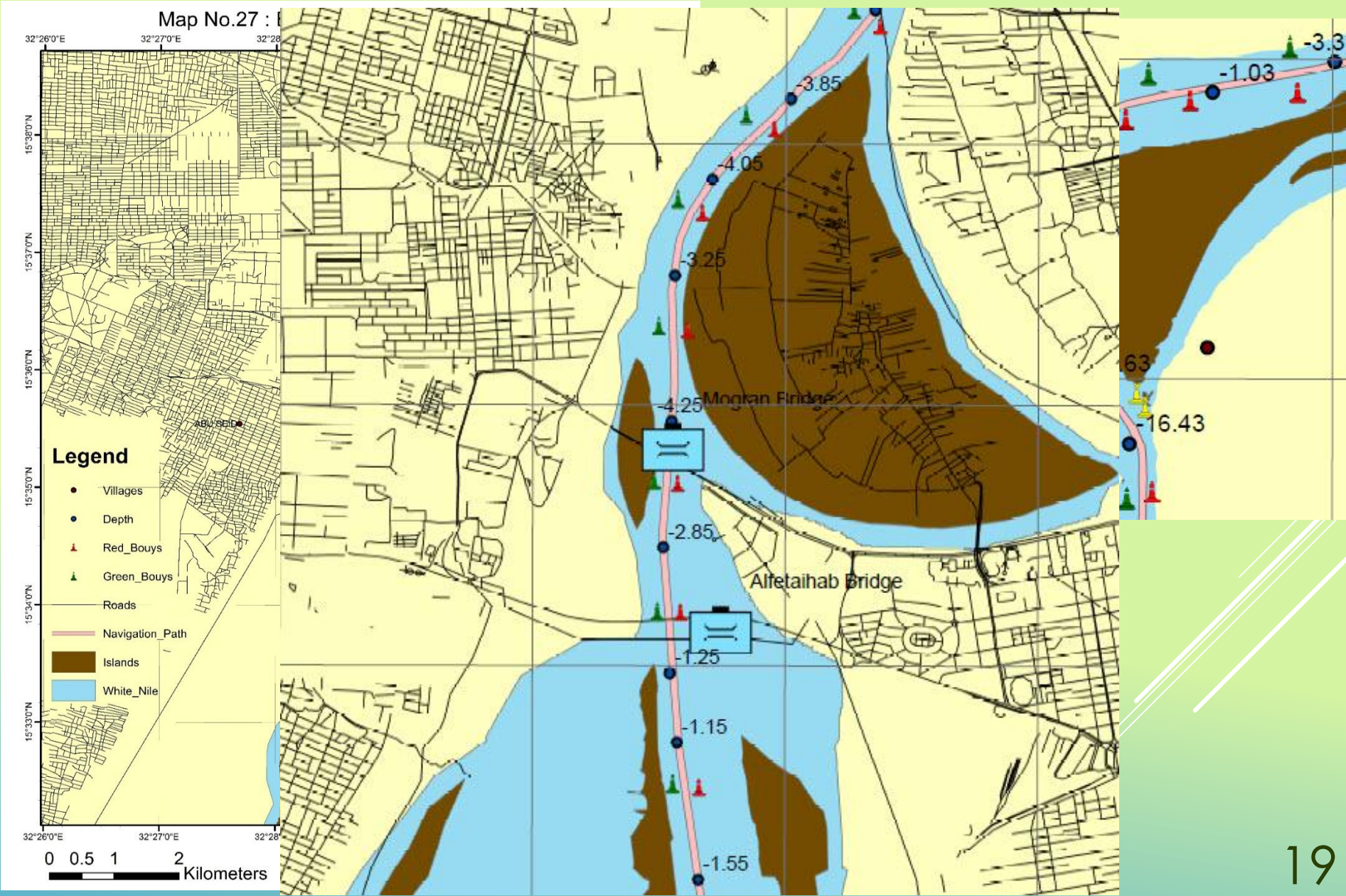
shallow depths



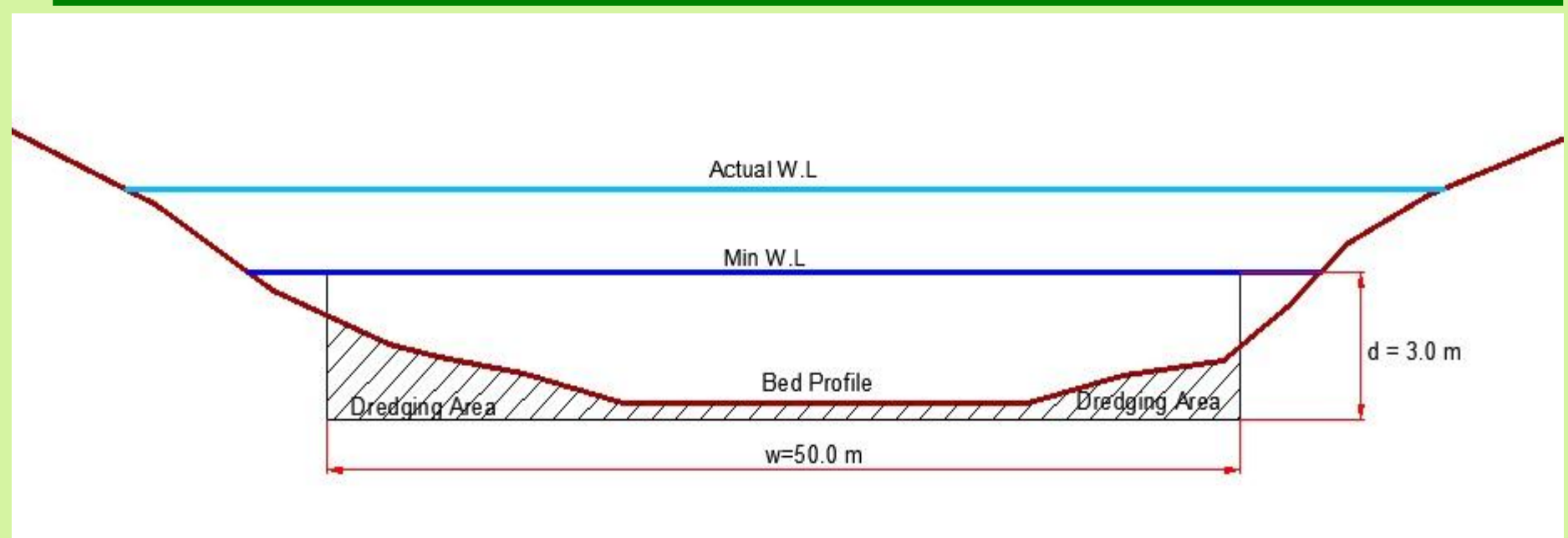
cataracts



6- Navigation charts and signs

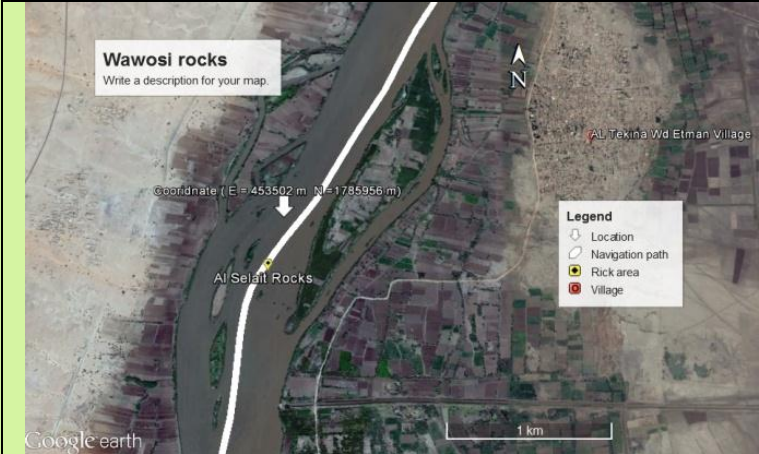


7- Dredging estimation: Method



Option	Quantity of soil (million m^3)		
	White Nile River		Main Nile River
	12 months	9 months	12 months
1	9.1	0.244	7
2	5.4	0.147	4.2
3	2.8	0.069	1.8

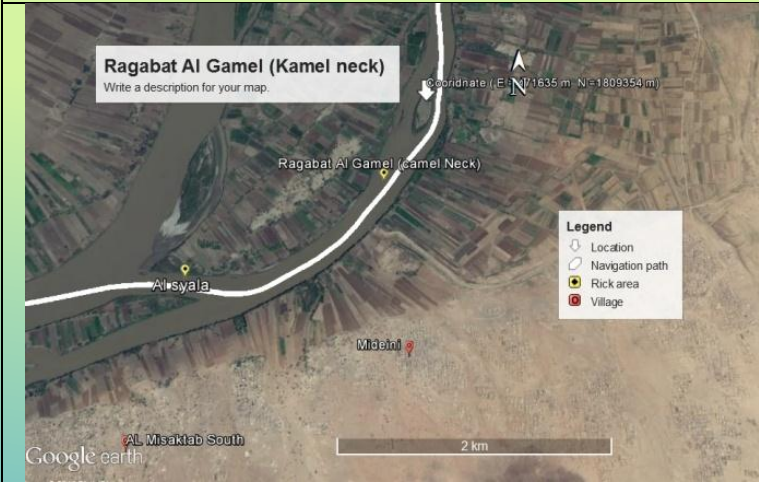
7- Dredging estimation:(Rocks)



1500 m³



1447 m³



2070 m³



2393 m³

8- conclusion

- ❑ The reach Kosti - Khartoum - Berber surveyed by 924 cross-sections.
- ❑ Hydrodynamic Model developed for both WN and MN.
- ❑ In total 27 and 30 maps for WN and MN in soft and hard copies, A1 size paper.
- ❑ Locations of rocks and shallow depths have been identified.
- ❑ The total dredging volume for MN and WN is calculated.
- ❑ Effect of GERD on navigation has been modeled.

