MEKONG RIVER, XAYABOURY DAM, MEKONG DELTA IN THE FIRST HALF DRY SEASON 2019-2020

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We are in the middle of the dry season 2019-2020. Drought and salinity in the Mekong Delta are thought to be even more severe than in the "historic" dry season 2015-2016. In order to understand the stuation, the paper examines the flow of the Mekong River (MR) in its Lower Basin during the first half of the current dry season, right after the Xayaboury hydroelectric dam put into operation. From there, some comments and recommendations. Data are from the Mekong River Commission's (MRC) database.

Hydrological stations on the mainstream of the MR in the Lower Basin

Daily water levels at 13 hydrological stations on the mainstream of the MR are from the MRC's database weekly updated. Location and informations about the stations are presented in Figure 1.

Figure 1.Location of hydrological stations

Station	(1) Control Catchment Area	(2) Inter-station CCA	(3) Distance	Coefficient A	Coefficient B
	(km^2)	(km^2)	(km)	A = (3)/(2)	B = (3)/(1)
Chiang Saen	189,000				
		79,000	353	223.80	41.80%
Luang Prabang	268,000				
		24,000	293	81.91	8.96%
Chiang Khan	292,000				
		7,000	137	51.09	2.40%
Vientiane	299,000				
		74,000	363	203.86	24.75%
Nakhon Phanom	373,000				
		18,000	92	195.65	4.83%
Mukdahan	391,000				
		154,000	256	601.56	39.39%
Pakse	545,000				
		90,000	201	447.76	16.51%
Stung Treng	635,000				
		11,000	123	89.43	1.73%
Kratie	646,000				
		14,000	135	103.70	2.17%
Kompong Cham	660,000				
		3,000	78	38.46	0.45%
Phnom Penh	663,000				

Table 1. Some informations about the stations [2]

In the below Figures, (Max), (Min) và (Avg) respectively are the highest, lowest and average daily water level curves [3] [4]. The area between the Max and Min curves is the domain of daily water level values during the years from 1980 to 2019.

In some Figures it may be curves of years 1992-1993 and 2003-2004. These years are respectively before and after the first hydroelectric dam in the Upper Basin, the Manwan, was put into operation in 1995.

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[1] Docteur d'Etat ès Sciences, University Professor, Chairman of the State scientific Programme *Integrated Basic Investigations of the Vietnamese Mekong Delta* (1983-1990), Member of Parliament (1992-2007).

[2] Cœfficients A and B have been used by Trinh Quang Hoa† and Nguyen Ngoc Tran in modelling *the Mekong Streamflow from Chiang Saen to Tân Châu and Châu Đốc* (1993), *in* Proceedings of the Symposium at the 78th International Commission on Large Dams (ICOLD) Annual Meeting, Hanoi, May 25-26, 2010.

[3] Observed data and curves are from http://ffw.mrcmekong.org/stations.php

[4] Max, Min và Avg are computed by MRC from historical data series (1980-2019).

Water level of the MR in the Lower Basin in the first half of the dry season 2019-2020

1. The water level at the *Chiang Saen* from November 1, 2019 to February 24 started from very low, at the Min level then increased gradually. By January 06, 2020, it dropped from *2.89m* on January 04, 2020 to *1.73m* after the Jinghong dam reduced the discharge drained downstream from January 1 to January 4, 2020, from 1200 - 1,400m³/s. 800 - 1,000m³/s, according to MRC notice [5] [6].

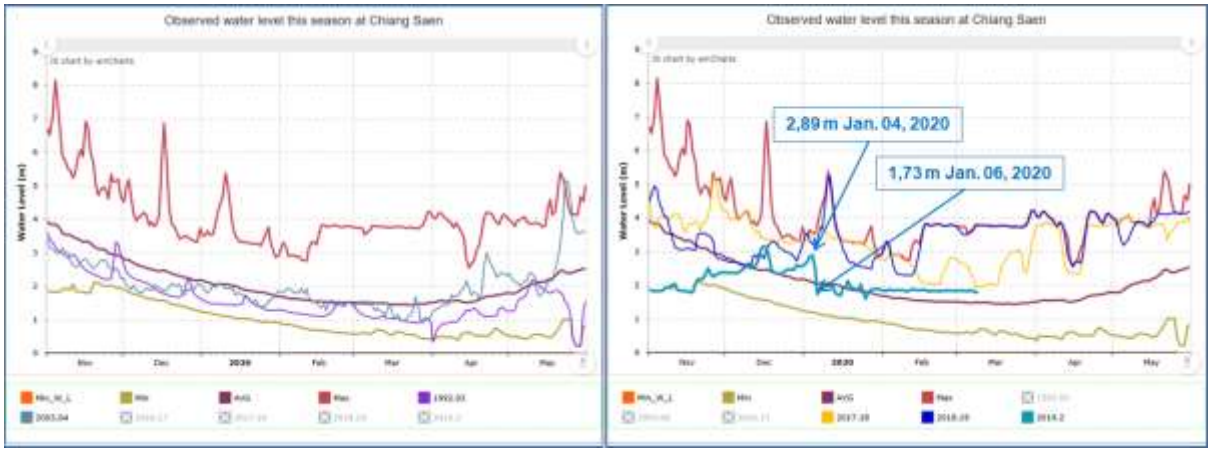


Figure 2. Water levels at Chiang Saen station for the current and for some past dry seasons

2. Xayaboury hydroelectric dam, located between *Luang Prabang* and *Chiang Khan* stations, was put into operation on October 31, 2019.

The water levels at Luang Prabang station started the dry season at the Avg values, lower than the previous dry seasons, then increased and until February 24 remained at 8m, even approached the Max values. *The Xayaboury dam stores water is a reason*. (Figure 2, left).

Meanwhile, at the Chiang Khan station, the water level started nearly equal to the Min values. Then, although some exceptions, it lyed between Min and Avg values (Figure 3).

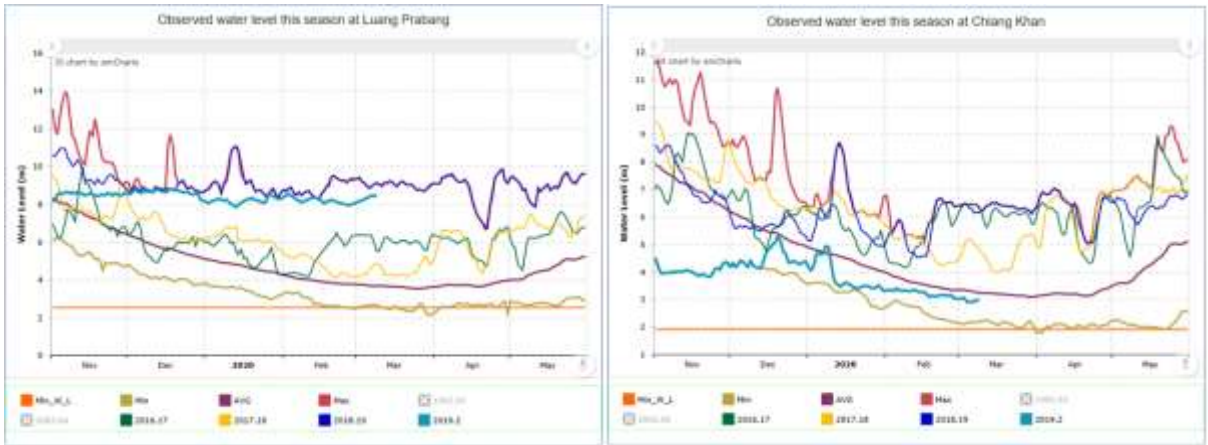


Figure 3. Water levels at Luang Prabang and Chiang Khan stations during four first months Xayaboury hydroelectric dam put into operation

[5] Operating modes of hydroelectric dams in the UMB are not notified neither to MRC nor to Mekong riparian countries. Notification only when necessary up to China..

[6] Two dams, Ganlanba and Mengsong, closer to three frontiers area are planned.

Beside the discharge flowing from Luang Prabang, so far Chiang Khan received rainfall on the catchment area, of which since this year's dry season, an important part will be retained by the Xayaboury dam.

3. *At Chiang Khan and Vientiane stations.*

Short distance, catchment area between two stations 7000 km^2, in this dry season, there is no additional lateral flow, water level curves at the two stations are nearly the same with time displacement and lie between Min and Avg curves (Figure 4).

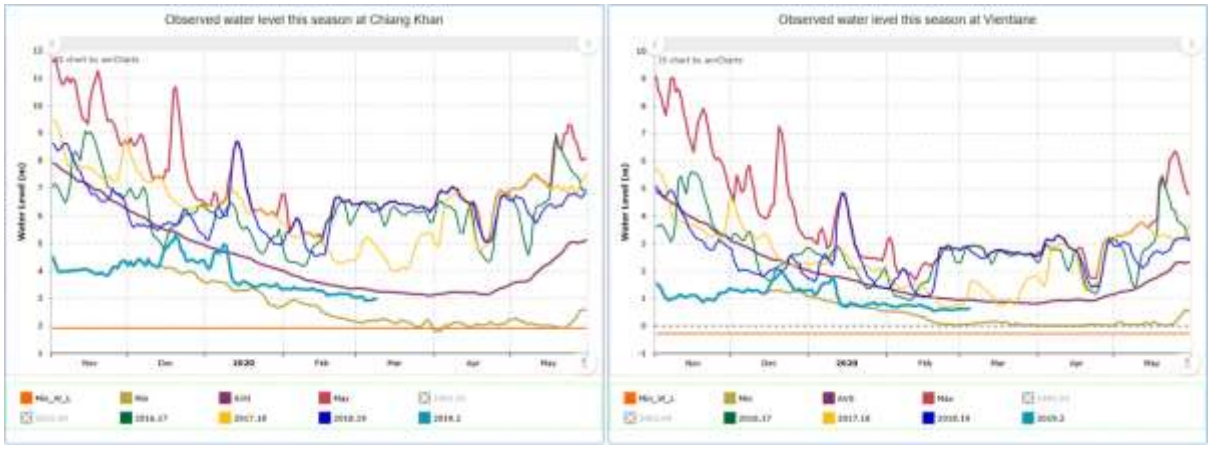


Figure 4. Water level for several dry seasons at Chiang Khan and Vientiane stations

4. *At Nakhon Phanom and Mukdahan stations.*

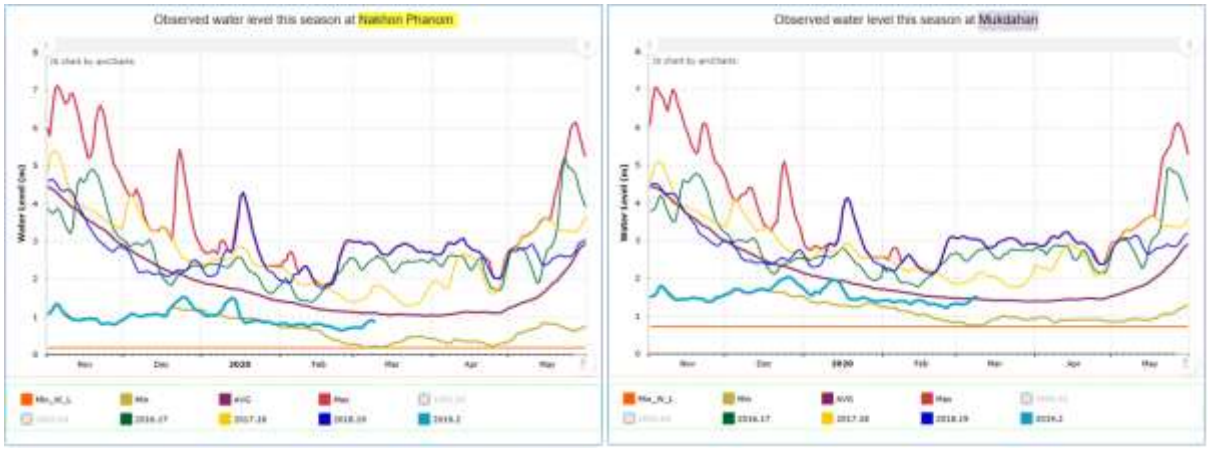


Figure 5. Water level in dry season at Nakhon Phanom and Mukdahan stations

Figure 6. Mekong River at Nakhon Phanom last days of October and early December 2019

Due to few rainfall, additional lateral flow is negligible. The water level curves at the two stations are similar, with day displacement and close to the Min curves. (Figure 5).

The water level at Nakhon Phanom station on November 27, 2019 is 0.79 m. Many sandy beaches at the river bed exposed, river water color changed from yellowish-brown to greenish-blue, as reported Thai newspaper (Figure 6).

5. *At Pakse, Stung Treng, Kratie and Kompong Cham stations*

Pakse station is 256 km from Mukdahan station. Although the catchment area between them is large (154,000 km^2) but due to the few rainfall, water level curves at the two stations are almost similar, coinciding and very close to the Min curves (Figure 7, left).

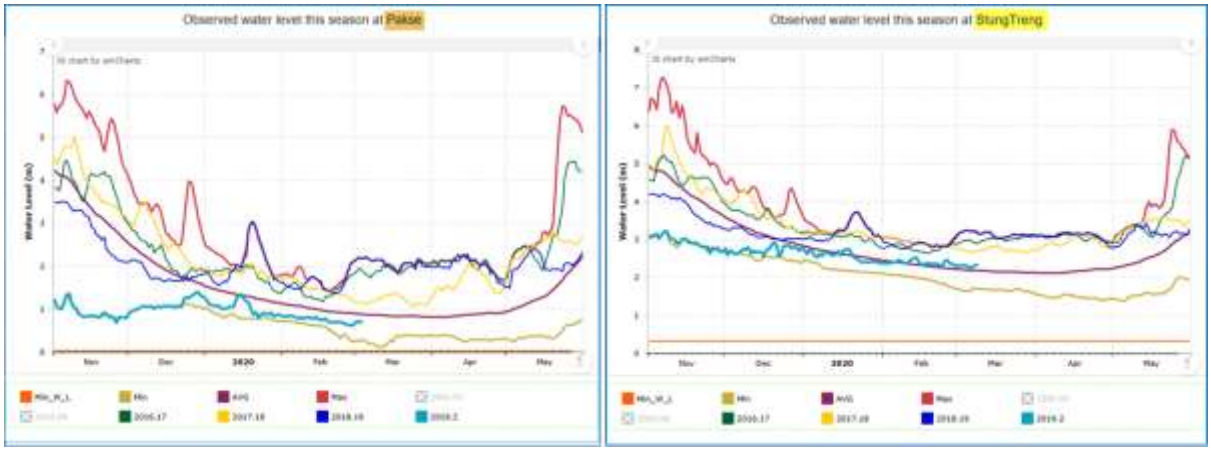


Figure 7. Water level at Pakse station (left) and at Stung Treng station (right)

The catchment area between Pakse and *Stung Treng* stations is 90,000 km^2. Although connected to the three rivers Sesan, Serepok and Sekong, originated in the Central Highlands of Vietnam, due to the drought, until February 24, 2020, the Stung Treng water level is still low, starting the dry season at the Min level and from the first week of January at the Avg level. (Figure 7, right).

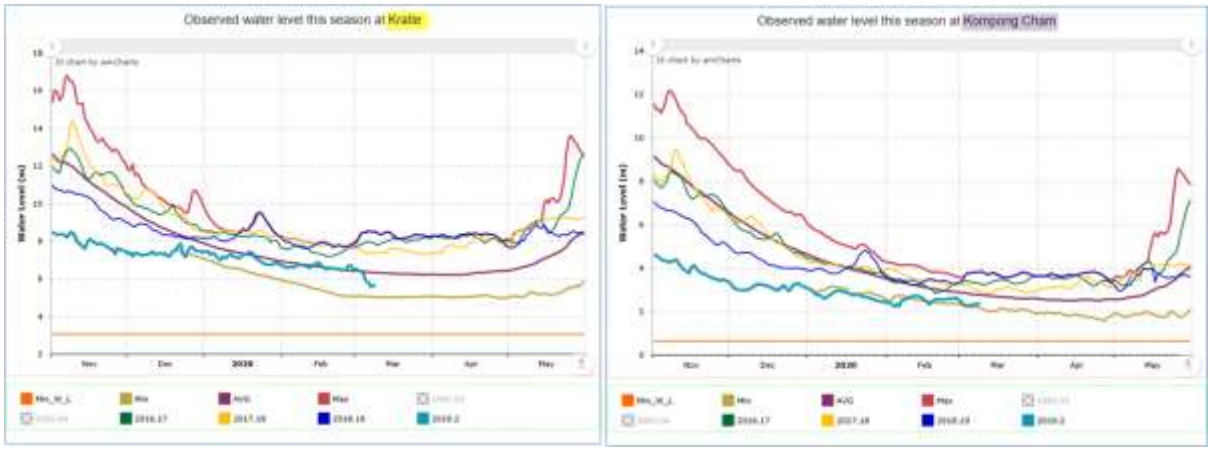


Figure 8. Water level at Kratie station (left) and Kompong Cham station (right)

Water levels at *Kratie* and *Kompong Cham* stations started at the Min values until December 24, then the Kratie water level progressed to the Avg values, while the Kompong Cham water level was even lower than the Min values.

6. At Phnom Penh Port and Phnom Penh on Bassac stations

The MR reaches Phnom Penh and joins here with the Tonle Sap River which is connected to the Great Lake. The Bassac River originates at this confluence. In Phnom Penh, there are two hydrographic stations, Phnom Penh Port (PPP) and Phnom Penh Bassac (PPB). Since the beginning of this dry season, water levels are low and fluctuates, differently from previous years, particularly 1992-1993, and 2003-2004 dry seasons (Figure 9).

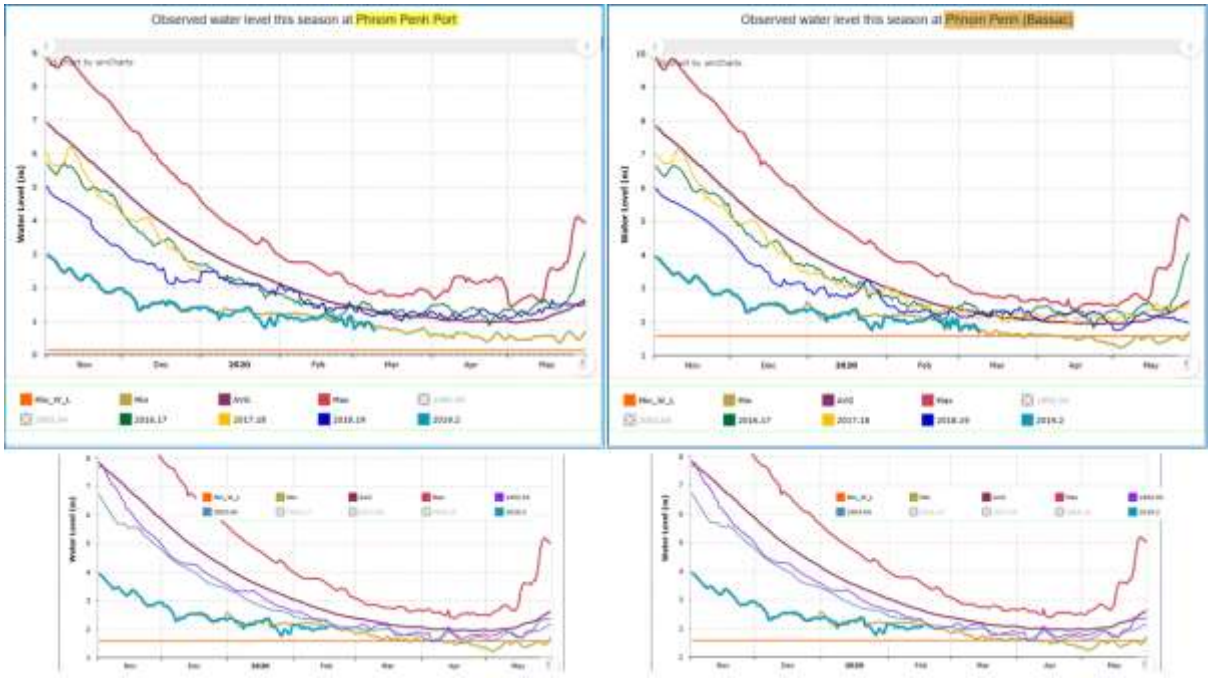


Figure 9. Water levels at PPP (left) and PPB (right) compared with 2017-2018, 2018-2019 curves (above) and 1992-1993, 2003-2004 curves (below).

7. At Neak Luong and Koh Khel stations

After Phnom Penh, there are *Neak Luong* station on the MR, and *Koh Khel* station on the Bassac River. Water levels are shown in Figure 10. The water levels this year dry season, up to March 16, 2020 are low, almost coincide with the Min values. Oscillations of the water level at both stations should be noted.

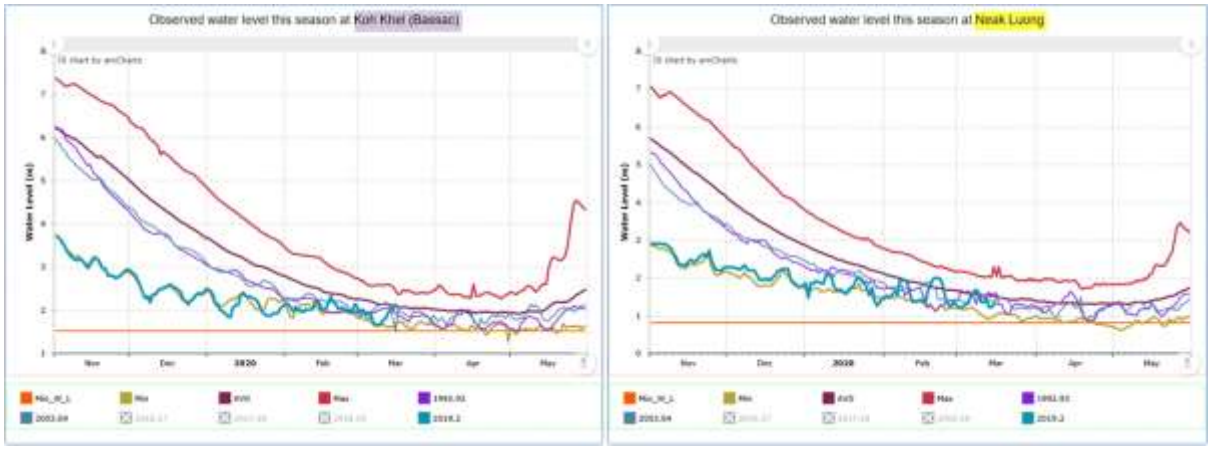


Figure 10. Water level at Koh Khel (left) and Neak Luong (right) this year dry season compared with dry seasons 1992-1993, 2003-2004

8. *At Tân Châu and Châu Đốc stations*

Figure 11 shows the low water levels at *Tân Châu* and *Châu Đốc* and its fluctuations This situation is also recognized, at lesser extents, at Neak Luong (Mekong) and Koh Khel (Bassac) and at two Phnom Penh, PPP and PPB stations. (Figures 9, 10).

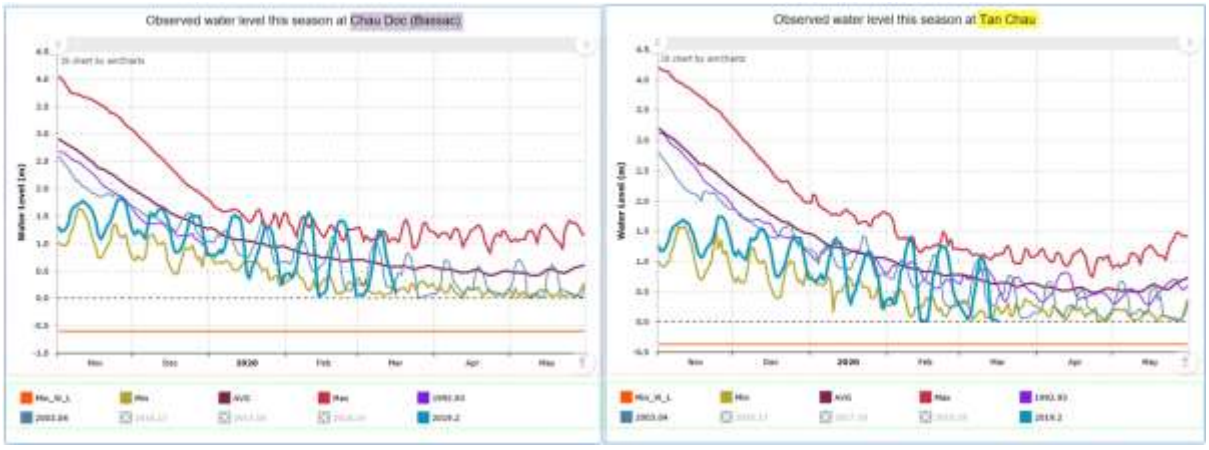


Figure 11. Water level at Chau Doc (left) and Tan Chau (right) compared with dry seasons 1992-1993, 2003-2004

9. *At Prekdam and Kompong Luong stations on the Tonle Sap River*

The water level at the *Prekdam* station on the Tonle Sap River this year dry season is also low, and a period of fluctuation from December 11 2019 to January 28 2020 is noted (Figure 12, left). The water level at Kompong Luong station in high flood years 1996-1997, 2000-2001, 2011-2012 and in drought years 2015-2016 and 2019-2020 are shown in Figure 12 (right).

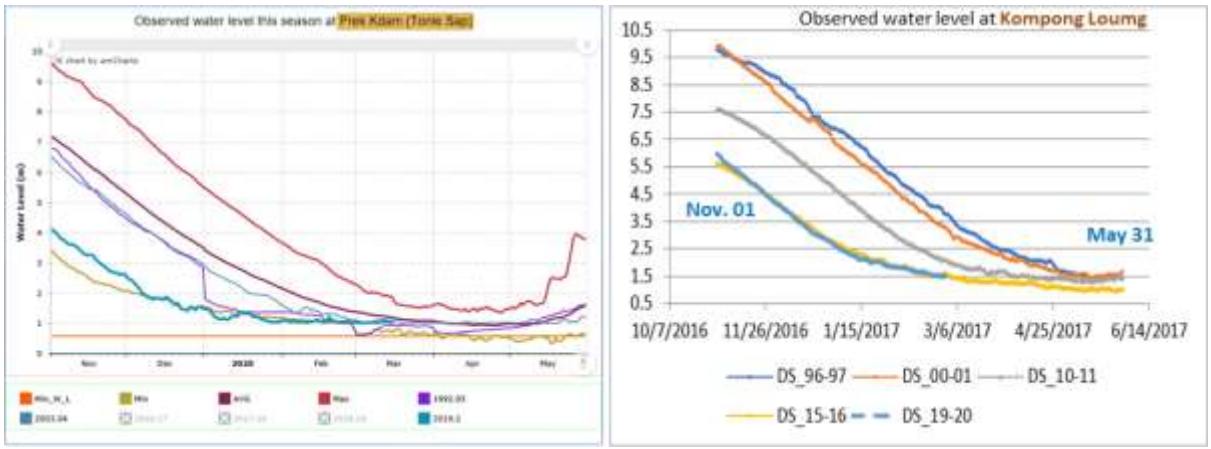


Figure 12. Water levels at Prekdam (left) and Kompong Luong (right) stations on the Tonle Sap River

Comments

(1) The overall comment at the first half dry season 2019-2020 is that water levels at all stations on the MR in the LMB, on the Bassac and on the Tonle Sap rivers are low, close to, and even lower than the Min values. *Except at Luang Prabang station.*

(2) The background element is the drought on the LMB in this year's first half dry season. Additional lateral water flows to the MR are negligible. This emphasizes the impact of the Xayaboury dam on the MR flow downstream the dam.

(3) The Xayaboury dam is the first artificial discontinuity in the gravitational flow of the MR in the LMB. The water level at Chiang Khan droped down. Are there or not, and why, the exposed river bed and the discoloration of the MR water in Nakhon Phanom last January as reported by Thai newspaper?

(4) The decrease of water discharge from Jinghong dam, from January 1 to January 4 2020, highlights once again the sensitivity, the high dependence of the flow of the MR in the LMB on the operation of hydropower dams in China.

This dependence must still be placed in the context of the global climate change (in which the increasing scarcity of fresh water is expected) and the "*Abundant Water, Rich Field*" strategy currently being practiced by China. (In Yunnan Province, with more than 30 lakes and over 5500 "water treasuries" built, the volume of stored water increased by 1.22 billion m^3 in 2017 [7]).

(5) The Great Lake (GL) plays an important role in slowing down floods in the Vietnamese Mekong Delta in the early rainy season, while providing fresh water for this plain in the early dry season through the Tonle Sap River.

Water flowing into the Great Lake or in the opposite direction depends on the water level difference between the Prekdam and Kompong Luong stations, positive or negative. This is illustrated in Figure 13. ALW curves at Prekdam and at Kompong Luong intersect on March 25, date for water flowing into the GL, and October 24, date for water flowing in the opposite direction.

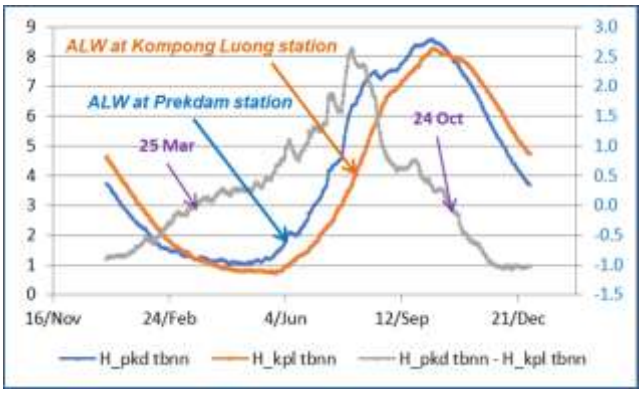
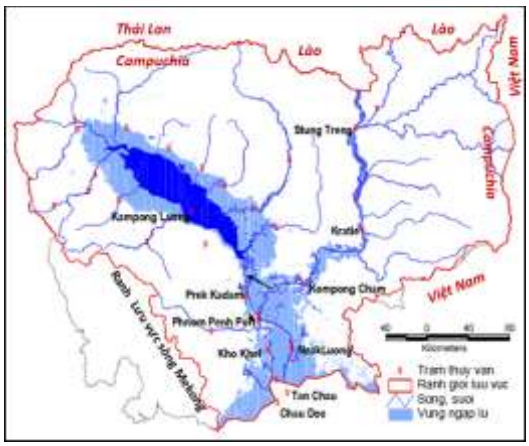


Figure 13. Average longterm daily water levels



Great Lake Basin, Tonle Sap and MD

In reality in early dry seasons, water flowing into the GL takes place during a period (T). Figure 14 shows the cases of drought years 2015-2016, 2019-2020.

In the period (T), the equation $H_{pkd} - H_{kpl} = 0$ may have many solutions. The Tonle Sap water flows into the GL when $H_{pkd} - H_{kpl} > 0$, and flows out in the reverse case, alternatively.

[7] Đỗ Tiến Sâm, *Hợp tác phát triển bền vững Mekong-Lan Thương trong bối cảnh mới*, Communication at the International Workshop co-organised by USSH Hà Nội and the KAS, Hanoi October 16,.2018.

In the first half dry season 2015-2016, (T) lasts from May 25 to July 12, during which overall, water flows out from the GL. Only from July 13, water continuously flows into the lake. (Figure 14, left).

Figure 14. Period (T) in early dry season 2015 and 2019

In the first half of the dry season 2019-2020, water flows alternatively into and out from May 09 to July 29, 2019. Mostly into from May 09 to June 04. Then flows out continuously from July 30, 2019. (Figure 14, right).

In other dry seasons, (T) is shorter. (T) even is reduced just inside one day, as the cases of large flood years 2000, and 2011. Figure 15.

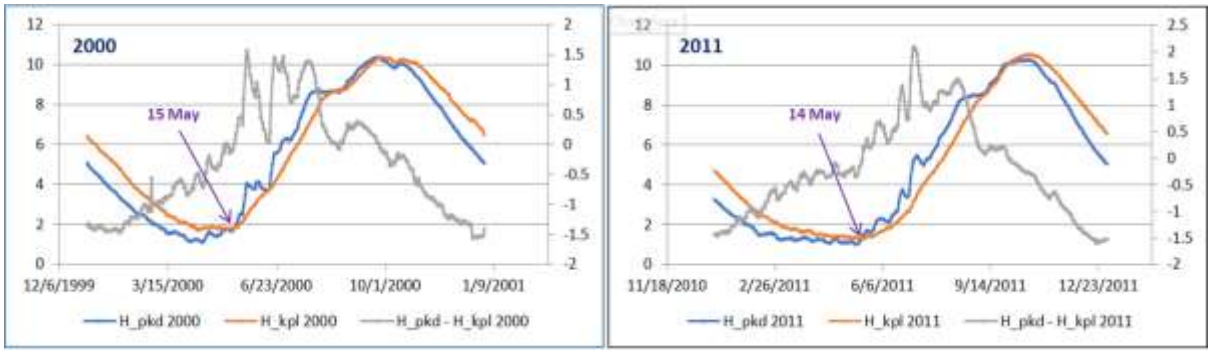


Figure 15. (T) is reduced just inside one day, as the cases of years 2000, 2011

(6) Table 2 (below) of the monthly highest amplitude of water level in the first four months in 1992-1993, 2003-2004 and recent dry seasons at Châu Đốc and Tân Châu stations, shows that the tide of the East Sea reaches these stations earlier, with wider water level amplitude. These changes are more pronounced on the Bassac River.

Monthly highest amplitude of the water level (in m) in the first four months of the dry season at Châu Đốc station

Dry Season	November	December	January	February
1992 -1993	no fluctuation	0.23	no data	
2003 - 2004	no fluctuation	0.53	0.78	0.97
2016 - 2017	0.59	0.65	0.9	1.17
2017 - 2018	0.59	0.72	1.04	1.16
2018 -2019	0.67	0.79	1.08	1.36
2019 - 2020	0.7	0.8	1.16	1.53

Monthly highest amplitude of the water level (in m) in the first four months of the dry season at Tân Châu station

Dry Season	November	December	January	February
1992 -1993	no fluctuation		0.52	0.64
2003 - 2004	no fluctuation		0.58	0.89
2016 - 2017	0.51	0.53	0.84	1.19
2017 - 2018	0.61	0.64	0.91	1.04
2018 -2019	0.65	0.76	0.97	1.24
2019 - 2020	0.68	0.8	1.1	1.38

Table 2 together with Figures 9, 10, 11, also indicates that at the first half dry season 2019-2020, tide goes up further on Mekong and Bassac rivers and its ìnfluence is felt up until Prekdam station.

This situation, and with it the saline intrusion into the delta, is it due to climate change, sea level rise, due to water arriving from upstream increasingly reduced, or due to excessive and mismanaged sand mining causing riverbank eroded, riverbed deepened, altering cross-sections of rivers?

Recent researches report on the sand mining in the LMB, especially in the Vietnamese Mekong Delta [8], exacerbating the sediment balance of the Mekong River already negative by hydroelectric dams on the Upper Basin [9]; on the deepening the bed of the Mekong River and its branches as well as of the Bassac River at numerous locations [10]; and on tidal propagation in the Mekong delta [11].

There are all the three reasons, but at the present, mostly the second and third, both resulting from human activities.

(7) The above-mentioned comments are related together. Drought, lower water discharges, excessive sand mining, wider and deeper river cross-sections, do not act separatedly but simultanously and inter-connected.

Recommendations

(1) It is necessary to observe the impact of the Xayaboury Dam during its first year of operation. From lessons learned, fully reassess the impact of other dams on the Mekong mainstream, particularly the Sambor on the ecology of the Great Lake basin and of the Mekong delta which are closely linked together.

During this first half dry season, water levels at Tan Chau and Chau Doc stations are low, the tide of the East Sea goes up further and sooner, the same for the saline intrusion. Climate change, sea-level rise is not the unique cause. There are also impacts of human activities from Tibetan Plateau to the Sea. Therefore,

(2) The use of Mekong River water resources does not involve only *rights and interests* but also *responsibilities and obligations* towards the whole basin. This is a transboundary issue to be resolved.

(3) The management and governance of the State must be strict and more effective, especially for the sand mining on the Mekong River and the Bassac River.

(4) Water diplomacy in the ASEAN Community and between ASEAN and China should be put soon on the agenda of the riparian countries of the Mekong River Basin and relevant institutions.

+ Laos, Thailand, Cambodia and Vietnam should have to review the *Procedures for Notification, Prior Consultation and Agreement* (PNPCA), one of the basic stipulations of the *Mekong Agreement* (1995), for more efficiency.

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[8] Bravard, J.-P., Goichot, M. & Gaillot, S., 2013, Geography of Sand and Gravel Mining in the Lower Mekong River. *EchoGéo*, **26**, https://doi.org/10.4000/echogeo.13659.

[9] Kondolf G. M. et al. 2017, Changing sediment budget of the Mekong: Cumulative threats and management strategies for a large river basin, Science of the Total Environment, Volume 625, 1 June 2018, Pages 114-134 https://www.sciencedirect.com/science/article/pii/S0048969717334198?via%3Dihub

[10] Anthony, E.J. et al, 2015. Linking rapid erosion of the Mekong River delta to human activities. Sci. Rep. 5, 14745. https://doi.org/10.1038/srep14745.

[11] Eslami, S., Hoekstra, P., Nguyen Trung, N. *et al.* 2019, Tidal amplification and salt intrusion in the Mekong Delta driven by anthropogenic sediment starvation. *Sci Rep* **9,** 18746, https://doi.org/10.1038/s41598-019-55018-9

+ The Mekong River, from the Tibetan Plateau to the sea is an international and indivisible river. The exploitation of its resources, especially its water, must be regulated by an international convention.

The Mekong River is not alone. Nu-Salween, Indus, Bramaputra rivers, … originate also in the Tibetan Plateau. International rivers such as Rhine, Danube rivers are regulated by international conventions. Why not one for the Mekong River, from Tibet to the Sea? [12]. Hard but not impossible to do.

Acknowledgments. This article has used the database of the Mekong River Commission. Sincere thanks from the author.

Keywords: Mekong River, Xayaboury dam, Great Lake, Tonle Sap River, Bassac River, Mekong delta, Mekong River Commission.

[12] Nguyễn Ngọc Trân, *Mekong River is international and indivisible*, Communication at the International Workshop *Cross-Border Cooperation in Water Resources Management. The Case of Greater Mekong Sub-Region,* orgnized by the University of Social Sciences and Humanities, Hanoi VNU, and the Konrad Adenauer Stiftung, Hanoi, October 16, 2018.