CALIBRATION OF THE NAVIGABLE WATERWAYS ON THE LOWER MEKONG RIVER INTO A CLASSIFICATION STANDARD

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1. Introduction

Under the component "Traffic Safety and Environmental Sustainability" of the MRC Navigation Program, it was mentioned that "Updating and harmonization of different Standards, Rules and Regulations to uniform common Standards is crucial for the development and liberalization of Inland Waterway Transport on the Mekong River System".

In 1992, Viet Nam issued a classification "Standards of Technical Class of Inland Waterways in Viet Nam" (Code TCVN 5664 – 1992). This classification, which differentiates between the natural rivers and the canals, identifies 6 categories, class I being the biggest category.
For modest inland navigation systems that have as their biggest ships self-propelled barges of not more than 500 tons, this classification is satisfactory. However, this classification does not mention anything about pushed convoys of 3,000 to 9,000 tons), self-propelled barges of 1,500 to 2,000 tons or River navigating seagoing vessels of 1,000 to 10,000 DWT).

Viet Nam Waterway Classification

Class		Minimum navigation channel dimensions					
	Tonnage DWT (T)	Depth T (m) (a)	Width B (m)	Radius R (m)	Bridge span (m)	Bridge Height H (m)	Electric wires height
I	500	> 3,0 (f)	> 90	> 700	80	10,00	12,00
II	300	2,0-3,0	70-90	500-700	60	9,00	11,00
III	100	1,5-2,0	50-70	300-500	50	7,00	9,00
IV	50	1,2-1,5	30-50	200-300	40	5,50	8,00
V	20	1,0-1,2	20-30	100-200	25	3,50	8,00
VI	< 10	< 1,0	< 20	60-150	15	2,50	8,00

Cambodia on the contrary has no vessel or waterway classification system.

Therefore, to achieve the higher mentioned harmonization, one of the actions of the "Master Plan for Waterborne Transport on the Lower Mekong River System in Cambodia" was "To calibrate the navigable waterways in Cambodia and Viet Nam into a classification standard", and this with four mayor goals:

1. to make this information available as a guarantee for users that minimum dimensions will be respected;
2. to inform the shipping and transport industry, determining IWT competitiveness by laying down maximum vessel sizes, affecting navigation costs;
3. to ensure the orderly and efficient control and maintenance of waterways;
4. to assist the authorities in planning and policy making by showing the missing links and bottlenecks that should be prioritized;

As an adequate classification system should be based both on the characteristics of the waterway and to the "normal" size of vessel or integrated push or tow barge, ensuring permanent navigability, the objective of the study was:

1. To sort all the vessels plying on the Lower Mekong River system into a recognized classification system in accordance with their main characteristics (Length, width, draught, tonnage, DWT, …) thereby guaranteeing that these vessels can safely operate in certain types of [classified] waterways which are meeting the minimum geometric requirements needed to suit the corresponding "design-vessel"
2. To categorize all the "navigable" stretches of waterways of the Lower Mekong watershed into a classification system which is meeting the minimum geometric requirements needed to suit a "design vessel" corresponding to a recognized category of vessels. These are mainly water depth, channel width, curvature, current velocity and air clearance under the bridges.

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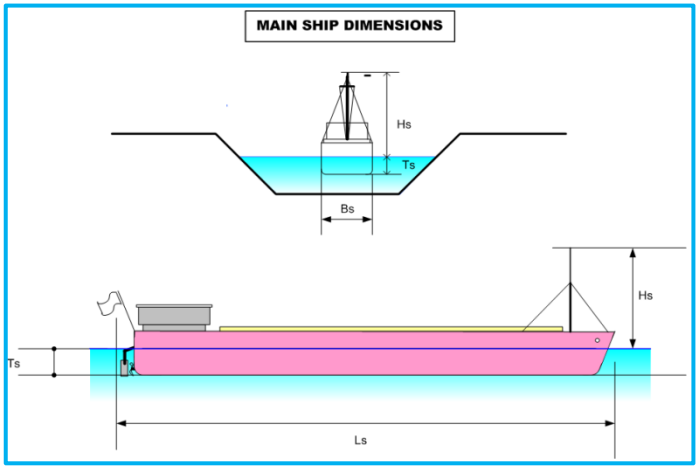
2. Procedure

In the study, following procedure was applied:

1. Drafting a list of all plying and registered vessels with their dimensions.
2. Preparing a vessel classification according to the vessel tonnage with maximum dimensions for that tonnage or DWT.
3. Draft a waterway classification, applying the internationally used formulas to calculate keel clearance, water depth, channel width, bend radius, passage width under bridges, bridge and electric wires air clearance for the maximum dimensions of the different vessel classes.
4. Choose the maximum vessel tonnage vessel that should pass a certain stretch of the river (permanently or during a limited period of the year) and apply the waterway characteristics of the corresponding class.

2.1. Drafting a list of all plying and registered vessels with their dimensions



In order to study the suitable navigation channel in the river stretches under the various scenarios, a design ship has to be established upon which a channel will be designed.
The PIANC recommendations in its Report of Working Group 16, supplement to Bulletin no. 90 (1996) related to *"Standardization of Ships and Inland Waterways for River/Sea Navigation"* advises that fairway classification be directly based on the largest class of *inland* vessels that are allowed to ply a given waterway.
It furthermore reports that with a view to increase the competitiveness of maritime transport, it would perhaps be recommendable to standardize vessels and inland waterways for *coaster* navigation as well, something which is perfectly possible in the Mekong River and some of its tributaries, because the Mekong River and its delta receives both kind of vessels: inland vessels and seagoing (maritime) vessels up to 10,000 DWT.

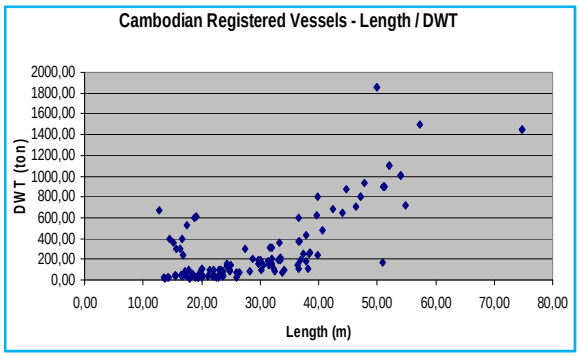
CAMBODIA

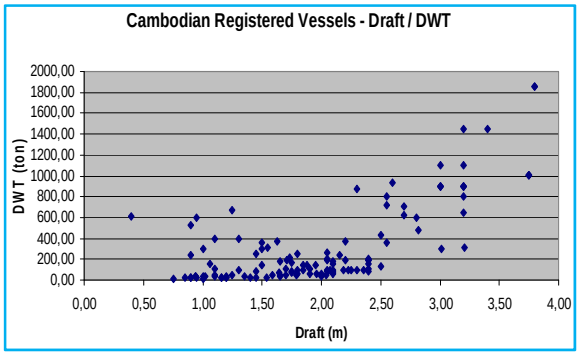
In Cambodia, the main traffic is dedicated to inland shipping for the domestic market and cross-border trade with Viet Nam. Occasionally, seagoing vessels up to 5,000 DWT enter Cambodia through the Mekong, mainly for general cargo, bulk, LPG and oil.
Cambodia has three vessel registration lists:

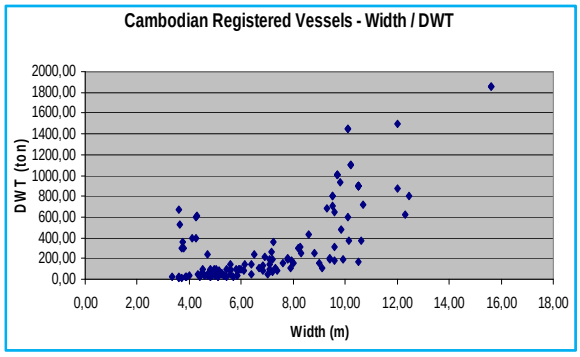
1. Provincial Public Works and Transport Department: registration of vessels < 50 tons
2. Ministry of Public Works and Transport – Waterway Transport Department: registration of Cambodian vessels > 50 tons
3. Phnom Penh Autonomous Port: registration of non-Cambodian cross bordering vessels

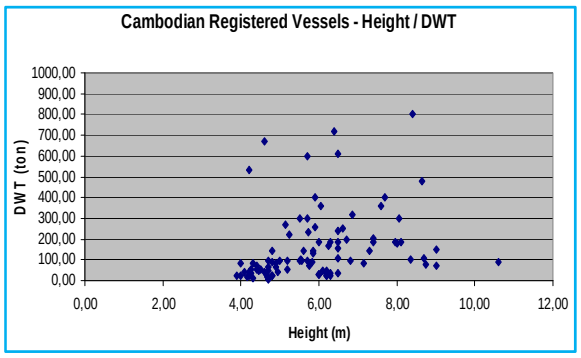
In total, less than 1,000 vessels are registered of which 256 vessels (dry bulk, general cargo and container vessels, oil tankers, passenger vessels, push and tow barges, ferries and dredgers) between 50 and 2,000 tons.

Summary Cambodian registered Vessel dimensions









VIET NAM

In Viet Nam, more than 50,000 inland waterway vessels are registered. Services are mainly provided by public operators in the north and private operators in the south. This is because the fleet capacity in the north is mainly owned by the central government or the provinces, whereas that in the south is mainly owned by private operators.
In the report *"Facilitating Trade through Competitive Low-Carbon Transport: The Case for Viet Nam's Inland and Coastal Waterways"*, World Bank (2014) the following classification is provided:

, World Bank (2014)

Class	Self-propelled vessel							Pushed barge						
	Weight	Length (m)		Width (m)		Draft (m)		Weight	Length (m)		Width (m)		Draft (m)	
	Ton	50%	90%	50%	90%	50%	90%	Ton	50%	90%	50%	90%	50%	90%
I	601-1,050	44.0	50.0	9.0	10.0	2.85	3.10	4 x 600	87.0	92.0	20.6	22.0	2.55	2.80
II	301- 600	39.0	42.0	7.7	8.8	2.50	2.75	4 x 400	87.0	92.0	20.6	22.0	2.55	2.80
III	101- 300	25.0	36.0	6.5	7.5	2.15	2.55	2 x 400	80.0	87.0	8.5	9.4	2.30	2.80
IV	51- 100	18.0	22.0	5.1	5.8	1.80	2.10	2 x 100	71.0	79.0	6.0	9.0	1.10	1.20
V	10- 50	14.0	16.0	3.4	4.4	1.05	1.50	NA						
VI	<10	11.0	13.0	2.3	2.7	0.65	0.85	NA						

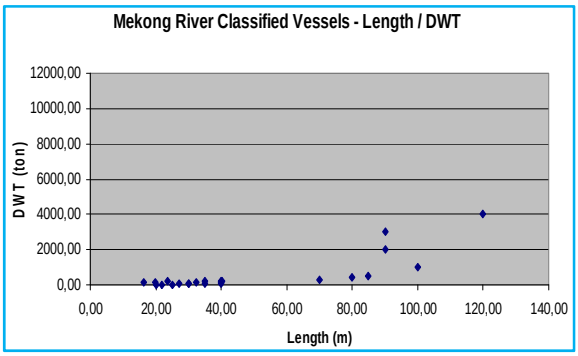
Source: VIWA 2007
Note: NA = not applicable

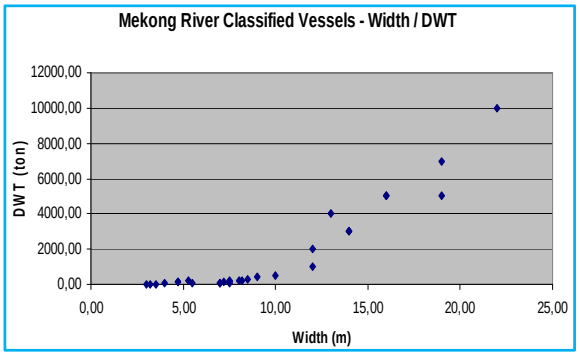
SEAGOING VESSELS

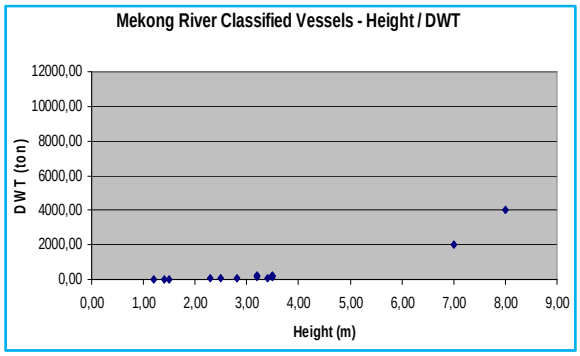
From a list of 2,107 ships in the "Lloyds List" with tonnage between 100 and 10,000 DWT, following kind of vessels have been examined

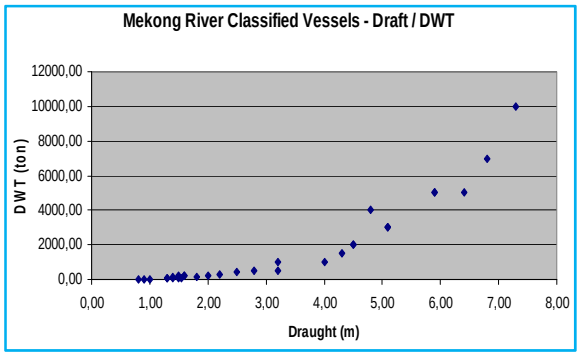
- Bulker (82 vessels)
- Dry cargo vessels (449 vessels)
- Miscellaneous (1,008 vessels)
- Offshore vessels (114 vessels)
- Passenger ships and ferries (99 vessels)
- Reefers (35 vessels)
- Roro vessels (19 vessels)
- Tankers (301 vessels)

Summary "Lloyds list" Classified Vessel dimensions



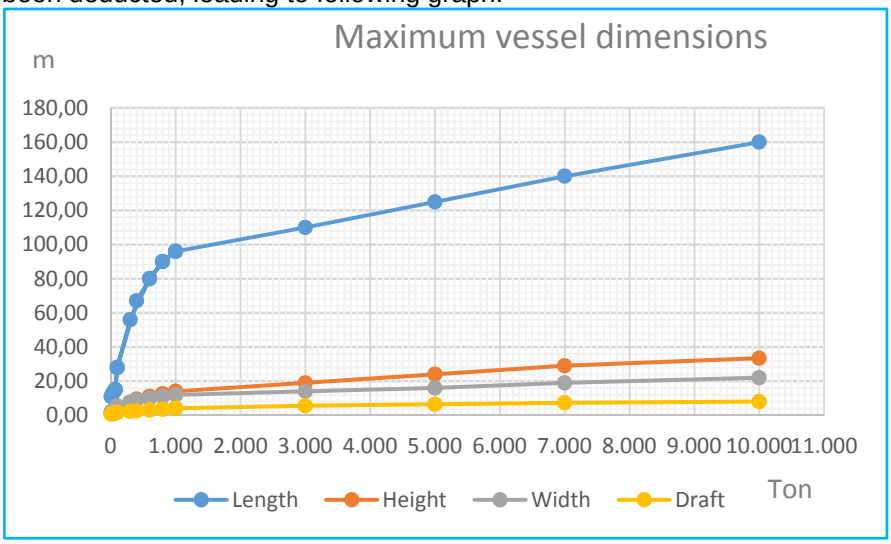






2.2. Preparing a vessel classification according to the vessel tonnage with maximum dimensions for that tonnage or DWT.

From the higher mentioned data, the maximum vessel dimensions related to the tonnage have been deducted, leading to following graph:



And these data are leading to following **proposal** for the Lower Mekong Vessel Classification[4]:

Class	Standard vessel dimensions				
	DWT (ton)	Length Ls (m)	Height Hs (m)	Width Bs (m)	Draft Ts (m)
0a (a)	7000 - 10000	140 - 160	29,0 - 33,4	19,0 - 22,0	7,3 - 8,0
0b	5000 - 7000	125 - 140	24,0 - 29,0	16,0 - 19,0	6,4 - 7,3
0c	3000 - 5000	110 - 125	19,0 - 24,0	14,0 - 16,0	5,6 - 6,4
0d (b)	1000 - 3000	96 - 110	14,0 - 19,0	12,0 - 14,0 (c)	4,1 - 5,6
Ia	800 - 1000	90 - 96	12,5 - 14,0	11,0 - 12,0	3,6 - 4,1
Ib	600 - 800	80 - 90	11,0 - 12,5	10,0 - 11,0	3,1 - 3,6
II	300 - 600	56 - 80	7,5 - 11,0 (d)	6,5 - 9,0	1,7 - 2,6
III	100 - 300	28 - 56	3,5 - 7,5	5,5 - 7,8	1,7 - 2,3
IVa	70 - 100	15 - 28	2,5 - 3,5	3,5 - 5,5	1,3 - 1,7
IVb	50 - 70	13 - 15	1,5 - 2,5	2,5 - 3,5	1,0 - 1,3
V	10 - 50	11 - 14	1,2 - 2,0	2,0 - 3,0	0,8 - 1,1
VI	< 10	< 11	< 1,2	< 2,0	< 0,8

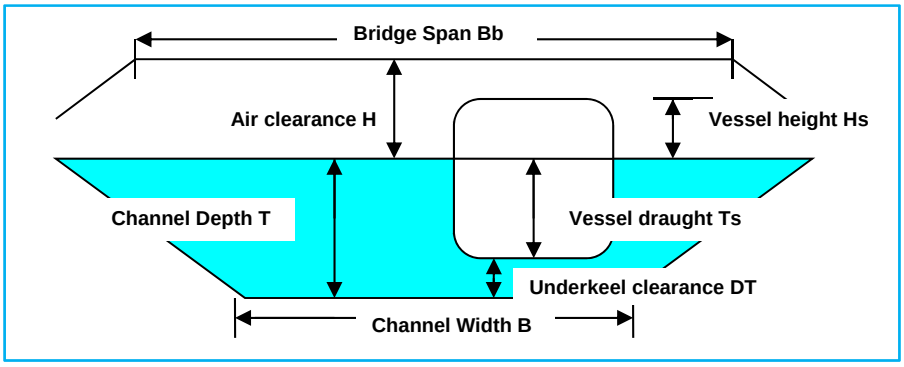
(a) Class 0 for river navigating seagoing vessels.
(b) Including container feeder barges up to 2000 ton and push convoys of 4 x 600 ton.
(c) Push convoys of 4 x 600 ton have a width of 22 m.
(d) Especially cruise vessels can be high for a relative low tonnage.

[4] For the Lower Mekong (Cambodia, Vietnam) it was proposed to use the Vietnamese vessel classification, but because this classification stops at 1,000 DWT, it was proposed to subdivide the Vietnamese classification into two additional classes (IVa + IVb and Ia + Ib) and to add four classes 0a, 0b, 0c and 0d for river / seagoing ships from 1,000 DWT to 10,000 DWT), container feeder barges of 2,000 ton and push convoys of 4 x 600 ton.

2.3. Draft a waterway classification, applying the internationally used formulas

Taking into account the data from the proposed Lower Mekong Vessel Classification, and by applying the prevailing standards for navigation channel dimensions, MRC secretariat drafted following formulas to calculate the waterway dimensions for the Lower Mekong Navigation (Cambodia, downstream of Kampong Cham, Mekong Delta of Vietnam, including waterway canals).

Prevailing standards for navigation channel dimensions:



Vessel Characteristics

Ls (m)	Length of vessel
Hs (m)	Vertical distance between the water line and the highest point of a stationary ship
Bs (m)	Width of vessel
Ts (m)	Draft of vessel
DWT (ton)	Deadweight Tonnage (the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew).

Minimum channel dimensions

R (m)	Bend radius	R (m) = 6 * Ls (m) (if no over width)
B (m)	Channel Width at Keel Level	B (m) = 3 * Bs (m) (narrow) to 4 * Bs (m) (normal)
H (m)	Passage height	H (m) = Hs + DH (m)
DH (m)	Clearance height	DH (m) = 0.2 m + 10% Hs (m)
Bb (m)	Passage width	Bb (m) = 4 * Bs (m) (one way traffic) to 6 * Bs (m) (two way traffic)
T (m)	Water depth	T (m) = Ts (m) + DT (m)
DT (m)	Keel Clearance	(according to VN professional standard 22 TCN 241 – 98)

A channel must have its full depth over a width which is three times the ship beam of the biggest ship allowed in the channel. Most of the ship sizes plying on the Mekong delta and listed on the Lloyds registers (between 100 DWT and 10,000 DWT) have a beam of 9.50 to 20 meters.

The radius of a curve must be equal or more than 6 times the LOA of the ship. The longest ship between 100 DWT and 10,000 DWT listed on the Lloyds registers is 160 meter. The minimum radius must therefore be greater than 6 x 160 = 960 meter.

If water depths in certain stretches of the Lower Mekong at LLW (Low lowwater) still reach navigable conditions (e.g. 1.50 m water depth) then an increase of the water level with say 2,50 m water, will make these stretches accessible for almost the biggest inland barges and vessels.

From these criteria, and taking into account the proposal of vessel classification, following table of Lower Mekong River System Waterway Classification is proposed:

Lower Mekong Waterway Classification proposal (not yet officially approved)

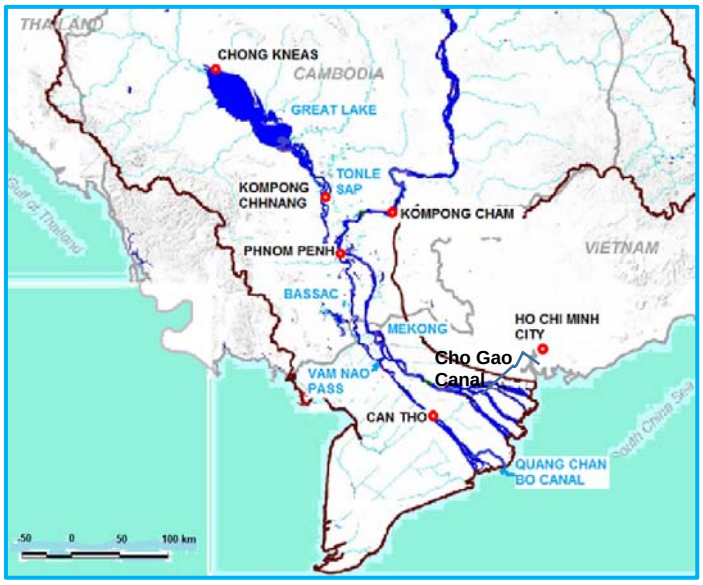
Class		Minimum navigation channel dimensions					
	Tonnage DWT (T)	Depth T (m) (a)	Width B (m) (b)	Bent Radius R (m)	Bridge span (m) (c)	Bridge Height H (m)	Electric wires height
0a (d)	7,000 - 10,000	8,8	66 - 88	960	88 - 132	37,00	39,00
0b	5,000 - 7,000	8,0	57 - 76	840	76 - 114	32,00	34,00
0c	3,000 - 5,000	7,0	48 - 64	750	64 - 96	26,50	28,50
0d (e)	1,000 - 3,000	6,2	42 - 56 (f)	660	56 - 84 (f)	21,00	23,00

Ia	800 - 1,000	4,5	36 - 48	575	48- 72	15,50	17,50
Ib	600 - 800	4,0	33 - 44	480	44 - 66	14,00	16,00
II	300 - 600	2,9	27 - 36	420	36 - 54	12,30	14,30
III	100 - 300	2,5	23 - 31	335	31 - 47	8,50	10,50
IVa	70 - 100	1,9	17 - 22	170	22 - 33	4,00	6,00
IVb	30 - 70	1,4	11 - 14	90	14 - 21	3,00	5,00
V	10 - 50	1,2	9 - 12	85	12 - 18	2,50	5,00
VI	< 10	< 0,9	6 - 8	66	8 - 12	1,50	5,00

(a) T (m) = Ts (m) + DT (m) with DT (m) = 10% Ts (m)
(b) Narrow (3 x Bs)-normal (4 x Bs)
(c) One way traffic (4 x Bs)-two way traffic (6 x Bs)
(d) Class 0 for river navigating sea-going vessels
(e) Including container feeder barges up to 2000 ton and push convoys of 4 x 600 ton
(f) Push convoys with a maximum width of 22 m need a channel width of 66 m (narrow) to 88 m (normal) and a bridge span of 88 m (one way traffic) to 132 m (two way traffic)

2.4. Application of the waterway characteristics to the corresponding class.

Applying the higher mentioned proposal of Waterway Classification on the several stretches of the Lower Mekong river system leads to following table:



River stretch	Low water level	Mid to high water level	Master Plan proposal (whole year)
Quang Chan Bo Canal and Bassac River up to Can Tho	0a (10,000 DWT)	0a (10,000 DWT)	0a (10,000 DWT)
Bassac River from Can Tho to Vam Nao Pass	0b (7,000 DWT)	0b (7,000 DWT)	0b (7,000 DWT)
Mekong River from Sea to Cho Gao Canal	0d (tidal) (2,000 ton)	0d (tidal) (2,000 ton)	0d (tidal) (2,000 ton)
Cho Gao Canal from Mekong River to Ho Chi minh	Ia (1,200 ton)	Ia (1,200 ton)	0d (2,000 ton)
Mekong River from Cho Gao Canal to Vam Nao Pass	0c (5,000 ton)	0c (5,000 ton)	0c (5,000 ton)
Mekong River from Vam Nao Pass to Phnom Penh	0c (5,000 DWT)	0b (5,000 DWT)	0b (7,000 DWT)
Mekong River from Phnom Penh to Kompong Cham	Ia (1,000 ton)	0d (3,000 DWT)	0d (3,000 DWT)
Tonle Sap River from Phnom Penh to Kompong Chhnang	II (500 ton)	Ia (1,000 ton)	Ia (1,000 ton)
Tonle Sap Lake from Kompong Chhnang to Chong Kneas	V (50 ton)	III (300 ton)	II (500 ton)

3. Conclusions

One has to take into account that this study was only a first simple approach to obtain a first proposal of classification standard for the navigation on the Lower Mekong river in Cambodia and Vietnam.

Other technical issues (for example the used formulas to calculate the waterway dimensions) and even political principles (for example safety and security regulations) can play an important role in the final determination method of a waterway classification.

Moreover, data collection is essential for a reliable classification of the waterways and the vessels that ply on them. Much of this information might be available in the archives but additional information has to be gathered before any tangible work can be started. Once all data are available, it's up to the Authorities of the riparian Countries to assess the possibility of lining up waterway classifications for the whole River System. Should incompatibilities occur, it would be wise to negotiate through an international "River Navigation Commission "to try to standardize the classifications.

Therefore, for each world river, it is of utmost importance to study the need for and scope of a "Intergovernmental River Navigation Commission", in order to ensure integration of the decision-making mechanisms across the riparian countries, to harmonize the legal framework for the management of the waterway over its entire navigable length, to increase efficiency of the governance structure, of the competitiveness of waterborne transportation and ports and the overall sustainability of the system.

Today, Cambodia is using following vessel classification standard for the Ship Registration but still has no waterway or navigation channel classification.

Class	Standard vessel dimensions				
	Length Ls (m)	Height Hs (m)	Width Bs (m)	Draft Ts (m)	DWT (ton)
0a (a)	140 - 160	29,0-33,4	19,0 - 22,0	7,3 - 8,0	7000 - 10000
0b	125 - 140	24,0-29,0	16,0 - 19,0	6,4 - 7,3	5000 - 7000
0c	110 - 125	19,0-24,0	14,0 - 16,0	5,6 - 6,4	3000 - 5000
0d	100 - 110	14,0-19,0	12,0 - 14,0	4,1 - 5,6	1000 - 3000
Ia	90 - 100	12,5-14,0	11,0 - 12,0	3,6 - 4,1	800 - 1000(b)
Ib	80 - 90	11,0-12,5	10,0 - 11,0	3,1 - 3,6	600 - 800
Ic	70 - 80	9,5-11,0	9,0 - 10,0	2,6 - 3,1	400 - 600
II	28 - 70	3,5- 9,5 (c)	6,5 - 9,0	1,7 - 2,6	100 - 400
III	15 - 28	2,5- 3,5	3,5 - 6,5	1,3 - 1,7	70 - 100
IV	13 - 15	1,5 - 2,5	2,5 - 3,5	1,0 - 1,3	30 - 70
V	11 - 13	1,2 - 1,5	2,0 - 2,5	0,8 - 1,0	10 - 30
VI	< 11	< 1,2	< 2,0	< 0,8	< 10

(a) class 0 for river navigating seagoing vessels
(b) Container feeder barges up to 2000 ton
(c) Especially cruise vessels can be high for a relative low tonnage

Viet Nam is still using the 2007 vessel classification (River Fleet for South Viet Nam waterways with 50 and 90 percent Load Factors) and is actually working on a new waterway classification to replace the 1992 "Standards of Technical Class of Inland Waterways in" (Code TCVN 5664), which is only satisfactory for modest inland navigation systems which biggest ships are self-propelled barges of not more than 500 tons.