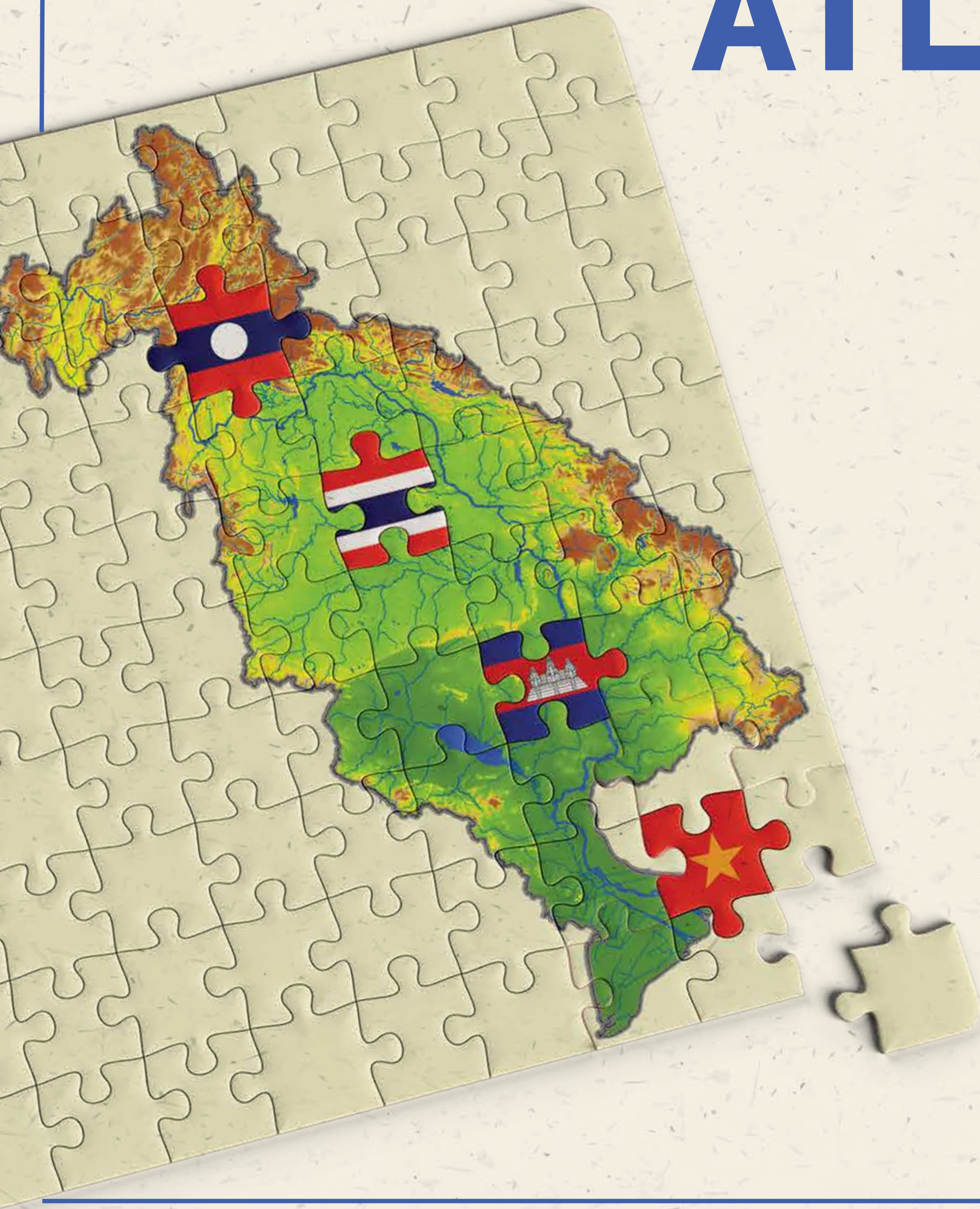




THE MEKONG ATLAS



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Lower Mekong River Basin Atlas 2023

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Mekong River Commission

Documentation and Learning Centre

184 Fa Ngoum Road, Unit 18, Ban Sithane Neua, Sikhottabong District, Vientiane 01000, Lao PDR

Telephone: +856-21 263 263 | E-mail: mrscs@mrcmekong.org | www.mrcmekong.org

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Authors

Project management:

Mr Tran Minh Khoi, Director of Technical Support Division, MRCS

Technical experts:

MRC Secretariat’s technical experts

Mr Kittiphong Phongsapan, Remote Sensing & GIS Specialist, Technical Support Division

National technical experts

Mr Chheang Hong, National Coordinator, CNMC, Cambodia

Mr Somphone Khamphan, National Coordinator, LNMC, Lao PDR

Ms Puttikul Tongnuesook, National Coordinator, TNMC, Thailand

Mr Nguyen Huy Phuong, National Coordinator, VNMC, Viet Nam



Dr. Anoulak Kittikhoun

Chief Executive Officer

FOREWORD

Pictures, or rather maps in this case, tell a thousand words! We are proud to introduce the Lower Mekong River Basin Atlas 2023 (The Mekong Atlas), a significant accomplishment by the Mekong River Commission (MRC) Secretariat and member countries. Over the years, the MRC has diligently collected and organized geospatial data from various sources, collaborating with experts to ensure its accuracy and relevance. The Mekong Atlas 2023 builds on the highly popular and widely cited MRC knowledge product: the Basin Development Plan Programme (BDP) Planning Atlas of the Lower Mekong River Basin 2011.

Ten years in the making, the Mekong Atlas 2023 with 62 maps serves as a comprehensive compilation of data, information and analyses of the Mekong River Basin, presenting technical content in a user-friendly manner. This offers valuable insights for researchers and stakeholders, empowering policymakers in addressing the region's challenges and capitalizing on its opportunities. Additionally, it enables the general public to access the extensive knowledge resources of the MRC, enhancing their understanding of the Mekong River—a vital resource for 70 million people in the region.

The Mekong Atlas 2023 follows the five dimensions of the Mekong River Basin Indicator Framework, providing geospatial data on baseline boundaries, environmental indicators, demographics including gender and vulnerability groups, economic aspects, climate information and more, offering a deep understanding of the Mekong region and its complex dynamics. This framework aligns with the Basin Development Strategy (BDS) 2021–2030, which

outlines how the water and related resources of the Mekong River Basin should be utilized, managed, and conserved from the perspectives of Cambodia, Laos, Thailand and Viet Nam—the Lower Mekong River Basin countries.

In addition to the traditional printed book format, the Mekong Atlas includes an innovative interactive platform accessible at <https://geo.mrcmekong.org>. Through this platform, users can dynamically interact with and visualize geospatial data specific to the Lower Mekong region. Users can create customized maps, navigate through different layers of data, zoom in on specific areas, and analyse spatial patterns and relationships.

The interactive platform revolutionizes the accessibility and utilization of geospatial data in the Lower Mekong region. It enables users to engage with information, discover patterns, and make data-driven decisions regarding climate change, the environment and socio-economic development.

We hope that you enjoy your journey of discovery through the Lower Mekong Basin Atlas 2023, both in its printed and online interactive versions. We believe that the Atlas will positively contribute to your work and knowledge, enhancing your understanding of the Mekong River from different aspects, and guiding actions toward its sustainable development and protection.



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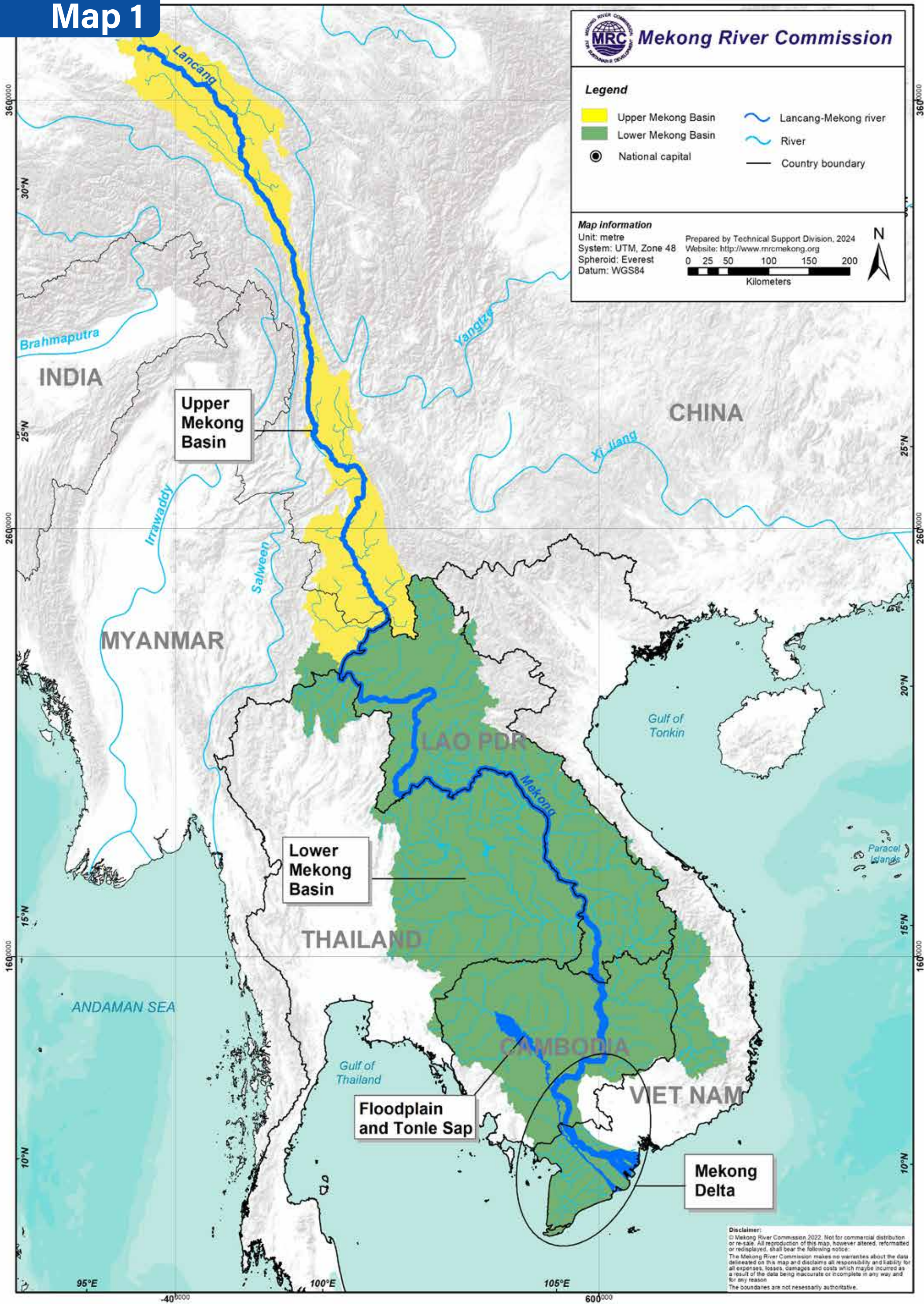
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Mekong River Basin overview

Map 1



Mekong River Basin overview

The Mekong River, stretching nearly 5,000 kilometres, is the 12th longest river in the world. This impressive waterway originates from a vast catchment area of 795,000 square kilometres (MRC, 2005) spanning six countries, China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam.

Table 1. Territory of six Mekong River Basin Countries with the catchment

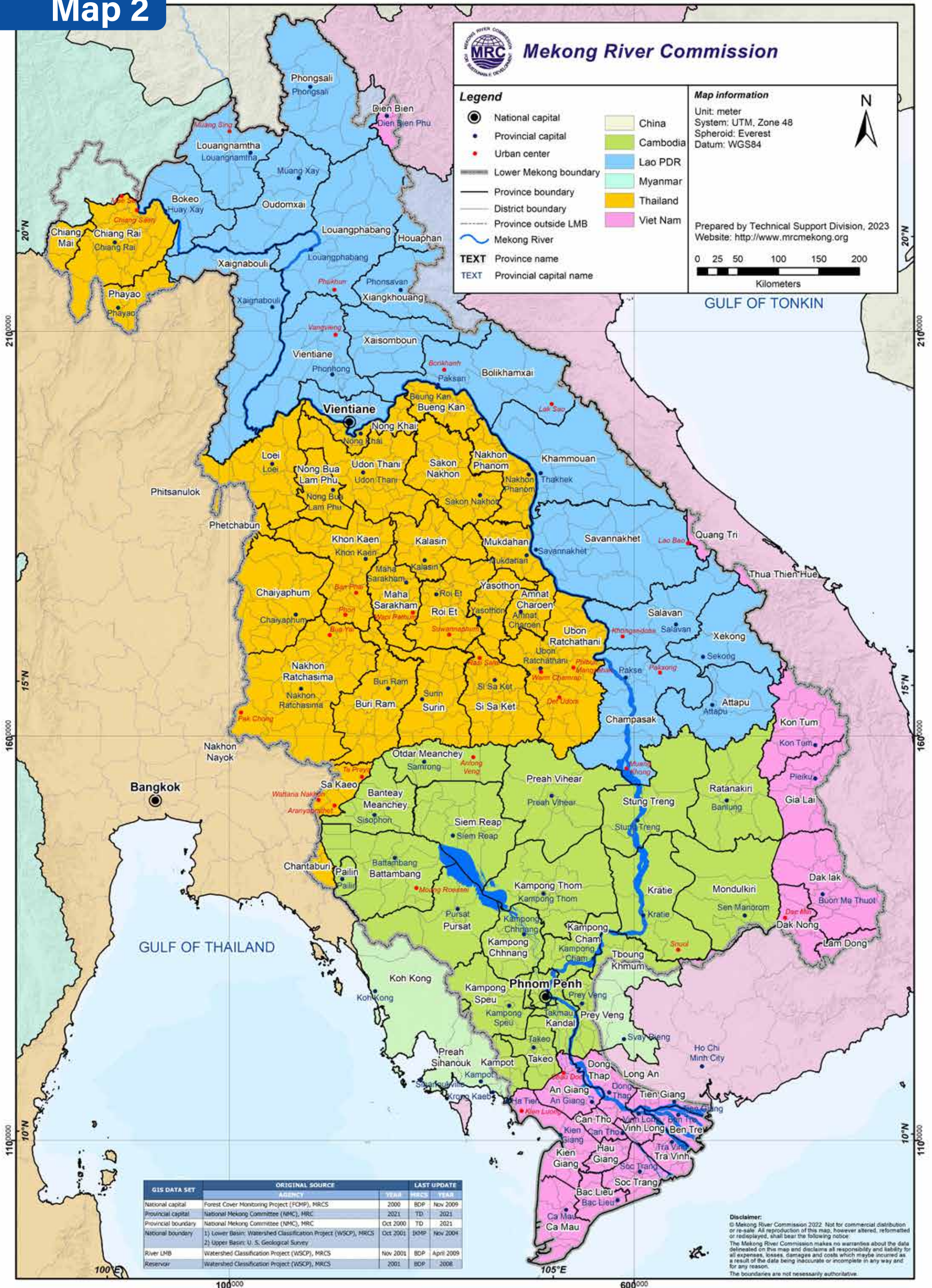
Description	China	Myanmar	Lao PDR	Thailand	Cambodia	Viet Nam	Total (Mekong River Basin)
Area (km ²)	165,000	24,000	202,000	184,000	155,000	65,000	795,000
Catchment as % of Mekong River Basin	21%	3%	25%	23%	20%	8%	100%

The Mekong Basin is traditionally divided into two distinct regions: the upper and lower basins. The Upper Mekong Basin, known as the Lancang Jiang in China, occupies 24% of the total basin area. At Chiang Saen, Nakhon Phanom, Pakse and Stung Treng hydrological stations, the Basin contributed on average around 64%, 16%, 14% and 10%, respectively, of the water that feeds into the Mekong River Basin during the 2000–2020 period. (LMEC and MRC, 2023) In contrast, the Lower Mekong Basin (LMB) extends downstream from the Chinese border with Lao PDR, encompassing most of the land areas of Lao PDR and Cambodia, the northern and northeastern regions of Thailand, and the Mekong Delta and Central Highlands of Viet Nam.

The Mekong Basin’s unique configuration, especially the elongated and narrow upper part within China, differentiates it from other large river basins, such as the Mississippi, Congo and Amazon basins, which typically feature broader upper basins and more straightforward dendritic drainage networks resembling tree branches.(Clark et al, 2004) This distinct shape and the abrupt changes in the Mekong River’s course bear witness to a long and intricate tectonic history. Notably, the collision of the Indian Plate with the Asian subcontinent in the Tertiary period uplifted the Himalayas and the Tibetan Plateau, significantly shaping the Basin’s physiography. (Brookfield, M.E., 1998), (Fielding, E.J., 2000) This uplift also played a pivotal role in triggering the formation of the southwest monsoon, which now dominates the region’s climate. (Clift, P.D., and Plumb, A.R., 2008)

The Mekong River commences its journey on the Tibetan Plateau, at an altitude exceeding 4,500 metres above sea level, alongside its companion rivers, the Salween and Yangtze. As these three mighty rivers descend from the Tibetan Plateau, they converge in a relatively narrow zone, no more than 100-km wide. Within this region, often referred to as the ‘Three Rivers Area’, these rivers have carved deep and narrow gorges. In contrast to the LMB, the upper Mekong’s tributary river systems remain small due to the narrow expanse of the upper basin.Number of provinces and districts in Lower Mekong Basin





Administrative boundary

The LMB is an ecologically and hydrologically dynamic region, spanning four countries in Southeast Asia: Cambodia, Lao PDR, Thailand and Viet Nam. This transboundary basin is characterized by its complex river network, comprising a vast delta, tributaries and floodplains.

Within the LMB, administrative boundaries delineate provinces and districts, and urban centres play a critical role in shaping the socio-economic landscape. These urban centres serve as hubs for trade, commerce and transportation, contributing to the region’s socio-economic development. Notably, some urban centres might not also serve as administrative centres, adding to the complexity of regional governance.

In Cambodia, 23 out of 25 provinces are located in the LMB; Svay Rieng and Kep province lie outside of the LMB; Koh Kong, Preah Sihanouk, Kampot, Prey Veng and Tboung Khmum partially lie in the LMB; and the other provinces lie entirely inside the LMB.

In Lao PDR, in contrast, all 18 provinces are located within the LMB, presenting a cohesive and interconnected landscape. Nevertheless, provinces such as Phongsali, Houaphan, and Xiangkhouang are only partially located in the LMB.

Thailand experiences a diverse hydrological setting within the LMB, with 28 out of its 77 provinces lying within the LMB. Although Nakhon Nayok and Phitsanulok provinces are situated in the LMB, their relatively small area of less than 100 km² poses unique challenges for resource management and environmental conservation.

Viet Nam’s LMB presence extends primarily to the southern and central parts of the country, encompassing 23 provinces. In contrast, Dien Bien province in the northern region lies within the basin, showcasing the diversity of ecosystems and water resource challenges.

The LMB is significant due to its hydrological complexities and plays a crucial role in the livelihoods of millions of people. It sustains essential sectors such as agriculture, fisheries and trade, which are intricately linked to the health of the Mekong River and its tributaries. Sustainable development, water resource management and climate change adaptation are pivotal aspects requiring collaborative efforts from the four countries to preserve the LMB’s ecological integrity and socio-economic well-being for generations to come.

Map 2 and its descriptive Table 2 were generated from the four countries’ national 2020 data. It should be noted that the delineation of district, province and international administrative boundaries on the map is approximate and must not be considered authoritative.

Table 2. Number of provinces and districts in the LMB

Cambodia		Number of Districts	Lao PDR		Number of Districts	Thailand		Number of Districts	Viet Nam		Number of Districts
1	Banteay Meanchey	9	1	Attapu	5	1	Amnat Charoen	7	1	An Giang	11
2	Battambang	14	2	Bokeo	5	2	Buang Kan	8	2	Bac Lieu	7
3	Kampong Cham	10	3	Bolikhamxai	7	3	Buri Ram	23	3	Ben Tre	9
4	Kampong Chhnang	8	4	Champasak	10	4	Chaiyaphum	17	4	Binh Phuoc	2
5	Kampong Speu	8	5	Houaphan	2	5	Chantaburi	2	5	Ca Mau	9
6	Kampong Thom	8	6	Khammouan	10	6	Chiang Mai	5	6	Can Tho	9
7	Kampot	6	7	Louangnamtha	5	7	Chiang Rai	18	7	Dak Lak	15
8	Kandal	11	8	Louangphabang	12	8	Kalasin	18	8	Dak Nong	5
9	Koh Kong	1	9	Oudomxai	7	9	Khon Kaen	26	9	Dien Bien	3
10	Kratie	6	10	Phongsali	7	10	Loei	15	10	Dong Thap	12
11	Mondulkiri	5	11	Salavan	8	11	Maha Sarakham	13	11	Gia Lai	9
12	Otdar Meanchey	5	12	Savannakhet	15	12	Mukdahan	7	12	Hau Giang	8
13	Pailin	2	13	Vientiane	11	13	Nakhon Nayok	1	13	Kien Giang	13
14	Phnom Penh	12	14	Vientiane Capital	9	14	Nakhon Phanom	12	14	Kon Tum	10
15	Preah Sihanouk	1	15	Xaignabouli	11	15	Nakhon Ratchasima	32	15	Lam Dong	2
16	Preah Vihear	8	16	Xaisomboun	5	16	Nong Bua Lam Phu	6	16	Long An	2
17	Prey Veng	11	17	Xekong	4	17	Nong Khai	9	17	Quang Binh	2
18	Pursat	6	18	Xiangkhouang	6	18	Phayao	7	18	Quang Tri	1
19	Ratanakiri	9				19	Phetchabun	4	19	Soc Trang	11
20	Siem Reap	12				20	Phitsanulok	2	20	Thua Thien Hue	1
21	Stung Treng	5				21	Roi Et	20	21	Tien Giang	11
22	Takeo	10				22	Sa Kaeo	7	22	Tra Vinh	9
23	Tboung Khmum	6				23	Sakon Nakhon	18	23	Vinh Long	8
						24	Si Sa Ket	22			
						25	Surin	17			
						26	Ubon Ratchathani	25			
						27	Udon Thani	20			
						28	Yasothon	9			
Total		173			139			370			169

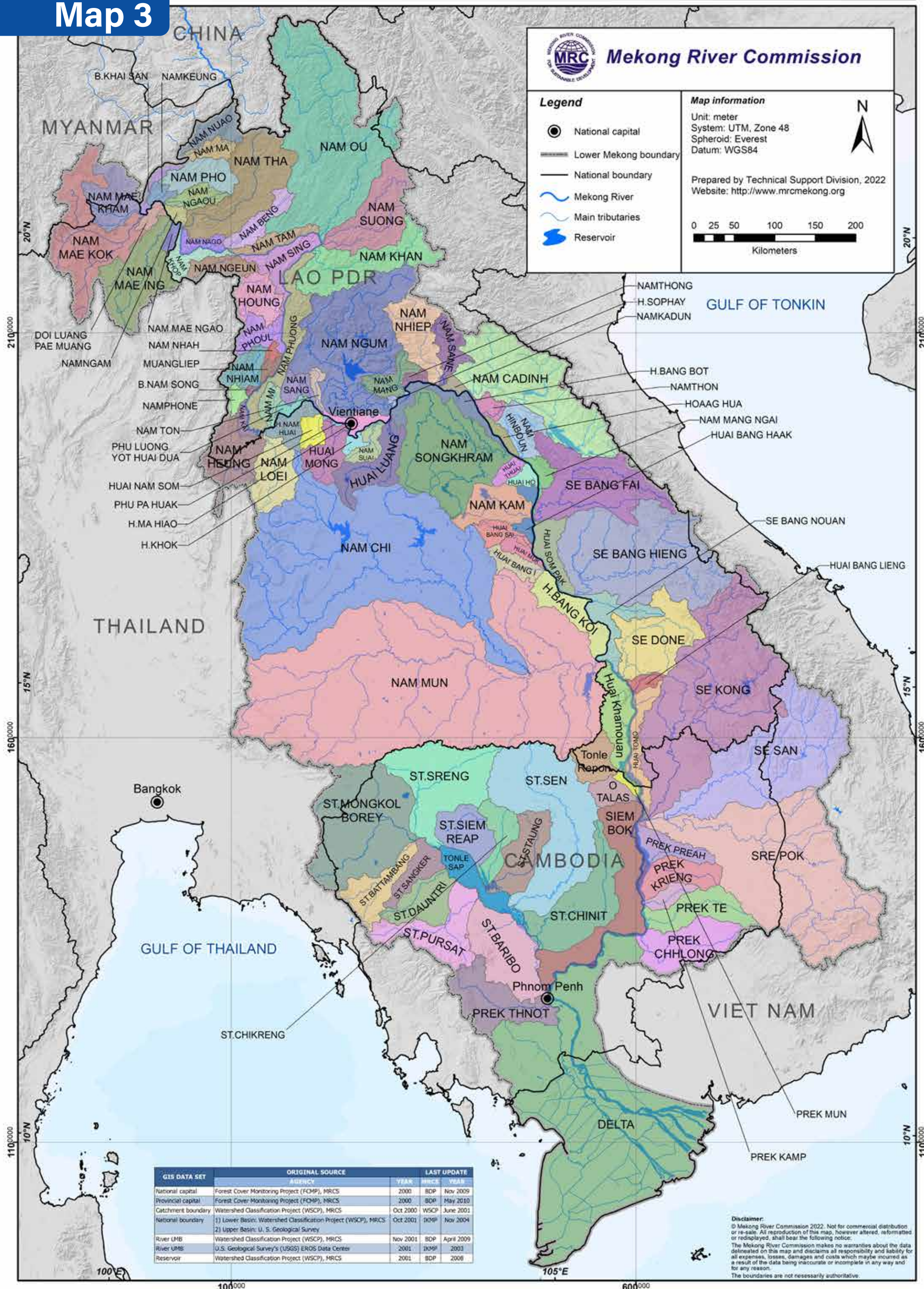
Note

Some of the maps at Social and Economic Dimension collected from the project of Data Acquisition and Generation Action Plan (DAGAP; 2019) by Planning Division (PD), which targeting the province within the LMB boundary. However, there are some LMB provinces, particularly for Thailand and Viet Nam are not included in the data and description of the LMB Atlas Maps in due to the small part of the province extended into LMB boundary.

For Thailand, there are 26 LMB provinces included in the SE data/maps (not include Nakhon Nayok and Phitsanulok).

For Viet Nam, there are 18 LMB provinces included in the SE data/maps (not include Dien Bien, Binh Phuoc, Quang Binh, Quang Tri and Thua Thien Hue).



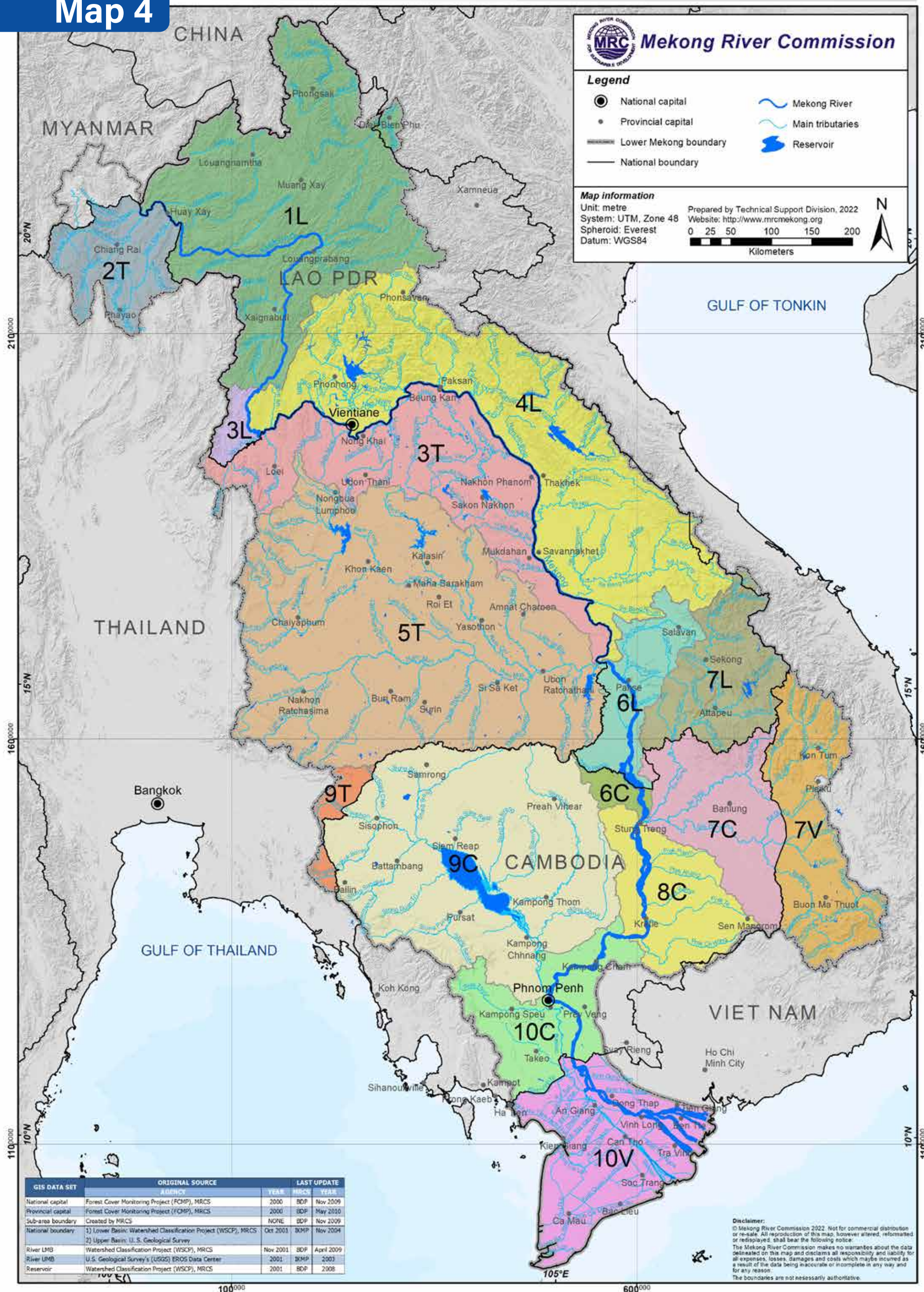


Catchments

Map 3 provides a comprehensive view of the catchment areas for tributary rivers that contribute to the Mekong River's flow. The Mekong River Commission's Watershed Classification Project, completed in 2001, meticulously delineated a total of 104 catchments in the region. In certain instances, larger catchments, such as those of the Tonle Sap, Mun, and Se Kong Rivers, have been divided into multiple subcatchments. This division is necessary as these catchments are drained by two or more major rivers with similar lengths and catchment sizes. Notably, the Se Kong – Se San – Sre Pok (often referred to as the 3-S basin) and Chi-Mun catchments are joined by multiple major rivers near the Mekong River. Along the Mekong River corridor, some smaller catchments contain several small rivers that directly flow into the Mekong River. These catchments are often named after the largest of these rivers. The map's rich dataset of catchment delineation offers valuable insights into the Mekong River Basin's hydrological complexities and contributes to improved water resource management and environmental conservation efforts in the region.

Table 3. Summary of the catchment area

Catchment name	Area (Sq.km)	Catchment name	Area (Sq.km)	Catchment name	Area (Sq.km)
B.Khai San	778	Nam Khop	1,521	Sre Pok	30,942
B.Nam Song	138	Nam Loei	4,012	St.Baribo	7,154
Delta	48,235	Nam Ma	1,141	St.Battambang	3,708
Doi Luang Pae Muang	688	Nam Mae Ing	7,267	St.Chikreng	2,714
H. Khok	538	Nam Mae Kham	4,079	Siem Bok	8,851
H.Bang Bot	2,402	Nam Mae Kok	10,701	Sre Pok	30,942
H.Bang Koi	3,313	Nam Mae Ngao	485	St.Baribo	7,154
H.Ma Hiao	990	Nam Mang	1,836	St.Battambang	3,708
H.Nam Huai	1,755	Nam Mang Ngai	944	St.Chikreng	2,714
H.Sophay	186	Nam Mi	1,032	St.Chinit	8,237
Hoaag Hua	626	Nam Mun	70,574	St.Dauntri	3,696
Huai Bang Haak	938	Nam Nago	1,008	St.Mongkol Borey	14,966
Huai Bang I	1,496	Nam Ngam	489	St.Pursat	5,965
Huai Bang Lieng	695	Nam Ngaou	1,495	St.Sangker	2,344
Huai Bang Sai	1,367	Nam Ngeun	1,819	St.Sen	16,360
Huai Ho	691	Nam Ngum	16,906	St.Siem Reap	3,619
Huai Khamouan	3,762	Se San	18,888	St.Sreng	9,986
Huai Luang	4,090	Siem Bok	8,851	St.Staung	4,357
Huai Mong	2,700	Sre Pok	30,942	Tonle Repon	2,379
Huai Muk	792	St.Baribo	7,154	Tonle Sap	2,744
Huai Nam Som	1,072	St.Battambang	3,708		
Huai Som Pak	2,516	St.Chikreng	2,714		
Huai Thuai	739	St.Chinit	8,237		
Huai Tomo	2,611	St.Dauntri	3,696		
Muang Liep	488	St.Mongkol Borey	14,966		
Nam Beng	2,131	St.Pursat	5,965		
Nam Cadinh	14,822	St.Sangker	2,344		
Nam Chi	49,133	St.Sen	16,360		
Nam Heung	4,901	St.Siem Reap	3,619		
Nam Hinboun	2,529	St.Sreng	9,986		
Nam Houng	2,872	St.Staung	4,357		
Nam Kadun	456	Tonle Repon	2,379		
Nam Kai	602	Tonle Sap	2,744		
Nam Kam	3,495	Nam Thon	838		
Nam Keung	633	Se San	18,888		
Nam Khan	7,490	Siem Bok	8,851		



Sub-areas

Sub-areas indicate points of convergence where one or more river catchments intersect with national borders, reflecting the intricate network of the Mekong River's tributaries. These sub-areas are sequentially numbered from upstream to downstream, and each sub-area is indicated by a letter designating the specific country where it is located. These sub-areas were meticulously delineated as part of the Basin Development Plan (BDP) Programme initiated by the MRC in 2002. This systematic approach aimed to improve the efficiency of basin development planning, a concept deeply entwined with the ecological significance of the Mekong.

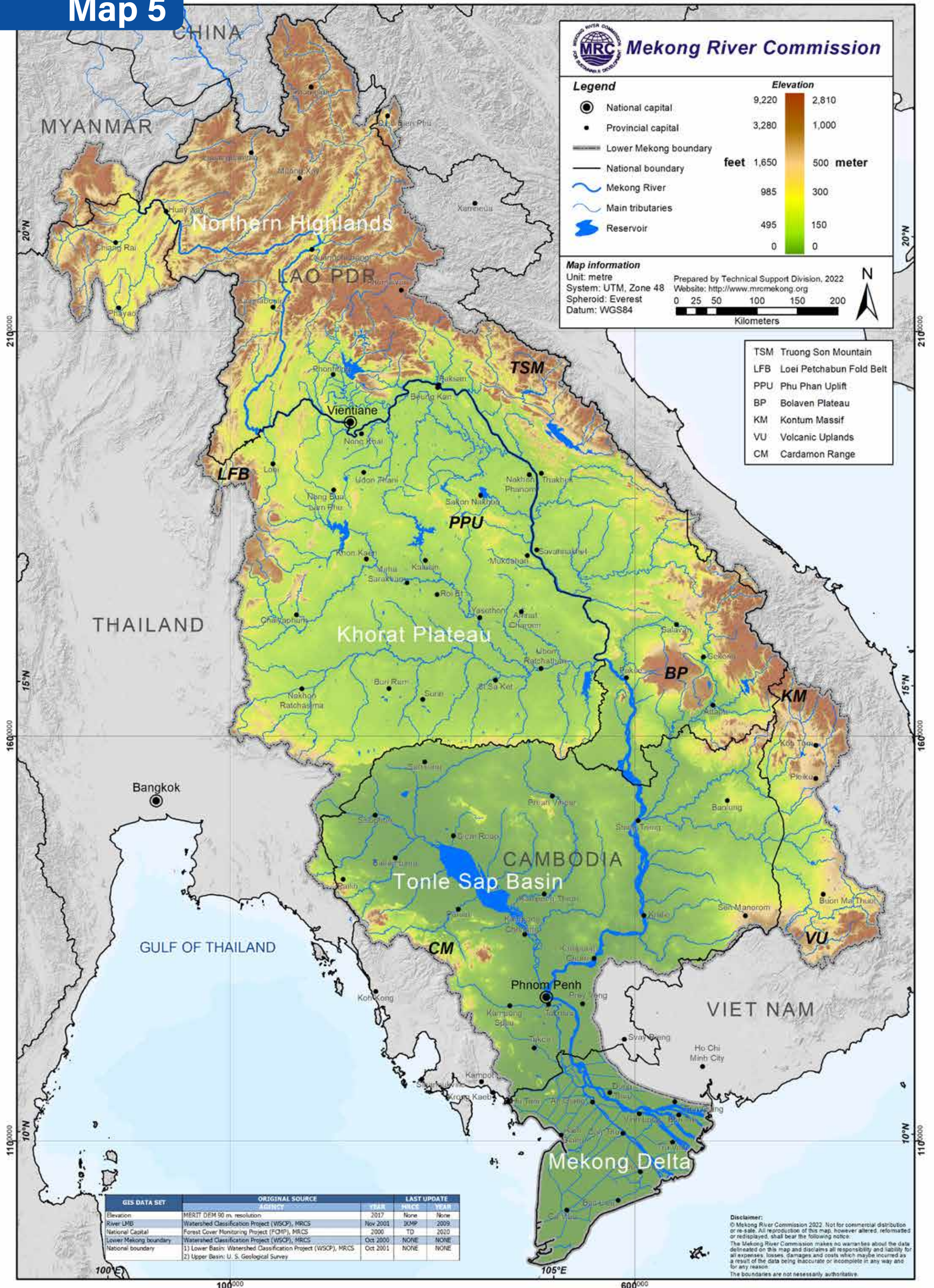
The notion of sub-areas in the LMB was introduced to facilitate the planning process. Sub-areas serve as a means to identify and categorize zones for the integrated management and development of water and water-related resources. Utilizing smaller planning units, as opposed to considering the entire LMB or individual countries, offers several advantages, including:

- ◆ enhanced coordination across various sectors;
- ◆ closer alignment with existing developments;
- ◆ increased stakeholder involvement;
- ◆ decentralization, fostering the potential for grassroots, community-driven planning; and
- ◆ the ability to define regions with shared planning concerns that transcend national boundaries.

Over the years, sub-area activities have played a pivotal role in evaluating and managing the region's water resources. These activities encompass comprehensive assessments of water-related resources, the formulation of strategic scenarios specific to each sub-region, and the development of strategies tailored to their unique requirements. These efforts have been instrumental in identifying and prioritizing projects that align with the overarching objective of sustainable water management.

Table 4. Sub-area descriptions and areas

Regional & catchment groupings	Sub-area code	Country	Area (sq.km)
A: Northern Highlands			
Northern Lao PDR	1L	Lao PDR	80,100
Chiang Rai, northern Thailand	2T	Thailand	17,265
B: Central Plateau & Highlands			
Nong Khai/Songkhram	3L	Lao PDR	3,295
	3T	Thailand	47,252
Central Lao PDR	4L	Lao PDR	86,911
Mun/Chi river basin	5T	Thailand	119,040
C: Southeast Highlands			
Southern Lao PDR	6L	Lao PDR	15,861
Northern Cambodia	6C	Cambodia	3,210
	7L	Lao PDR	22,580
	7C	Cambodia	26,368
Se San / Sre Pok / Se Kong river basins	7V	Viet Nam	29,242
D: Southern Region			
Kratie	8C	Cambodia	22,675
Tonle Sap basin	9C	Cambodia	81,916
Sa Kaeo/Chantaburi	9T	Thailand	4,114
Mekong delta	10C	Cambodia	23,055
	10V	Viet Nam	34,070



Elevation

The elevation of the LMB ranges from just over 2,800 m above mean sea level (amsl) to zero at the coast in the Delta in Viet Nam. Major topographic features and broad physiographic regions are depicted on this map, showcasing land surface elevation across the Basin. Throughout the Basin, mountain ranges stand as testament to a lengthy and intricate tectonic history (Brookfield, M.E., 1998).

Four distinct physiographic regions, as described by MRC and outlined below, (MRC, 2018) characterize the basin's key attributes.

Northern Highlands

Encompassing the upland areas of northern Lao PDR and northern Thailand, the Northern Highlands contain steep-sided valleys where the Mekong River and its major tributaries flow. Many valleys, especially in the west, are part of the Loi-Petchabun fold belt, a significant regional structural feature. Some areas of the Mekong River and its tributaries, such as near Chiang Saen and Huay Xai, expand to develop floodplains.

Khorat Plateau

The Khorat Plateau, uplifted and tilted to about 300 m amsl, is bounded by a resilient sandstone ridge along its western and southern perimeters. The Annamite Mountains flank its eastern boundary, while the central eastern area features the Phu Phan Uplift. This uplift divides the plateau into two sub-basins: Sakhon Nakhon/Savannakhet Basin to the north and Min/Chi Basin to the south. While the central Khorat Plateau is predominantly flat or gently folded, rivers like Songkhram, Chi and Mun have low gradients and wide floodplains.

Tonle Sap Basin

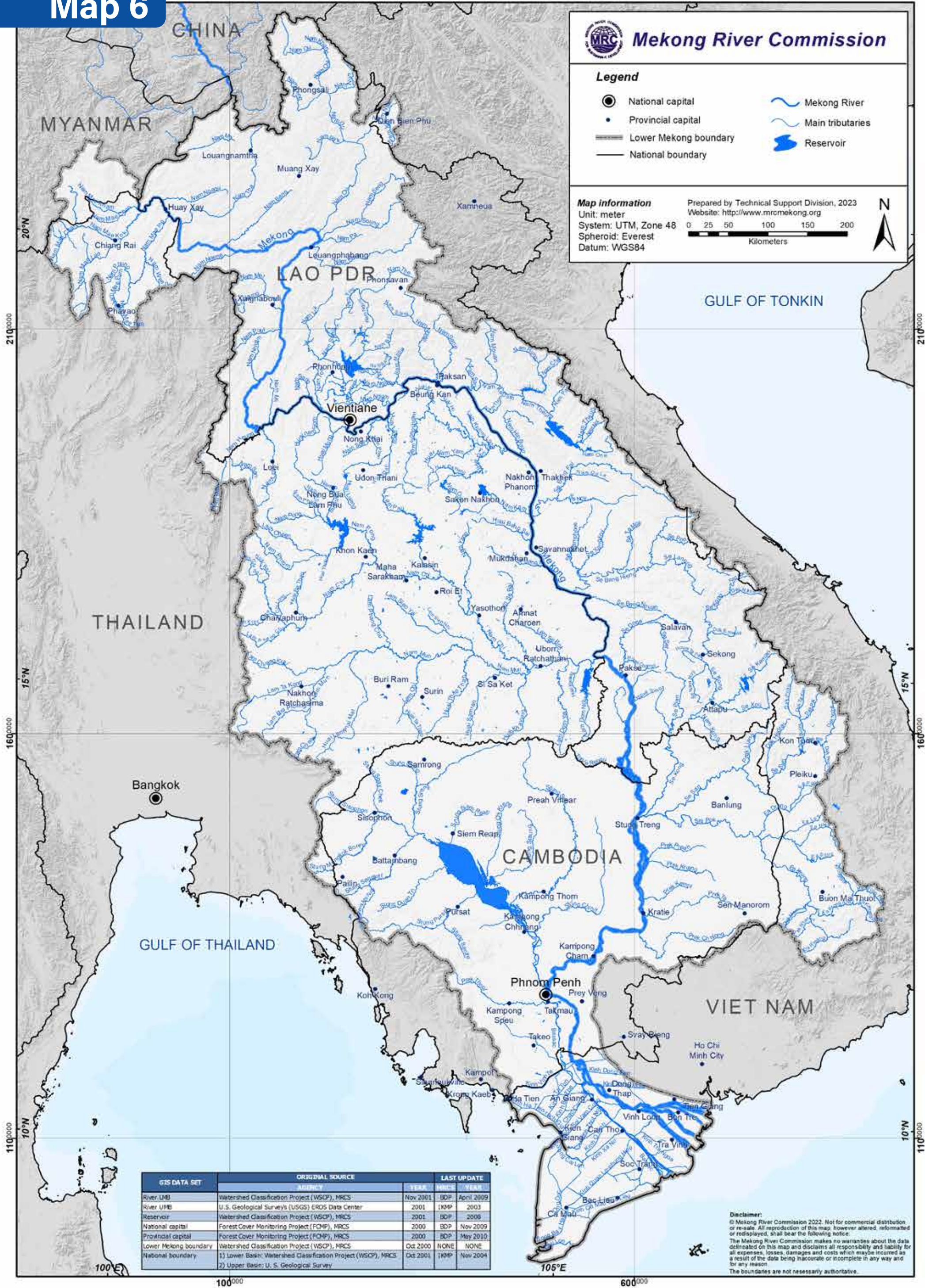
The Tonle Sap Basin takes the form of a large dome-like geological structure that has been 'unroofed' through erosion. Low-gradient and low-relief landscapes characterize the western and central regions. The basin's northern boundary comprises the ridge of the Khorat Plateau's southern edge and the Cardamon Range in the southwest. Basaltic lava flows shape upland areas in the LMB's southern region, including the Bolaven Plateau east of Pakse and northern areas near Ho Chi Minh City.

The Mekong Delta

The Mekong Delta plain covers an area of 62,520 km². The Delta begins below Kratie around upper Kampong Cham province and at Phnom Penh the Mekong River splits into two main distributary channels: the Mekong and Bassac Rivers, which further downstream split into nine smaller channels that discharge into the sea. The Delta plain can be divided into two regions: the inner delta plain located upstream and dominated by fluvial (river) processes, and the outer delta plain located nearer the sea and subject to marine processes such as the influence of tides, waves and ocean currents (Nguyen et al., 2000; Ta et al., 2002). The outer delta is of slightly higher elevation than the inner delta due to the formation of sand dunes and ridges near the coast.

The Multi-Error-Removed Improved-Terrain Digital Elevation Model (MERIT DEM) (Yamazaki D. et al. 2017) was used for the elevation data for this map. The MERIT DEM was developed by removing multiple error components (absolute bias, stripe noise, speckle noise and tree height bias) from the existing spaceborne DEMs (SRTM3 v2.1 and AW3D-30m v1). It represents the terrain elevations at a 3-second resolution (around 90 m at the Equator). After the error removal, land areas mapped with 2 m or better vertical accuracy were increased from 39% to 58%. Significant improvements were found in flat regions where height errors larger than topography variability, and landscapes such as river networks and hill-valley structures became clearly represented.

Map 6



Rivers

Map 6 shows the intricate drainage configuration within the LMB, as well as the sinuous course of the Mekong River and the convoluted network of both major and minor tributaries. For a clearer understanding, minor watercourses are deliberately omitted from the map. It should be noted that the longest tributaries are the Mun and Chi Rivers in northeast Thailand, the Nam Ou in northern Lao PDR, and the Se Kong, Se San and Sre Pok rivers in the southern part of the basin.

The Mekong River tributaries fall into two groups: left-bank tributaries, which originate from regions with high precipitation and that contribute substantially to the river's flow during the wet season, and right-bank tributaries that drain into terrain characterized by relatively subdued relief and lower rainfall.

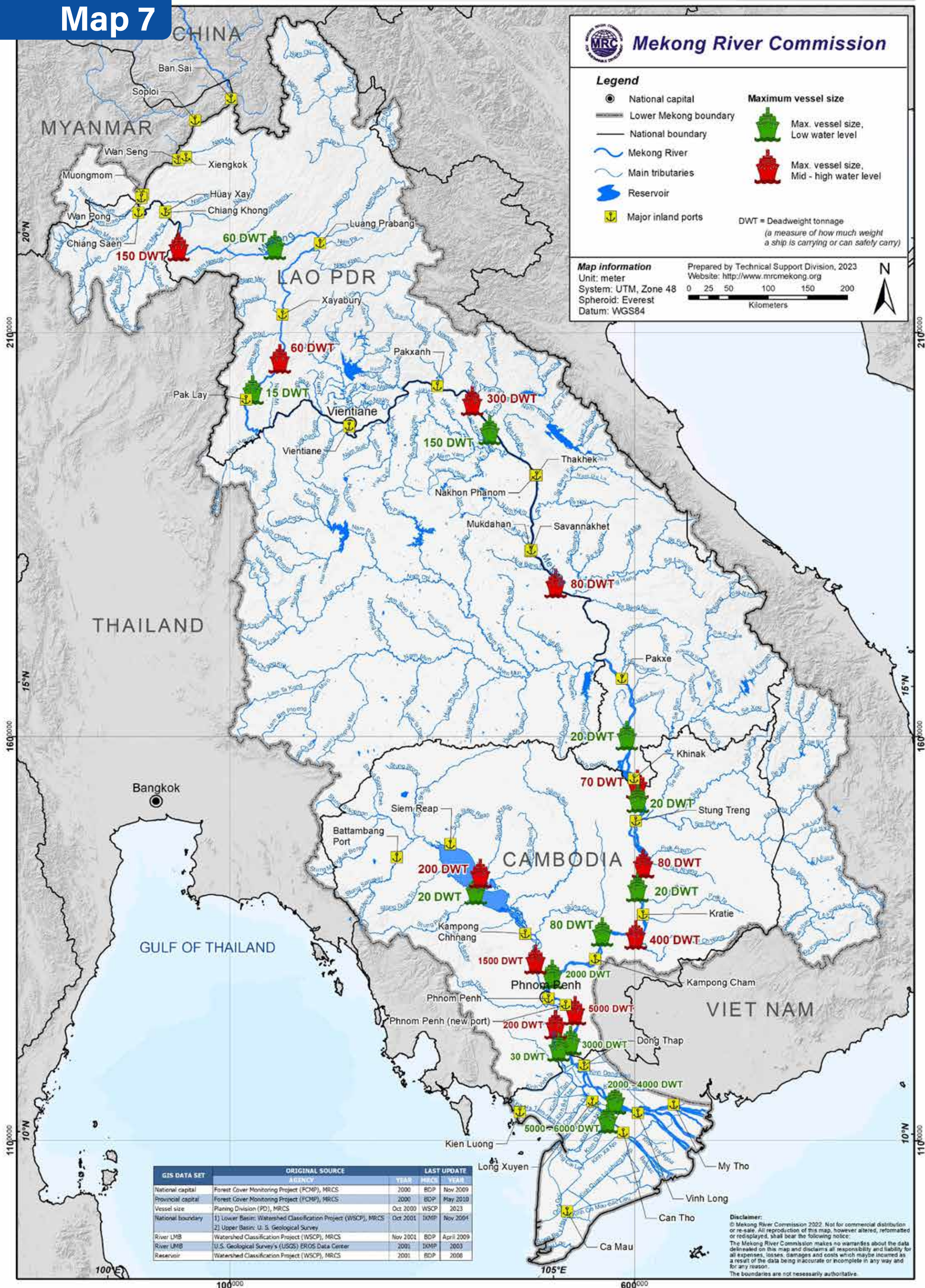
Within China's Yunnan Province, the Upper Mekong River Basin witnesses the convergence of diminutive tributaries. As the river flows through the Northern Highlands, it assimilates substantial left-bank tributaries such as Nam Ta, Nam Ou, Nam Soung and Nam Khan while substantial right-bank tributaries, such as Nam Mae Kok and Nam Mae Ing, increase the Mekong's volume.

Downstream, as the primary channel crosses the Khorat Plateau, it merges with the Songkhram and Mun Rivers on the right bank, contrasting with the steeper left-bank tributaries, such as Nam Ca Dinh, Se Bang Fai and Se Bang Hiang.

Significantly, the Se Kong, Se San, and Sre Pok, referred to collectively as the 3S river basin, are the principal left-bank tributaries that merges with the Mekong. Additionally, the Tonle Sap River serves as a conduit, draining the Great Lake (Tonle Sap Lake) into the Mekong during the dry season, and has a reverse flow during the rainy season.

The Mekong River system has two major distributary channels, known as the Bassac River and the Mekong River, which diverge near Phnom Penh, the capital of Cambodia. This results in the distribution of the water flow from the Bassac River to the Mekong River, which irrigates a fertile alluvial plain in southern Viet Nam. The Mekong subsequently divides into six main channels and the Bassac into three to form the nine 'dragons' of the outer delta in Viet Nam.

Map 7



Navigation of the Mekong River

The Mekong River is a source of valuable natural resources and has extensive natural navigation potential. Waterborne transport along the Mekong River has served as one of the main modes of transportation between communities in the riparian countries since they first settled along its embankments, many centuries ago.

The Mekong River is being increasingly utilized for waterborne trade and tourism. While traditional forms of trade in small boats linking local communities has occurred for thousands of years and continues today, the river is also becoming an important international trade route. Each year, tonnes of goods are shipped via the Mekong for part of the transit chain between Kunming in China and Bangkok.

The navigation capacity of the Mekong River is highly variable as shown in Map 7 of deadweight tonnage (DWT), i.e. the maximum weight a ship can safely carry in various river reaches. The location of all ports on the Mekong mainstream and the Tonle Sap River are also shown. Much of the Lower Mekong River is cut into bedrock and flows through steep and narrow valleys.

The influence of bedrock is intermittent but extends downstream to within 20 km of Kratie in Cambodia, placing a major constraint on the navigation potential of the river. Rapids, narrow channels, strong currents and tight bends limit the size and weight of vessels able to safely navigate bedrock reaches.

Navigation is further limited by the prolonged dry season, when water levels drop to as low as 2–5 m along the thalweg (line of deepest flow along a river) of alluvial reaches and 5–10 m in bedrock reaches. In bedrock reaches, flow is often limited to a narrow inner channel cut into the much wider outer channel that carries the wet season flow. The narrow channel width poses safety risks for two ships passing each other. Furthermore, outcrops of bedrock in the riverbed become exposed at low flows creating additional hazards for ships. Partially submerged rocks also pose great hazards. In alluvial reaches, deposition of large sand bars towards the end of the wet season pose draft restrictions as water levels continue to drop through the dry season, especially in the alluvial reach between Vientiane to Savannakhet where low water DWT is only 150 T compared with 2,000–3,000 T in alluvial reaches downstream of Kampong Cham in Cambodia. The navigation capacity of various river reaches is summarized below and based on the Master Plan for Regional Waterborne Transport in the Mekong River Basin of the MRC.

Golden Triangle to Louangphabang (362 km)

Year-round navigation is possible but hampered by rocky passages and strong currents. The maximum capacity is 70 T at low water levels and 150 T at mid-high water levels. The channel width and depth are highly variable but the channel is generally deeper than the next reach.

Louangphabang to Vientiane (425 km)

This is one of the most difficult reaches for navigation due to strong structural controls on the river with extensive bedrock exposed in the bed and banks. Navigation capacity is limited to 60 T at mid-high water levels. During the dry season, only small boats (max. 15 T) and skilled pilots can negotiate the swift currents combined with sharp bends and frequent bedrock obstructions in the narrow and winding inner bedrock channel of this reach.

Vientiane to Savannakhet (459 km)

Navigation is possible year-round in this wide alluvial reach but restricted to 150 T during low water conditions and 300 T during mid to high water levels. During the low water season, draft restrictions must be observed due to shallow sand bars and occasional rocky outcrops.

Savannakhet to the Lao PDR-Cambodian border (419 km)

South of Savannakhet, numerous rapids extending along 60 km of the river in the vicinity of Khemmarat restrict navigation to mid to high water levels and a maximum DWT of 80 T. The Mekong River is a narrow and winding bedrock channel as it crosses a mountain range from the Phu Phan Uplift to the edge of the Khorat Plateau.

Lao PDR-Cambodian border to Kratie (168 km)

Although a number of rapids make navigation difficult, 400 concrete beacons have been installed since 1910 to mark the navigation channel. During high water levels, vessels of up to 50–70 T can pass, while dry season navigation is restricted to vessels of only 15–20 T. Khone Falls, a 10-m high waterfall located near the Lao PDR – Cambodian border, creates an absolute barrier to navigation.

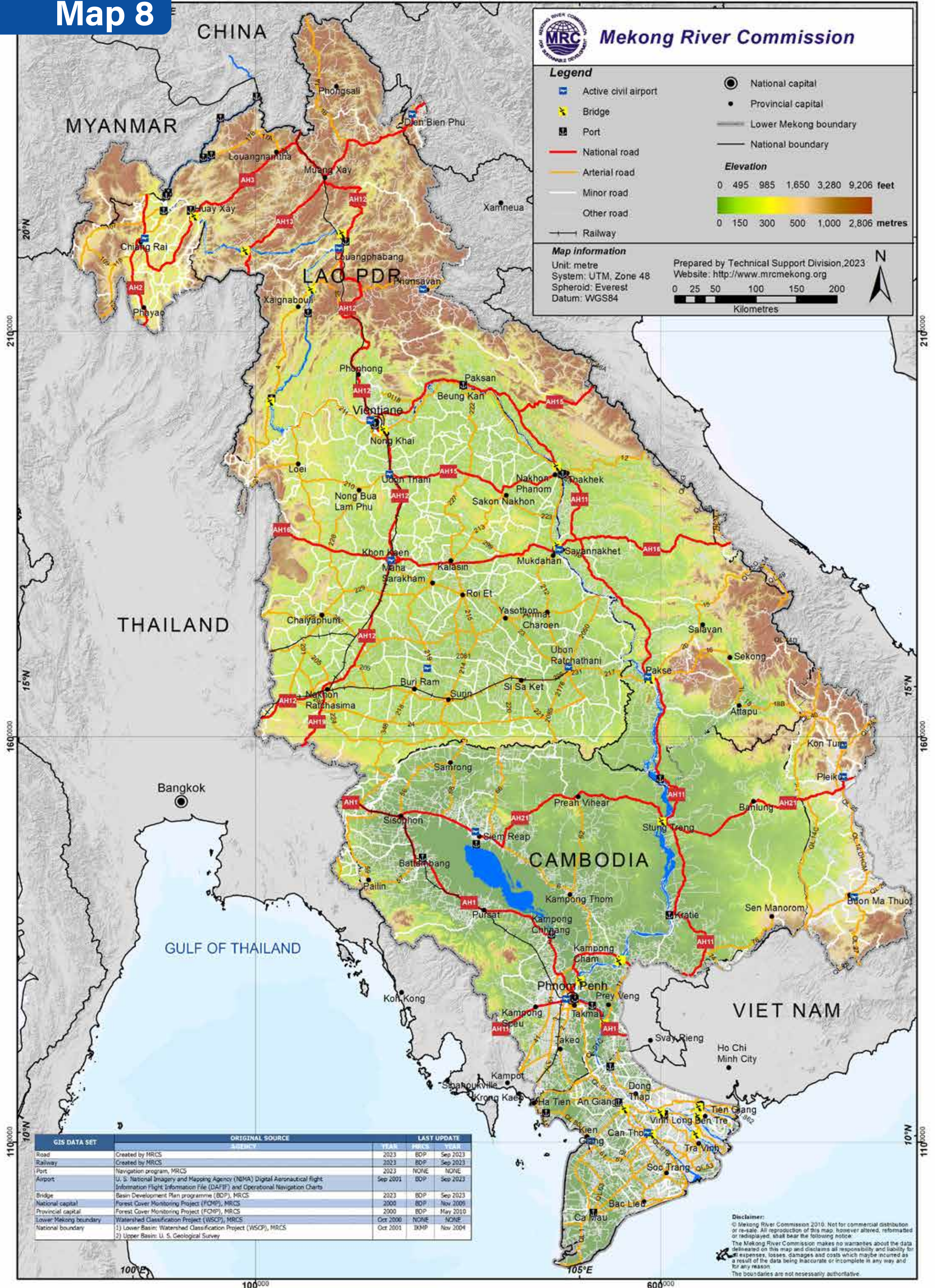
Kratie to Phnom Penh (213 km)

Downstream of Kratie, there is an abrupt change to an alluvial channel without bedrock control. Navigation capacity between Kratie and Kampong Cham increases to 400 T at mid-high water levels, and 80 T at low water levels. Deposition of sandy sediment on the riverbed during the dry season limits the available draft for vessels. Navigation capacity increases with distance downstream to the delta and is due to steady increase in thalweg depth associated with downstream fining of bank sediments, which increases bank strength and forms a narrower and deeper channel. Maritime ships with a 4-m draft, equivalent to around 2,000 DWT, can easily reach Kampong Cham from the sea year round provided that proper navigation systems and river maintenance are ensured.

Phnom Penh to the sea

Phnom Penh can be reached by maritime vessels up to 4,000–5,000 DWT. The proximity to the sea means that the difference between wet and dry season water levels is much smaller than upstream river reaches, and this DWT can be maintained throughout the year. The Bassac River distributary between Phnom Penh and the Vam Nao Pass (a short channel linking the Mekong and Bassac distributaries in Viet Nam) has a low DWT capacity of 400 T. However, downstream of the Vam Nao Pass, the Bassac River has the larger capacity of up to 5,000 T.





Transportation

Transportation within the LMB predominantly relies on the Mekong River and its various tributaries, acting as the primary conduit connecting towns and nations along its banks. The river serves as a crucial means of accessing essential resources and community services, such as schools and healthcare. Furthermore, it has assumed an increasingly vital role in facilitating international trade routes, linking the Mekong countries with each other and the global community.

There are various modes of transportation within the LMB, as described below.

Waterborne transport: This category encompasses navigation, cargo and passenger transportation on the river and its branches. Navigation is facilitated through enhancements to the waterway, including the removal or relocation of rocky obstacles, rendering the river navigable for larger cargo vessels. Cargo transport involves the movement of diverse goods across borders, such as petroleum, cement, steel, coal, fertilizers and agricultural products. Passenger transport contributes significantly to the development of tourism, attracting thousands of tourists from China, Thailand and Lao PDR. There is a wide array of vessels, from small traditional craft to sizable inland and seagoing vessels, that travel along the river.²

Road transport: This mode comprises bridges, roads and highways that connect various towns and cities across national borders. The construction of these infrastructures has streamlined the movement of people and goods across borders while the development of ports and riverine terminals has enhanced the efficiency of cargo transportation along the river. Road transport also provides access to remote areas that are not accessible by water. Nevertheless, road transport faces several challenges such as traffic congestion, road safety concerns, environmental impacts and maintenance costs.

Rail transport: This mode involves the establishment of railways and the operation of trains linking major urban centres and industrial zones in the region. Rail transport is a relatively cost-effective and environmentally friendly means of moving significant volumes of passengers and freight. However, its potential is constrained by the lack of connectivity and interoperability among diverse railway systems within the region. Issues related to land acquisition, resettlement, financing and coordination among various stakeholders also need to be addressed.



² <https://www.mrcmekong.org/navigation/>





ENVIRONMENTAL DIMENSION

Core river monitoring network stations

- » Discharge and sediment monitoring
- » Ecological health monitoring
- » Fishery monitoring
- » Hydrometeorology monitoring
- » Water quality monitoring

Deep pools

Rapids

Protected areas

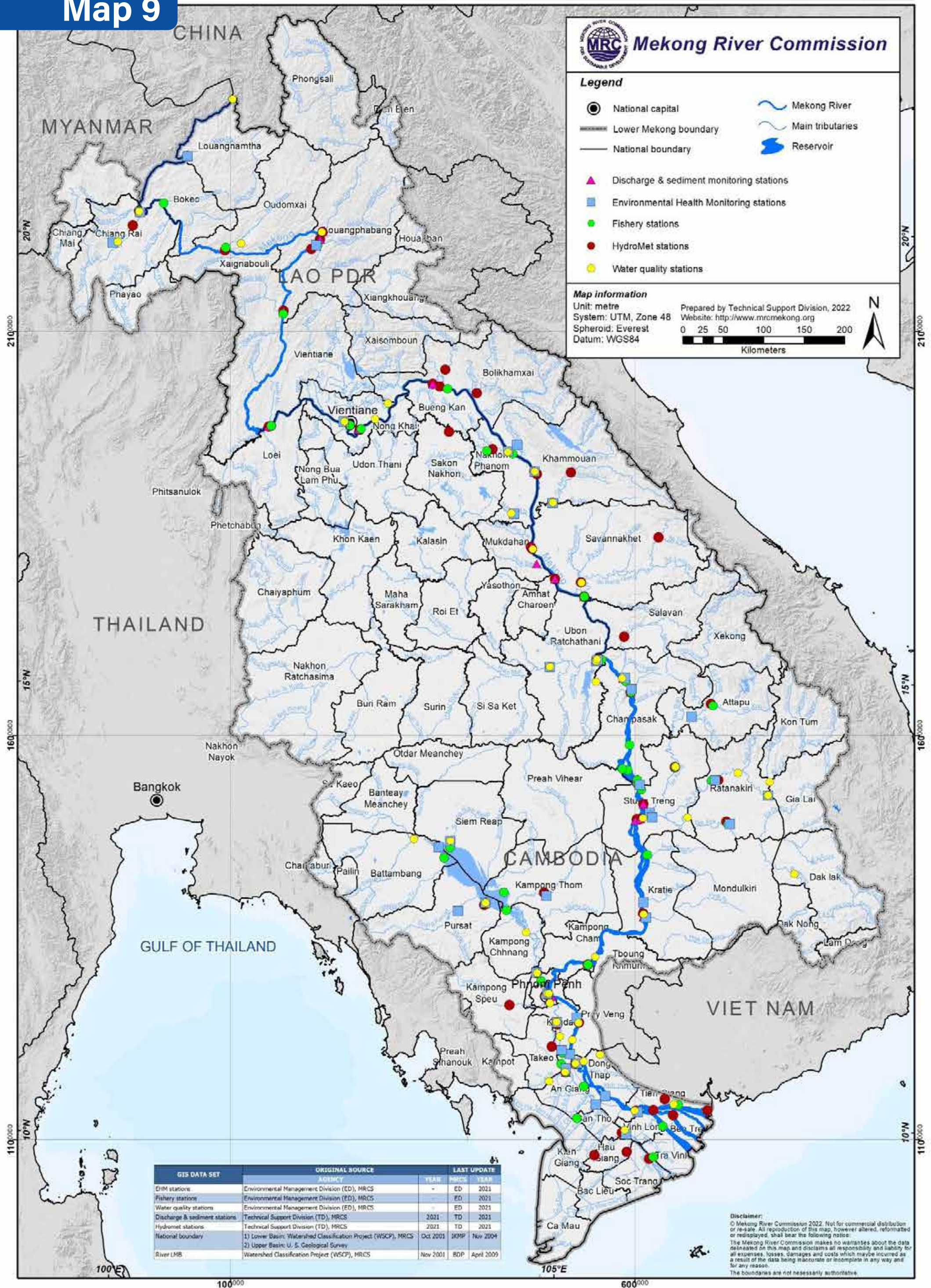
Fish habitat

Land use land cover 2020

Wetlands 2020

Core river monitoring network stations

Map 9



Core river monitoring network stations

The MRC 2019 Mid-Term Review (MTR) identified issues in the decentralization of the Core River Basin Management Function (CRBMF) activities. In response to the issues raised in the MTR, a Core River Monitoring Network for the Mekong mainstream is identified as a key output of the Basin Development Strategy (BDS) 2021–2030.

The Core River Monitoring Network (CRMN) monitors five environmental disciplines: hydrology, sediments, water quality, ecological health and fisheries. This Network consists of a minimum set of stations or sampling locations that provides critical data to enable the MRC to perform the CRBMFs.

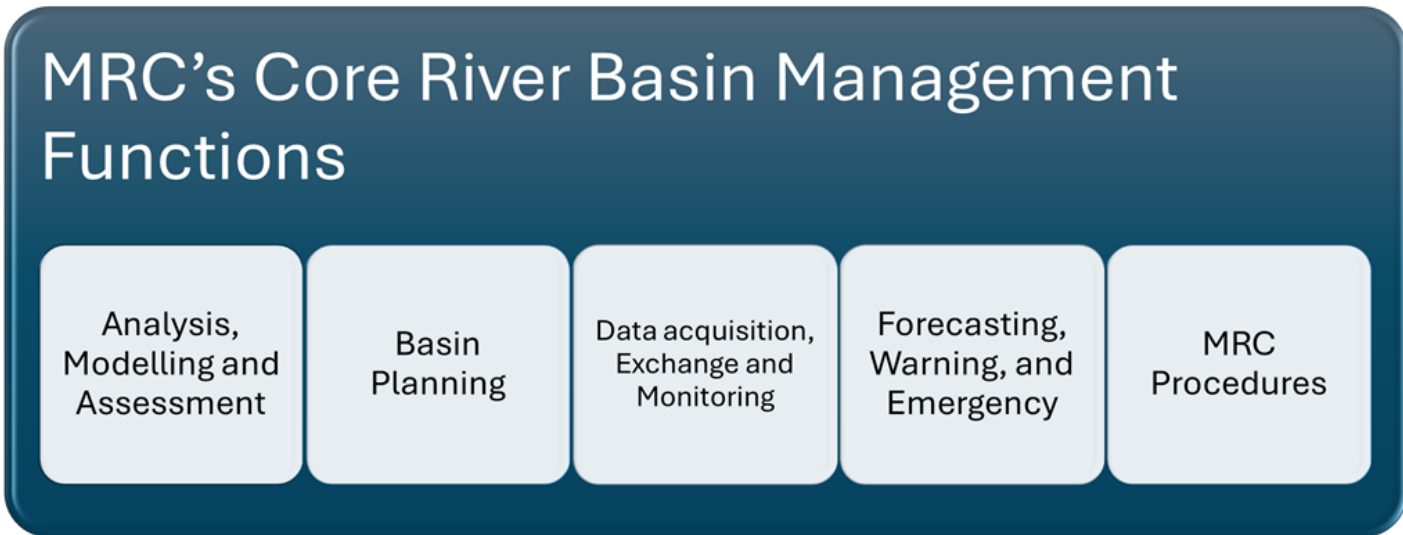


Figure 1. MRC's Core River Basin Management Functions.

The CRMN should be fit-for-purpose, financially affordable and cost-effective. Therefore, the CRMN does not include all stations in the basin, but only a subset of the most important stations for the CRBMFs.

To ensure its independence, the CRMN only includes the stations for which the MRC controls the monitoring. Excluded from the CRMN are stations from dam operators and all stations belonging to, or products produced by, third parties, such as satellite data and products from meteorological models. These data can reduce the need for monitoring included in the CRMN.

The broader monitoring network is made of the monitoring stations that are not included in the CRMN, because they are not a top priority for the MRC to undertake its basic core functions. They may still be a top priority for national needs. The non-CRMN sites are nevertheless important for the MRC functions. The broader network consists of stations that are complementary to the CRMN.

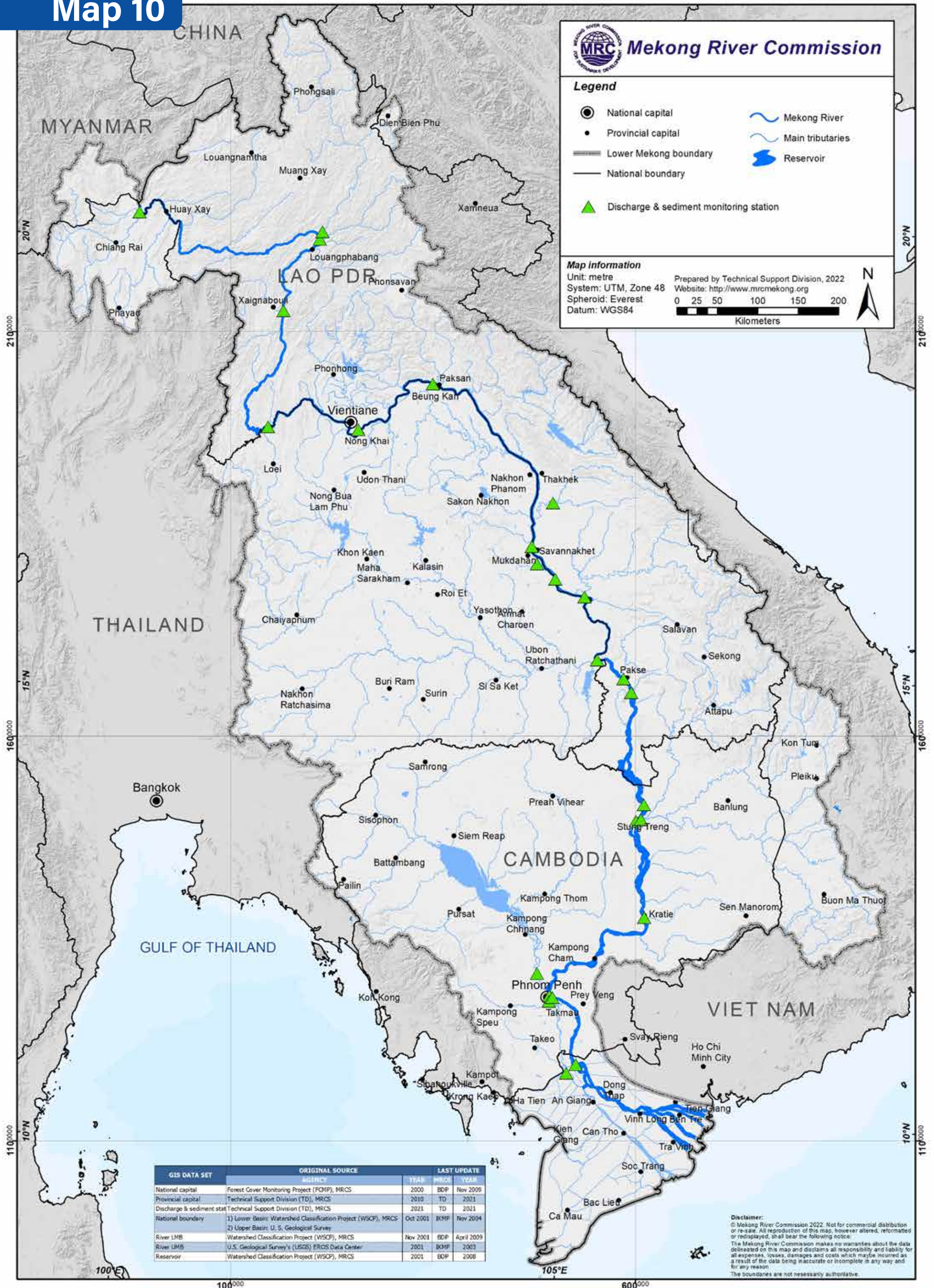
The CRMN will only provide a fundamental view of the state of the Mekong River in terms of hydrology, sediments, water quality, ecological health and fisheries, with a specific focus on:

- | | |
|----|---|
| 1. | Monitor and assess changing river conditions, |
| 2. | Monitor the impacts of water infrastructures operations, |
| 3. | Improve the accuracy and timeliness of flood and drought forecasting, |
| 4. | Inform on changes on socio-economic conditions. |

Map 9 shows the CRMN stations that monitoring five environmental disciplines distinguish by different color and symbol. However, the individual monitoring station could be referring to the maps in page 26-42.

Discharge and sediment monitoring

Map 10



Discharge and sediment monitoring

Recognizing that development activities in the Mekong River Basin can alter the hydrological, physical and ecological characteristics of the river, which may have economic and social consequences, the MRC established the Discharge and Sediment Monitoring Programme (DSMP) in 2009. The DSMP equips Member Countries with the necessary tools and expertise to conduct precise sediment measurements, thereby enhancing their understanding of sediment transport in the Mekong River. The DSMP also aims to obtain discharge measurements for updating the water-discharge rating curves at these stations. A rating curve represents the relationship between water level and discharge, allowing to estimate continuous time-series discharge based on continuous water level measurements.

This map shows sites for discharge and sediment measurement activities. DSMP initiatives involve monthly measurements during the wet season (four times) and one to two times per month during the dry season. Lao PDR and Thailand jointly conduct measurements at the Mekong mainstream stations located between these two countries, while the measurements at the remaining stations in Cambodia, Lao PDR and Viet Nam are conducted individually according to their station-specific requirements.

Across all MRC monitoring stations, sediment measurements at only two sites (Chiang Saen and Sekong Bridge) have not displayed an apparent declining trend in suspended sediment concentrations or loads since 2009. Nevertheless, sediment concentrations at Chiang Saen had already significantly declined before 2009, suggesting that sediment transport has stabilized at a considerably lower level (Figure 2).

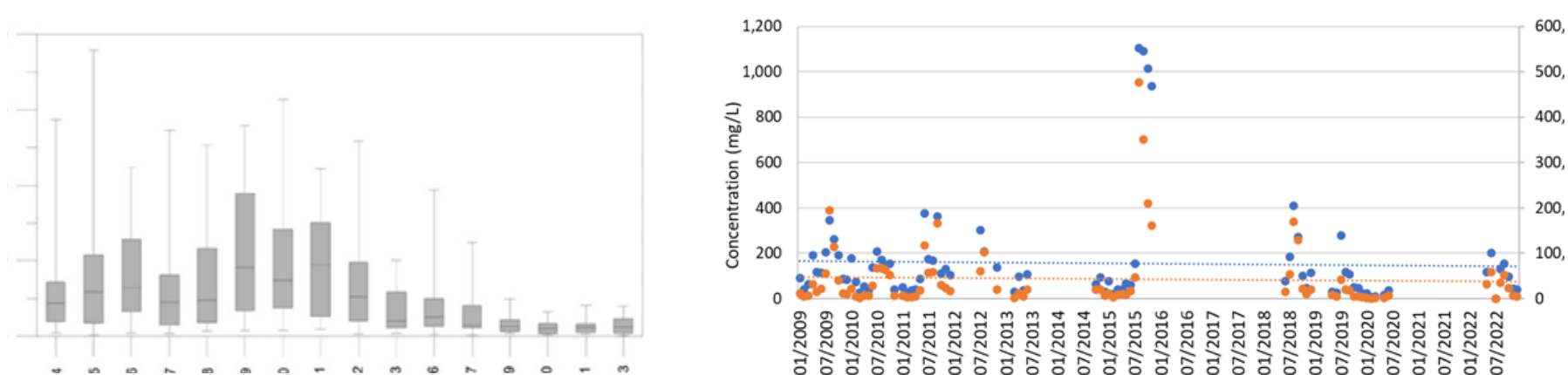


Figure 2. Suspended sediment concentrations at Chiang Saen

A statistically significant reduction ($p < 0.05$) in average daily sediment loads was observed at Mukdahan, Choy Chang Var, Koh Norea and Phnom Penh, as well as in suspended sediment concentrations at Tan Chau (Figure 3). Average daily sediment loads have decreased by over 75% at Mukdahan since 2009 and by around 70% at Phnom Penh since 2011. Suspended sediment loads at Tan Chau have nearly halved since 2009.

Based on the analysis presented in Figure 4, it is evident that sediment transport in the Upper Mekong River Basin has significantly decreased over the past 10 to 20 years. This decline is not confined to a specific stretch of the river, but has been observed at sites along the river all the way to Tan Chau, where sediment holds potential significance for the construction and maintenance of the Mekong Delta.

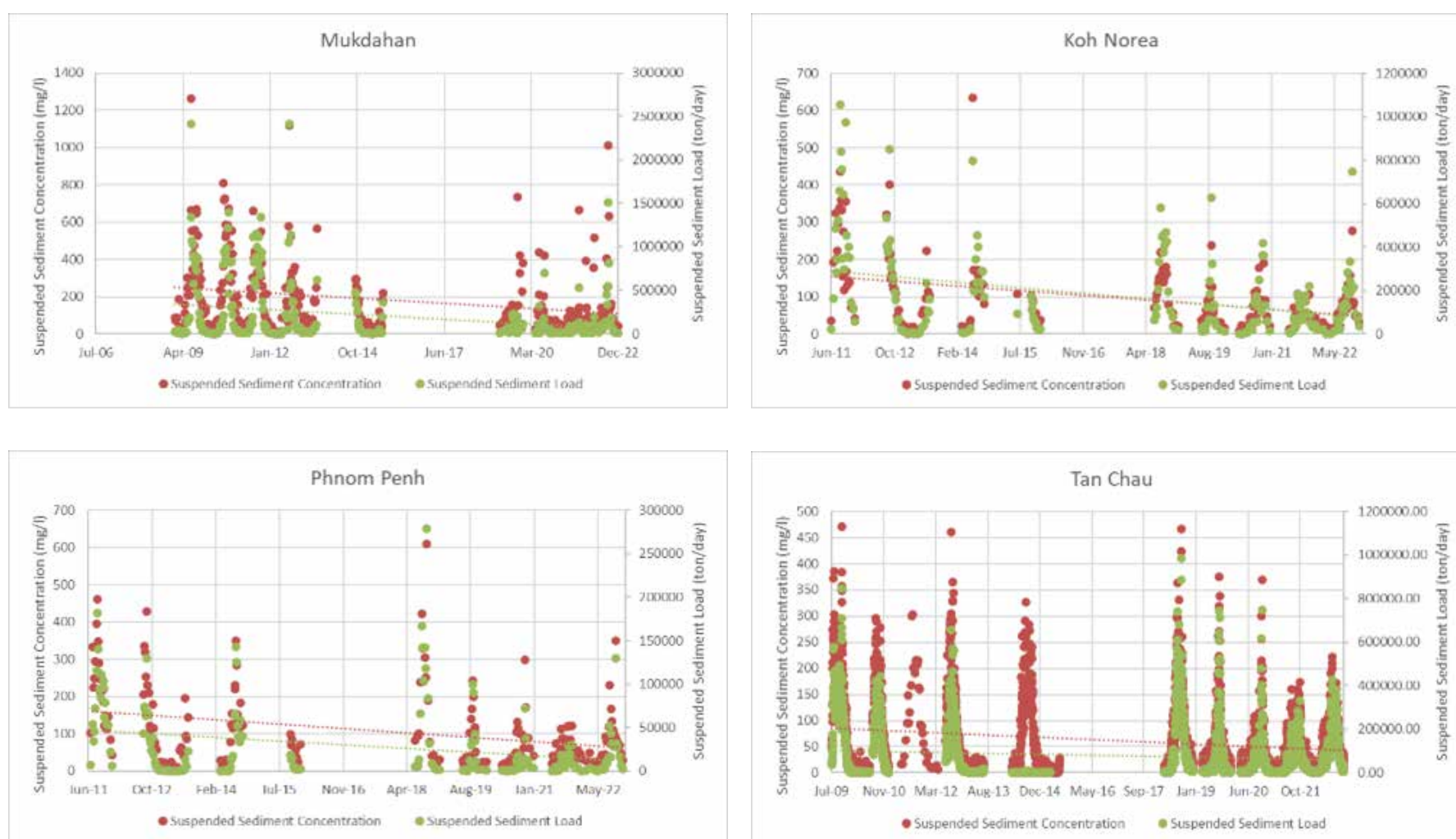
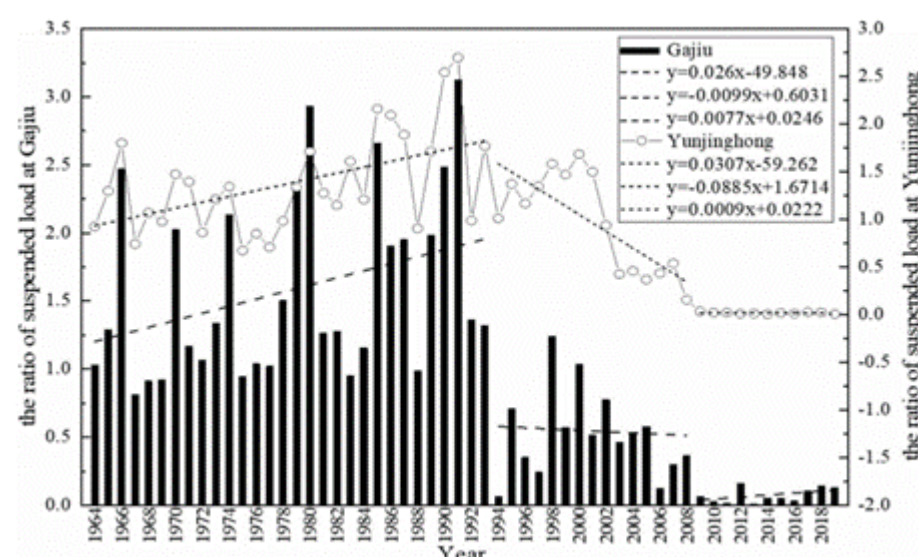


Figure 3. Suspended sediment concentrations and loads between 2009 and 2022 at selected DSMP stations for which a statistically significant trend in daily sediment loads was observed.



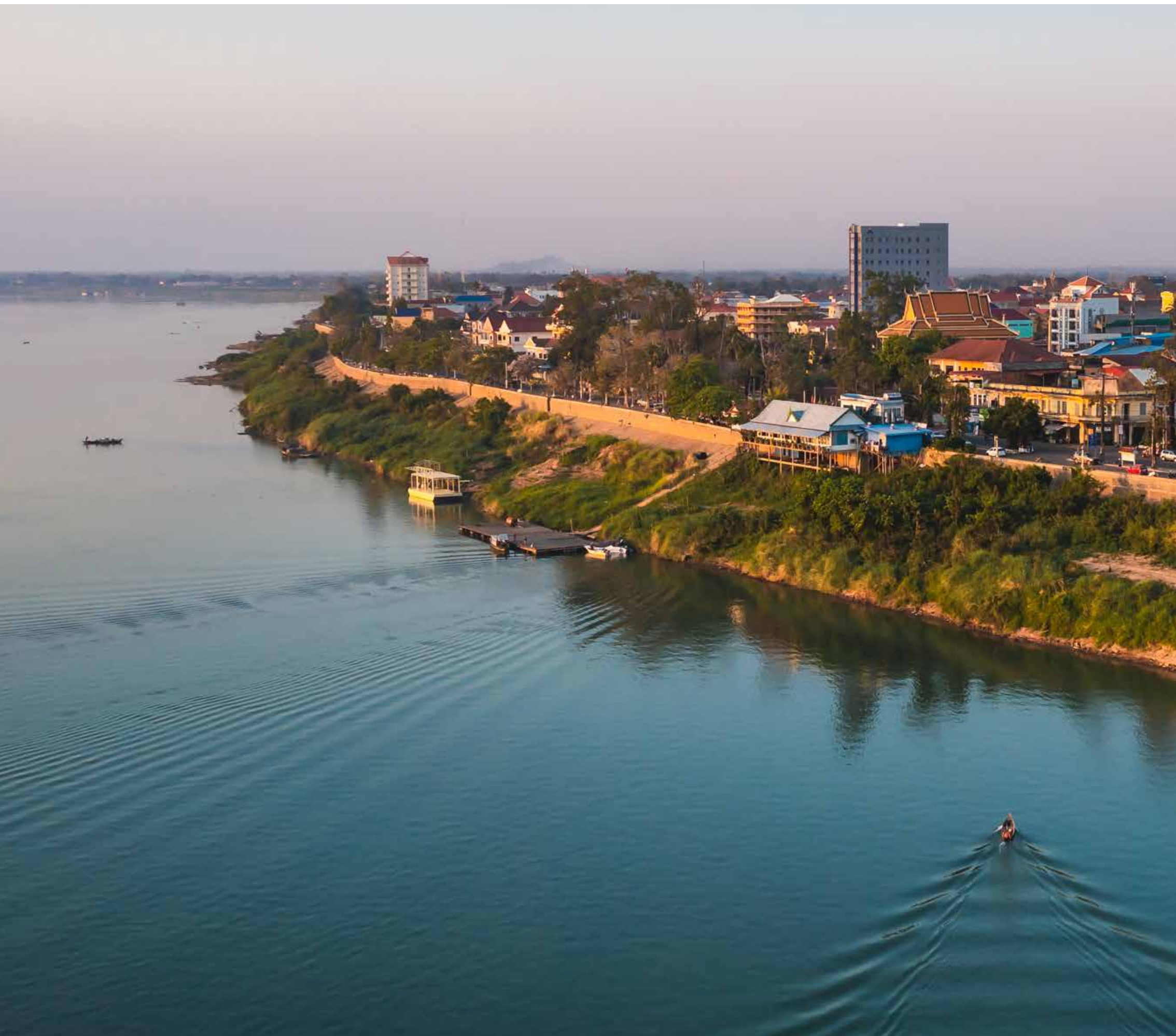
Source: Sun et al. (2022)

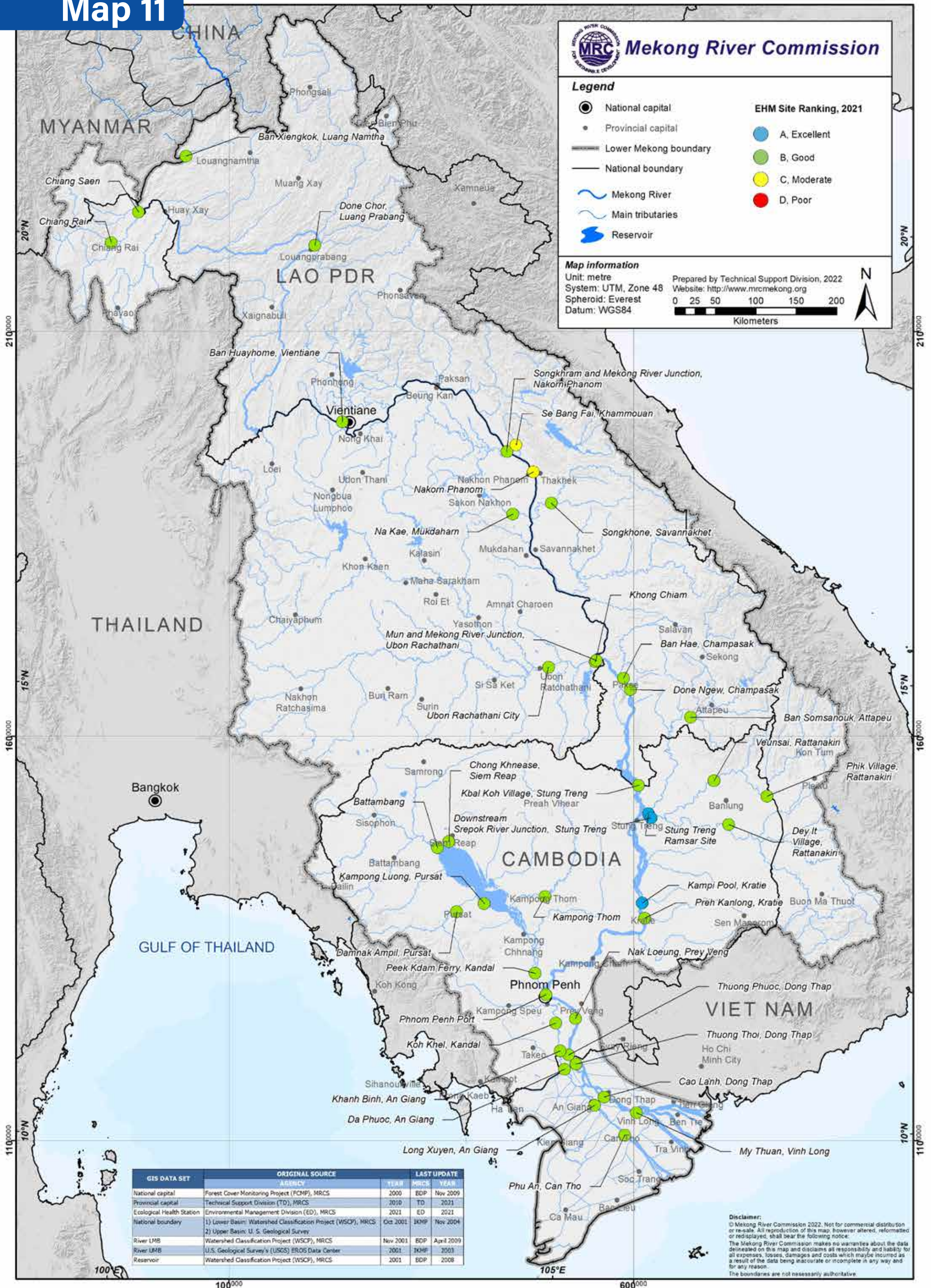
Figure 4. Normalised annual suspended load at Gaiju and Yunjinghong between 1964 and 2019

References and further reading

Discharge and Sediment Monitoring Programme data from the MRC data portal.

Sun, L., Sun, Z., Li, Z., Zheng, H., Li, C., and Xiong, W. (2022). Response of runoff and suspended load to climate change and reservoir construction in the Lancang River. *Journal of Water and Climate Change*, 13(4), 1966–1984. <https://doi.org/10.2166/wcc.2022.429>





Ecological health monitoring

In order to conduct ecological health monitoring, a total of 41 sites were assessed, such as rocky rapids and sandy-alluvial areas of tributaries and the mainstream, Tonle Sap Lake, and adjacent rivers including estuaries of the delta areas. Four groups of organisms are considered effective indicators of the health of the aquatic environment in the Mekong River Basin: benthic diatoms, zooplankton, littoral macroinvertebrates and benthic macroinvertebrates. Ecological health is evaluated based on the calculation of three metrics for each of these groups of organisms: average abundance, average richness and Average Tolerance Score Per Taxon (ATSPT). A healthy ecosystem is characterized by high average abundance, high average richness and low ATSPT. Each metric was calculated for individual samples of each group of organisms.

Based on the results of these calculations, the ecological health of the river has been relatively good in recent years. In 2021, 39 of 41 stations were rated as either 'excellent' or 'good' based on the ecological health classification for the LMB (Table 5). The number of stations rated as 'poor' declined from seven in 2013 to one in 2019 and then to zero in 2021, and only two stations were rated as 'moderate' in 2021, Se Bang Fai in Lao PDR, and Nakhon Phanom City in Thailand. Nevertheless, signs of ecological stress are evident in the values for ATSPT across all biological groups.

Trends in species abundance and richness are markedly different for different taxa and stations in each country. For benthic diatoms, the average abundance decreased over time in all countries except for Viet Nam, which saw substantial improvements, although this was mainly due to statistically significant increases at one station, Da Phuoc on the Bassac River. Average richness of diatoms improved most notably in Lao PDR at three stations and at one station in Viet Nam, while Cambodia saw declines, with a statistically significant ($p < 0.05$) decreasing trend at six stations.

Regarding average abundance and richness of benthic macroinvertebrates, there were large declines in Thailand, but improvements in Lao PDR, where three stations showed statistically significant improvements in abundance, and five stations showed statistically significant improvements in richness over the 2011–2021 period. One station in Cambodia also showed a statistically significant increasing trend in species richness, at Preh Kanlong station, Kratie.

Regarding average abundance and richness of littoral macroinvertebrates, Cambodia saw substantial improvements over the 2011–2021 period, although a statistically significant increasing trend ($p < 0.05$) was evident at only one station, i.e. Kampi Pool station, Kratie. A statistically significant declining trend in both abundance and richness was evident at one station, i.e. Nakorn Phanom City in Thailand.

Regarding average abundance and richness of zooplankton, there was general improvement across all four countries over the 2011–2021 period, with the most substantial increases in Cambodia. Statistically significant increases ($p < 0.05$) in abundance were evident at two stations in Cambodia, and increases in zooplankton richness at six stations in Cambodia.

The threshold values for the ATSPT were exceeded in 2021 for littoral macroinvertebrates at all stations, for benthic macroinvertebrates at 28 stations, for diatoms at 29 stations, and for zooplankton at 15 stations. In 2021, the ATSPT was exceeded at all stations in Viet Nam for all taxa, indicating sites that are under stress and more favourable to taxa that dominate in disturbed environments.

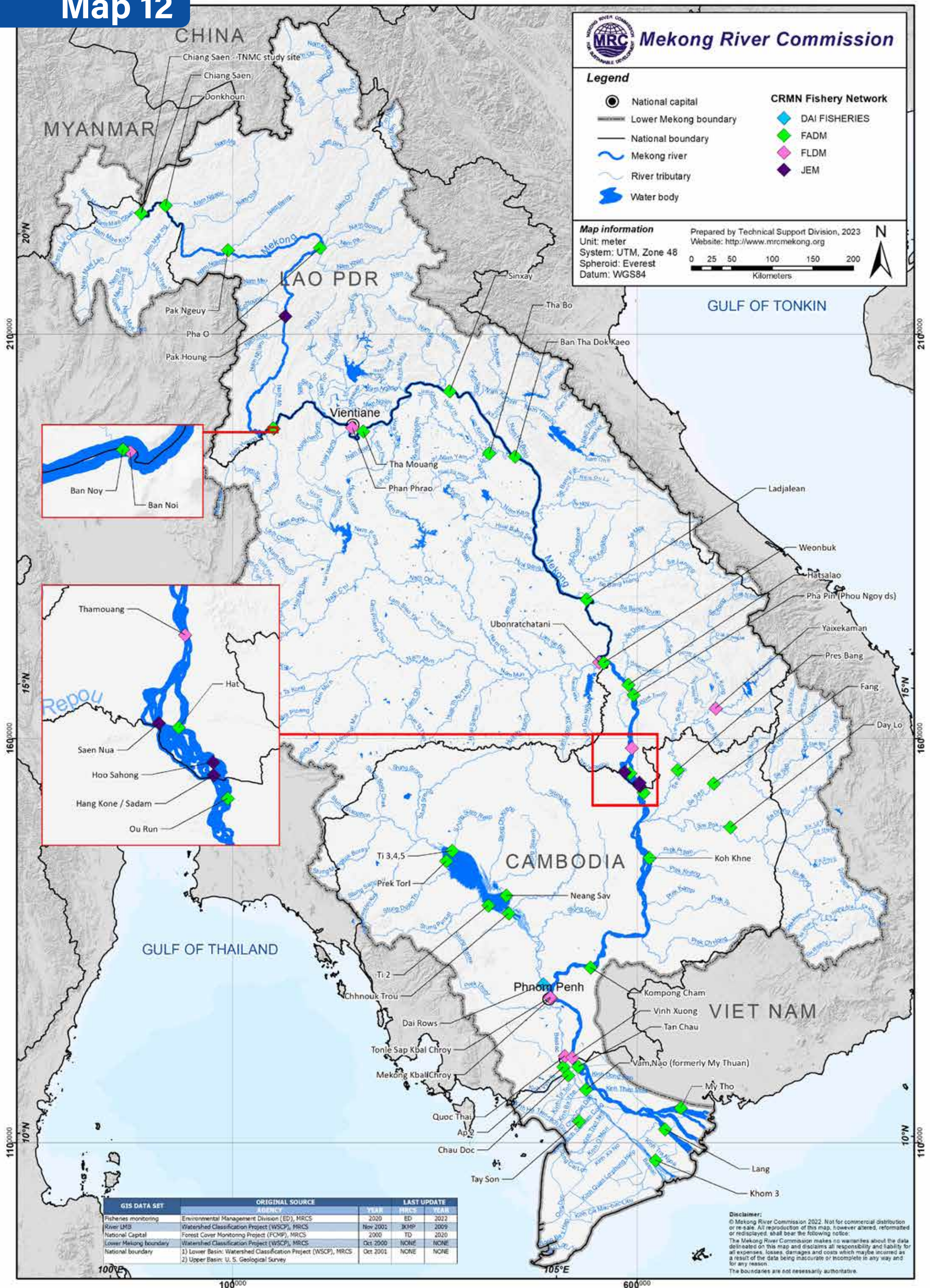
Over the 2011–2021 period, there was a statistically significant deterioration in ATSPT for diatoms at 10 stations, for benthic macroinvertebrates at 5 stations, and for littoral macroinvertebrates at 18 stations. ATSPT for zooplankton improved at two stations, both in Cambodia.

Table 5. Overall rating of ecological health for sites across the LMB, 2011–2021

Location	Waterbody	Site	2011	2013	2015	2017	2019	2021
Se Bang Fai, Khammouan	Nam Hin Boun	LBF	C	D	C	B	C	C
Songkhone, Savannakhet	Se Bang Fai	LBH	B	D	C	B	C	B
Done Ngew, Champasak	Mekong	LDN	A	D	B	B	B	B
Ban Hae, Champasak	Se Done	LSD	B	D	B	B	B	B
Ban Somsanouk, Attapu	Se Kong	LKL	C	D	B	C	C	B
Done Chor, Luang Prabang	Mekong	LPB	A	C	B	B	B	B
Ban Xiengkok, Luangnamtha	Mekong	LMX	D	C	C	B	C	B
Ban Huayhome, Vientiane	Mekong	LVT	C	D	B	B	B	B
Nakorn Phanom	Mekong	TNP	B	A	B	C	B	C
Songkhram and Mekong River Junction, Nakorn Phanom	Mekong	TSM	C	B	A	C	B	B
Na Kae, Mukdaharn	Nam Kham	TNK	B	A	B	B	B	B
Khong Chiam	Nam Mun	TMU	C	A	A	B	B	B
Mun and Mekong River Junction, Ubon Rachathani	Nam Mun	TKC	C	B	A	C	C	B
Ubon Rachathani City	Nam Mun	TUN	A	A	A	A	B	B
Chiang Saen	Mekong	TCS	B	B	B	D	D	B
Chiang Rai	Nam Mae Kok	TKO	B	B	B	C	C	B
Phnom Penh Port	Tonle Sap	CPP	B	C	C	B	B	B
Kampong Thom	Stung Sen	CSN	B	C	C	B	B	B
Battambang	Stoeng Sangke	CSK	C	B	B	B	B	B
Chong Khnease, Siem Reap	Tonle Sap	CCK	B	B	B	B	B	B
Damnak Ampil, Pursat	Stung Pursat	CPS	B	B	B	B	B	B
Koh Khel, Kandal	Bassac	CKK	B	B	B	B	C	B
Stung Treng Ramsar Site	Mekong	CKT	A	B	B	A	B	A
Preh Kanlong, Kratie	Prek Te	CPT	C	D	B	B	B	B
Dey It Village, Rattanakiri	Sesan	CUS	C	B	B	A	B	B
Veunsai, Rattanakiri	Sesan	CSS	B	C	B	B	A	B
Phik Village, Rattanakiri	Sre Pok	CSP	A	B	A	B	A	B
Kampi Pool, Kratie	Mekong	CMR	A	B	B	B	B	A
Kbal Koh Village, Stung Treng	Xekong	CKM	B	C	B	A	B	B
Downstream Srepok River Junction, Stung Treng	Sesan	CSJ	A	C	C	A	A	A
Nak Loeung, Prey Veng	Mekong	CNL	B	C	B	B	B	B
Kampong Luong, Pursat	Tonle Sap	CKL	B	B	B	A	A	B
Peek Kdam Ferry, Kandal	Tonle Sap	CTU	B	B	C	A	B	B
Phu An, Can Tho	Bassac	VCT	B	C	B	B	B	B
Long Xuyen, An Giang	Bassac	VLX	C	C	B	B	C	B
Da Phuoc, An Giang	Bassac	VDP	B	C	B	B	C	B
Khanh Binh, An Giang	Bassac	VKB	B	B	B	B	B	B
Thuong Phuoc, Dong Thap	Mekong	VTP	B	C	C	C	B	B
Thuong Thoi, Dong Thap	Mekong	VTT	B	C	B	B	B	B
Cao Lanh, Dong Thap	Mekong	VCL	B	B	B	B	C	B
My Thuan, Vinh Long	Mekong	VVL	C	C	B	B	B	B
A, Excellent			B, Good		C, Moderate		D, Poor	



Map 12



Fish monitoring

The Mekong River system is one of the most diverse and prolific inland capture fisheries in the world. Capture fisheries play an important role in securing livelihoods and nutrition for millions of people within the LMB countries. Fisheries monitoring is a core activity of the MRC Secretariat (MRCS) and has been put in place since the mid-1990s with the overall objective to measure yield and biodiversity indicators enabling interpretation of the status and trends of basin-wide capture fisheries, as well as providing an effective means of monitoring and assessing the effects of water management and basin development activities.

In 2019, the MRC developed the Mekong River Basin Indicator Framework (MRB-IF) to provide a consistent and streamlined approach to data collection, analysis and reporting. The MRB-IF defines five fisheries-related parameters: (i) fish abundance; (ii) fishing effort; (iii) fish size; (iv) fish diversity; and (v) diversity and abundance of introduced species, which need to be monitored to evaluate the condition and status of fisheries and other aquatic resources (MRB-IF/Assessment indicator no. 17) as well as to measure the status of environmental assets in the LMB (MRB-IF/Strategic indicator no. 6). Information to respond to these indicators is available from the MRC routine fish monitoring programme, which consists of three main activities: (i) Dai fisheries monitoring on the Tonle Sap River; (ii) Fish Larvae Drift Monitoring (FLDM); and (iii) Fish Abundance and Diversity Monitoring (FADM).

From 2025, the fisheries monitoring will be integrated into MRC Core River Monitoring Network (CRMN) together with the other four environmental disciplines, i.e. hydrology, sediments, water quality and ecological health, to better support for MRC Core River Basin Management Functions. The fisheries monitoring network under redesigned CRMN is made up of 38 FADM stations (including Dai fisheries) and 10 FLDM stations, i.e. 48 stations.

Fish Abundance and Diversity Monitoring

Three experienced full-time fishers were recruited at each monitoring site to collect fishing and catch data. The fishers were trained to record their daily catches using each gear type used on a fishing day and all habitat types in which they used these gears. Fishers had to record fishing effort accurately, including the dimensions of the fishing gear (including mesh size) and soak hours, in addition to species name (in local languages), number of individuals, weights and maximum length of each species in the catch. The information was recorded in handwritten form in logbooks provided to the fishers and regularly collected by the national fisheries line agencies. The national fisheries line agencies then cross-check and clean the data before submitting them to the MRCS for error checking and storing it in the MRC central database system.

From 2018 to 2022, the total amount of catch in Lao PDR and Thailand was very stable, and the highest annual change, of less than 19%, occurred in 2021. Between 2018 and 2021/2022, there was a clear pattern of declining fish catches at 60% in Cambodia. In Viet Nam, the amount of catch was stable between 2018 and 2020, and then increased by over 50% between 2021 and 2022 (Figure 5).

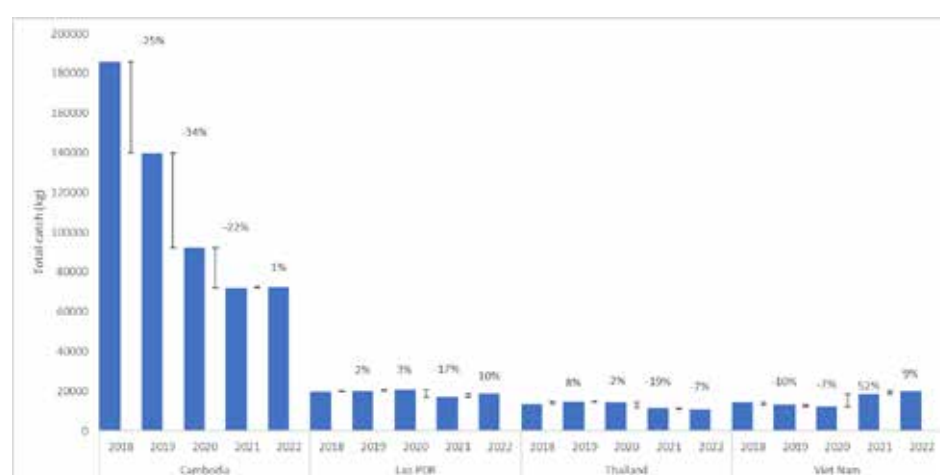


Figure 5. Total weight catch (kg) by country from the FADM monitoring stations in the LMB, 2018–2022

FADM station to monitor the effects of hydropower projects

The first hydropower project in the LMB's mainstream, Xayaburi HP, started its operation in 2019. FADM data in 2 stations, both the upstream (LXB) and downstream (LNS) of the Xayaburi HP (Figure 8) showed that the number of fish species and the H'-biodiversity index gradually decreased between 2018 and 2022.

FADM station to monitor the effects of hydropower projects

The first hydropower (HP) project in the LMB's mainstream, Xayaburi HP, started its operation in 2019. FADM data in two stations, both upstream (LXB) and downstream (LNS) of the Xayaburi HP (Figure 6), showed that the number of fish species and the score on the Shannon-Weiner diversity index (H') gradually decreased between 2018 and 2022.

From 2018 to 2021, the number of fish species at LXB drastically decreased by 65.33%, from 75 to 26, before increasing by 15.38% in 2022, from 26 to 30 species. At LNS, the number of fish species decreased by 43.37%, gradually decreasing from 83 to 47 species between 2018 and 2021, and then remained stable in 2022.

Between 2018 and 2022, the H' -biodiversity index at LXB showed 21.9% decrease in biodiversity, from 2.51 to 1.96, while, at LNS, there was an overall decrease by 13.59%, from 3.09 to 2.67 over the same period.



Figure 6. Fish species and H' -biodiversity index of LXB and LNS, 2018–2022

FADM data by BioRA Zone

Fisheries monitoring stations represent, and provide information on, status and trend of fisheries in BioRA Zones. These zones are based on biota and physical characteristics of the LMB. For example, despite a constant number of fishing hours over the years, the fish capture in Zone 7 of Tonle Sap Lake in Cambodia decreased from 2018 to 2022, 158,276.48 kg to 61,966.84 kg, or 60.84% (Figure 7). The decline was also observed in catch per unit of effort (CPUE – kg/hr/100 m²) of the stationary gillnet, the most popular fishing gear around Tonle Sap Lake.

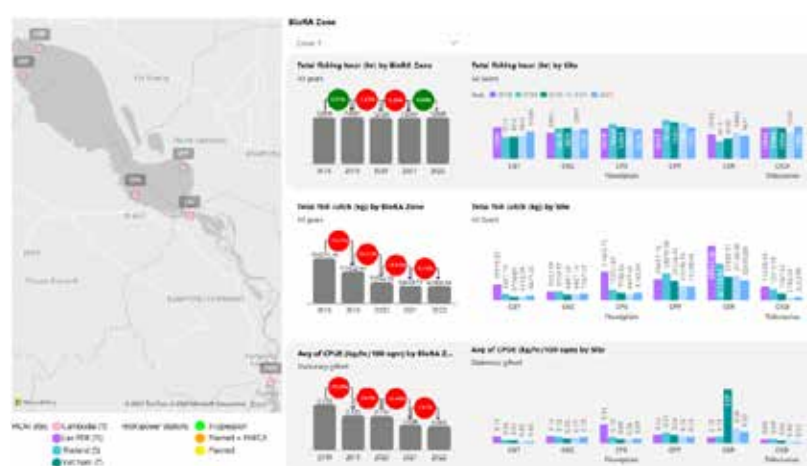
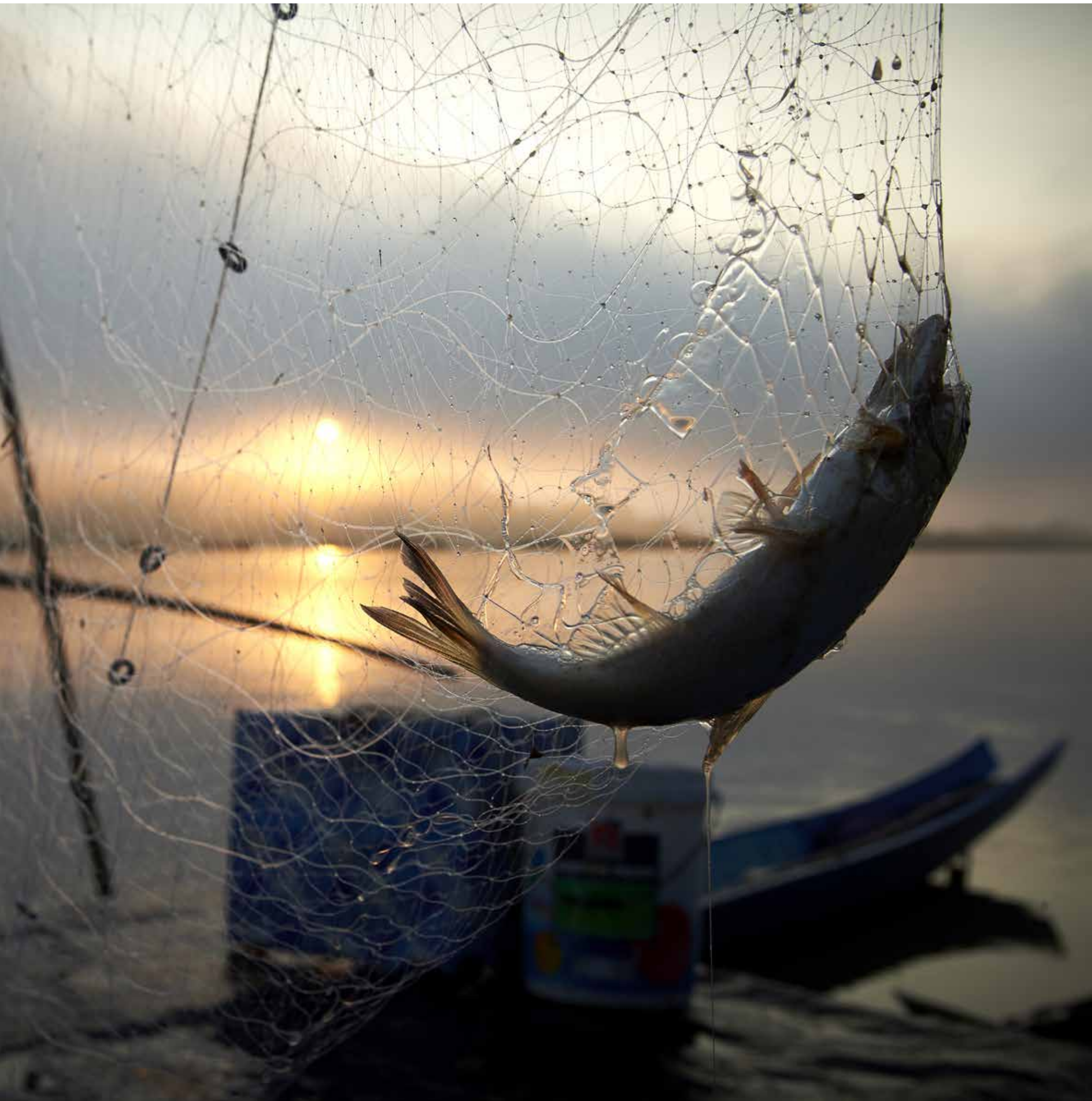


Figure 7. Fishing hour, fish catch, and CPUE of BioRA Zone 7 (Tonle Sap Lake, Cambodia), 2018–2022

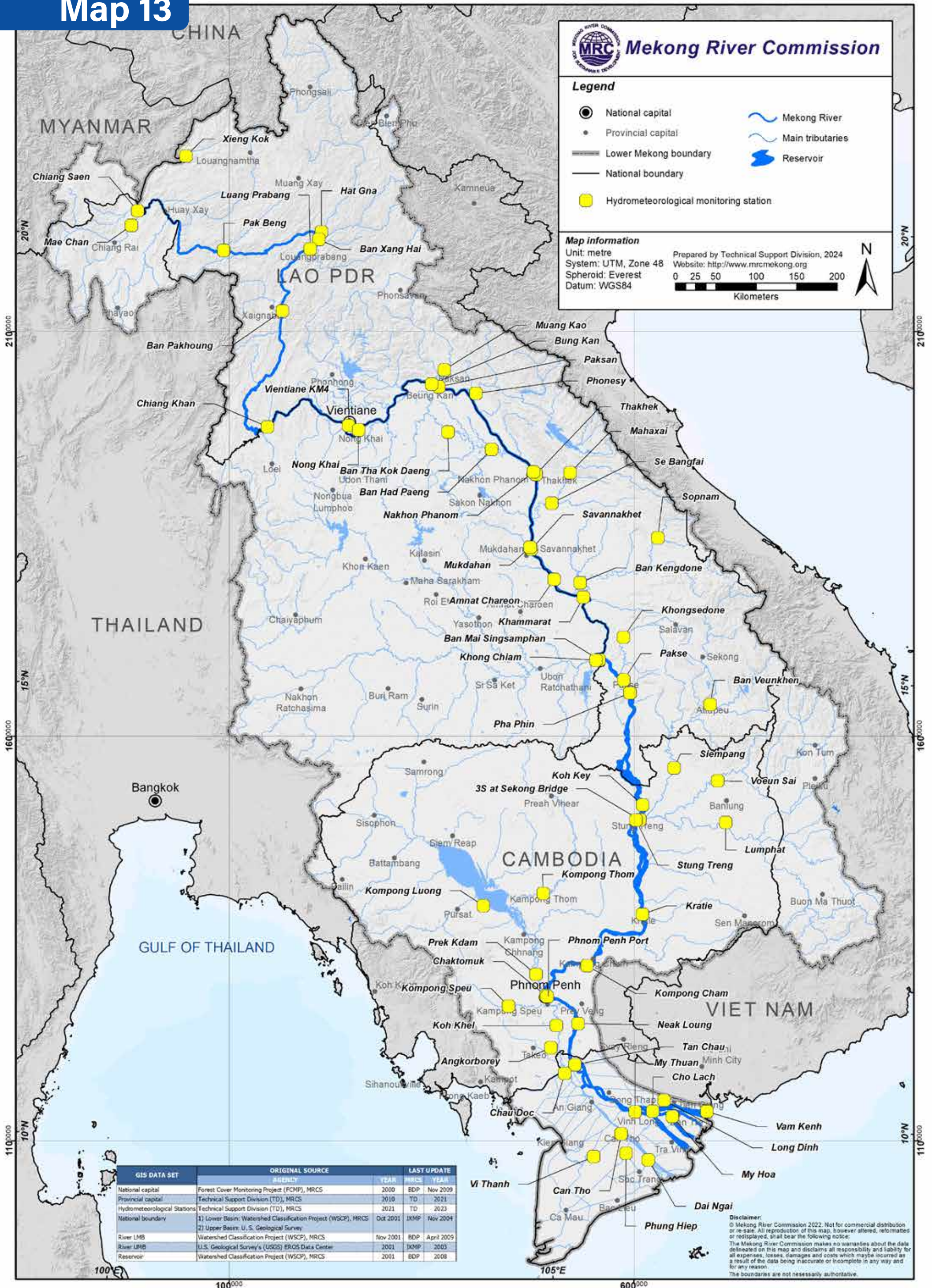
Further reading

Mekong River Commission. (2024). Fish Abundance and Diversity Monitoring Regional Report 2018–2022.



Hydrometeorology monitoring

Map 13



Hydrometeorology monitoring

Map 13 shows the locations of stations along the Mekong River and its key tributaries where near real-time data on rainfall and water levels are monitored via the MRC river monitoring website. These stations receive contributions from the Mekong Hydrological Cycle Observing System Project (the 'Mekong-HYCOS project'), the drought management project, and the MRC's Joint Environment Monitoring (JEM) Programme, which are now integrated into the MRC Core River Monitoring Network (CRMN). Equipped with telemetry systems, these stations transmit near real-time water level and rainfall data at 15-minute intervals to a central database located at the MRCS and respective line agencies in each Member Country. It is important to note that all hydrological stations are operated and managed by the relevant provincial or national government agencies of the four riparian countries.

On the Mekong River mainstream, water levels and stream flow are continuously monitored at seven stations, with an additional two operational stations on the Bassac River and three on the Tonle Sap River, primarily for implementing the MRC Procedures for the Maintenance of Flows on the Mainstream (PMFM). The PMFM is designed to facilitate cooperation in maintaining flows on the mainstream, except in the cases of historically severe droughts and/or floods, from diversions, storage releases or other permanent actions. Specifically, under the following Articles::

- 💧 Article 6A: Of not less than the acceptable minimum monthly natural flow during each month of the dry season;
- 💧 Article 6B: To enable the acceptable natural reverse flow of the Tonle Sap River to occur during the wet season; and
- 💧 Article 6C: To prevent average daily peak flows greater than what naturally occurring on average during the flood season.

Recorded water levels at key stations provide insights into hydrological flow regimes: Chiang Saen captures mainstream flows from the Upper Mekong River Basin; Vientiane reflects flows influenced by climate conditions in the upper part of the LMB; Pakse investigates flows influenced by inflows from Mekong tributaries; Kratie captures overall flows in the Mekong Basin; and Tan Chau and Chau Doc monitor flows into the Viet Nam Delta.

Changes in flow patterns result from diverse factors, including rainfall patterns, human activities, upstream hydropower operations, extensive land use, deforestation, climate change, and the encroachment of natural floodplains and wetlands.

The data collected are periodically transferred to the MRC and are accessible on the MRC Data Portal. Daily rainfall and water level data at key mainstream and tributary stations are available at the MRC website: www.mrcmekong.org

Table 6. Programmes and functions of hydrometeorological stations

Country	Station	River	Near real-time monitoring	PMFM	MRC Forecasting Service
Lao PDR	Xieng Kok	Mekong	✓	✗	✗
Lao PDR	Pak Beng	Mekong	✓	✗	✗
Lao PDR	Ban Xang Hai	Mekong	✓	✗	✗
Lao PDR	Luang Prabang	Mekong	✓	✗	✓
Lao PDR	Ban Pakhoung	Mekong	✓	✗	✗
Lao PDR	Vientiane KM4	Mekong	✓	✓	✓
Lao PDR	Paksan	Mekong	✓	✗	✓
Lao PDR	Thakhek	Mekong	✓	✗	✓
Lao PDR	Savannakhet	Mekong	✓	✗	✓
Lao PDR	Ban Mai Singsamphan	Mekong	✓	✗	✗
Lao PDR	Pakse	Mekong	✓	✓	✓
Lao PDR	Pha Phin	Mekong	✓	✗	✗
Lao PDR	Don Sahong	Mekong	✓	✗	✗
Lao PDR	Hat Gna	Nam Ou	✓	✗	✗
Lao PDR	Muang Kao	Nam Sane	✓	✗	✗
Lao PDR	Phonesy	Nam Ca Ding	✓	✗	✗
Lao PDR	Mahaxai	Se Bang Fai	✓	✗	✗
Lao PDR	Se Bangfai	Se Bang Fai	✓	✗	✗
Lao PDR	Ban Kengdone	Se Bang Hieng	✓	✗	✗
Lao PDR	Sopnam	Se Bang Hieng	✓	✗	✗
Lao PDR	Khongsedone	Nam Sedone	✓	✗	✗
Lao PDR	Ban Veunkhen	Se Kong	✓	✗	✗
Thailand	Chiang Saen	Mekong	✓	✓	✓
Thailand	Chiang Khan	Mekong	✓	✗	✓
Thailand	Nong Khai	Mekong	✓	✗	✓
Thailand	Bueng Kan	Mekong	✓	✗	✗
Thailand	Nakhon Phanom	Mekong	✓	✗	✓
Thailand	Mukdahan	Mekong	✓	✗	✓
Thailand	Amnat Chareon	Mekong	✓	✗	✗
Thailand	Khammarat	Mekong	✓	✗	✗
Thailand	Khong Chiam	Mekong	✓	✓	✓
Thailand	MAE CHAN	NAM MAE KOK	✓	✗	✗
Thailand	BAN THA KOK DAENG	NAM SONGKHRAM	✓	✗	✗
Thailand	BAN HAD PAENG	NAM SONGKHRAM	✓	✗	✗

Country	Station	River	Near real-time monitoring	PMFM	MRC Forecasting Service
Cambodia	Koh Key	Mekong	✓	✗	✗
Cambodia	Stung Treng	Mekong	✓	✓	✓
Cambodia	Kratie	Mekong	✓	✓	✓
Cambodia	Kompong Cham	Mekong	✓	✗	✓
Cambodia	Neak Luong	Mekong	✓	✗	✓
Cambodia	Siempang	Sekong	✓	✗	✗
Cambodia	3S at Sekong bridge	Sekong	✓	✗	✗
Cambodia	Voeun Sai	Sesan	✓	✗	✗
Cambodia	Lumphat	Sre Pok	✓	✗	✗
Cambodia	Prek Kdam	Tonlesap	✓	✓	✓
Cambodia	Phnom Penh Port	Bassac	✗	✓	✓
Cambodia	Chaktomuk	Bassac	✓	✗	✓
Cambodia	Koh Khel	Bassac	✓	✗	✓
Cambodia	Kompong Luong	Tonlesap	✓	✓	✗
Cambodia	Kompong Thom	Stung Sen	✓	✗	✗
Cambodia	Kompong Speu	Prek Thnot	✓	✗	✗
Cambodia	Angkorborey	Stung Angkor Borey	✓	✗	✗
Viet Nam	Tan Chau	Mekong	✓	✓	✓
Viet Nam	Chau Doc	Bassac	✓	✓	✓
Viet Nam	My Thuan	Mekong	✓	✗	✗
Viet Nam	Can Tho	Bassac	✓	✗	✗
Viet Nam	Cho Lach	Ham Luong	✓	✗	✗
Viet Nam	My Hoa	Ham Luong	✓	✗	✗
Viet Nam	Vam Kenh	Mekong	✓	✗	✗
Viet Nam	Vi Thanh	Xa No	✓	✗	✗
Viet Nam	Phung Hiep	Cai Con	✓	✗	✗
Viet Nam	Long Dinh	Xang	✓	✗	✗
Viet Nam	Dai Ngai	Bassac	✓	✗	✗

Reference and further reading

MRC Hydrometeorological data available via <https://portal.mrcmekong.org/time-series/water-level>

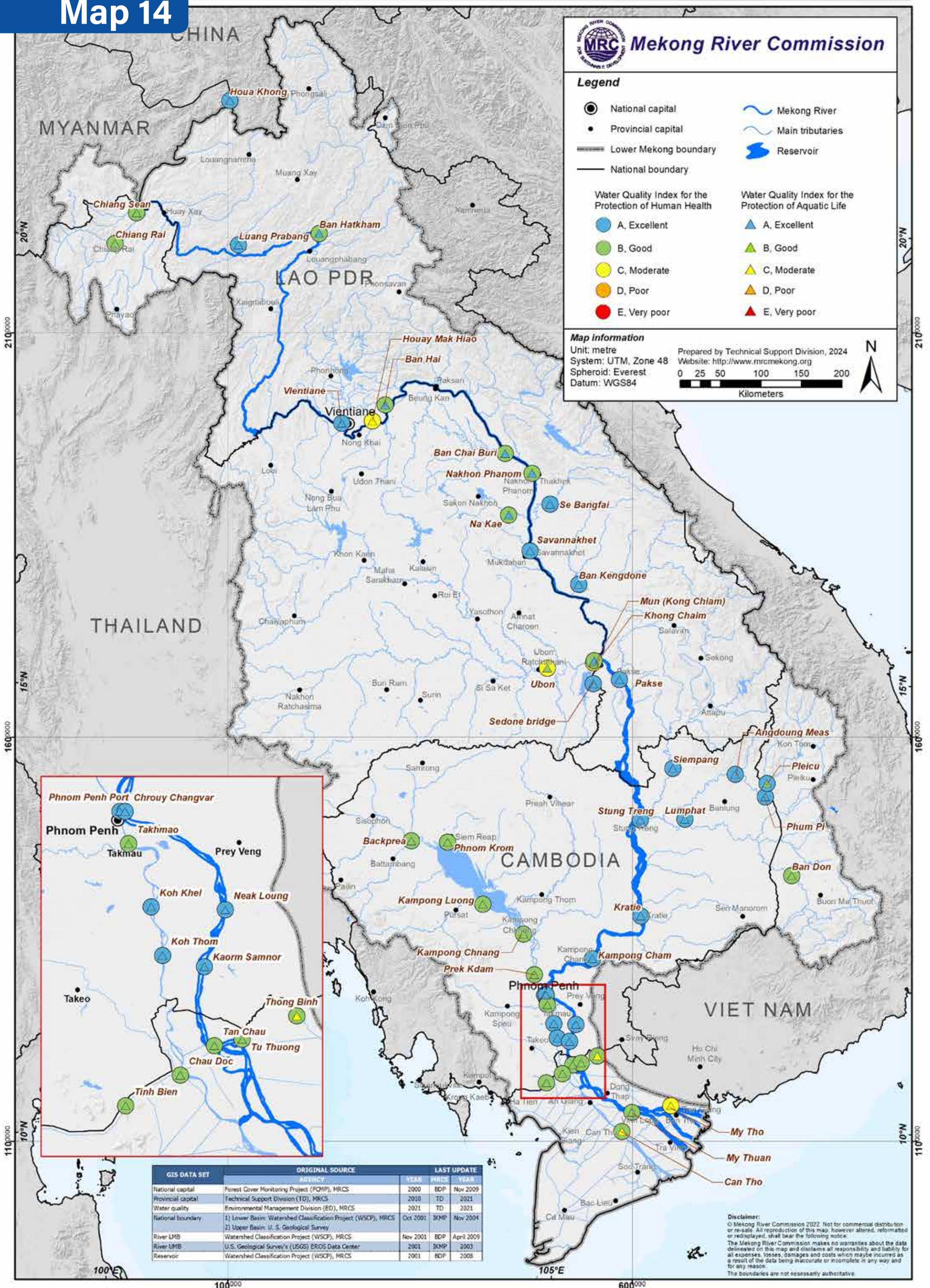
About PMFM monitoring stations <https://pmfm.mrcmekong.org/>

About near real-time monitoring <https://portal.mrcmekong.org/monitoring/river-monitoring-telemetry>



Water quality monitoring

Map 14



Water quality monitoring

The Water Quality Monitoring Network (WQMN) of the Lower Mekong Basin (LMB) was established in 1985 with the objectives of monitoring the status, detecting changes in the Mekong River water quality, and ensuring preventive and remedial actions are taken if any changes are detected. Several parameters have been measured to provide data on the Mekong River and its selected tributaries. Since 2006, 48 stations including 17 stations located in the mainstream and 31 stations located in the main tributaries of the Mekong River. In 2021, 19 parameters were measured by the WQMN. Of these parameters, 12 parameters are monitored monthly and seven (major anions and major cations) are required to be analysed monthly for each sample taken between May and October.

In addition, routine water quality monitoring under the WQMN has become an integral part of sustainable water resources development in the LMB with the establishment of the 1995 Mekong Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, which led to the adoption of the Procedures for Water Quality (PWQ) in 2011. The main objective of PWQ is “to establish a cooperative framework for the maintenance of acceptable/good water quality to promote the sustainable development of the LMB”. In 2013, the MRC Member Countries adopted three Water Quality Indices (WQIs) considering the requirements of the PWQ, including the Water Quality Index for the Protection of Human Health WQI_{hh} , the Water Quality Index for Protection of Aquatic Life WQI_{al} and the Water Quality Index for Agricultural Use for general irrigation and paddy rice (WQI_{ag}). The parameters assessing these Water Quality Indices are shown in Table 7. The classification of WQI_{hh} and WQI_{al} (Table 8) is mainly based on the percentage of values exceeding target values, while WQI_{ag} is based on electrical conductivity (EC) values.

Table 7. Parameters used for calculating the rating score of the Water Quality Indices for the Protection of Human Health, Aquatic Life, and Agricultural Use, together with their target values

WQI_{hh}		WQI_{al}		WQI_{ag}	
Parameters	Target Values	Parameters	Target Values	Parameters	Target Values
pH	6 – 9	pH	6 – 9	For general irrigation: EC (mS/m)	<70
EC (mS/m)	150	EC (mS/m)	150		70 - 300
NH ₃ (mg/L)	0.5	NH ₃ (mg/L)	0.1		>300
DO (mg/L)	≥4	DO (mg/L)	≥5	For paddy field: EC (mS/m)	<200
NO ₂₋₃ (mg/L)	5	NO ₂₋₃ (mg/L)	0.5		200-480
COD (mg/L)	5	TOTP (mg/L)	0.13		>480
BOD (mg/L)	4				

Table 8. Rating systems for the Water Quality Indices for the Protection of Human Health, Aquatic Life, and Agricultural Use

Rating Score		Class	Description
WQI_{hh}			
95 ≤ WQI ≤ 100		A: Excellent Quality	All measurements are within objectives virtually all of the time
80 ≤ WQI < 95		B: Good Quality	Conditions rarely depart from desirable levels
65 ≤ WQI < 80		C: Moderate Quality	Conditions sometimes depart from desirable levels
45 ≤ WQI < 65		D: Poor Quality	Conditions often depart from desirable levels
WQI < 45		E: Very Poor Quality	Conditions usually depart from desirable levels
WQI_{al}			
9.5 ≤ WQI ≤ 10		A: High Quality	
8 ≤ WQI < 9.5		B: Good Quality	
6.5 ≤ WQI < 8		C: Moderate Quality	
4.5 ≤ WQI < 6.5		D: Poor Quality	
WQI < 4.5		E: Very Poor Quality	
WQI_{ag} for general irrigation	WQI_{ag} for paddy rice		
EC < 70	EC < 200	None (A)	No Restriction
70 ≤ EC ≤ 300	200 ≤ EC ≤ 480	Some (B)	Some Restriction
EC > 300	EC > 480	Sever (C)	Severe Restriction

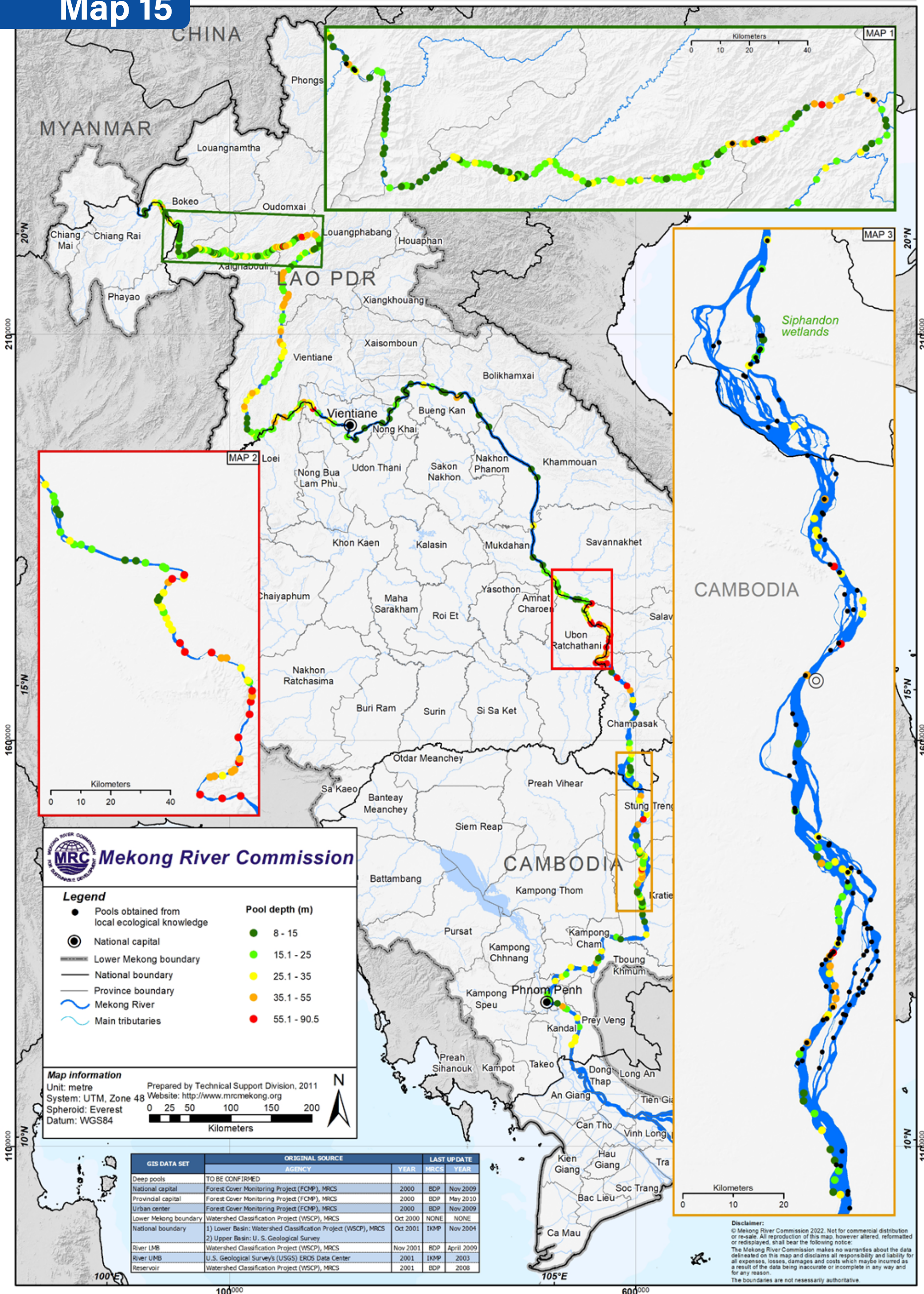
Regarding the assessment of 2021 Water Quality for the WQI_{hh} in the LMB, 44 stations were rated as either ‘good quality’ or ‘excellent quality’ (91.7% of monitored stations) and 4 stations (8.3% of monitored stations) were rated as ‘moderate quality’. The results indicate that the water quality maintains acceptable/good quality in the Mekong River and its main tributaries with respect to the WQI_{hh}. Similarly, WQI_{al} also showed ‘high quality’ or ‘good quality’ in 44 stations, and 4 stations were rated ‘moderate quality’. The WQI_{ag} is ‘no restriction’ (46 stations) or ‘some restriction’ (2 stations) in the LMB. The temporal patterns (2018–2022) of WQI_{hh}, WQI_{al}, and WQI_{ag} show the acceptable/good condition of water quality in the mainstream of the Mekong River (Table 9).

Table 9. Temporal pattern of water quality of the Mekong river for the protection of human health, aquatic life, and agricultural use, 2018–2022

No.	Station Names	Countries	WQI _{hh}					WQI _{al}					WQI _{ag} – General irrigation				
			2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
1	Houa Khong	Lao PDR	B	A	A	A	B	B	A	A	A	A	A	A	A	A	A
2	Chiang Saen	Thailand	B	A	A	B	B	B	A	B	B	B	A	A	A	A	A
3	Luang Prabang	Lao PDR	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A
4	Vientiane	Lao PDR	A	A	B	A	B	A	A	A	A	A	A	A	A	A	A
5	Nakhon Phanom	Thailand	B	B	A	B	B	B	A	A	A	A	A	A	A	A	A
6	Savannakhet	Lao PDR	A	A	A	A	B	B	A	A	A	A	A	A	A	A	A
7	Khong Chiam	Thailand	B	A	B	B	A	A	A	A	A	A	A	A	A	A	A
8	Pakse	Lao PDR	A	A	B	A	A	B	A	A	A	A	A	A	A	A	A
9	Stung Trieng	Cambodia	A	A	B	A	A	A	A	A	A	A	A	A	A	A	A
10	Kratie	Cambodia	A	A	A	A	A	B	B	A	A	A	A	A	A	A	A
11	Kampong Cham	Cambodia	A	A	A	A	A	B	B	A	A	A	A	A	A	A	A
12	Chrouy Changvar	Cambodia	A	A	A	A	A	B	B	A	A	A	A	A	A	A	A
13	Neak Loung	Cambodia	A	A	A	A	A	B	A	A	A	A	A	A	A	A	A
14	Kaorm Samnor	Cambodia	A	A	A	A	A	B	A	A	A	A	A	A	A	A	A
15	Tan Chau	Viet Nam	B	B	A	B	B	B	B	B	B	B	A	A	A	A	A
16	My Thuan	Viet Nam	B	A	B	B	B	B	B	B	B	B	A	A	A	A	A
17	My Tho	Viet Nam	B	A	B	C	B	B	C	C	C	A	A	A	C	B	A

For more information on water quality, see: <https://portal.mrcmekong.org/monitoring/water-quality>





Deep pools

Pools, also termed ‘deep pools’, are natural depressions in the bed of a river. They occur at regular intervals along most rivers and take on many forms, including shallow, long depressions in wide alluvial channels and deep, short depressions in bedrock-influenced rivers (Figure 8). Along the Mekong mainstream and many of its tributaries, pools provide an important dry season refuge for a number of important Mekong fish species and a spawning habitat for some species (Poulsen et al., 2002a). The large water depths and slow moving water in pools in the dry season provide shelter from predators and a thermal refuge (Baird, 2006), as well as a refuge for migratory species between seasonal migrations. It is believed that the distribution of deep pools in the LMB has had an important influence on the evolution of the three geographically distinct migration systems in the Mekong, as illustrated in Map 5.3. of the MRC BDP Atlas 2011 (Poulsen et al., 2002).

Map 15 shows the location of pools on the Mekong mainstream from two different sources:

a) Black dots – These indicate the pools identified from local ecological knowledge (LEK) obtained during several independent surveys conducted between 1995 and 2010, and synthesized by Halls et al. (2011). These surveys identified pools based on interviews with fisher groups in ecologically significant areas and productive fishing grounds, often in combination with field surveys of river bathymetry (depth) and the interpretation of bathymetric maps. Some pools identified in these surveys did not have geographic coordinates and so have not been included in this map. Only some tributaries have been surveyed.

b) Coloured circles – These indicate pools identified from a statistical analysis of the riverbed long profile (a plot of river depth along the line of deepest flow versus distance downstream) of the Lower Mekong River. Pools were identified by fitting a trend to the long profile and then selecting all depressions beneath the trend line (see Halls et al., 2009 for details of the method). A more detailed presentation and analysis of these two datasets can be found in Halls et al. (2011). The two datasets provide different but complimentary information.

The LEK-based pools indicate pools of particular ecological significance. Note that the LEK surveys were concentrated in specific areas and may not represent the true distribution of deep pools. The statistically identified pools include all major depressions in the riverbed based on a physical (geomorphic) interpretation of the river regardless of whether the depressions are utilized as a fishing ground. The statistical method also provides an objective and consistent measure of pool dimensions (depth, length and volume). Pools on minor channels (e.g. Siphandon wetlands and northern Cambodia) and the numerous channels in the delta could not be identified using this statistical method.

In northern Lao PDR, ecologically significant (LEK) pools are located around Huay Xai and upstream of Luang Prabang. In the middle, predominantly alluvial, river reaches one pool has been identified from LEK surveys about 20 km upstream of Vientiane in a constricted gorge section of the river. Between Pakse and Kratie, including the Siphandon wetlands in southern Lao PDR, there are a particularly large number of LEK-based pools. This river reach supports one of the most productive fisheries in the LMB. It is characterized by an anabranching river with multiple channels separated by islands and rocky outcrops. Pools in this river reach have formed at lateral channel constrictions, meander bends and downstream of islands where flow from two channels converges.

Pools identified from a statistical analysis of the river long profile are colour-coded by the maximum depth of the pool in the dry season. Pool depth ranges from 3.1 m to 90.5 m; however, only pools deeper than 8 m are shown in this map. Pools are more closely spaced and deeper in the northern reaches between Chiang Saen and Vientiane, between Savannakhet and Pakse and from the Siphandon wetlands downstream to Kratie. These are all bedrock-influenced reaches, where channel obstructions and constrictions, and an overall narrow channel create deeper and more frequent pools. In contrast, the middle reaches between Vientiane and Savannakhet and downstream of Kratie are predominantly wide and shallow alluvial reaches, with fewer constrictions and obstructions. In alluvial reaches, pools form at meander bends, opposite sand bars and at occasional confluence zones downstream of islands or channel constrictions due to isolated geological structures that impinge on the river. Pools in the downstream alluvial reaches in Cambodia are deeper and larger in volume than pools in the middle alluvial reaches due to greater discharge and hence more flow energy to scour larger pools and to more frequent and narrower channel constrictions downstream of the numerous large islands. Flow convergence and acceleration in these constricted reaches scours deeper and longer pools. There are fewer islands in the middle reaches.

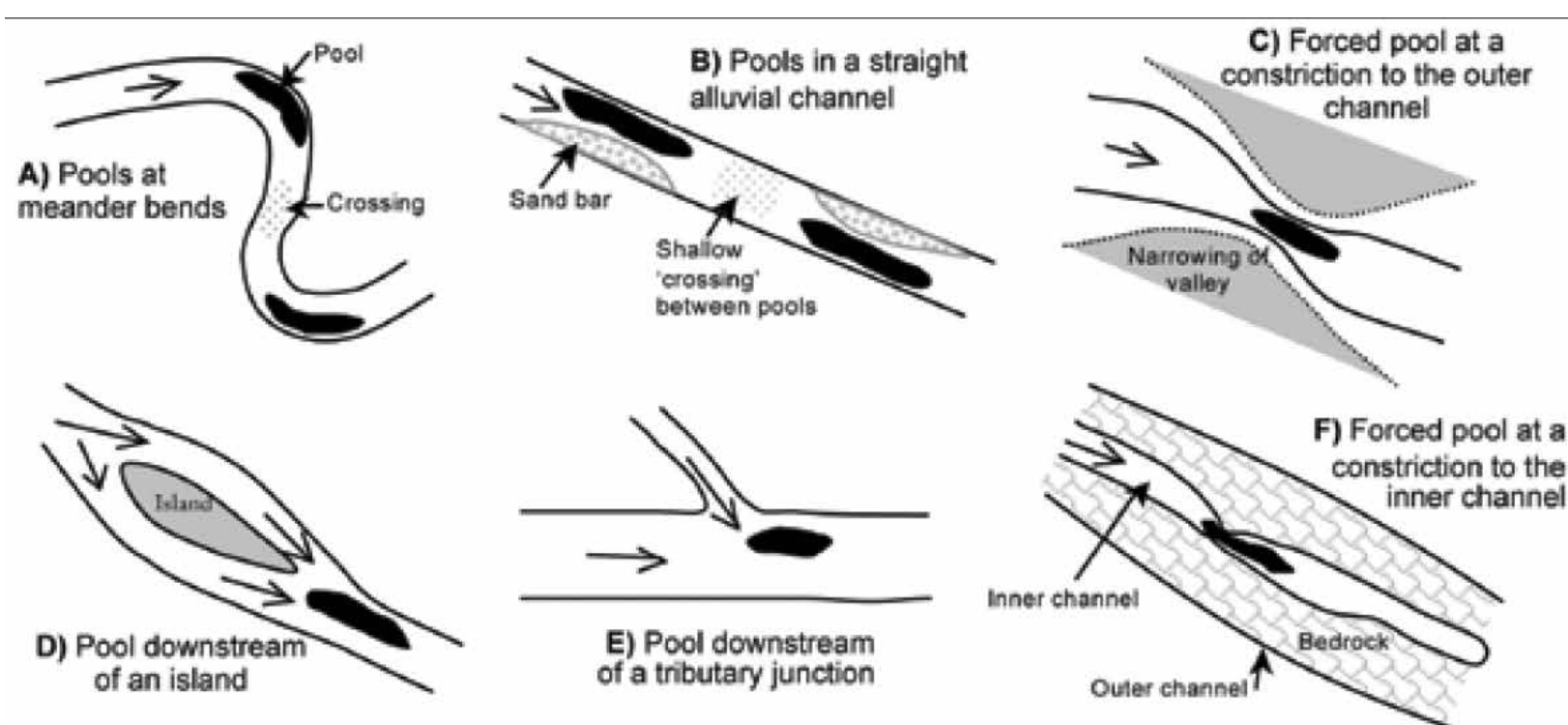


Figure 8. Major pool types found on the Lower Mekong River

Source: Halls et al., 2009.

Note: Pools at constrictions (C and F) are the most common type of pool on the Mekong mainstream.

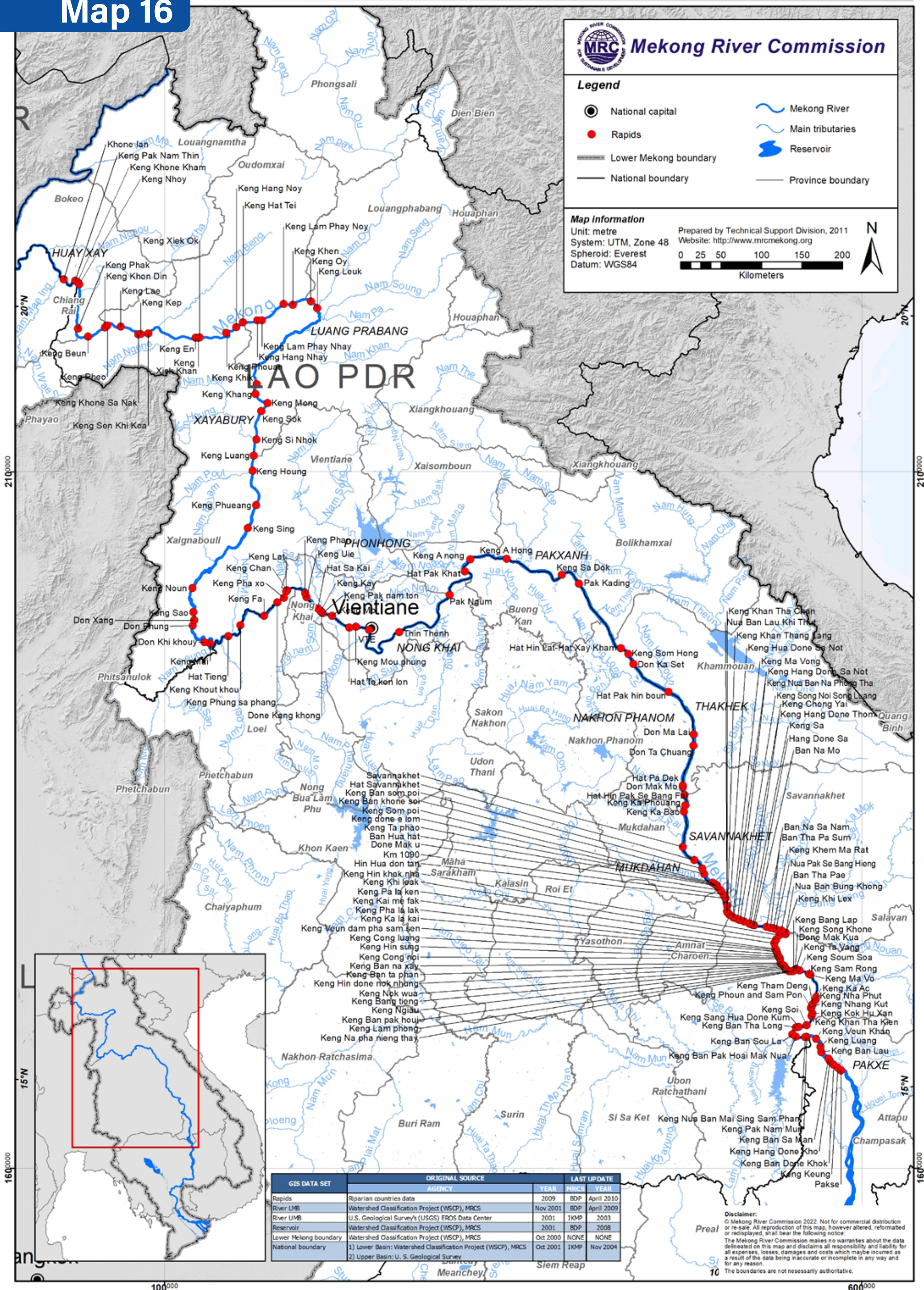
Further reading

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Poulsen, A.F., Poeu, O., Viravong, S., Suntornratana, U., and Tung, N., Thanh. (2002). Deep pools as dry season fish habitats in the Mekong Basin.





Rapids

The Mekong River is a mixed alluvial-bedrock river, i.e. certain reaches are alluvial, with a bed and banks composed of alluvial sediment (gravel, sand, silt and clay), while others have solid bedrock exposed in all or part of the bed and banks. Rapids form where bedrock is exposed in the riverbed and create obstacles to the flow. Map 16 shows the location of 173 known rapids between Chiang Saen and Pakse. Numerous rapids also occur in bedrock reaches between Pakse and Kratie, but their location is still being finalized.

The map indicates that rapids are common along the entire length of the Lower Mekong River. They even occur intermittently in the predominantly alluvial reach between Vientiane and Savannakhet where structural features such as faults and fold structures intersect the river. The highest density of rapids occurs in the reach between Savannakhet and Pakse where the Mekong cuts across the Phu Phan Range and the southeastern edge of the Korat Plateau. Resistant sandstones rocks are exposed in the channel in this reach.

Typically, rapids are characterized by fast water flow and turbulence, evidence of which can be seen at the water surface as broken water (i.e. white water), standing waves, boils and eddies. The bedrock obstacles are not necessarily exposed above the water surface and often are only visible during the low flow period in the dry season. During the wet season, many rapids are completely submerged but continue to create fast flow speeds and high turbulence, which can be hazardous for navigation, but important for fish and other aquatic biota. As illustrated in on Map 6.7 on navigation capacity of MRC BDP Atlas 2011, only small vessels are able to safely navigate many reaches of the Lower Mekong River due to the presence of rapids, limiting the potential of inland maritime transport in the upper and middle reaches of the River.

Rapids provide important feeding and spawning habitat for fish due to the hydraulic conditions created by them but also the rock substrate that supports food sources including plants and macro-invertebrates. The hydraulic conditions also consist in large eddies characterized by slow recirculating water flow in the wake (immediately downstream) of large obstacles where fish can take refuge during both wet and dry seasons. The fast flow jets and turbulence generated at rapids mobilize nutrients, plants and macro-invertebrates from the riverbed into the water column, providing sources of food for fish. The importance of rapids for aquatic organisms is evidenced by the many productive fishing grounds located at or nearby rapids (Poulsen et al., 2002b; Valbo-Jørgensen and Poulsen 2000). In addition, deep pools are often found immediately downstream of rapids due to the high erosive power of the fast flow jets and turbulence exiting the rapids that scour of the bed downstream.



Figure 9. A rapid, Keng Si Nhok, on the Mekong River downstream of Luang Prabang in northern Lao PDR.

Note: Keng Si Nhok is a dangerous area for navigation resulting from two bedrock islands that heavily obstruct the navigation channel. The active channel in the dry season is only 31-m wide and 15-m deep, which together with fast flow and turbulence makes the rapid a major hazard for commercial and tourist vessels. Nonetheless, the same conditions make it an important fishing ground (Photo: Navigation Programme, MRC)



Figure 10. Fishing activity at Keng Si Nhok rapid in northern Lao PDR.

Note: The rapids are characterized by high turbulence and alternating areas of fast and slow flow, which provide important feeding and spawning habitat for many Mekong fish species (Photo: Navigation Programme, MRC).

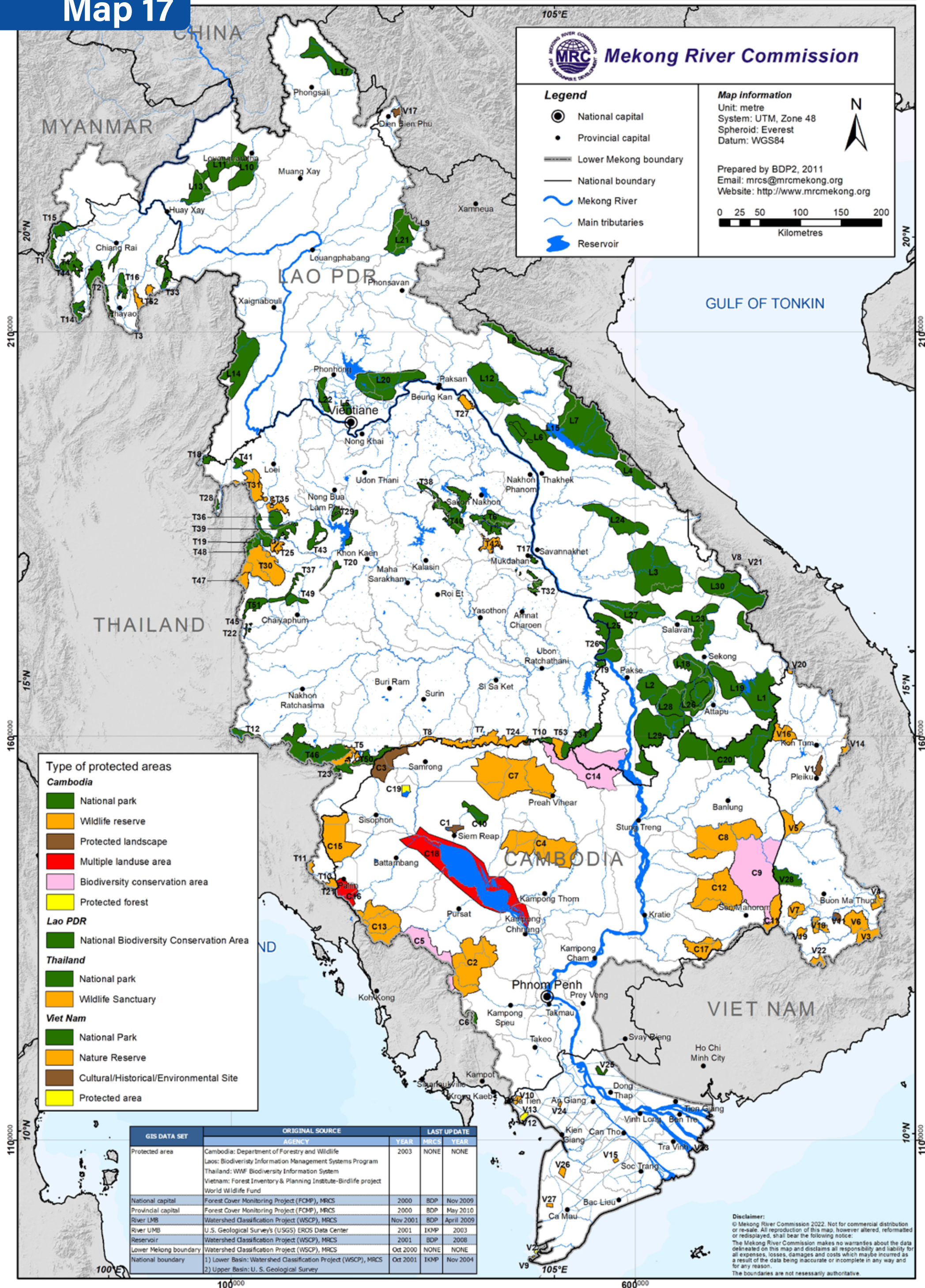
Further reading

MRC Navigation Programme: www.mrcmekong.org/navigation

Poulsen, A.F., Poeu, O., Viravong, S., Suntornratana, U., and Tung, N., Thanh. (2002). Fish migrations of the Lower Mekong Basin: implications for development, planning and environmental management. Mekong River Commission Technical Paper No. 8. p 62.

Valbo-Jørgensen, J., and Poulsen, A.F. (2000). Using local knowledge as a research tool in the study of river fish biology: experiences from the Mekong. *Environment, Development and Sustainability* 2, 253–276.





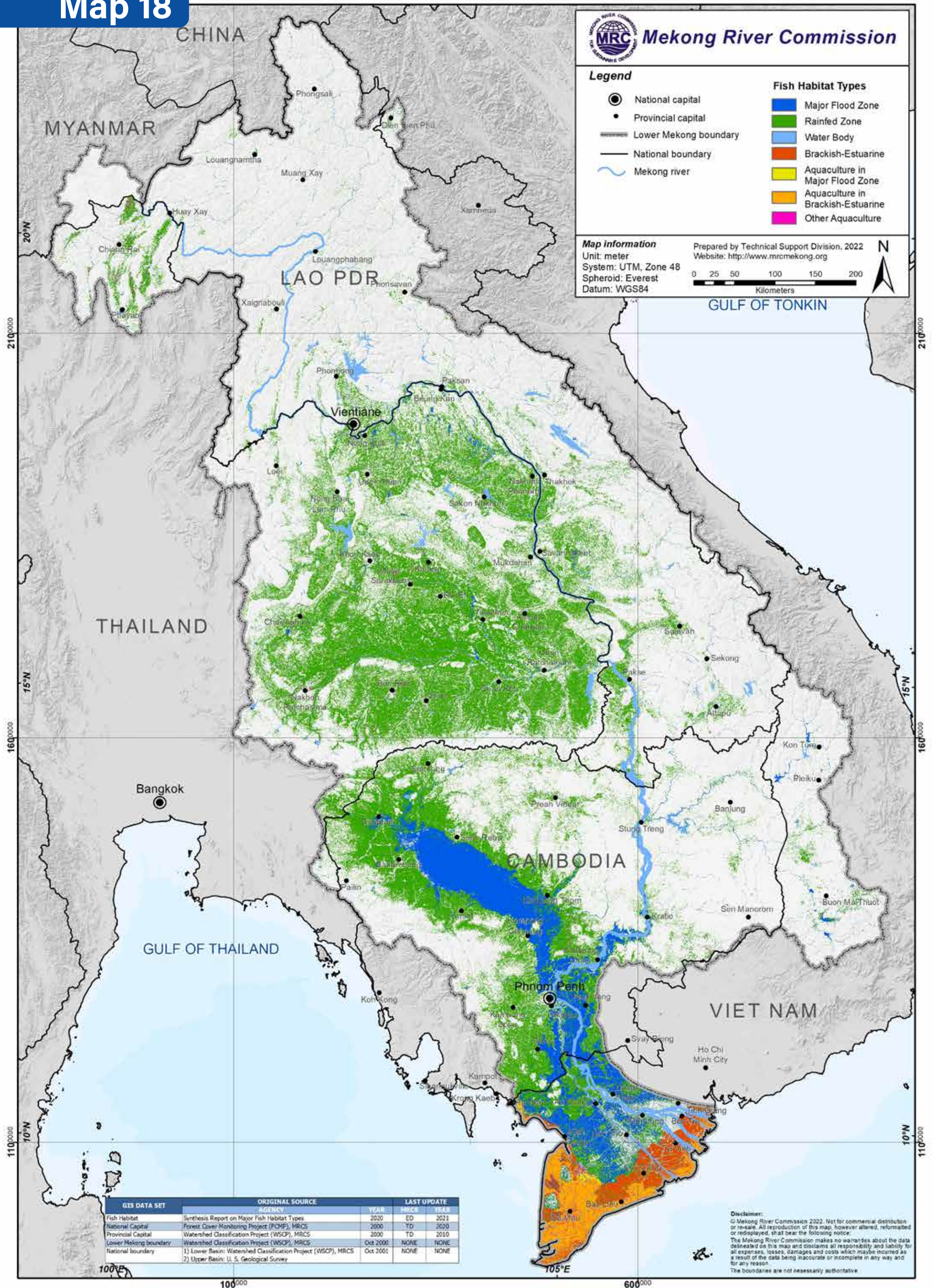
Protected areas

Map 17 shows the location of all protected areas officially designated by each of the MRC Member Countries, including national parks, wildlife reserves and sanctuaries, nature reserves, cultural and historical sites and biodiversity conservation areas. The classification of protected areas is specific to each country, as shown in the legend key of the map. The surface area of each protected area is given in Table 10. In the LMB, protected areas cover a total of 100,728 km². Cambodia has 20 protected areas, the largest of which are the Tonle Sap Multiple Land Use Area, Kulen Promtep Wildlife Reserve and Mondulkiri Biodiversity Conservation Area: all areas are over 4,000 km². In Lao PDR, there are 30 National Biodiversity Conservation Areas (NBCAs): Nakai-Nam Theun NBCA, which borders the new Nam Thuen II reservoir, is the largest, followed by Gi Do NBCA, located in the Xe Bang Hieng catchment, southeast of Savannakhet. Thailand has 53 protected areas in the north and northeast parts of the country, which fall within the LMB. Some of these protected areas, such as Kao Yai National Park, extend outside the LMB, which are not included in Table 10. The largest protected areas in Thailand are Tablarn National Park located south of the city of Nakhon Ratchasima and Pu Kiew Wildlife Sanctuary located west of Khon Kaen. In Viet Nam, there are 28 protected areas within the LMB: small areas in the delta, larger areas in the headwaters of the Se San and Se Prok catchments, and one in the north of the country near Dien Bien Phu.

Table 10. Protected areas and their size, by country (km²)

Cambodia			Lao PDR			Thailand			Viet Nam			
Code	Name	Area (km²)	Code	Name	Area (km²)	Code	Name	Area (km²)	Code	Name	Area (km²)	
C1	Angkor	138	L1	Dong Ampham	1,758	T1	Chiang Dao	67	V1	Bac Pleicu	140	
C2	Aural	2,575	L2	Dong Hua Sao	947	T2	Doi Luang	746	V2	Bai Boi	56	
C3	Benteay Chmar	848	L3	Gi do	3,065	T3	Doi Pu Nang	38	V3	Bi Dup Nui Ba	434	
C4	Beng Per	2,486	L4	Hin namnu	840	T4	Doi Vieng Pa	474	V4	Chu Hoa	187	
C5	Cardamon Mountain	1,165	L5	Houay Nhang	124	T5	Dong Yai	322	V5	Chu Prong	479	
C6	Kirirom	140	L6	Khammouane Limestone	2,172	T6	Huiy Huad	793	V6	Chu Yang Sin	584	
C7	Kulen Promtep	4,028	L7	Nakai-Nam Theun	3,720	T7	Huiy Sala	364	V7	Dak Mang	299	
C8	Lomphat WS	2,507	L8	Nam chuan	656	T8	Huiy Tabtan-Hadsamran	462	V8	Dak Rong	0.1	
C9	Mondulkiri	4,285	L9	Nam et	5.1	T9	Kang Tana	84	V9	Dat Mui	63	
C10	Phnom Kulen	365	L10	Nam ha (East)	790	T10	Khao PraViham	134	V10	Ha Tien	70	
C11	Phnom Nam	538	L11	Nam ha (West)	915	T11	Khao Soi Dao	119	V11	Ho Lek	93	
C12	Phnom Prich	2,208	L12	Nam kading	1,598	T12	Khao Yai	329	V12	Hon Chong	19	
C13	Phnom Samkos	1,930	L13	Nam Kan	749	T13	Klong Kruewai Chalermprak	179	V13	Kien Luong	75	
C14	Preah Vihear BGCA	3,225	L14	Nam Phoun (Poui)	1,924	T14	Kun Jae	285	V14	Kon Ka Kinh	147	
C15	Roniem Daun Sam	1,737	L15	Nam Theun Corridor	227	T15	Mae Phang	527	V15	Lung Ngoc Hoang	28	
C16	Samlot	591	L16	Nam Theun Ext.	426	T16	Mae Puem	354	V16	Mom Ray	487	
C17	Snuol WS	751	L17	Phou Dene Dinh	946	T17	Mukdahan	50	V17	Muong Phang	92	
C18	Tonle Sap	5,957	L18	Phou Kateup	731	T18	Na Haow	106	V18	Nam ca	245	
C19	Trapeang Thmor	129	L19	Phou kathong	1,569	T19	Nam Nao	668	V19	Nam Nung	105	
C20	Virachey	3,349	L20	Phu Khao Khoay	1,888	T20	Nam Pong	224	V20	Ngoc Linh KTum	80	
Total area		38,954	L21	Phou Loeuy	1,430	T21	Nam Tok Kaw	1.7	V21	Phong Dien	6.6	
			L22	Phou Pha Nang	361	T22	Pa Him Ngam	72	V22	Ta Dung	189	
			L23	Phou Theung	1,374	T23	Pang Sida	112	V23	Thanh Phu	77	
			L24	Phou Xang He	1,169	T24	Panom Dong Rak	332	V24	Tinh Doi	21	
			L25	Phou Xiang Thoung	1,091	T25	Paphung	178	V25	Tram Chim Tam Nong	80	
			L26	Phu Luang (Bolavens)	1,001	T26	Pha Tam	355	V26	UMinh Thuong	80	
			L27	Xe Ban Nouan	1,356	T27	Pu Hao	189	V27	Vo Doi	34	
			L28	Xe Khampho	1,136	T28	Pu Hin Tonkla	94	V28	Yok Don	557	
			L29	Xe Pian	2,443	T29	Pu Kao Pupankam	295	Total area		4,729	
			L30	Xe Sap	2,264	T30	Pu Kiew	1,577				
			Total area			38,675	T31	Pu Luang				709
							T32	Pu Sa Dok Boa				207
							T33	Pu San				283
							T34	Pujong-Nayoy				688
							T35	Pukaw-Pukratae				237
							T36	Phukradung				255
							T37	Pulan ka				201
							T38	Pupalek				425
							T39	Pupamarn				361
							T40	Pupan	713			
			T41	Purua	120							
T42	Pusithan	308										
T43	Puvieng	323										
T44	Sri Lanna	38										
T45	Sub Lanka	1.5										
T46	Tablanka	1,855										
T47	Tabo-Huiyyai	319										
T48	Tad Mok	42										
T49	Tadtone	217										
T50	TaPhrya	618										
T51	Tri tone	333										
T52	Vieng Law	308										
T53	Yod Dome	243										
			Total area			18,334						





Fish habitat

Fish habitat is defined as parts of the landscape. which, at some time of the year, are likely to be significantly inundated with water to the extent that they can support the production of fish, OAAs or organisms that support the food chain to fisheries species. There is a wide diversity of fisheries habitat types, which can be reduced to four main categories, defined broadly as follows:

Major flood zone: This refers to land that is flooded in most years to depths of over 0.3 m by water from adjacent rivers. Based on the 2010–2019 maximum annual flood extents, the zone consists in the inundated area in at least 50% of the area indicated on maximum annual flood maps. Most of this zone consists in floodplains, covered by recession rice-fields, forest or scrub, streams, swamps and water bodies, and also includes the Tonle Sap-Great Lake system. Floodplains can also be termed ‘water resource-rich’ habitats; they may not flood every year and may be modified, but there is relatively abundant surface water most of the time.

Rainfed zone: This refers to land that is inundated by rainwater or local diversions to shallow depths in most years up to about 0.5 m; it mainly includes rainfed rice-fields as well as smaller streams, channels and swamps located outside major flood zones.

Large water bodies: These refer to all water bodies outside major flood zones, such as:

- Large rivers
- Artificial reservoirs
- Large canals.

Note: If these water bodies are small, they may be included in the rainfed zone because of the GIS resolution (30-m pixels). These may be considered as independent of other habitats.

Brackish water zone: This refers to brackish habitats located in zones where fresh water meets seawater, including mangrove areas, exclusively in the southern Viet Nam delta.

In addition, distinct aquaculture production areas in each of the major fish habitat types can be determined. GIS tools are used to determine the coverage of the major fisheries habitat types in the LMB. The procedure to define these major habitat areas is described in MRCS (2023). All datasets were produced in raster format with a 30-m spatial resolution. The coverage of these different habitat types in 2020 are illustrated in Map 18 and their values are shown in Table 11.

Table 11. Area of fisheries habitat in the LMB (km²)

Habitat Zone	Cambodia	Lao PDR	Thailand	Viet Nam Delta	Viet Nam Highlands	TOTAL LMB
Wetland area						
Major flood zone: permanent water-bodies including most major rivers, the Tonle Sap – Great Lake system, and seasonally flooded land; includes recession rice-fields.	19,069	2,740	2,278	8,957	553	33,597
Rain-fed zone: mainly rice-fields, other wetland crops and associated habitats not within the major flood zone. Most is former forest.	36,867	13,556	74,947	6,706	1,033	133,109
Large water-bodies outside the flood zone, including reservoirs, and canals in the southern delta.	529	2,010	2,422	7	283	5,251
Brackish-estuarine	18	0	0	12,995		12,995
Total wetland area	56,483	18,305	79,648	28,665	1,869	184,970
Aquaculture habitat area						
Major flood zone	64.4	36.7	110.0	834.8	7.6	1,054
Brackish-estuarine	11.0	0	0.6	6,518.8		6,590
Other	154.3	182.3	944.6	889.1	77.6	2,267
Total Aquaculture outside flood zone, not considered in yield figures	228.6	215.9	1,069.5	8,396	-	9,910
Total aquatic habitat area	56,713	18,524	80,703	36,908	1,954	194,881

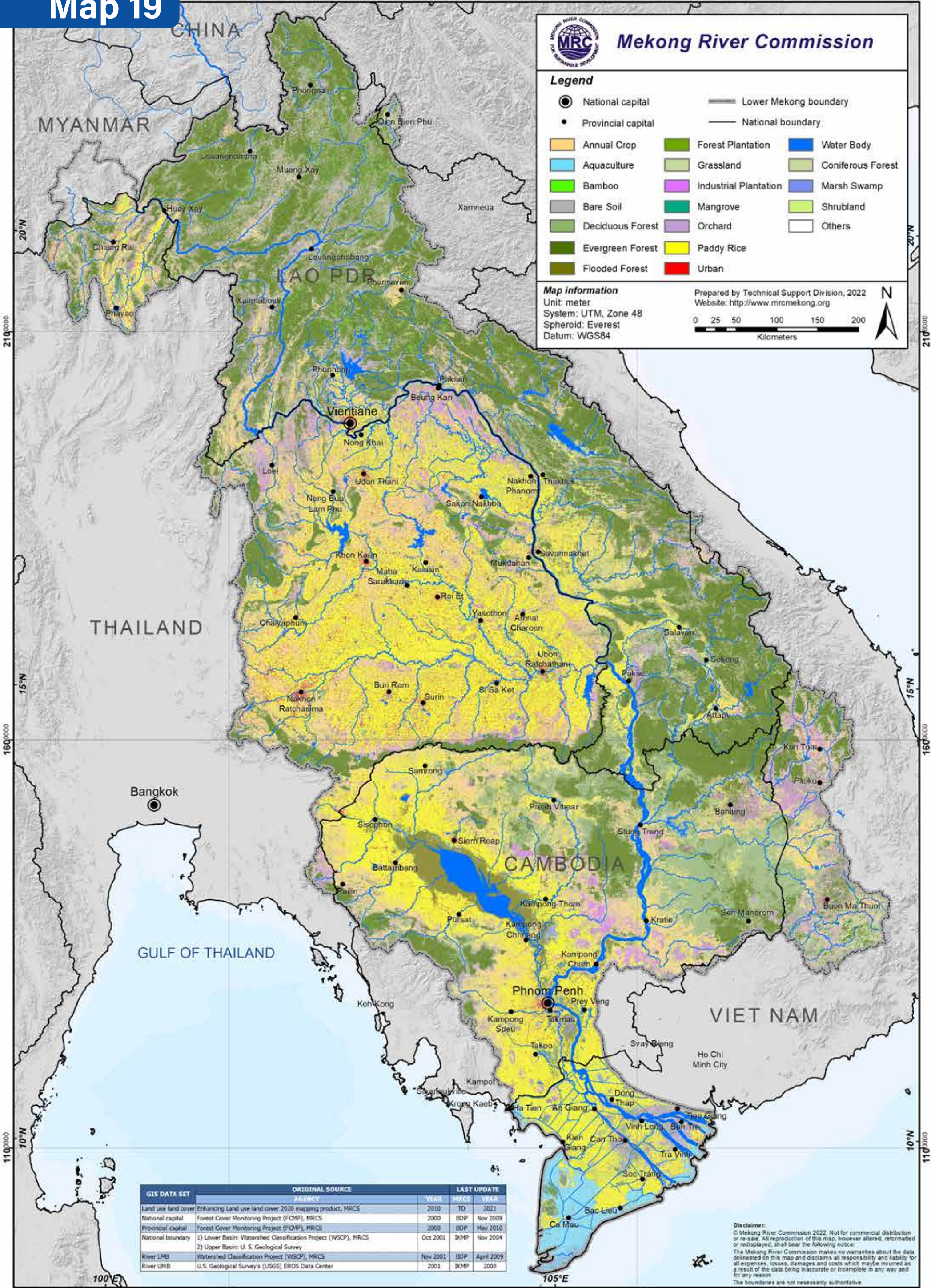
Note: Small areas (-) are not delineated by the GIS data.

Further reading

Mekong River Commission. (2023a). Fisheries Yield Assessment by Habitat Type at The Landscape Scale in The Lower Mekong River Basin 2020. Mekong River Commission Secretariat, Vientiane, Lao PDR.

Mekong River Commission. (2023b). Technical Guidance on Fisheries Yield Assessment by Habitat Type at The Landscape Scale in The Lower Mekong River Basin. Mekong River Commission Secretariat, Vientiane, Lao PDR.





Land use land cover 2020

The development of the Land Use Land Cover (LULC) 2020 map and its associated analysis in the LMB is the result of an extensive research initiative undertaken to understand and assess the land cover dynamics in the region. This work was initiated with the collaboration of various stakeholders, including government sectors, research institutions and international partners.

The initiative aimed to provide a comprehensive and up-to-date understanding of the land cover composition and changes occurring in the LMB. It involved the collection and analysis of satellite imagery and field surveys, and the application of advanced remote sensing and Geographic Information System (GIS) techniques.

To ensure the accuracy and reliability of the LULC 2020 map, rigorous methodologies were employed for image processing, classification and validation. The use of high-resolution satellite data, combined with ground truth data collection, enabled the identification and mapping of different land cover classes with a resolution of 10 metres. The project also involved extensive collaboration with experts and local stakeholders to interpret and validate the classification results. This process helped to refine the accuracy of the map and ensure its alignment with ground realities.

Overall, the initiation of this work reflects a concerted effort to leverage advanced technologies and collaborative partnerships to enhance understanding of land cover dynamics in the LMB and promote informed decision-making for the region's ecosystems and communities.

The LULC 2020 map depicts the land cover of the LMB at a regional scale, with a resolution of 10 metres. The classification of LULC2020 can be broadly categorized into three major components based on the area: forest, rice paddy and annual crops.

Forest constitutes the majority of the land cover in the LMB. It encompasses two main types of classification, namely evergreen and deciduous forest, covering 28.11% and 12.13% of the area, respectively. Most of the forested areas are located in Lao PDR and the eastern part of Cambodia.

Rice paddy production, shown in yellow on the map, occupies around 22.39% of the LMB. It dominates the vast low-lying alluvial plains of the Chi-Mun Basin in northeast Thailand, the Vientiane plain in Lao PDR, the Tonle Sap Basin in Cambodia, and the delta in southern Viet Nam. Narrower river valleys in northern Thailand and central and southern Lao PDR are also utilized for paddy cultivation. Although smaller paddy areas adjacent to rivers and streams in northern Lao PDR are too small to be mapped, they hold significant economic importance in the otherwise steep topography of the region.

Annual crops constitute the third major land cover type in the LMB. The orange colour on the map represents the area of annual crops in 2020. The total area of annual crops in the entire basin is around 15%, equivalent to around 92,747 km². The distribution of annual crops in the LMB is as follows: 29,104 km² in Cambodia, 18,070 km² in Lao PDR, 37,765 km² in Thailand, and 7,808 km² in Viet Nam.

Mangrove forests are only present in Viet Nam, as the boundaries of Cambodia, Lao PDR and Thailand in the LMB are not connected to the ocean. The area of mangrove forests in Viet Nam is relatively small, accounting for only 0.15% of the LMB area.

In addition to the LMB regional LULC map, country-specific LULC2020 area and percentage are presented in Table 12. Figure 11 provides the percentage of the area covered by each land cover classification.

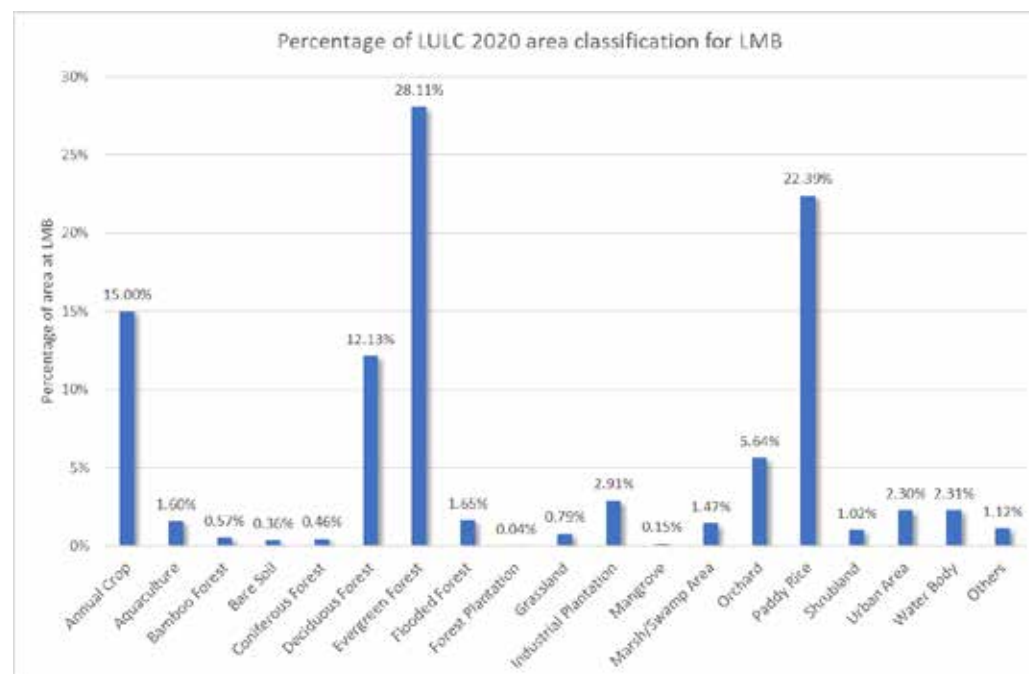


Figure 11. LULC 2020 area (in %)

Table 12. LULC 2020 classification areas

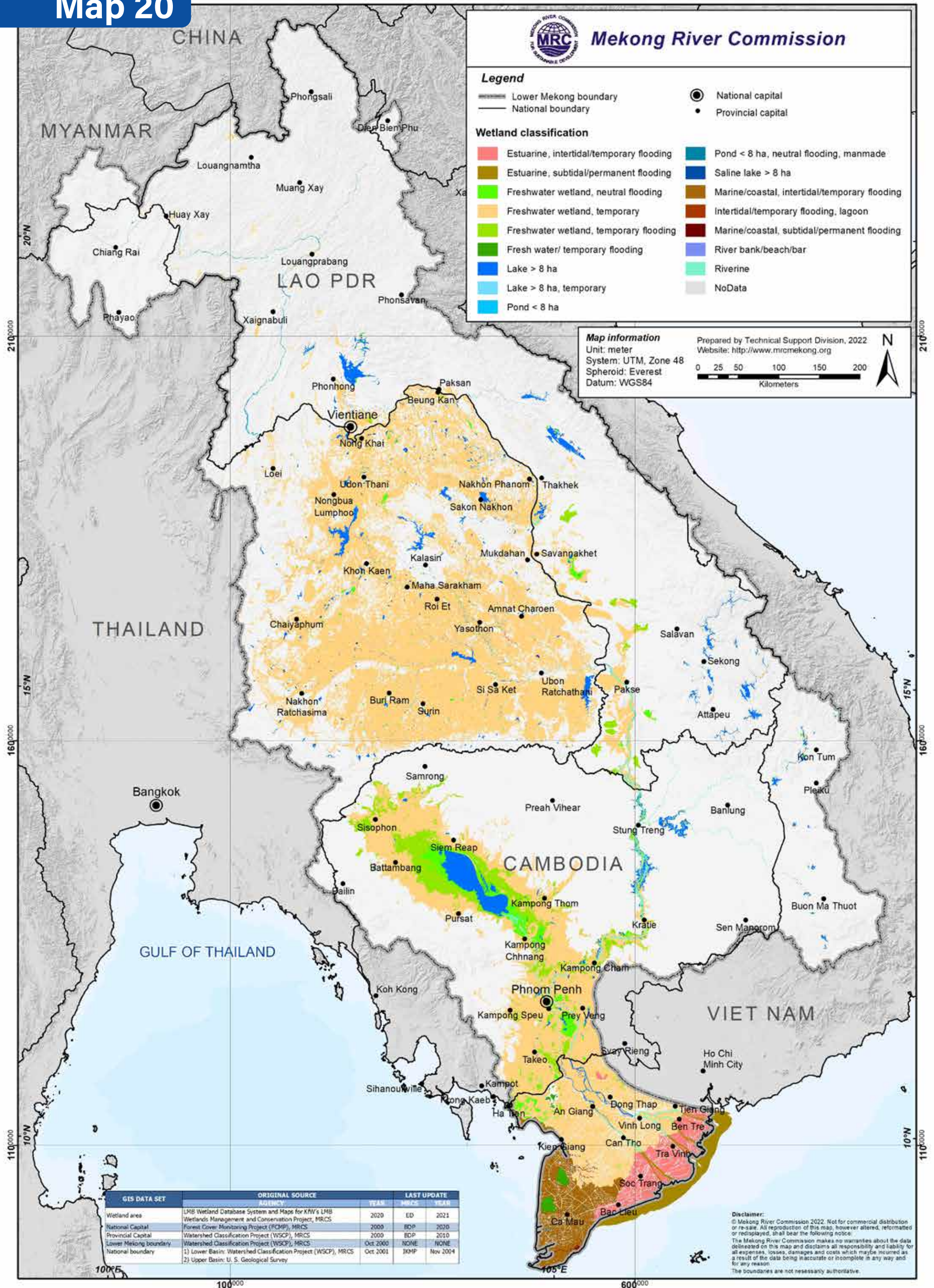
Class	Area (sq.km)					Area (%)				
	Cambodia	Lao PDR	Thailand	Vietnam	LMB	Cambodia	Lao PDR	Thailand	Vietnam	LMB
Annual crop	29,104	18,070	37,765	7,808	92,747	18.6%	8.7%	20.1%	11.7%	15.00%
Aquaculture	229	215	1,070	8,397	9,911	0.1%	0.1%	0.6%	12.5%	1.60%
Bamboo forest	124	3,127	83	182	3,517	0.1%	1.5%	0.0%	0.3%	0.57%
Bare soil	982	481	606	166	2,235	0.6%	0.2%	0.3%	0.2%	0.36%
Coniferous forest	14	753	-	2,103	2,870	0.0%	0.4%	0.0%	3.1%	0.46%
Deciduous forest	28,836	23,384	17,160	5,644	75,023	18.4%	11.3%	9.1%	8.4%	12.13%
Evergreen forest	27,599	114,108	23,029	9,074	173,810	17.6%	55.1%	12.3%	13.6%	28.11%
Flooded forest	9,075	12	2	1,105	10,195	5.8%	0.0%	0.0%	1.7%	1.65%
Forest plantation	3	10	208	1	222	0.0%	0.0%	0.1%	0.0%	0.04%
Grassland	287	3,249	727	602	4,865	0.2%	1.6%	0.4%	0.9%	0.79%
Industrial plantation	3,718	1,774	9,599	2,873	17,965	2.4%	0.9%	5.1%	4.3%	2.91%
Mangrove	-	-	-	915	915	0.0%	0.0%	0.0%	1.4%	0.15%
Marsh/Swamp area	2,627	2,843	1,776	1,814	9,061	1.7%	1.4%	0.9%	2.7%	1.47%
Orchard	4,963	19,687	4,874	5,336	34,860	3.2%	9.5%	2.6%	8.0%	5.64%
Others	1,637	2,847	1,125	1,325	6,934	1.0%	1.4%	0.6%	2.0%	1.12%
Paddy rice	38,712	10,847	73,807	15,119	138,485	24.8%	5.2%	39.3%	22.6%	22.39%
Shrubland	1,322	1,491	2,633	863	6,309	0.8%	0.7%	1.4%	1.3%	1.02%
Urban area	1,961	932	10,107	1,193	14,194	1.3%	0.4%	5.4%	1.8%	2.30%
Water body	5,203	3,396	3,287	2,412	14,298	3.3%	1.6%	1.7%	3.6%	2.31%
Grand Total	156,398	207,227	187,859	66,932	618,416	100.0%	100.0%	100.0%	100.0%	100.00%

The full report of the LULC 2020 project is available at

www.mrcmekong.org/publications/enhancing-the-mrc-land-use-and-land-cover-2020-mapping-products/



Map 20



Wetlands 2020

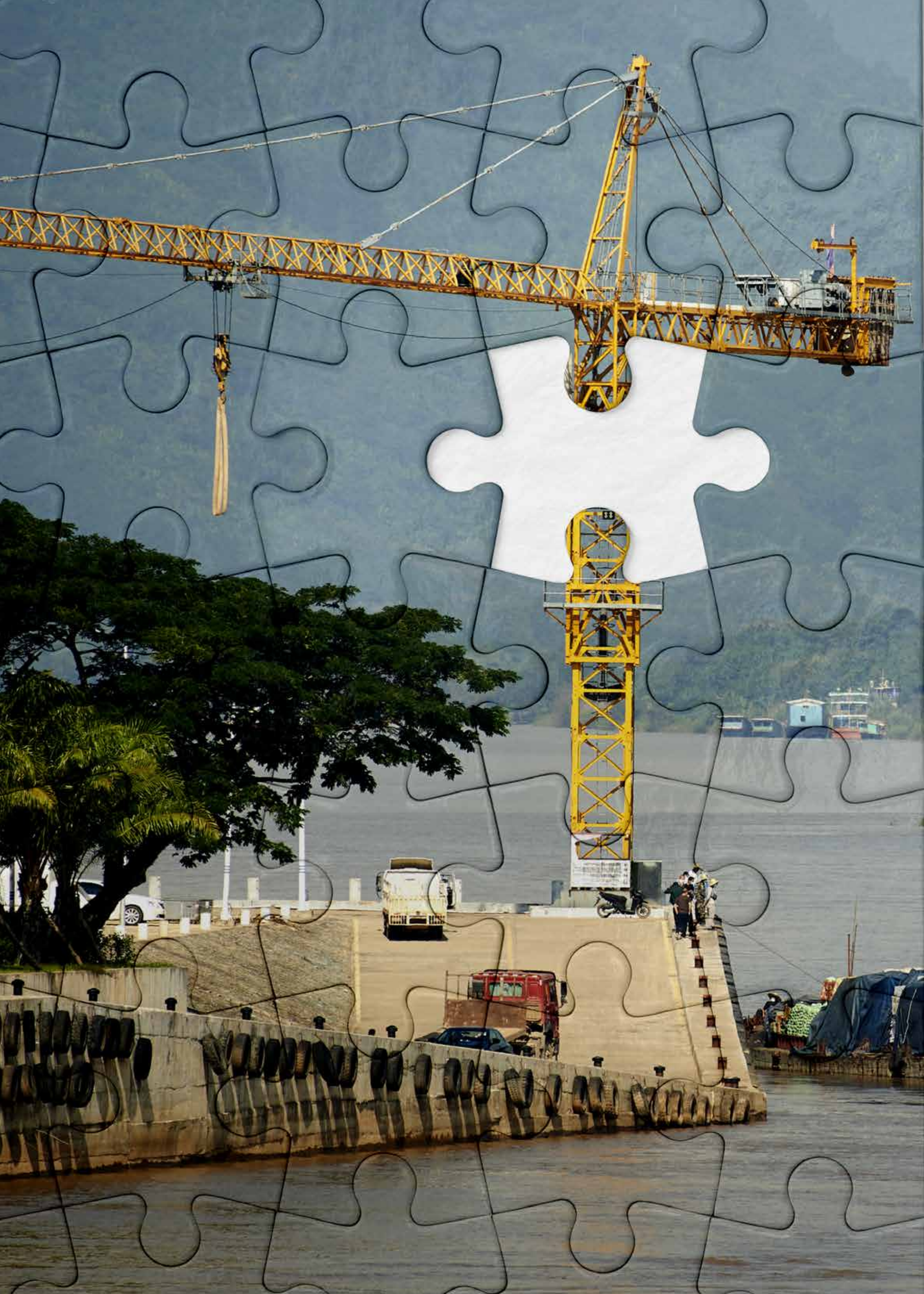
The LMB wetlands are important biodiversity hotspots that play an important role in the economy, society and culture of the region. Yet, LMB wetlands are being gradually either lost or degraded, mostly as a result of agricultural and other developments. If this trend continues, the remaining wetlands may all but disappear, with the consequent impacts that this will have on the biodiversity of the basin. Steps are urgently needed to go beyond assessing individual projects and to develop a strategy by which all, or at least a large number, of the remaining wetlands can be both protected and nurtured for future generations.

The MRC Member Countries-designated environmental assets of regional importance encompass a range of different ecosystem types, such as rivers, wetlands, forests and grasslands. This increased protection for important natural habitats should, over time, help support the LMB’s threatened plants and animals. Furthermore, by increasing recognition of its importance, a substantial number of LMB wetlands are under some form of protection as Ramsar sites, biosphere reserves, national parks and others. Wetlands should be recognized for their ability to support habitats connected through biodiversity corridors. A cooperative landscape approach to managing wetlands and enforcing regulations engages the local communities and is integrated into activities of the MRC Strategic Plan to support the achievement of the BDS 2021–2030.

In drafting of the Mekong River Basin’s State of the Basin Report for 2023, the MRCS and its Member Countries have finalized the updated LMB wetland areas and classifications by integrating secondary data generated by remote sensing techniques into the ground-truthing results from the 2020 Land Use/Land Cover Survey Project and the 2020 wetland mapping project. The updated wetland areas utilized the previously developed MRC Wetland Classification System in which wetland types were grouped into nine broad categories, such as marine or coastal wetlands, riverine wetlands, lakes, ponds and freshwater wetlands. These categories make up the seven wetland habitat types of natural and man-made occurrence, as defined by the MRB-IF Assessment Indicator No. 23. Natural wetland habitat types accounts for around 17% of the total LMB wetland area, while the inundated rice field – man-made wetland habitat type dominates the wetland landscape of the LMB with over 77% of the total wetland area, contributes to the high agricultural productivity of the basin, and provides other ecosystem services.

Table 13. Area of LMB wetlands (MRB-IF 15) and wetland classes (MRB-IF 23), 2020

Wetland Habitat Types (MRB-IF; Assessment Indicator No. 23)	Extent of wetland area (hectares) MRB-IF 15						
	Cambodia	Lao PDR	Thailand	Viet Nam	LMB	LMB	LMB
	2020	2020	2020	2020	2020	Percentage of all wetlands (%)	Percentage of natural wetlands (%)
Flooded Forests	907,609	1,211	209	110,523	1,019,552	5.72	34.12
Inundated Grasslands	518	2,665	1,070	1,063	5,316	0.03	0.18
Marshes and Swamps	262,648	284,300	177,784	181,350	906,082	5.08	30.32
Mangroves	0	0	0	91,437	91,437	0.51	3.06
Water Bodies	435,202	175,784	232,478	122,507	965,971	5.42	32.32
Total natural wetlands	1,605,977	463,960	411,541	506,880	2,988,358	16.76	100.00
Aquacultures	22,925	21,499	106,921	839,632	990,977	5.56	
Inundated Rice Fields	3,870,644	1,084,445	7,380,034	1,511,559	13,846,682	77.68	
Total	5,499,546	1,569,904	7,898,496	2,858,071	17,826,017	100	





SOCIAL DIMENSION

Population

- » The LMB population
- » Population density
- » Gender ratio
- » Working-age population
- » The gender ratio
- » Population living below the poverty line

Household

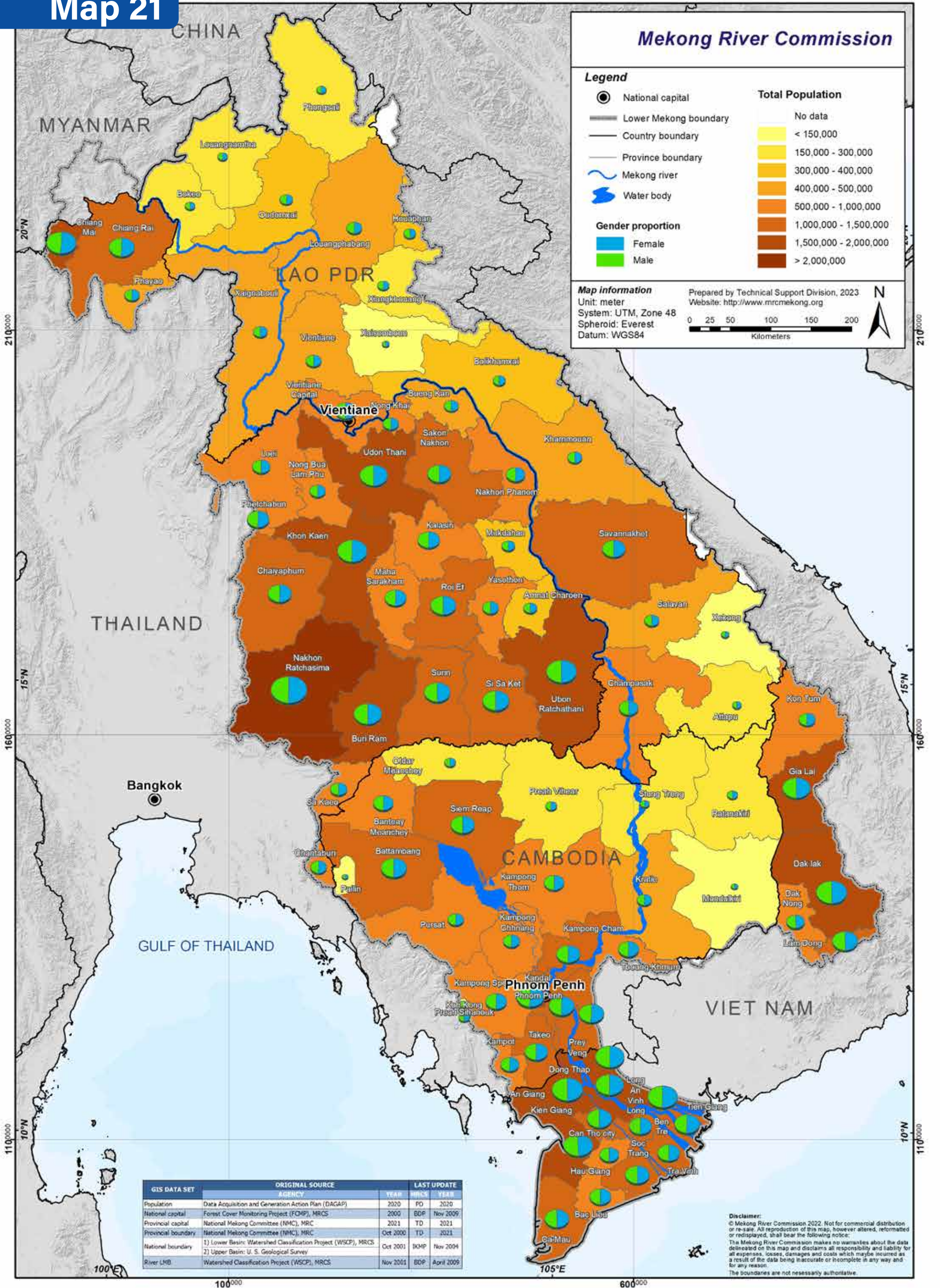
- » Number of households
- » Household size
- » Land-owning households
- » Households with access to water supplies from improved sources
- » Households with access to sanitation facilities
- » Households with access to electricity

Education

- » Boys and girls attending primary schools
- » Boys and girls attending secondary schools
- » Literacy rate

Health

- » Prevalence of stunting among children under five
- » Prevalence of wasting among children under five
- » Cases of dengue fever
- » Cases of malaria



The LMB population

The population data are comprehensive and available for creating maps and for analyses. The LMB population refers to all of the people living in a particular location or province in the LMB. The LMB population map shows the distribution of people across the LMB, according to the most recent population data (2020) transmitted officially by the MRC's Member Countries through socio-economic (SE) data collection and transmission system under the DAGAP in 2023. In Cambodia, the total population refers to the total number of males and the total number of females of all ages. In Lao PDR, the total population refers to all people residing in Lao PDR for last six months (Laotians, aliens and foreigners). In Thailand, this refers to the population as of December of each year. In Viet Nam, it refers to the average population. According to the population census method by the United Nations, the total population refers to the total number of inhabitants of a given sex and/or age group who actually live within the border limits of the country, territory or geographical area at a specific point of time, usually mid-year (actual population as at 1 July).

In the LMB, since the 2018 State of the Basin Report, the population has increased by 22%, from 60.6 million population in 2008 to 73.7 million in 2020. The male and female population in the LMB were equal (50% each).

In the LMB, the population of Cambodia makes up 21% of the total population, and around 96% of the Cambodian population live in the basin (23 provinces located in the LMB). Cambodia is sparsely populated and its population is concentrated mostly in the LMB provinces, such as Phnom Penh (10%), Battambang, Kandal and Prey Veng (8%) and Kampong Cham, Siem Reap and Takeo (7%). The average male and female populations in Cambodia differ slightly, with a higher female population (51%) than male population (49%).

The LMB population of Lao PDR makes up only 10% of the total LMB population, and 100% of its population live in the basin (all 18 provinces in Lao PDR are located in the LMB). The country is sparsely populated and most of its population is concentrated in the southern and central regions including Savannakhet (15%), Vientiane capital (13%) and Champasak provinces (10%). The average male and female population are equal (50%) across the provinces in Lao PDR.

The LMB population of Thailand makes up 37% of the total LMB population, and around 42% of its national population live in the basin (26 provinces are located in the LMB). The most populous region of Thailand is the northeast, which includes Nakhon Ratchasima (9.6%), Ubon Ratchathani (7%), Khon Kaen (6.5%), Udon Thani (6%) and Buri Ram provinces (6%), together with parts of the northern Thailand – Chiang Mai province (6.5%) of the total LMB population in Thailand. Map 21 shows that the average male and female populations in the LMB in Thailand differ slightly, with around 13.5 million (49%) males and 13.8 million (51%) females.

In Viet Nam, the LMB population makes up 32% of the total LMB population, and around 47% of its national population live in the basin (23 provinces are located in the LMB, but data were available from 18 provinces only). The most populous provinces of Viet Nam that are located in the LMB are the An Giang and Dak Lak provinces, which make up around 8% of the total LMB population. In Viet Nam, the total LMB population is 23,250,650, i.e. an urban population of 6,190,090 (27%) and a rural population of 17,060,560 (73%)., Most of the population live in rural areas in almost all LMB provinces. In contrast, only Can Tho City has a significantly higher population living in urban areas, at 868,840 (70%) while 371,890 live in rural areas (30%). This may be due to several factors, such as industrialization and rural to urban migration for education, employment and tourism opportunities in the city. The map shows that the total LMB population in Viet Nam has an equal number of males and females.

Table 14. Total LMB population, 2020

LMB countries	Total no. of LMB population	Percentage of population in the LMB (%)	Male population	Female population
Cambodia	15,782,144	21	7,742,723	8,039,421
Lao PDR	7,221,129	10	3,617,817	3,603,312
Thailand	27,473,404	37	13,583,039	13,890,365
Viet Nam	23,250,650	32	11,611,440	11,639,210
Total LMB Population	73,727,327	100%	36,555,019	37,172,308
	Gender %		49.58%	50.42%

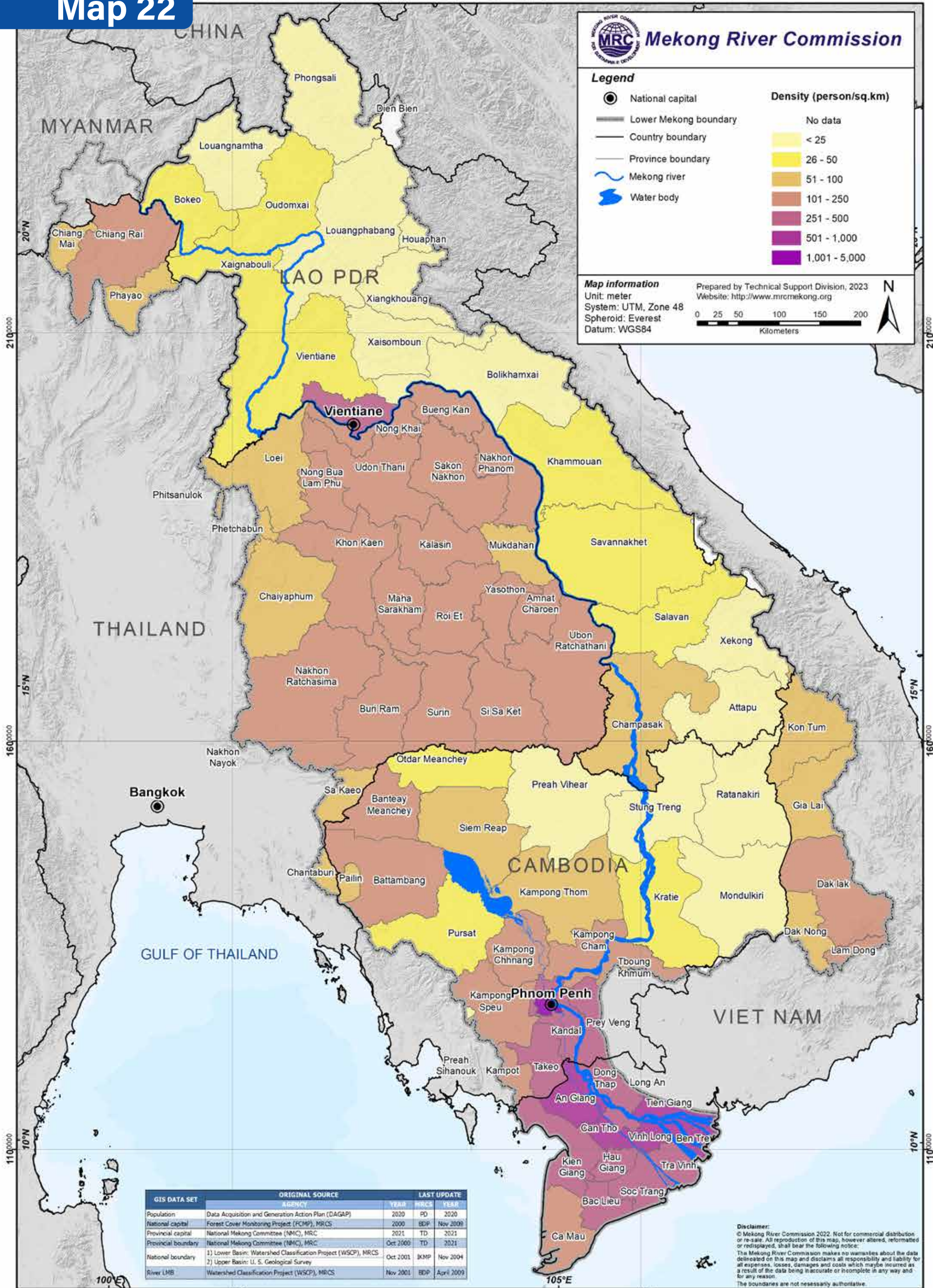
Table 15. National and LMB population, and percentage of the respective population residing in the LMB, 2020

LMB countries	Total national population	Total LMB population	Proportion of country's population residing in the LMB (%)
Cambodia	16,478,430	15,782,144	95.77%
Lao PDR	7,231,210	7,221,129	99.86%
Thailand	66,186,727	27,473,404	41.51%
Viet Nam	97,582,700	23,250,650	23.83%
Total	187,479,067	73,727,327	39.33%

Data source

Country	Source	Year	Data level	Agency
Cambodia	- Statistical Yearbook, 2001, 2005 and 2006 - Cambodia General Population Census, 1998 and 2008 - Commune database, 2006–2017 - Province profile reports, 2018–2020	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Statistics Sector, Provincial Department of Planning and Investment	2020	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Statistics Database Population as of December of each year	2020	Province	The Bureau of Registration Administration, Department of Provincial Administration
Viet Nam	Provincial Statistics Yearbooks	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment





Population density

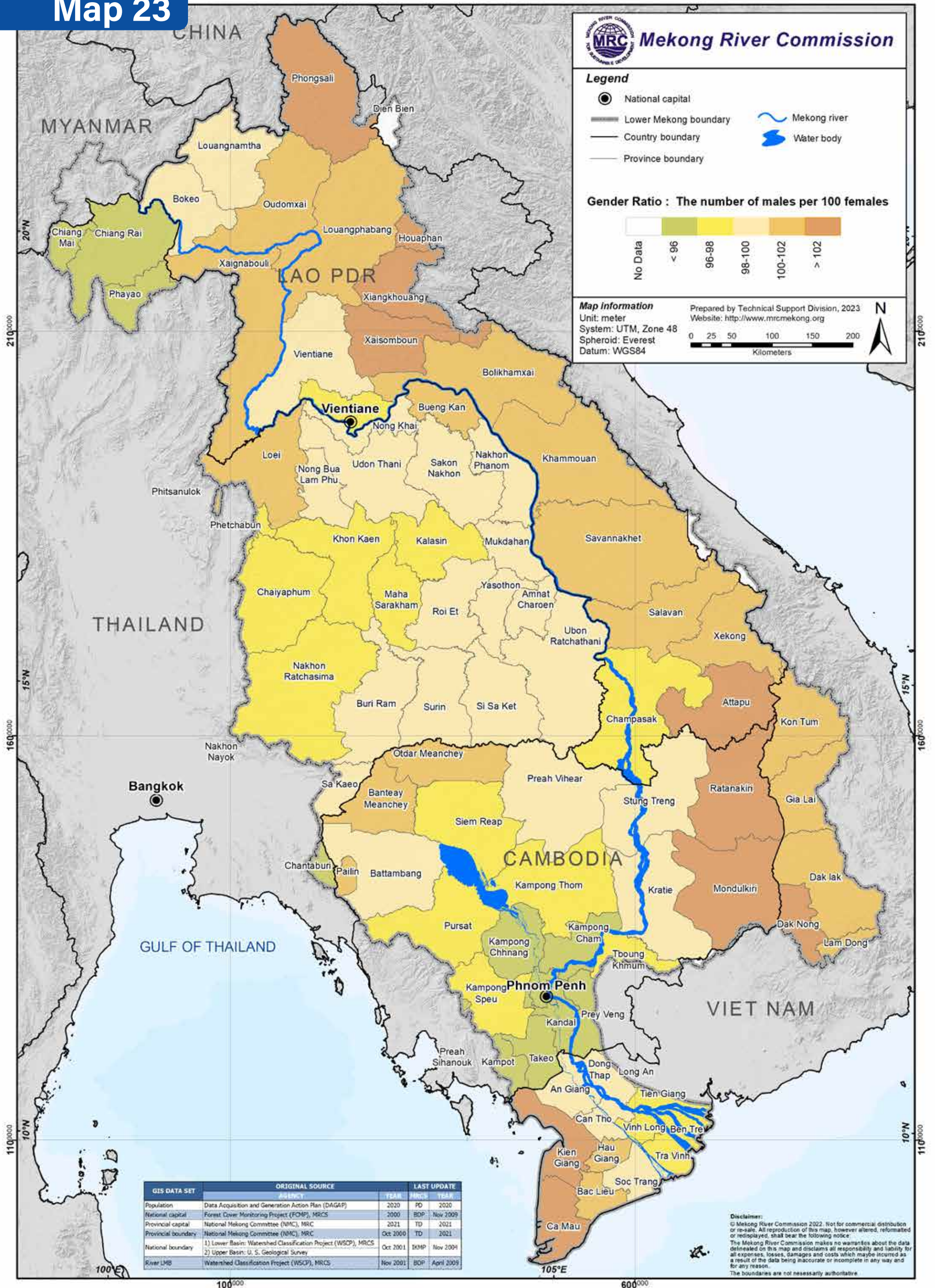
Population density is the number of people per km² of land area. Population density varies widely across the LMB, as shown by Map 22 according to the available 2020 data. The Mekong Delta in Viet Nam and the area around the capital cities (Phnom Penh city in Cambodia and Vientiane capital city in Lao PDR) have the largest population densities, with at least 250 persons per km², and up to 4,185 persons per km² in Phnom Penh city. The population density in the Mekong Delta is also high, especially in Can Tho, Tien Giang and Vinh Long provinces, at 862 persons/km², 741 persons/km² and 671 persons/km², respectively. Vientiane Capital Province in Lao PDR also has a high population density, at 262 persons per km².

In contrast, the upland regions of Lao PDR along the country’s border with Viet Nam, Myanmar and China have significantly low population densities of less than 25 persons per km². These include Louangnamtha and Phongsali provinces, with population densities of 10 persons/km² and 13 persons/km², respectively. Similarly, Cambodia has the lowest population density in the northeast region, which includes Mondulhiri and Stung Treng provinces, at 7 persons/km² and 14 persons/km², respectively. In the LMB provinces of Thailand, the population density is also low; for example, Loei and Mukdahan have population densities of 64 persons per km² and 86 persons per km², respectively; however, Phetchabun has a high population density, of 1,050 persons per km².

Data source

Country	Source	Year	Data level	Agency
Cambodia	- Statistical Yearbook (2001, 2005 and 2006) - Cambodia General Population Census (1998 and 2008) - Commune Data Base 2006-2017) - Province profile Report (2018-2020)	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Statistic Sector, Provincial Department of Planning and Investment	2020	Province	Lao Statistic Bureau (LSB), Ministry of Planning and Investment
Thailand	- Statistic Database - Population as of December of each year	2020	Province	The Bureau of Registration Administration, Department of Provincial Administration
Viet Nam	Provincial Statistics Yearbooks	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment

Map 23



The gender ratio

Gender ratio measures the number of men for every 100 women in the population. Map 23 illustrates the gender ratio by province based on provincial data submitted by the LMB countries under the DAGAP. Overall, the gender ratio is not significantly different across the provinces. In 2020, in most provinces of Cambodia, the gender ratio was less than 100, indicating that women outnumbered men. In contrast, there were more men than women in some provinces such as Banteay Meanchey, Kratie, Ratanakiri, Mondulkiri, Stung Treng, Otdar Meanchey and Pailin, with gender ratios over 100.

In 2020, in Lao PDR, the gender ratio was not significantly different across provinces. Some provinces had gender ratios lower than 100, particularly in Bokeo, Luangnamtha, Vientiane and Champasak provinces as well as in Vientiane Capital. Similarly, in Thailand, differences in the gender ratio were slight, i.e. male and female populations were approximately equal across the LMB provinces. In most LMB provinces of Viet Nam, the gender ratio was slightly above or below 100, indicating that the male and female populations have gradually been increasing, reaching an equal gender ratio.

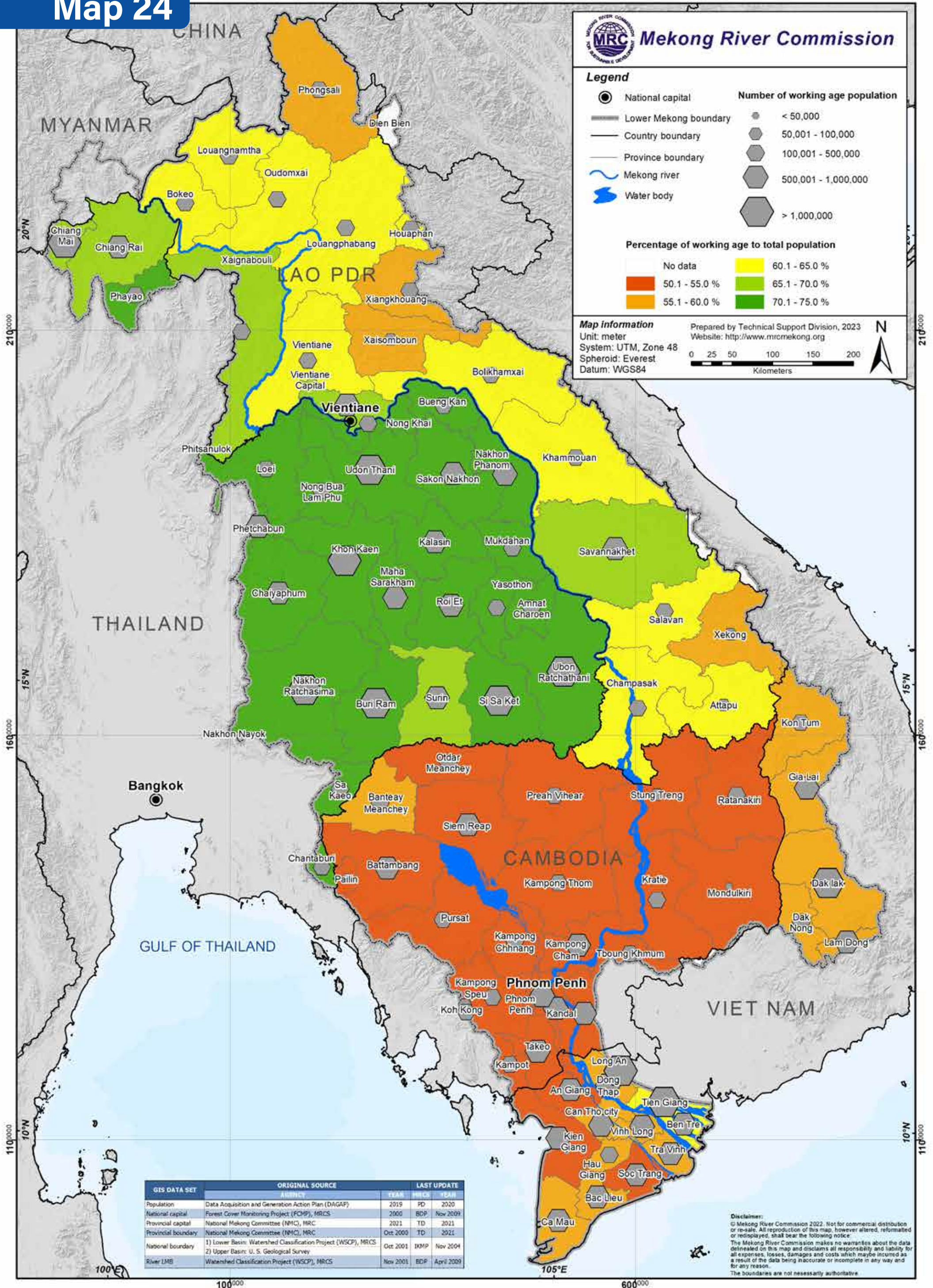
Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Statistical Yearbook (2001, 2005 and 2006) ◆ Cambodia General Population Census (1998 and 2008) ◆ Commune Data Base 2006-2017) ◆ Province profile Report (2018-2020)	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Statistic Sector, Provincial Department of Planning and Investment	2020	Province	◆ Lao Statistic Bureau (LSB), Ministry of Planning and Investment
Thailand	◆ Statistic Database ◆ Population as of December of each year	2020	Province	◆ The Bureau of Registration Administration, Department of Provincial Administration
Viet Nam	◆ Provincial Statistics Yearbooks	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment



Working-age population

Map 24



Working-age population

Map 24 shows the number and proportion of the working-age population (aged 15–64) based on 2018 and 2020 data by province in the LMB countries as well as some data disaggregated by urban and rural areas and by male and female populations. In Cambodia, the age of the working-age population is 18–60. In Lao PDR and Thailand, the age of the working-age population is 15–64. According to ILO, however, the working-age population is 15 and older, although this may vary slightly from country to country.

According to 2018 and 2020 data, in the LMB, there were a total of 73.8 million people, of whom 45.9 million were of working-age (i.e. 62%). Out of the total working-age population in the entire LMB, Thailand had the highest number of working-age people, at 19.5 million (43%), while Lao PDR had the lowest, at 4.6 million people (10%). In Viet Nam, the working-age population was 13.3 million people (29%) and in Cambodia, 8.4 million people (18%); the total male working-age population was around 23.6 million people, which was slightly higher than the female working-age population, at 22.3 million people. In comparison with the total number of male/female LMB population, male working-age population is around 64% which is slightly higher than female working-age population 60%.

In the LMB provinces of Cambodia, the total working-age population was 8.4 million people, which was 53% of the total population (15.78 million people) in the LMB areas in 2020. Phnom Penh had the largest working-age population, at 888,895 people, while Pailin has the lowest, at 39,424 people. The total male and female working-age populations slightly differed, at 49% and 51%, respectively. In Cambodia's LMB provinces, in comparison, the male and female working-age populations were around equal, at 53% and 54%, respectively; only some provinces had a significant gender difference, especially Koh Kong, at 62% male and 52% female.

In 2020, in the LMB provinces of Lao PDR, the total working-age population was 4.6 million people, i.e. 64% of the total LMB population (7.2 million people). Savannakhet had the highest working-age population, i.e. 701,289 people, while Xaisomboun recorded the lowest number, i.e. 61,259 people. The total male and female working-age populations were equal, at 50%, hence there were no significant gender gaps. The number of male working-age population is slightly higher than female working-age population in most of the provinces in Lao PDR, particularly significant difference in some provinces such as Xayaboury (142,243 and 133,256), Xiengkhuang (80,319 and 78,761) and Xaysomboun (33,533 and 27,726) male and female working-age population respectively. In contrast, number of female working-age population is higher than male working-age population in some provinces including Champasak, Khammuane, Luangnamtha, Saravane, Savannakhet and Vientiane Capital.

In 2018, in the LMB provinces of Thailand, the working-age population was around 19.5 million people, i.e. 71% of the total population (27.4 million people). The male and female working-age populations were equal, at 50% of the total working-age population. There were some disparities between the LMB provinces in terms of total working-age populations, and the working-age populations disaggregated by male and female workers. Nakhon Ratchasima had the highest working-age population, at around 1.8 million people, while Mukdahan had the lowest, at around 251,828 people. Chiang Mai and Chiang Rai had the lowest working-age population (65% of the total population), whereas in other LMB provinces, around 70–74% of the total population were of working age.

In 2020, in the LMB provinces in Viet Nam, the working-age population was around 13.5 million, or 57% of the total population (23.2 million people). The male and female working-age population differed slightly, at 56% and 44%, respectively, of the total working-age population in the country. There were some disparities between the LMB provinces regarding the male and female working-age populations. Tien Giang had the highest working-age population, at around 1.1 million people, while Kon Tum had the lowest working-age population, at 312,800 people. There were some gender gaps in the province, i.e. a larger male than female working-age population in Tien Giang (68% and 58%, respectively), Ben Tre (70% and 58%, respectively), Tra Vinh (64% and 54%, respectively) and Can Tho City (68% and 47%, respectively).

Table 16. Number and proportion of the working-age population in the LMB

Number of working age population in LMB in 2018/2020			Proportion of working age population in LMB in 2018/2020			
Country	No. of working-age pop.	Percentage in the LMB (%)	Country	No. of working-age pop.	Total population	Percentage in each country (%)
Cambodia	8,442,838	18	Cambodia	8,442,838	15,782,144	53
Lao PDR	4,610,478	10	Lao PDR	4,610,478	7,221,129	64
Thailand (2018)	19,544,098	43	Thailand (2018)	19,544,098	27,473,404	71
Viet Nam	13,355,490	29	Viet Nam	13,355,490	23,250,650	57
Total LMB	45,952,904	100	Total LMB	45,952,904	73,727,327	62

Based on 2018 and 2020 data

Table 17. Proportion of the male/female working-age population in the LMB

Country	Male working-age population	Female working-age population	Male population	Female population	Percentage male (%)	% female
Cambodia	4,126,696	4,316,142	6,894,291	8,887,853	60	53
Lao PDR	2,308,145	2,302,333	3,617,817	3,603,312	64	64
Thailand (2018)	9,730,202	9,813,896	13,583,039	13,890,365	72	71
Viet Nam	7,441,930	5,913,560	11,611,440	11,639,210	64	57
Total LMB	23,606,973	22,345,931	35,706,587	38,020,740	66	62

Based on 2018 and 2020 data

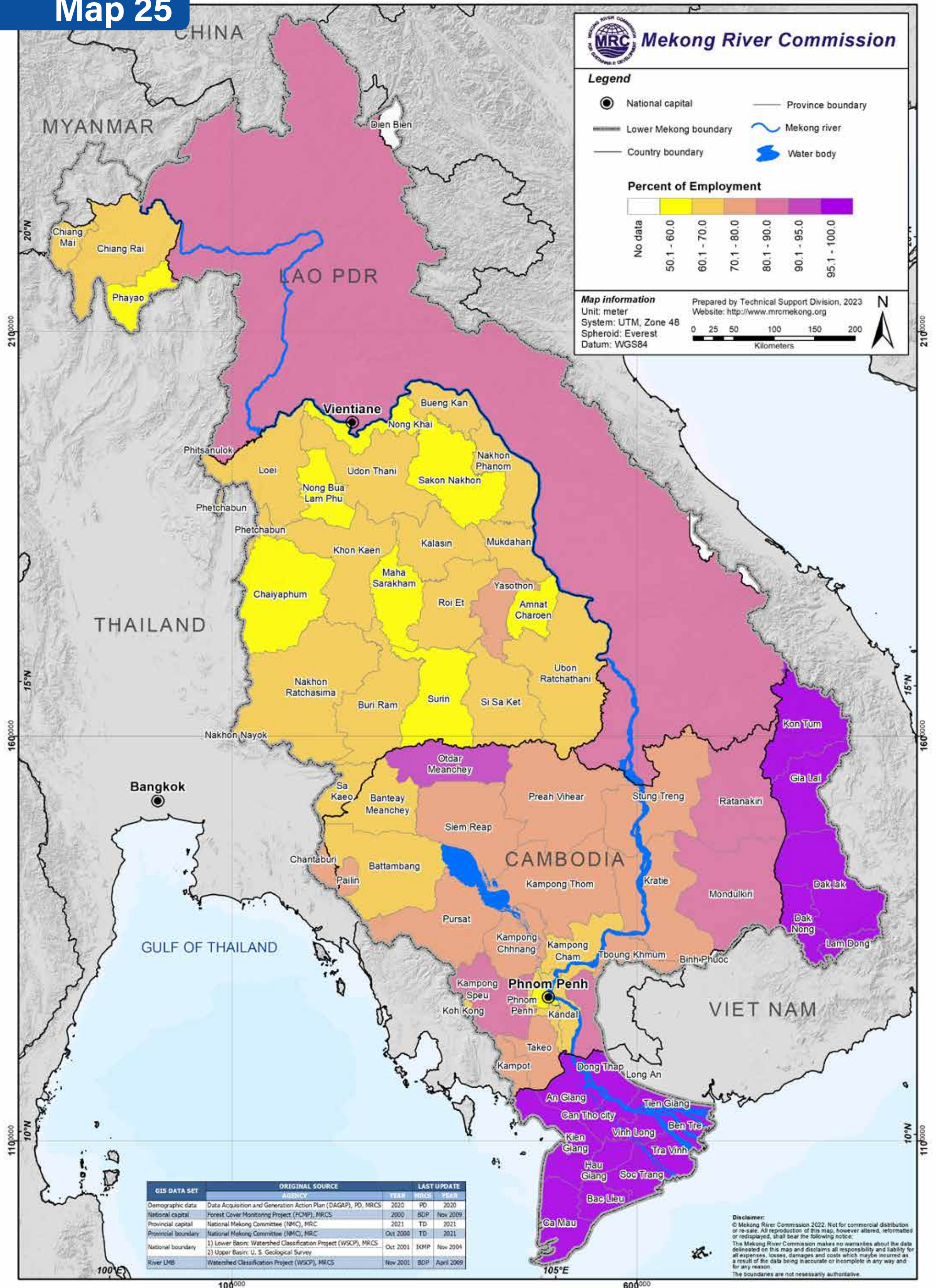
Data source

Country	Source	Year	Data level	Agency
Cambodia	- Commune Database 2006-2017) - Province profile Report (2018-2020) - General population Census 1998	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Lao Statistics Bureau, Ministry of Planning and Investment	2020	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Department of Provincial Administration, Ministry of Interior	2018	Province	Department of Provincial Administration, Ministry of Interior
Viet Nam	Statistical Yearbook of Viet Nam	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment



The employment rate

Map 25



The employment rate

Map 25 shows the employment rate by province in the LMB countries and some disaggregated data by urban and rural areas in 2020. In Cambodia, the employment rate refers to the number of people employed in a primary occupation divided by the number of people aged 18–60 and multiplied by 100. In Lao PDR, the employment rate refers to the percentage of the employed working-age population out the total working-age population. In Thailand, the employment rate refers to the number of employed people aged 15 years and over out the total working-age population multiplied by 100. The Organization for Economic Co-operation and Development (OECD) defines the employment rate as the employment-to-population ratio. This is a statistical ratio that measures the proportion of a country's working-age population that is employed. This includes people who have stopped looking for work.

At the basin level, in 2020, the average employment rate was 79.53%: Viet Nam had the highest employment rate, at 97.77%, Lao PDR, at 80.50%, Cambodia, at 76.48%, and Thailand, at 63.36%.

In 2017, most of the LMB provinces in Cambodia recorded lower employment rates than the average rate (76.5%), in particular, Phnom Penh, at 55.84%. In contrast, Otdar Meanchey province had the highest employment rate, at 91.74%. The male employment rate was lower than the female employment rate in LMB provinces, for instance, at 67% and 77.8%, respectively in the LMB provinces of Cambodia. Some LMB provinces had significant gender disparities; for example, Kampong Chhnang and Monduliri had much lower male employment rates than female employment rates, at 54% and 82%, and 48% and 89%, respectively.

In Lao PDR, province data were not available. Based on the available national data, the employment rate has fluctuated from 98% in 1995, 99% in 2005 and 95.8% in 2017, to 80.5% in 2020.

In 2020, many LMB provinces of Thailand recorded lower employment rates (56–62%) than the average LMB rate in Thailand of 63.36%, such as in Nakhon Ratchasima, Surin, Chiyaphum, Amnat Charoen, Nong Bua Lam Phu, Khon Kean, Udon Thani, Nong Khai, Maha Sarakham, Kalasin, Sakon Nakhon, Phayao, Chiang Mai and Phetchabun. Sakon Nakhon had the lowest rate, at 56%, while Chantaburi had the highest rate, at 78%. The average female employment rate in the LMB provinces was 72.14%, which was lower than the male employment rate (72.14%). There were higher male employment rates than female employment rates across all LMB provinces. In particular, there were significant gender disparities in Chaiyaphum, Maha Sarakham and Sakon Nakhon provinces, and the lowest female employment rate was less than 50%.

In 2020, most LMB provinces of Viet Nam recorded higher rates than the average LMB rate of 97.77%; for example, Kon Tum and Lam Dong recorded the highest rates (99%), whereas Kien Giang had the lowest (96%).

Table 18. Average employment rate, 2020

Country	Average employment rate (%)
Cambodia	76.48
Lao PDR (National Data)	80.50
Thailand	63.36
Viet Nam	97.77
Average LMB	79.53

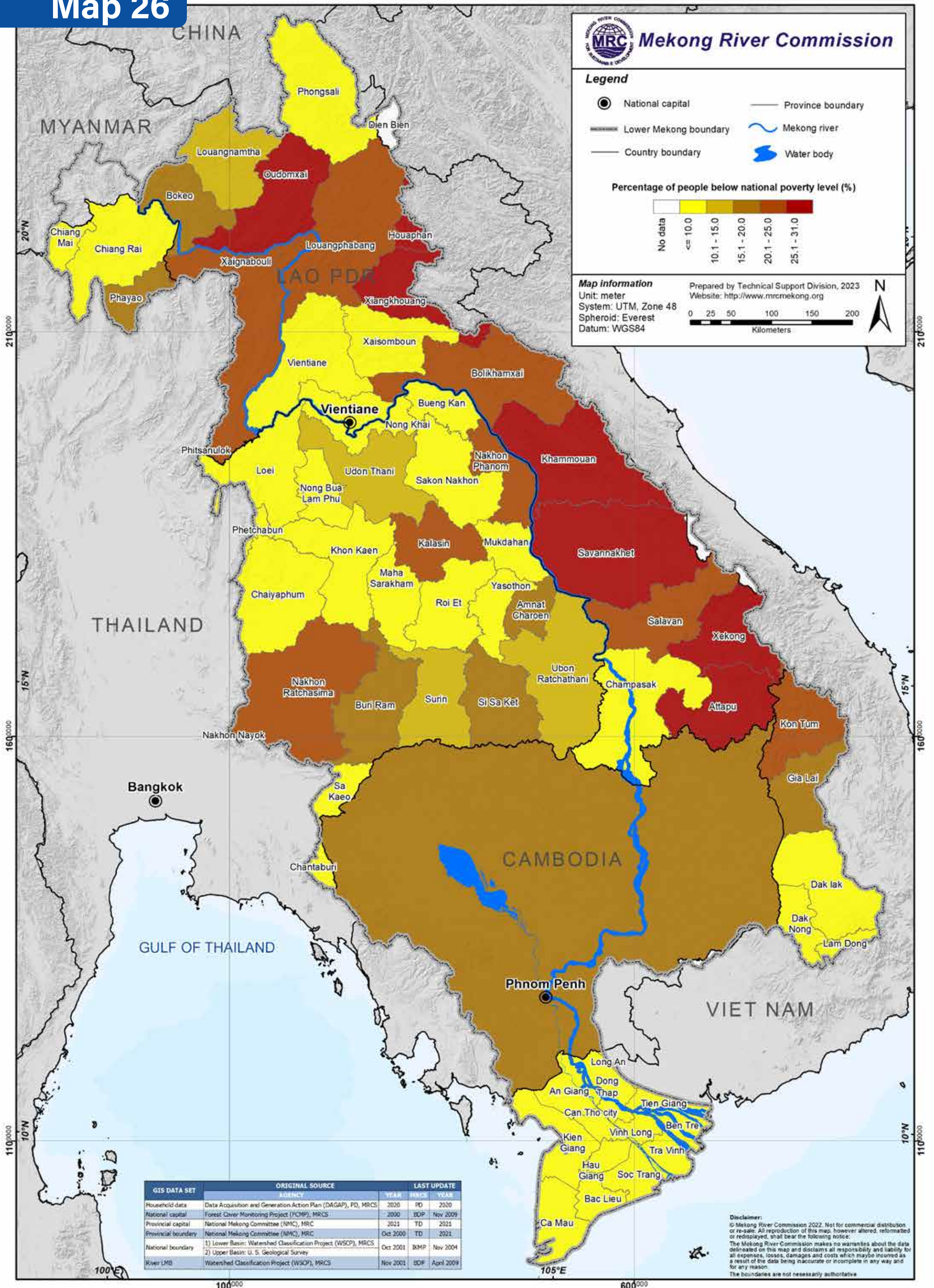
Data source

Country	Source	Year	Data level	Agency
Cambodia	● Commune Database 2006–2017 ● Province Profile Reports, 2018–2020	2020	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● Labour surveys, 2017 and 2022 ● 2020 data are estimated by the 2017–2022 trend	2020	National	● Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	● The labour force survey by the National Statistical Office	2020	Province	● National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	● The 2006 Rural, Agricultural and Fishery Census ● The 2016 Rural, Agricultural and Fishery Census ● The 2020 Mid-term Rural, Agricultural and Fishery Census ● Calculation from internal documents of General Statistics Office: for Hydropower.	2020	Province	● General Statistics Office



Population living below the poverty line

Map 26



Population living below the poverty line

Map 26 shows the percentage of people living below the national poverty line by province in the LMB countries and some disaggregated data by urban and rural areas based on 2019 and 2020 data. In Cambodia, the national poverty line is defined based on food and non-food consumption equal to US\$2.50 per day per person. In Lao PDR, the poverty line is defined as the proportion of what the population spends to meet basic food and non-food needs, which is less than poverty line that is established through a certain value per month. In Thailand, these data refer to the proportion of poor in terms of expenditure. The percentage of people living below the national poverty level = (number of people living below the poverty line /total population) * 100. In Viet Nam, the poverty rate is calculated by monthly average household income per capital (2002–2009 data). The Government's poverty line for the 2011–2015 period is calculated by the monthly average income per capital of household, which is updated by the Consumer Price Index (CPI). For 2016–2020 data, the household poverty rate is calculated according to the multi-dimensional poverty approach.

According to the United Nations, the percentage of the population living below the poverty line captures the prevalence of poverty by measuring the proportion of the population for whom consumption (or any other suitable measure of living standards) is below the poverty level.² An increase in this indicator implies a worsening of the poverty situation with a greater proportion of the population falling below the poverty level. Information on consumption and income is obtained through sample surveys in which households are asked to answer detailed questions on their spending habits and sources of income. The national poverty rates use a country-specific poverty line, which reflects the country's economic and social circumstances; hence, the limitation of this indicator is not intended for comparisons across countries. National poverty lines tend to have higher purchasing power in developed countries, where more generous standards are used than in poor countries.

Based on 2019/2020 data, the average percentage of people in the LMB living below the national poverty line was 11.43%: in 2019, Lao PDR recorded the highest at 18.28%, followed by Cambodia at 17.8%; and in 2020, Thailand recorded 10.58% and Viet Nam, 5.99%, in the LMB provinces.

In Cambodia, provincial data were not available. Based on the available national data, the percentage of people living below the national poverty level decreased from 39% in 1993 (37% in urban and 43% in rural areas) to 17.8% in 2019 (12.6% in urban and 22.8% in rural areas). This shows that a higher proportion of the population in the LMB provinces fell below the national poverty level, and the rural population was more vulnerable than the urban population.

In 2019, in Lao PDR, an average of 18.28% of people were living below the national poverty line. Most of the provinces recorded a higher percentage than the average, at between 19.40% and 30.60%, including Attapu, Bokeo, Borikhamxay, Huanphanh, Khammuane, Luangprabang, Oudomxai, Salavan, Savannakhet, Xekong, Xaignabouli and Xiengkhuang provinces. Xekong and Oudomxai recorded the highest percentage of people living below the national poverty level, at 29–31%, while Vientiane Capital and Vientiane Province had the lowest percentage, at 5%.

In 2020, in Thailand, an average of 10.58% of people were living below the national poverty line. Many LMB provinces recorded a higher percentage of people below the national poverty line than the average, at between 11.61% and 23.79%, such as Nakhon Ratchasima, Buri Ram, Surin, Si Sa Ket, Ubon Ratchathani, Amnat Charoen, Udon Thani, Kalasin, Nakhon Phanom and Phayao provinces. Kalasin province had the highest percentage of people living below the national poverty level, at 23.79%, while Loei and Khon Kaen provinces recorded the lowest, at 0.28% and 0.75%, respectively.

In 2020, in Viet Nam, an average of 5.99% of people were living below the national poverty line. Some LMB provinces recorded a high percentage of people living below the national poverty level, such as Kon Tum and Gia Lai, at 22% and 18.40%, respectively, whereas Can Tho City, Long An and Ten Giang recorded low percentages, at around 2%.

Table 19. Average percentage (%) of people in the LMB living below the national poverty line, 2019/2020

Country	% of people below poverty level	Total population	Total people below poverty level
Cambodia (2019)	17.80	15,782,144	2,809,222
Lao PDR (2019)	18.28	7,221,129	1,320,193
Thailand	10.58	27,473,404	2,906,801
Viet Nam	5.99	23,250,650	1,391,583
Average LMB	11.43	73,727,327	8,427,799

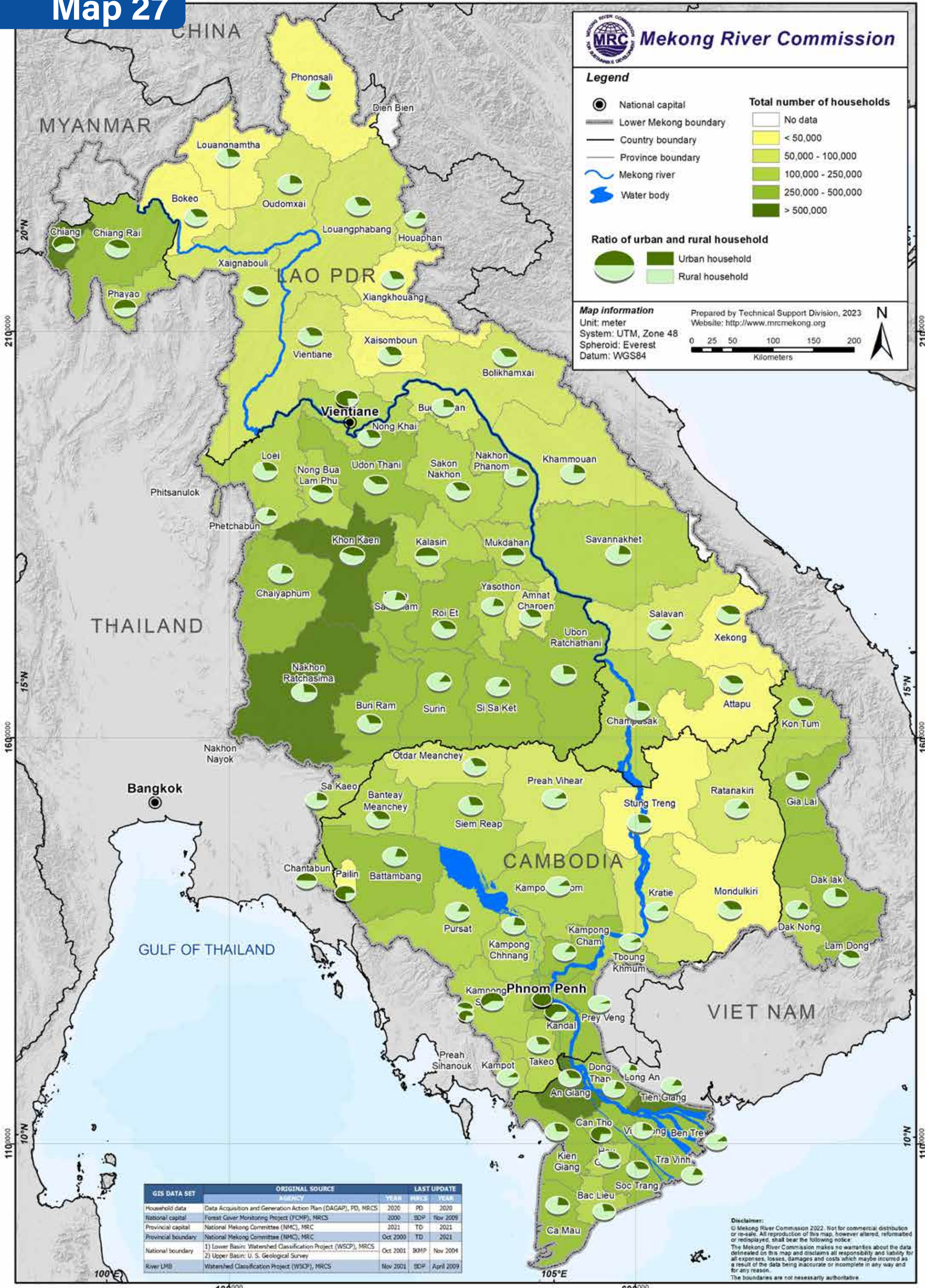
Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ National poverty line profiles	2019	National	
Lao PDR	◆ Lao Expenditure Consumption Survey I, II, III, IV, V and VI, of 1993, 1998, 2003, 2008, 2013, 2019, respectively	2019	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Office of the National Economic and Social Development Council, Office of the Prime Minister	2020	Province	◆ Office of the National Economic and Social Development Council, Office of the Prime Minister
Viet Nam	◆ Statistical Yearbook of Viet Nam	2020	Province	



Number of households

Map 27



Number of households

The number of households in the LMB provinces varies widely across the LMB, as illustrated in Map 27 based on 2019/2020 available data. In Cambodia, the total number of households refers to the total number of families and regular households. In Lao PDR, total number of households refers to the total number of households including collective and individual households. In Thailand, total number of households is based on a socio-economic survey of private households (except for households of ambassadors, foreign representatives and temporary residents of Thailand), including institutional households such as dormitories and hospitals.

In 2020, the total number of households in the LMB provinces was around 18.7 million: Thailand recorded the highest number in the LMB, at 7.5 million (40%), followed by Viet Nam, at 6.3 million (34%), Cambodia, at 3.5 million (19%) and Lao PDR, at 1.2 million (only 7%).

In 2020, the highest number of households was recorded in Viet Nam’s Mekong Delta, the area around capital cities (Phnom Penh, Cambodia) and the northeast region in Thailand, with at least a total of 300,00households. In particular, the northeast and northern provinces of Thailand recorded the highest number, including Nakhon Ratchasima at 794,065, Chiang Mai at 603,775, and Ubon Ratchathani at 497,889. In contrast, the upland regions of Lao PDR and the northeast region of Cambodia recorded the lowest number of households, at less than 100,000; for example, Xaisomboun province recorded only 15,806 households, and Pailin province, only 17,083 households in the LMB provinces of Cambodia.

Table 20. Total number and proportion of households in the LMB, 2020

Country	Total no. of HHs	Total no. of urban HHs	Total no. of rural HHs	Percentage of LMB HHs (%)
Cambodia	3,570,783	1,177,637	2,393,146	19
Lao PDR	1,247,248	431,121	816,127	7
Thailand	7,558,386	2,534,637	5,023,749	40
Viet Nam	6,303,870	1,714,180	4,511,290	34
Total in the LMB	18,680,287	5,857,575	12,744,312	100

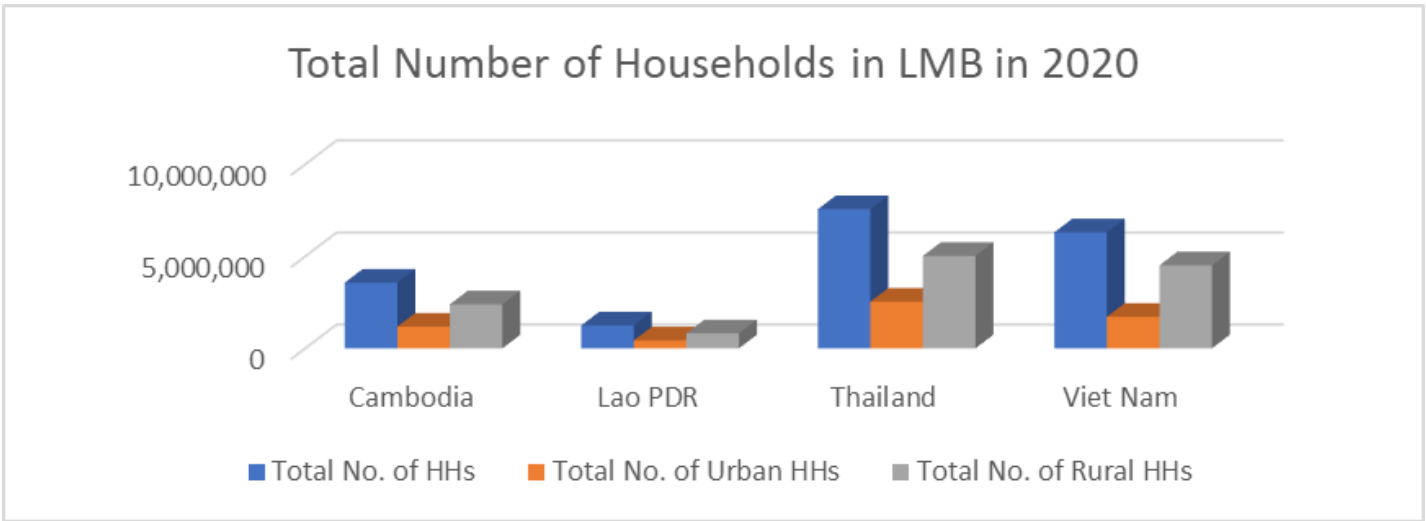
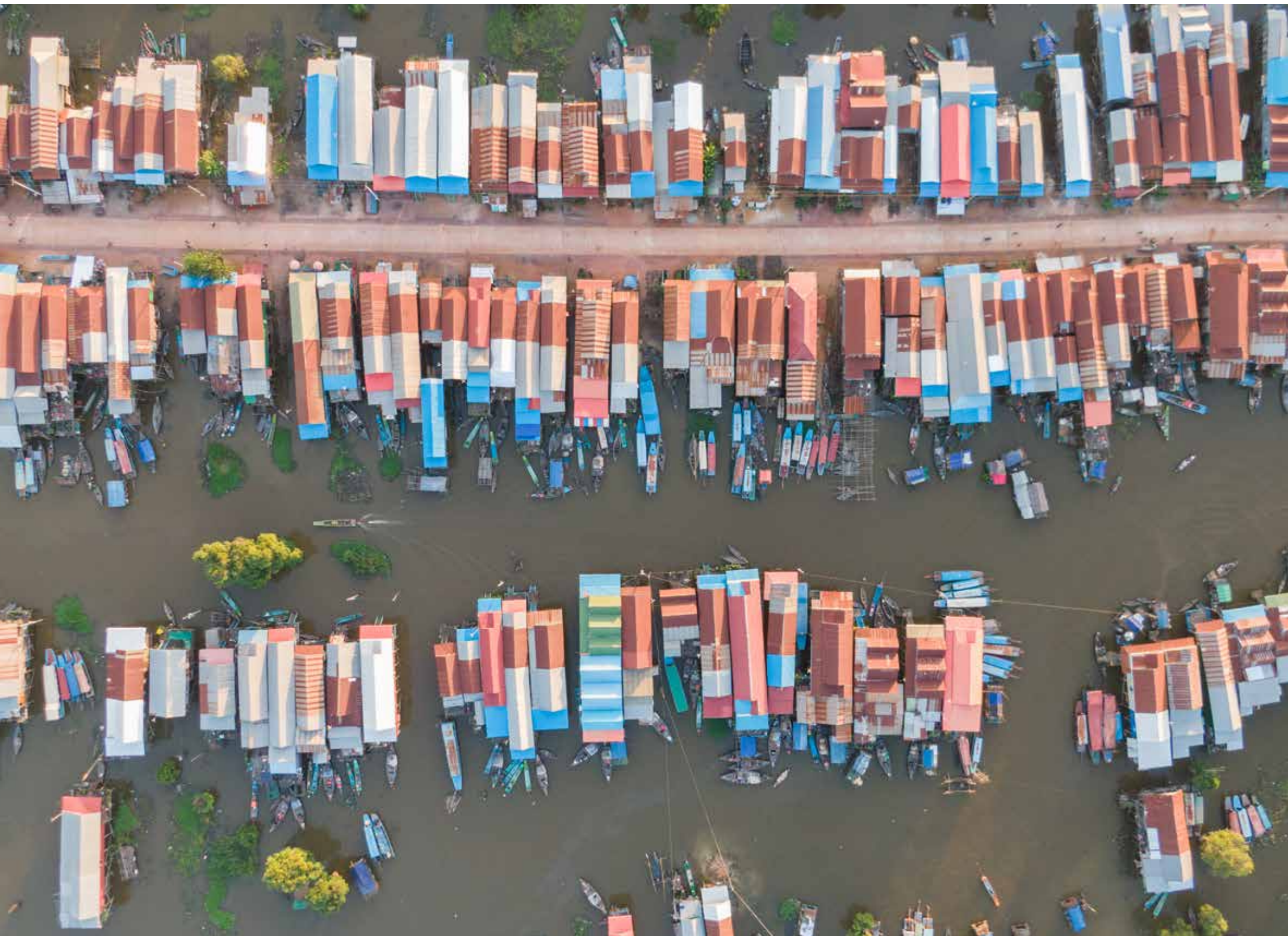
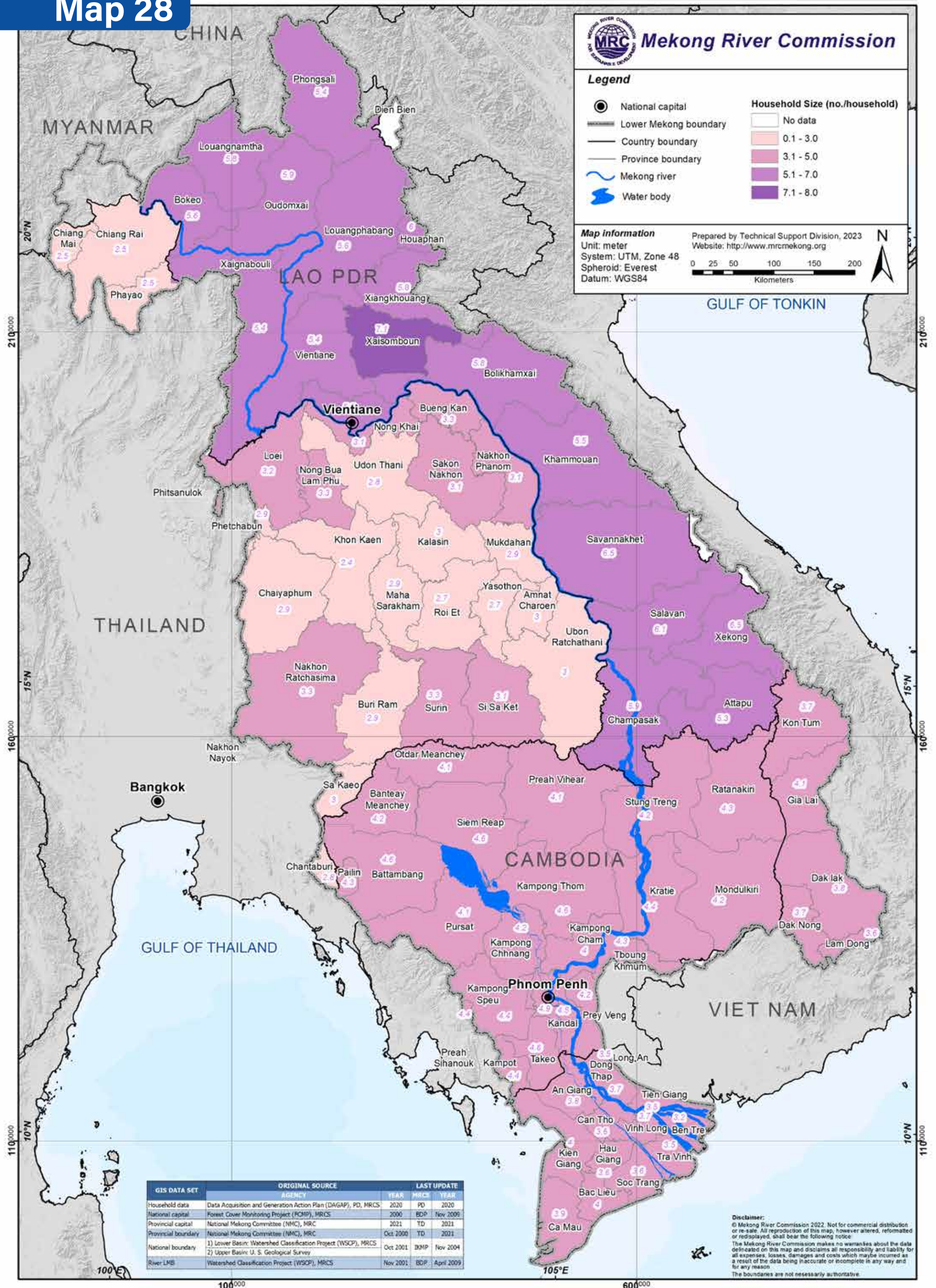


Figure 12. Total number of households in the LMB, 2020

Data source

Country	Source	Year	Data level	Agency
Cambodia	- Statistical Yearbooks, 2001, 2005 and 2006 - Cambodia General Population Census, 1998 and 2008 - Commune Database, 2006–2017 - Province profile reports, 2018–2020 - Provincial Planning and Statistics Department (for Svay Rieng, only 1981–1997)	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	- LSB, MPI. Data is available in the year of conducting the census in 1995, 2005 and 2015; 2020 is estimated from the 2005–2015 trend - Statistics Sector, Provincial Department of Planning and Investment; - Administrative data	2020	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Socio-Economic Survey (SES)	2020	Province	National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	- The 2009 and 2019 Viet Nam Population and Housing Census - The Viet Nam Household living standards surveys	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment





Household size

Household size is defined as the number of members per household in the LMB, which can be calculated by dividing the total population by the total number of households. Map 28 shows the average number of people per household by province in 2020 in the LMB countries. In Cambodia, the household size is based on the total population divided by the total number of households. In Lao PDR, it refers to the number of members per household. Data are based on 1995, 2005 and 2015 censuses. The 2020 data were estimated from the 2005 to 2015 trend. In Thailand, household size refers to the sum of the number of household members divided by the number of households. According to the United Nation Division for Sustainable Development, the average household size is defined as the ratio of the total population to the total number of households. The measurement unit is the number of members per household.

In 2020, in the LMB provinces of Lao PDR recorded the highest the average number of members per household, at around 6. followed by Cambodia (4), Thailand (3) and Viet Nam (4).

In 2020, most of the LMB provinces of Cambodia had a similar number of members per household, at around 4–5: i.e. around 4–7 persons per household in urban areas and 4–5 persons per household in rural areas. Phnom Penh capital city recorded the highest number of members per household, at around 5. In urban areas, some provinces recorded a large number of members per household such as Battambang, Kompot and Ratanakiri, around 6–7 members. In rural areas, some provinces such as Kampong Thom, Kandal, Siem Reap, Preah Sihanouk and Takeo recorded a higher household size, around 5 members. It is assumed that this situation might be due to rural-to-urban migration where households migrate from rural areas to urban areas in search of education, employment and economic opportunities, as well as social services.

In 2020, in Lao PDR, most of the provinces have a similar household size of around 5–6 persons per household. Some of the northern and southern provinces had large households of around 6-7 member per household, including Huaphanh, Salavan, Savannakhet, Xekong and Xaisomboun provinces. This could reflect the conditions and assumptions that the traditional household in rural provinces and areas is typically large, often including several generations and relatives, with many children who help with care, work in agriculture and food production, and carry out other tasks to meet family needs.

In 2020, most of the LMB provinces of Thailand had a similar household size, of around 2–3 persons/household, both in urban and rural areas. In total, the northeast provinces such as Nakhon Ratchasima, Nong Bua Lam Phu, Bueng Kan, Surin, Nakhon Phanom and Si Saket provinces had larger households than other LMB provinces, with more than 3 persons/household.

In 2020, most of the LMB provinces of Viet Nam had around 3–4 persons per household. The household size in the Mekong Delta (An Giang, Kien Giang, Bac Lieu and Ca Mau provinces) and Gai Lai and Dak Lak provinces was larger than in other LMB provinces, at around 4 persons per household. The households in rural areas are slightly larger than in urban areas because, traditionally, the former are typically large and include several generations, with many children contributing to family care work and agricultural production. However, this may be influenced by many factors such as: government policies and development programmes and projects in the country; and improved living conditions, rural development and poverty reduction in rural areas where people need not migrate to urban areas for employment or other social services. In addition, traditionally households in rural areas are typically large and include several generations, with many children contributing to family care work and agricultural production.

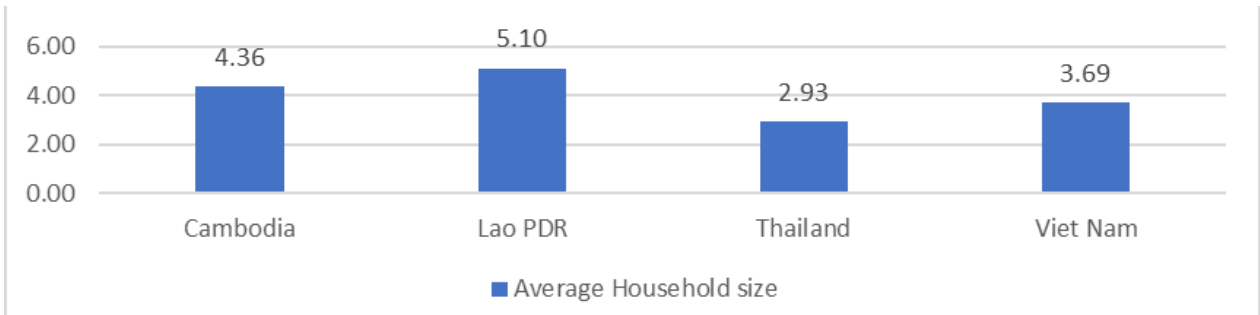
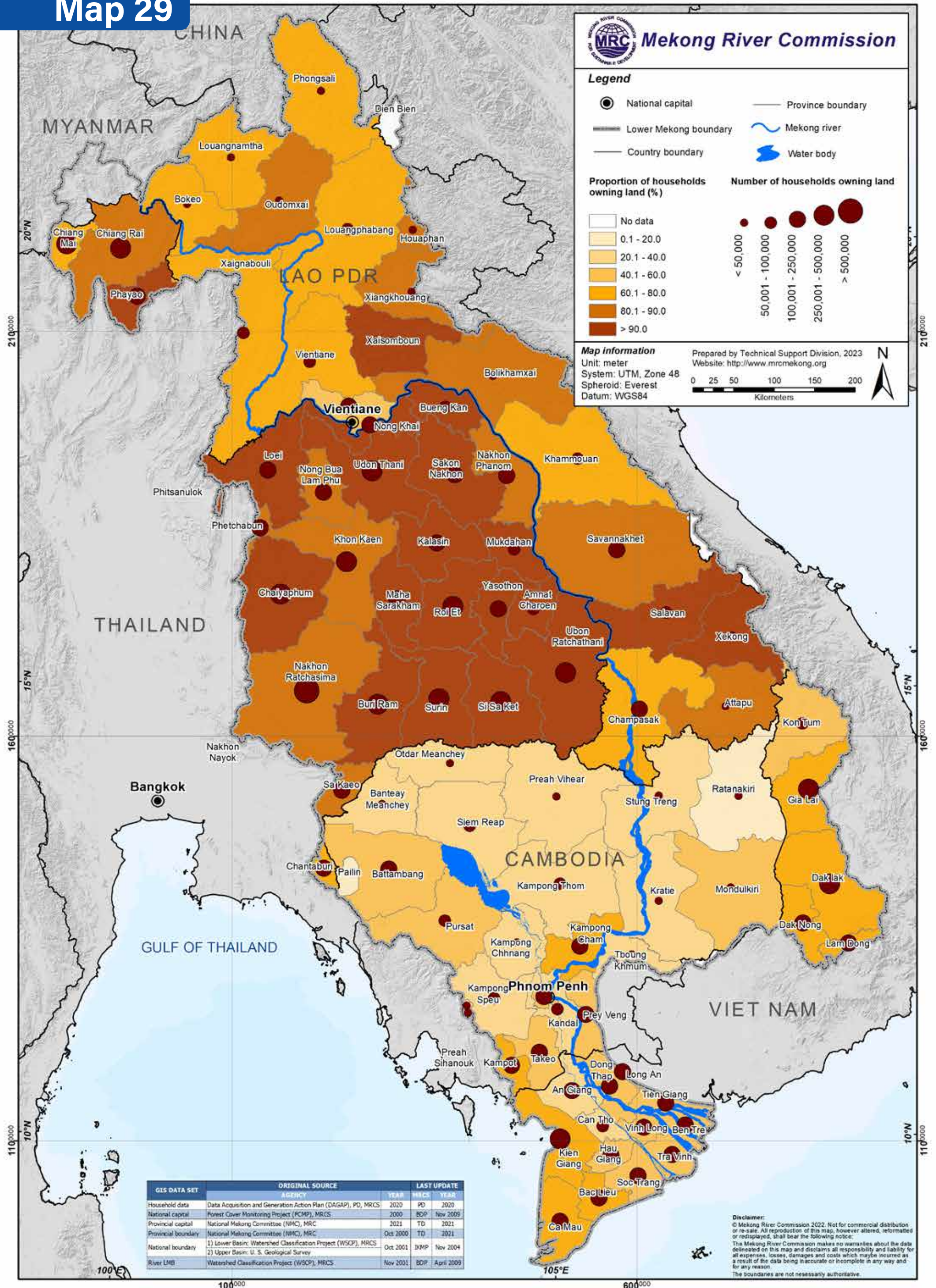


Figure 13. Average household size in the LMB, by country, 2020

Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Census, 1998, 2008 and 2019 ◆ Commune Database 2006–2017 ◆ Province profile reports, 2018–2020	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Lao Statistics Bureau, Ministry of Planning and Investment; ◆ Population and Housing Census, 1995, 2005 and 2015, Lao Statistics Bureau; ◆ For Saravane province, data are taken from Statistics sector, Department of Planning and Investment	2020	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Socio-Economic Survey data conducted by the National Statistics Office)	2020	Province	◆ National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	◆ Viet Nam Household Living Standards Survey	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment





Land-owning households

Map 29 shows the number and proportion of land-owning households by province based on 2019 and 2020 data in the LMB countries. In Cambodia, the number of land-owning households refers to the number of households owning land with a land title; however it was not possible to disaggregate the data by male/female numbers because the data refer to the entire village population. In Lao PDR, the number of rural land-owning households is estimated from the number of households that own agricultural land. In Thailand, this refers to the number of households owning houses and land. In Viet Nam, this refers to the number of households that have the right to use land (i.e. the right to exploit, use and enjoy the benefits and income from the land), since the land is owned by the State. In Viet Nam, this refers to the number of households that have agricultural land in rural areas. According to FAO, land tenure is the relationship, legally or customarily defined, among people, as individual or groups, with respect to land.

Around 12.3 million households out of 18.7 million households in the LMB own land, i.e. 66%. In 2020, Lao PDR and Thailand recorded the highest number and proportion of households owning land among the LMB countries, at 82% and 89%, respectively, compared to Cambodia and Viet Nam, at 41% and 49%, respectively.

In 2019, in Cambodia, the average national rate of land-owning households was 41%. However, most of its LMB provinces recorded lower than this average rate, at 17–39%, such as Ratanakiri and Pailin, at 17–18%, respectively. Hence, further support and assistance are required in order to increase the number of households owning land. Kampot recorded the highest rate, at 80%, followed by Kampong Cham, at 64%, Monduliri and Takeo, at 57%, and Preah Sihanouk, at 50%. Data on urban and rural land-owning households were not available for 2020, but were available for 2016, albeit they were not accurate.

In 2019, in Lao PDR, the national average rate of land-owning households was 67%, and there were some disparities between the provinces. The Vientiane Capital recorded the lowest rate of households owning land, at 25%, while Huaphanh had the highest rate, at 84%. Some provinces had slightly lower rates of than the national average of 67%, such as Attapu, Borikhamxay, Xekong and Xaignabouli provinces. Data on urban/rural land-owning households were available for 2019, but data on urban and rural households were not, hence, it was not possible to calculate the percentage of urban/rural households owning land.

In 2020, in Thailand, the average LMB rate of land-owning households was high, at 89%, compared to that in its LMB provinces. In total, most of the LMB provinces recorded higher rates of household land ownership than the average national rate; however, some provinces recorded lower rates, such as Chantaburi (72%), Sa Kaeo (86%), Nakhon Ratchasima (84%), Khon Kaen (84%), Nakhon Phnom (87%), Chiang Mai (76%), Chiang Rai (85%) and Phetchabun (82%), out of the total number of households in each LMB province in Thailand. In urban areas, some provinces recorded lower rates of urban land-owning households than the average of 80%, such as Chantaburi (66%), Nakhon Ratchasima (67%) and Maha Sarakham (63%). In rural areas, some provinces recorded lower rates of rural land-owning households than the average of 93%, such as Chantaburi (79%), Chiang Mai (81%) and Nakhon Phanom (88%).

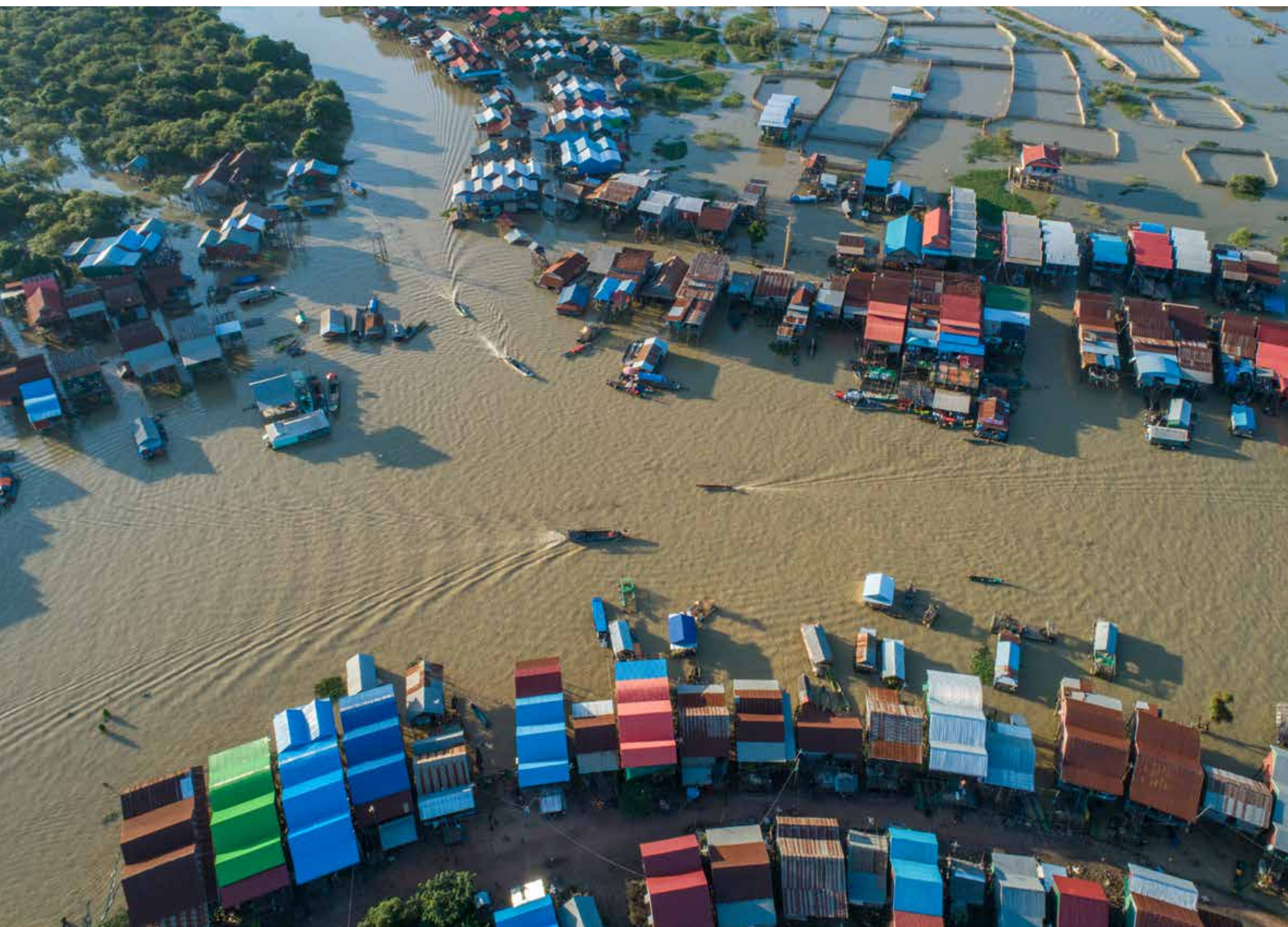
In 2020, in the LMB provinces of Viet Nam, the average rate of land-owning households was low, at only 49%. Some provinces had a much lower land-ownership rate than the average rate, such as Long An, Tien Giang, Tra Vinh, Vinh Long, Dong Thap, An Giang, Can Tho city and Soc Trang provinces, at 24–46%. Data on number of urban and rural households were available, but not on the number of urban and rural land-owning households.

Table 21. Number and proportion of household owning land in the LMB, 2019/2020

Country	Total no. of HHs	Total no. of HHs owning land	Percentage of total HHs owning land in each country (%)	Percentage of total HHs owning land in the LMB (%)
Cambodia (2020)	3,570,783	1,469,413	41	12
Lao PDR (2019)	1,322,989	1,025,547	78	8
Thailand (2020)	7,558,386	6,714,055	89	54
Viet Nam (2020)	6,303,870	3,120,022	49	25
Total LMB	18,756,028	12,329,037	66	100

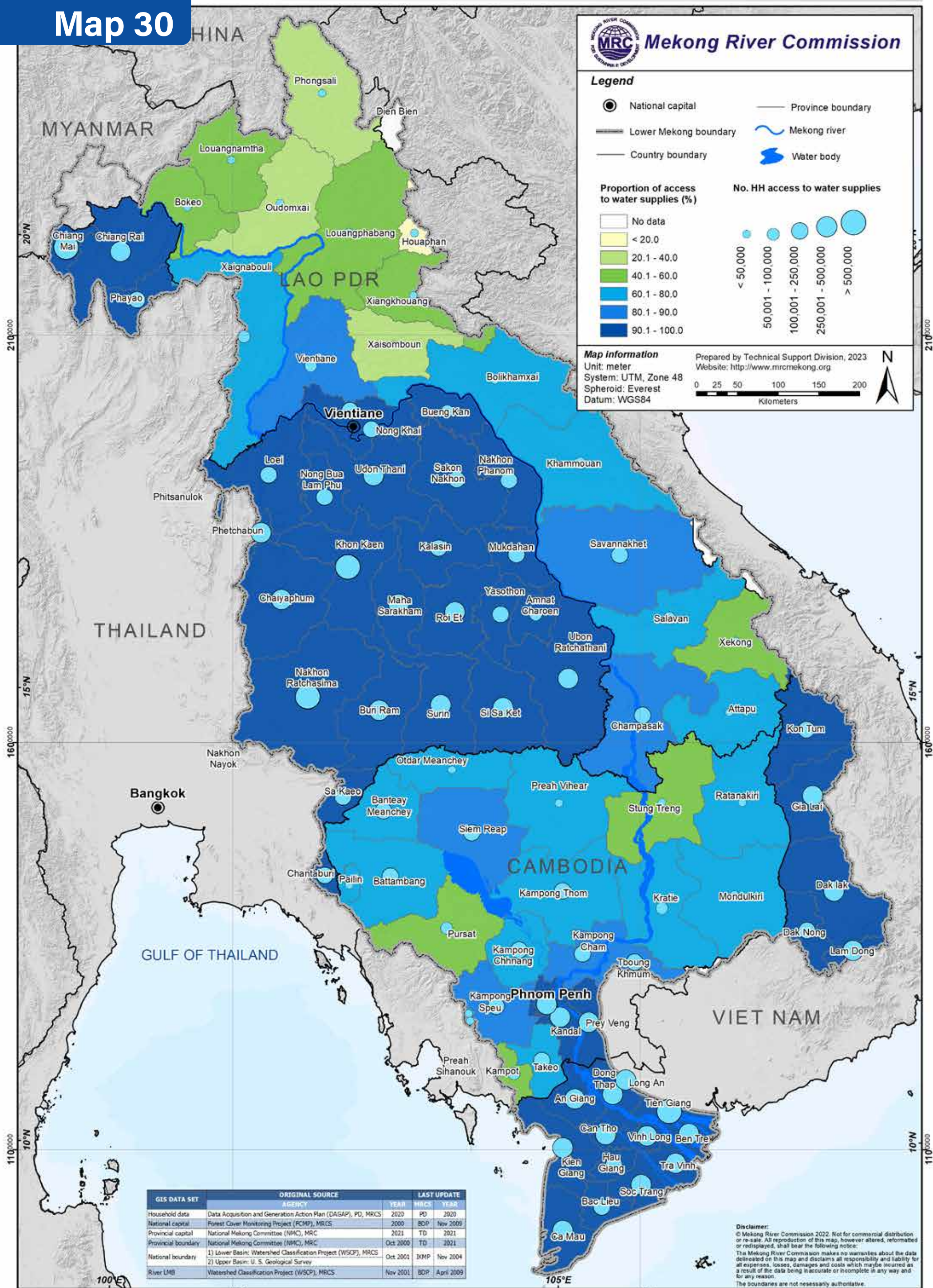
Data source

Country	Source	Year	Data level	Agency
Cambodia	- Commune Database, 2011–2016 - Province profile, 2017–2020	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	- Database from Lao Expenditure Consumption Survey 3rd, 4th, 5th, and 6th - Lao Statistics Bureau	2019	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Socio-Economic Survey data conducted by the National Statistics Office	2020	Province	National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	2006 Rural, Agricultural and Fisheries Census; - The Mid-term Rural, Agricultural and Fisheries Census, 2011, 2016 and 2020	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment



Household with access to water supplies from improved source

Map 30



Household with access to water supplies from improved source

According to World Health Organization and United Nations Children's Fund (WHO and UNICEF (2017), improved drinking water sources are defined as those that are likely to be protected from outside contamination, and from faecal matter in particular. And according to UNICEF, improved sources include piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water. Improved water sources include household connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collection. Map 30 shows the number and proportion of households with access to water supplies from an improved source by province in the LMB countries in 2020. In Cambodia, access to an improved water source refers to the number of families who have access to water purification systems, pumps, mixed wells, protected dug wells and protected rainwater collection. In Lao PDR, improved drinking-water sources are piped water, protected wells/boreholes and water bottles. In Thailand, improved sources include tap water, treated tap water (boiled/filtered), rainwater, bottled water, or water from vending machines, tubewell or groundwater. In Viet Nam, it refers to the sources of drinking water consisting of running water, water bottles, hand-dug wells, constructed wells and wells drilled with pump, filtered spring water and rainwater.

In 2020, Thailand and Viet Nam had the largest share of LMB households with access to water supplies from an improved source, at 40% and 34%, respectively, compared to Cambodia and Lao PDR, at 19% and 7%, respectively. In Thailand and Viet Nam, around 98–99% of LMB households had access to water supplies from an improved source. In Cambodia and Lao PDR, around 81% and 70%, respectively, of LMB households had access.

In 2020, most of Cambodia's LMB provinces recorded a higher rate of access to water supplies from an improved source (at 81%) than the average LMB rate. It is important to note that there were some disparities between the provinces and between urban and rural households. For example, Banteay Meanchey, Battambang, Stung Treng and Otdar Meanchey recorded rates of access of 47–59%; further assistance is required in order to improve access in these LMB provinces. In urban households in Kampong Thom, the access rate was very low, at 55%, and in rural households in Banteay Meanchey, Battambang, Stung treng and Otdar Meanchey, it was also very low, at around 45–56%.

In 2020, in Lao PDR, the national average rate of households with access to water supplies from an improved source was 70%. There were some disparities between the provinces: in particular, the northern provinces such as Huaphanh, Phongsali and Xaisomboun had very low rates of access, at only 15%, 26% and 34%, respectively, whereas the central and southern provinces such as Xaisomboun, Vientiane, Vientiane Capital, Savannakhet and Champasak had high rates of access, at 149%, 80%, 92%, 78% and 83%, respectively. Data on the number of urban and rural households and the number of urban and rural households with access to water supplies were not available.

In 2020, most LMB provinces of Thailand recorded a very high rates of access to water supplies from an improved source, at nearly 100%. There were some disparities between the provinces; some recorded lower rates of access such as Chiang Mai (93%), Chiang Rai (97%) and Phayao (98%). There were also disparities between rural and urban areas in the LMB provinces. The households in rural areas (99%) recorded lower access to water supplies from an improved source than households in urban areas (100%). In particular, rural households in some provinces recorded lower rates of access than other provinces, such as Chiang Mai, at 86%, and Phayao and Chiang Rai, at 96%.

In 2020, in the LMB provinces of Viet Nam, the average rate of households with access to water supplies from improved sources was 98%. There are some disparities between the provinces; for example, some recorded lower rates of access than the average rate, such as Gia Lai, Dak Lak, Lam Dong, Ben Tre, Vinh Long, Hau Giang and Ca Mau, at 92–97%. Data on number of both rural and urban households were available in Viet Nam but data on urban and rural households with access to water supplies were not.

Table 22. Number of households with access to water supplies in the LMB, 2020

Country	Total no. of HHs	Total no. of HHs with access	Percentage of HHs with access in each country (%)	Share of total LMB HHs with access (%)
Cambodia	3,570,783	2,887,567	81	19
Lao PDR	1,247,255	877,347	70	7
Thailand	7,558,386	7,491,607	99	40
Viet Nam	6,303,870	6,146,977	98	34
Total LMB	18,680,294	17,403,498	93	100

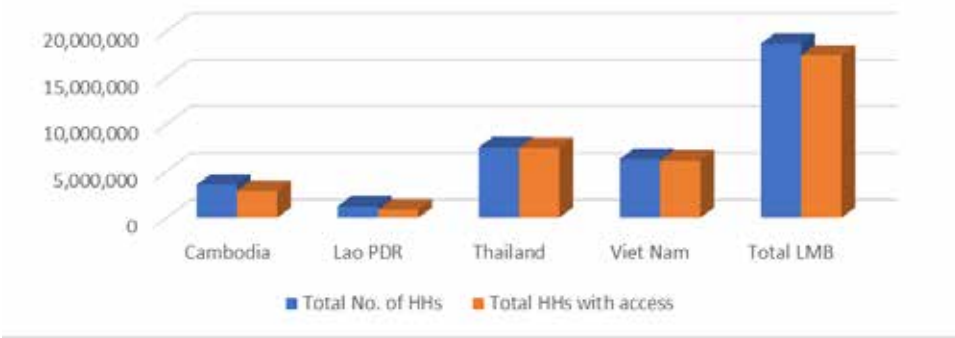


Figure 14. Number of households with access to water supplies in the LMB, 2020

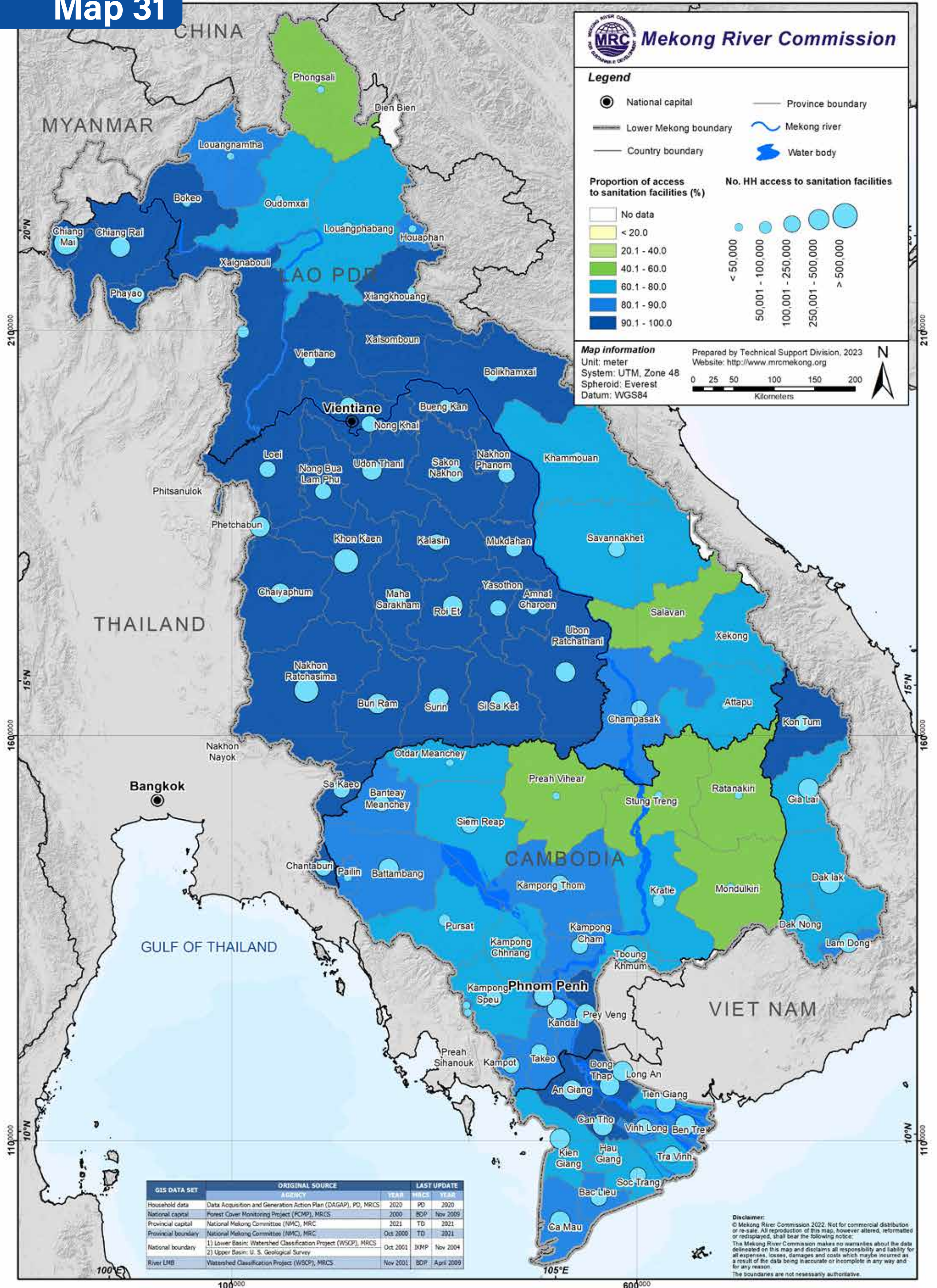
Data source

Country	Source	Year	Data level	Agency
Cambodia	Commune Database (CDB) 2006-2020	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Constructed from Population Census, 1995, 2005, 2015; for 2020, it is estimated by the trend from 2005 to 2015.	2020	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Socio-Economic Surve	2020	Province	National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	Statistical Yearbooks of Viet Nam and of Provinces	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment



Household with access to sanitation facilities

Map 31



Household with access to sanitation facilities

According to WHO (n.d.), improved sanitation facilities are defined as those that hygienically separate human waste from human contact. Improved sanitation includes flush or pour-flush to piped sewer system, septic tank pit latrines, ventilated-improved pit latrines, or pit latrines with slab or composting toilets. Shared or public-use sanitation facilities are not considered to be improved. Also, flush or pour-flush toilets, pit latrines without slabs or open pits, bucket latrines, hanging latrines or open defecation are not considered to be improved sanitation. According to UNICEF (2023), improved facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; pit latrines with slabs and composting toilets (including twin pit latrines with slabs and container-based sanitation). For SDG monitoring, populations using improved facilities are divided into three categories.

Map 31 shows the number and proportion of households with access to sanitation facilities by province in 2020 in the LMB countries. In Cambodia, sanitation facilities refer to improved and unimproved latrines. In Lao PDR, this refers to modern toilets, normal toilets and dry toilets. In Thailand, this refers to foot-hanging and squatting toilets. In Viet Nam, this refers to hygienic toilets, which include flush toilets with septic tanks, sewage pipes, pour-flush toilets, double-vault composting latrines and ventilated improved pit latrines.

In 2020, an average of 89% of households in the LMB had access to sanitation facilities. Thailand and Viet Nam recorded the highest share of the total LMB households with access, at 40% and 34%, respectively, compared to Cambodia and Lao PDR, at 19% and 7%, respectively. Thailand recorded the highest rate of access in its LMB provinces, at 100% of households. Cambodia, Lao PDR and Viet Nam recorded rates of access each of around 82% of households.

In 2020, most households in the LMB provinces of Cambodia recorded higher access rates to sanitation facilities than the average rate in the LMB provinces of Cambodia (82%). It is important to note that there were some disparities between the provinces; for example, Kratie, Mondulkiri, Preah Vihear, Ratanakiri and Stung Treng recorded percentage of access of 53–61%. Hence, further assistance is required in order to improve access to sanitation facilities in these LMB provinces. In addition, there were some disparities between urban and rural households, with average rates of access at 90% and 78%, respectively, across the LMB provinces of Cambodia.

In 2020, in Lao PDR, the national average rate of households that have access to sanitation facilities was 82%. Some provinces had an access rate of less than the average rate of 82%, including Attapu (69%), Khammuane (74%), Luangprabang (79%), Oudomxai (70%), Salavan (59%), Savannakhet (66%) and Xekong (77%). There were some disparities between the provinces; for example, Phongsali recorded the lowest access rate, at only 56%, while Vientiane Capital had the highest rate, at 99%. Data on number of urban and rural households and the number of urban and rural households with access to sanitation facilities were not available.

In 2020, in the LMB provinces of Thailand, most of the households recorded 100% rates of access to sanitation facilities. Only Nakhon Ratchasima and Phetchabun recorded lower rates of access, at 99%. In urban households, Surin and Nong Khai provinces recorded a lower rate of access, at 99%; in rural households, only Chantaburi, Nakhon Ratchasima and Phetchabun provinces recorded a lower rate of access, at 99%.

In 2020, in the LMB provinces of Viet Nam, there were some disparities between the provinces; for example, some recorded lower rates of access than the average rate, such as Gia Lai, Dak Lak, Dak Nong, Long An, Tien Giang, Tra Vinh, Kien Giang, Hau Giang and Soc Trang provinces, at 62–81%. Data on number of households disaggregated by urban and rural households were available in Viet Nam; however, data on urban and rural households with access to sanitation facilities were not

Table 23. Proportion (%) of households with access to sanitation facilities in the LMB, 2020

	Total no. of HHs	Total no. of HHs with access	Percentage of HHs with access in each country (%)	Share of total LMB HHs with access (%)
Cambodia	3,570,783	2,922,834	82	19
Lao PDR	1,247,250	1,021,064	82	7
Thailand	7,558,386	7,542,403	100	40
Viet Nam	6,303,870	5,188,070	82	34
Total LMB	18,680,289	16,674,371	89	100

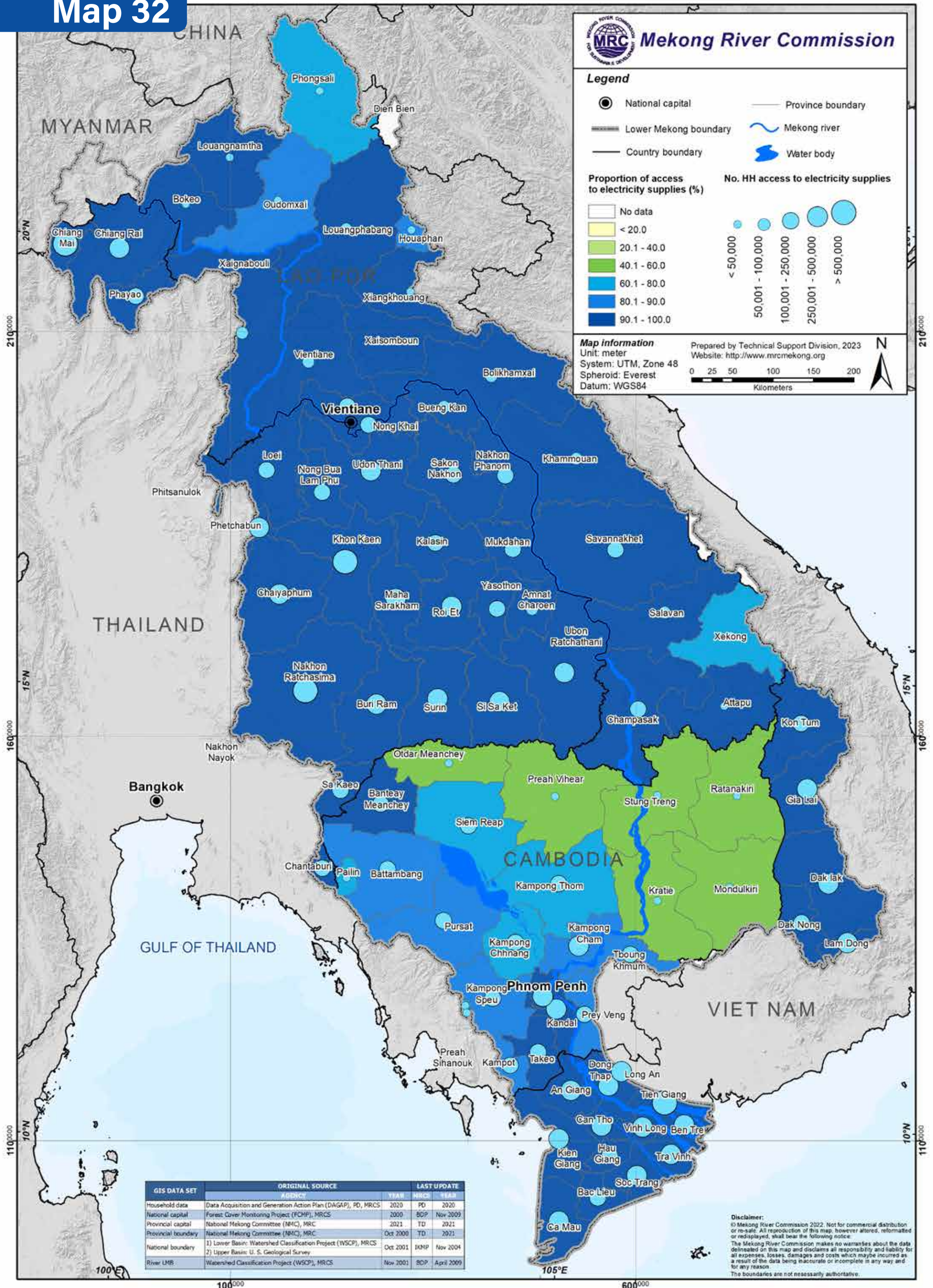
Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Commune Database, 2006–2020	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Constructed from Population Census 1995, 2005 and 2015; for 2020, it is estimated by the trend from 2005 to 2015.	2020	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Socio-Economic Survey	2020	Province	◆ National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	◆ Statistical Yearbooks of Viet Nam and of Provinces	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment



Households with access to electricity

Map 32



Households with access to electricity

Map 32 shows the number and proportion of households with access to electricity by province in 2020 in the LMB countries. In Cambodia, the households with access to electricity refers to the number of thatched roof houses with electricity + Number of zinc or fibro roof houses with electricity + Number of zinc or fibro roof houses of less than 20 sheets with electricity connection + Number of tiled roof houses with electricity + Number of houses with cement walls without a concrete roof with electricity connection + Number of apartments with electricity connection + Number of villas with electricity.

In Lao PDR, number of households with access to electricity refers to the number of households with access to public electricity network. In Thailand, it refers to the number of households with electricity. In Viet Nam, it refers to households using the national electricity network. According to the International Energy Agency (IEA), households with access to electricity refers to households that initially have access to sufficient electricity to meet their basic energy needs – i.e. to power, at a minimum, several lightbulbs, cell phones, a radio and possibly a fan or television. The amount of electricity will increase over time.

In 2020, the average rate of households with access to electricity was around 96%. Thailand and Viet Nam recorded the highest share of LMB households with access to electricity, at 40% and 34%, compared to Cambodia and Lao PDR, at 19% and 7%, respectively. In the LMB provinces of Thailand and Viet Nam, a high percentage of households with access to electricity were recorded, at 99–100%. In 2020, in the LMB provinces of Cambodia and Lao PDR, there was a high percentages of households with access, at around 84% and 94%, respectively.

In 2020, most LMB provinces of Cambodia recorded higher rates of access to electricity than the average rate, at 84. It is important to note that there were some disparities between the provinces; for example, Kratie, Monduliri, Preah Vihear, Ratanakiri, Stung Treng and Otdar Meanchey had low rates of access, at 44–54%. Further assistance is required in order to improve access to electricity in these provinces. In addition, there were some disparities between urban and rural households, with rates of access of 97% and 78%, respectively.

In 2020, in Lao PDR, the national average rate of households with access to electricity was 94%. There were some disparities of access between the provinces; for example, Phongsali recorded the lowest access rate, at 65%, while Champasak and Vientiane Capital recorded the highest rates, at 100%. Some provinces had low rates of access, especially Xekong (78%). Data on the number of urban and rural households, and on the number of urban and rural households with access to electricity were not available.

In 2020, most of the LMB provinces of Thailand recorded 100% access to electricity. In urban households in Chantaburi and Nakhon Ratchasima recorded rates of access of 99%. In rural households, Nakhon Ratchasima and Phetchabun provinces recorded an access rate of 99%.

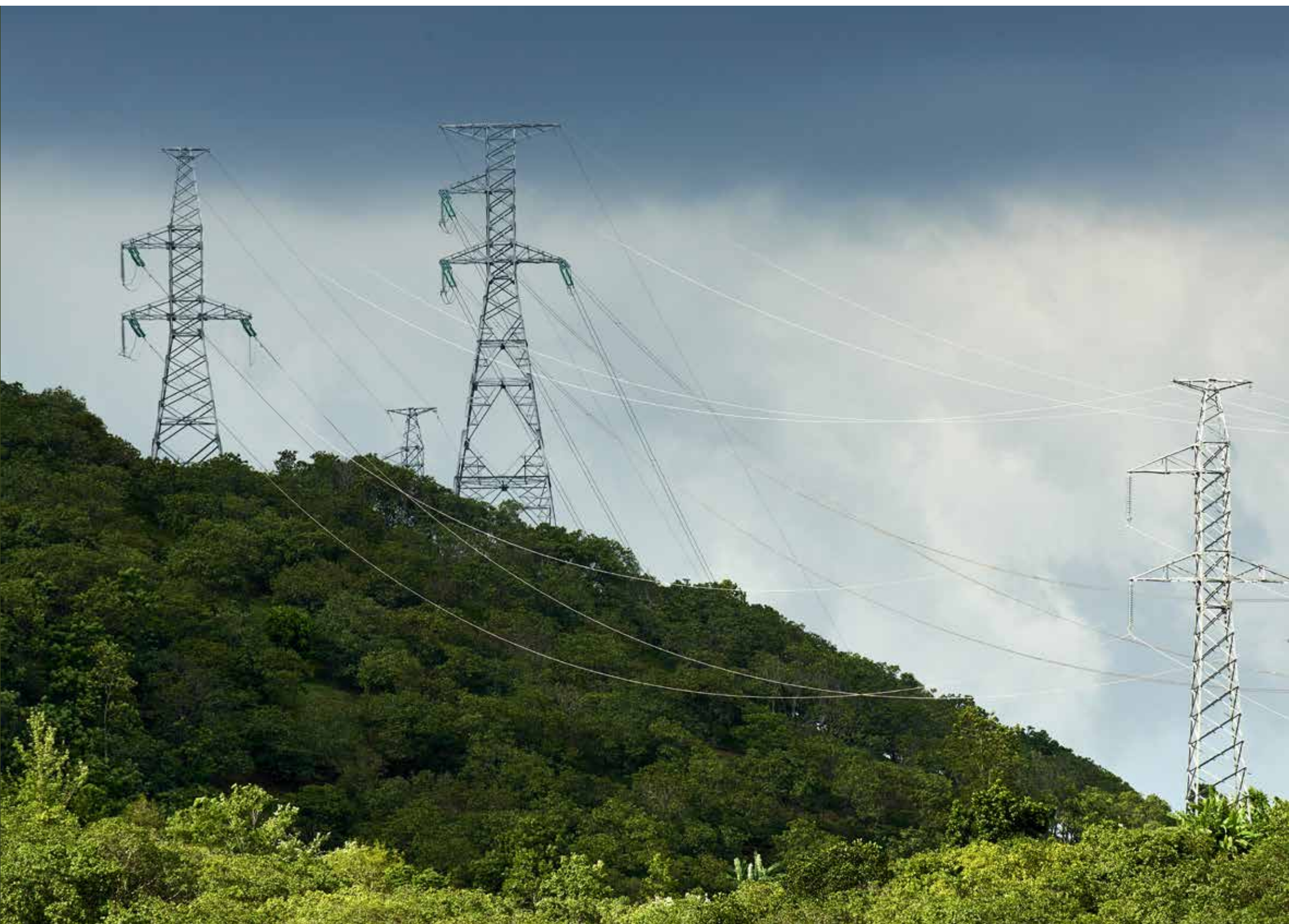
In 2020, most LMB provinces of Viet Nam recorded high rates of access to electricity, at 99%. Some provinces recorded lower rates of access, such as Gia Lai (99%), Dak Lak (98%), Dak Nong (96%), An Giang (99%) and Ca Mau (99%). Data on number of urban and rural households were available in Viet Nam, but data on urban and rural households with access to electricity were not

Table 24. Proportion (%) of households in the LMB with access to electricity, 2020

Country	Total No. of HHs	Total HHs with access	% Total HHs with access in each country	Share of Total LMB HHs with access
Cambodia	3,570,783	2,995,649	84	19
Lao PDR	1,247,250	1,176,253	94	7
Thailand	7,558,386	7,550,056	100	40
Viet Nam	6,303,870	6,271,276	99	34
Total LMB	18,680,289	17,993,234	96	100

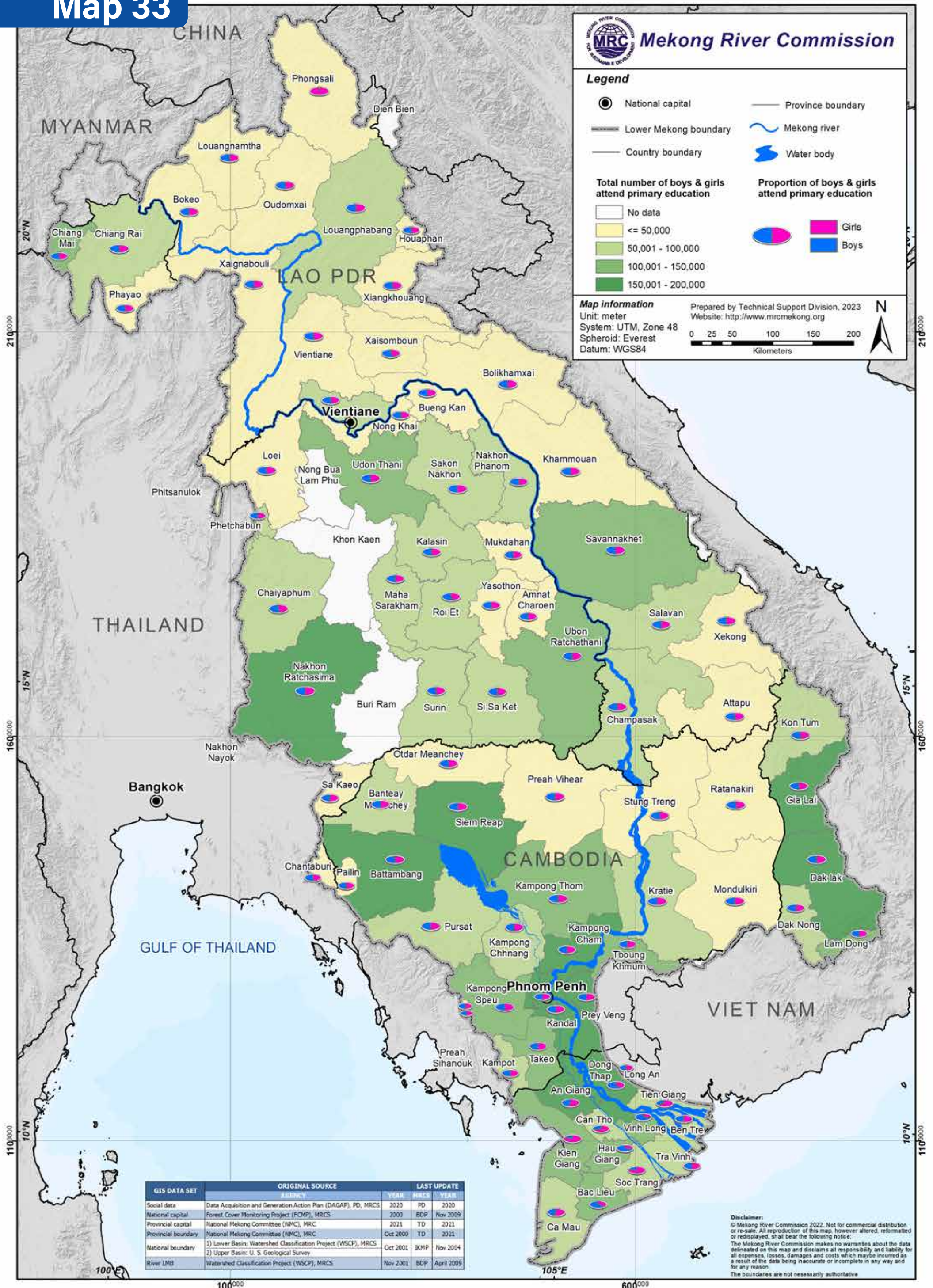
Data source

Country	Source	Year	Data level	Agency
Cambodia	● Commune Database 2006-2020	2020	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● Constructed from Population Census, 1995, 2005, 2015; for 2020, it is estimated by the trend from 2005 to 2015.	2020	Province	● Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	● Socio-Economic Survey	2020	Province	● National Statistical Office of Thailand, Ministry of Digital Economic and Society
Viet Nam	● Statistical Yearbooks of Viet Nam and of Provinces	2020	Province	● General Statistics Office of Viet Nam, Ministry of Planning and Investment



Boys and girls attending primary schools

Map 33



Boys and girls attending primary schools

Map 33 shows the number and proportion of boys and girls attending primary school by province based on 2019 and 2020 data in the LMB countries. The boys and girls attending primary school refers to the primary school attendance of children of primary school age who are attending primary school. In Cambodia, the number of boys and girls of primary school age is defined as those aged 6, 7–11, 12–14 and 15–17 years who attend primary school. In Lao PDR, the number of girls and boys attending primary school refers to grades 1 to 5. In Thailand, the number of boys and girls attending primary school refers to those aged 6–11. In Viet Nam, the number of boys and girls attending primary school refers to those attending grades 1 to 6. According to UNICEF and UNESCO, the primary school age is typically defined as children aged 6–11.

The map shows that, according to 2019 and 2020 data, the average rate of boys and girls attending primary school in all LMB provinces in all LMB countries was high, at 99%. In 2020, in the LMB provinces of Cambodia and Lao PDR, the rate was around 13% and 11%, respectively, of the total number of boys and girls attending primary school, while in 2019, in the LMB provinces of Thailand, it was around 6%, and in 2020, in the LMB provinces of Viet Nam, 9%.

In 2020, in the LMB provinces of Cambodia, the average rate of boys and girls attending primary school was around 100%. This high percentage may be explained by several factors: for example, some boys and girls over the primary school age also attended and/or continued to attend primary school. However, the percentage of boys and girls attending primary school in Mondulkiri province was 96%, with an equal average number of boys and girls.

In 2020, in Lao PDR LMB provinces, the average rate of boys and girls attending primary school was high, at around 98%. However, in some provinces, the rates were low, such as in Salavan (89%), Savannakhet (90%) and Xaignabouli (93%). There was an equal number of boys and girls attending primary school. It should be pointed out, however, that in Phongsali province, there were very significant gender disparities: i.e. the number of boys attending primary school (904) was much lower than that of girls (22,220)-

In 2018/2020, in the LMB provinces of Thailand, the average rate of boys and girls attending primary school was around 81%. Most of the LMB provinces in Thailand have quite high percentage of boys and girls attending primary education of more than 90%. However, the average rate of boys and of girls attending primary school differed slightly across each LMB province, at 51% and 49%, respectively.

In 2018, in the LMB provinces of Viet Nam, the average rate of boys and girls attending primary school was high, at around 100%. Some LMB provinces recorded low rates, especially Kien Giang (68%), Tien Giang (75%), Soc Trang (71%) and Can Tho city (76%). The number of boys and girls attending primary school increased from 2,094,181 boys and girls in 2018, to 2,107,864 boys and girls in 2020. The average primary school attendance rates among boys and girls slightly differed between the LMB provinces.

Table 25. Number and proportion (%) of boys and girls attending primary school in the LMB, 2018 and 2020

Countries	Total boys and girls in community	Total boys and girls attending primary education	Percentage (%) of total boys and girls attending primary education
Cambodia (2020)	1,844,186	2,090,353	113
Lao PDR (2020)	778,999	761,970	98
Thailand (2018/2019)	1,929,985	1,554,833	81
Viet Nam (2018)	1,978,843	2,094,181	106
Total LMB	6,532,013	6,501,337	100

Table 26. Number and proportion (%) of boys and girls attending primary school and the LMB population, 2020

Countries	Total boys and girls attending primary education	Total LMB population	Percentage (%) of total LMB population
Cambodia (2020)	2,090,353	15,782,144	13
Lao PDR (2020)	761,970	7,221,129	11
Thailand (2020)	1,554,833	27,473,404	6
Viet Nam (2020)	2,107,864	23,250,650	9
Total LMB	6,515,020	73,727,327	9

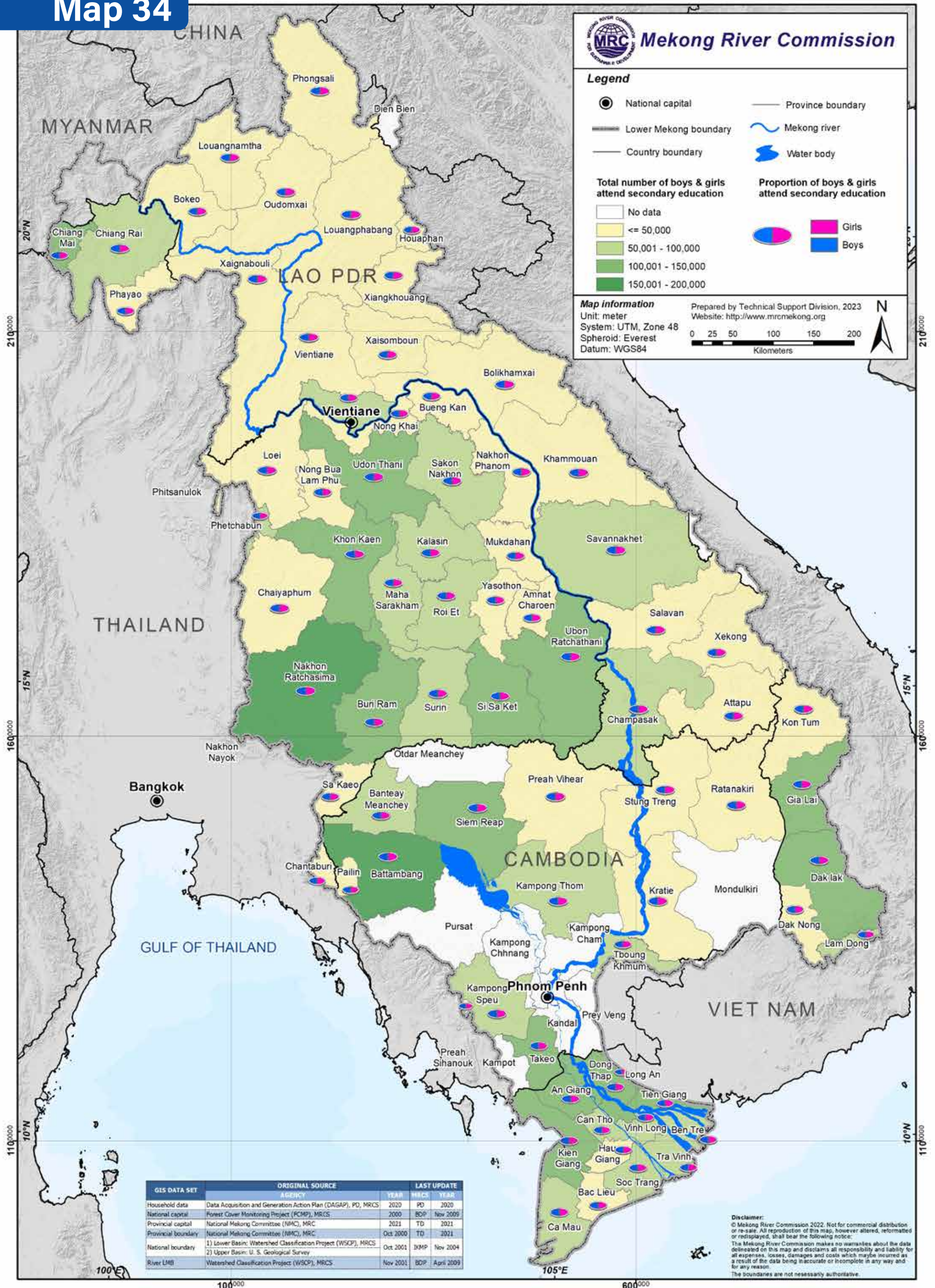
Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Commune Database Year 2006–2020	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Statistics Database from Ministry of Education and Sport	2020	Province	◆ Ministry of Education and Sport
Thailand	◆ Statistics Database	2018 and 2020	Province	◆ Office of the Permanent Secretary, Ministry of Education
Viet Nam	◆ Provincial Statistics Yearbooks.	2018 and 2020	Province	◆ General Statistics Office of Viet Nam



Boys and girls attending secondary schools

Map 34



Boys and girls attending secondary schools

Map 34 shows the number and proportion of boys and girls attending secondary school by province in 2020 in the LMB countries. These data refer to the secondary school attendance of children of secondary school age. In Cambodia, the lower secondary school age is 12–14, and the upper secondary school age is 15–17. In Lao PDR, the secondary school age is 11–17; in Thailand, it is 12–17; and in Viet Nam, 11–14.

In 2020, a total of 4.5 million boys and girls in all LMB areas attended secondary school (around 50% for both boys and girls), i.e. around 7% of the total LMB population. In Cambodia and Lao PDR, around 9% of the total number of boys and girls attended secondary school, and in Thailand and Viet Nam, around 6% for both (no data were available for Viet Nam³). Thailand had the highest secondary school attendance rate of boys and girls, at around 95% in the LMB areas, followed by Cambodia at 65% and Lao PDR at 63%, respectively.

In 2020, in the LMB provinces of Cambodia, out of around 2 million boys and girls at secondary school age, a total of 731,982 boys and girls attending secondary school, i.e. around 35%. However, there were some disparities in some LMB provinces: some provinces had high secondary attendance rates, such as Battambang (82%), Takeo (81%) and Siem Reap (73%), and other had very low rates, such as Stung Treng (38%), Ratanakiri (45%), Kratie (46%), Preah Vihear (49%) and Tboung Khmum (55%). On average, there was an equal number of boys and girls attending secondary school, i.e. around 50%.

In 2020, in Lao PDR's LMB provinces, the total number of boys and girls attending secondary school was 634,320, i.e. 63% (out of around 1 million boys and girls). There were some disparities between LMB provinces: some had high secondary attendance rates, such as Vientiane Capital (90%) and Xiengkhuang (82%), whereas some had very low rates, such as Salavan (40%), Savannakhet (46%), Champasak (52%) and Phongsali (54%). The number of boys attending secondary school (52%) was slightly higher than of girls (48%).

In 2020, in the LMB provinces of Thailand, there was a total of around 1.7 million boys and girls attending secondary school, i.e. 95% of the total number of boys and girls of secondary school age (around 1.8 million boys and girls). There were some disparities between the LMB provinces: some recorded very high secondary attendance rates, at around 100%, such as Yasothon, Khon Kaen, Loei, Nong Khai, Roi Et, Sakon Nakhon, Chiang Mai, Phayao and Chiang Rai, whereas some recorded low rates, such as Chaiyaphum (52%), Sakaeo (77%), Bueng Kan (78%) and Nakhon Phanom (80%). On average, there was an equal number of boys and girls attending secondary school, i.e. around 50%.

In 2020, in the LMB provinces of Viet Nam, the total number of boys and girls attending secondary school was around 1.4 million (738,337 boys and 722,681 girls). The percentage of boys and girls attending secondary school differed slightly, at 51% and 49%, respectively. Data on the number of boys and girls of secondary school age were not available for calculating the secondary school attendance rates in the LMB provinces.

3 There are data for number of boys and girls attending secondary school from Viet Nam. However, there are no data from Viet Nam for the number of boys and girls of secondary school age in the community. Here, these two data items/indicators are used to compare and calculate the percentage of boys and girls attending secondary education in each LMB province.

Table 27. Number and proportion (%) of boys & girls attending secondary education in LMB in 2020

Country	Total no. of boys and girls in the community	Total no. of boys and girls attending secondary education	No. of boys attending secondary education	No. of girls attending secondary education
Cambodia	1,123,329	731,982	367,220	364,762
Lao PDR	1,006,696	634,320	304,226	330,094
Thailand	1,811,809	1,720,031	864,457	855,574
Viet Nam	-	1,461,018	738,337	722,681
Total LMB	4,918,359	4,547,351	2,274,240	2,273,111

Note: The total number of boys and girls of secondary school age in Cambodia does not include 10 LMB provinces due to a lack of data.

Table 28. Number and proportion (%) of boys and girls attending secondary school and LMB population, 2020

Country	Total no. of boys and girls attending secondary education	Total LMB population	Percentage of total LMB population (%)
Cambodia	731,982	8,186,755	9
Lao PDR	634,320	7,221,129	9
Thailand	1,720,031	27,473,404	6
Viet Nam	1,461,018	23,250,650	6
Total LMB	4,547,351	66,131,938	7

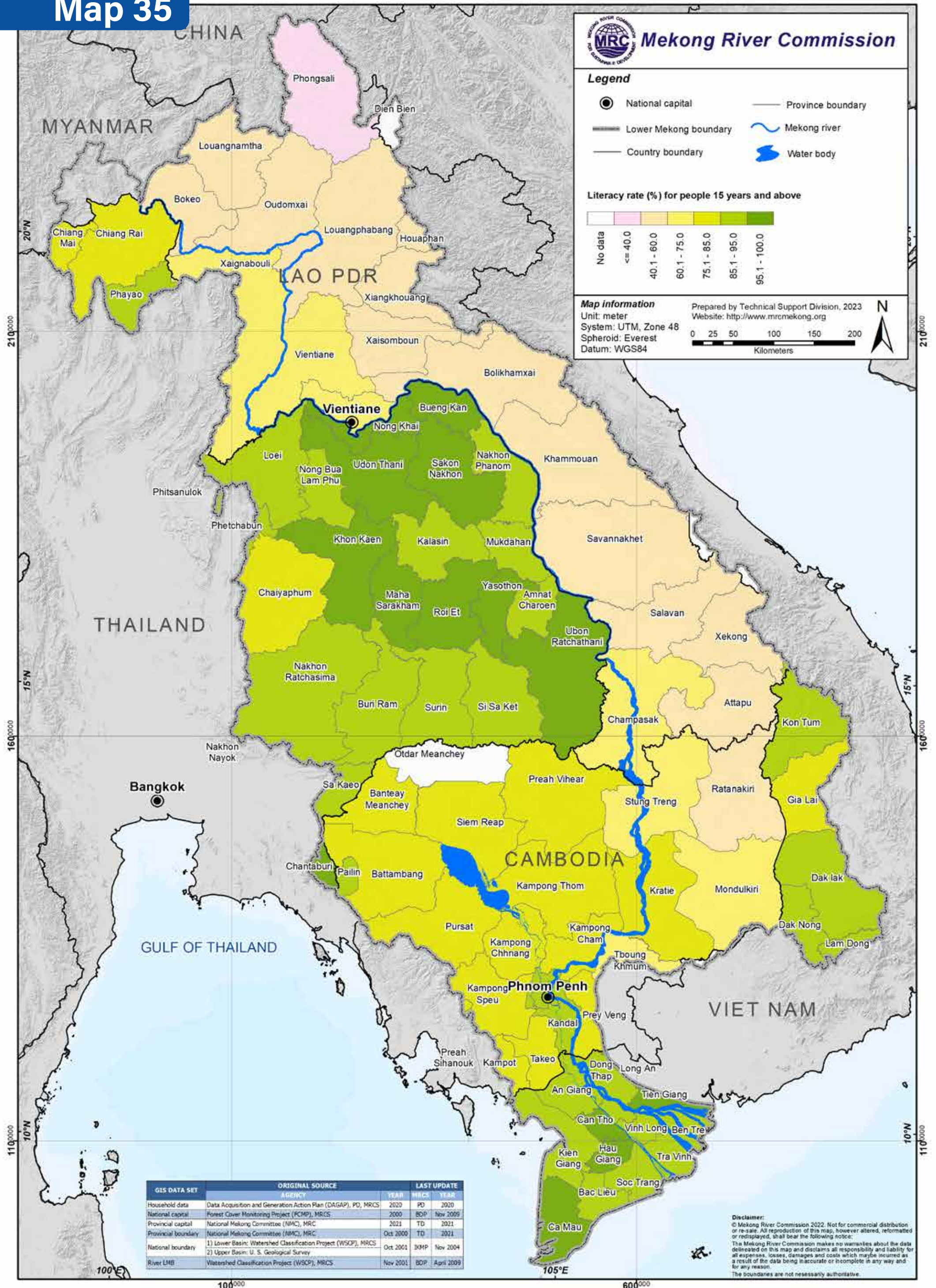
Note: The total number of boys and girls of secondary school age in Cambodia does not include 10 LMB provinces due to a lack of data.

Data source

Country	Source	Year	Data level	Agency
Cambodia	● Commune Database, 2006–2020	2020	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● Data from Population and Household Census	2020	Province	● Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	● Statistics Database 2020	2020	Province	● Office of the Permanent Secretary, Ministry of Education
Viet Nam	● Statistical Yearbook of Viet Nam	2020	Province	● General Statistics Office of Viet Nam, Ministry of Planning and Investment



Map 35



Literacy rate

Map 35 shows the literacy rate of people aged 15 or older in the LMB countries by province in 2018, 2019 and 2020. In Cambodia, these data refer to those who can read, write and understand the simple sentences, out of the total number of girls and boys aged 15 or older. In Lao PDR, these data refer to the proportion of the population aged 15 years and older who can read and write. In Thailand, the literacy rate is determined by dividing the population aged 15 years who are able to read and write by the total population aged 15 years or older, and then multiplying the result by 100 to obtain the percentage.

According to data for 2018 and 2020 in the LMB provinces of Thailand and Viet Nam, respectively, very high literacy rates were recorded, both at around 92%, while in 2019, the LMB provinces of Cambodia and Lao PDR recorded lower literacy rates, at 87% and 53%, respectively.

In 2019, in Cambodia, the average national literacy rate was around 88%: 93% in urban areas and 83% in rural areas, and 91% for males and 85% for females; however, there were some disparities across different provinces: for example, Phnom Penh recorded a literacy rate at 92.90% whereas Ratanakiri recorded only a 59.60% literacy rate. Across the LMB provinces, the literacy rate in rural areas was lower than in urban areas; there were some disparities among some provinces such as Ratanakiri, at 53% and 93%, respectively. The female literacy rate was lower than the male literacy rate in all LMB provinces (85% and 91%, respectively), and there were some significant disparities in some provinces, such as Ratanakiri (52% and 67%, respectively) and Mondulakiri (64% and 81%, respectively).

In 2019, in Lao PDR, the average national literacy rate was 53.7%, i.e. around 21% in urban areas and around 33% in rural areas, and around 28% for males and around 25% for females rates. However, there were some disparities across different provinces; for example, Vientiane Capital had a literacy rate at 75%, whereas Phongsali had only a 36% literacy rate. It is interesting to note that the literacy rate in rural areas is higher than urban areas; in particular, some provinces had significant disparities such as Huaphanh (7% and 42%, respectively), Salavan (8% and 39%) and Phongsali (9% and 26%, respectively) of urban and rural areas respectively. The female literacy rate was slightly lower than the male literacy rate across all LMB provinces (25% and 28%, respectively), and there are some significant disparities in some provinces, such as Xaysomboon (19% and 27%, respectively) and Phongsali (16% and 20%, respectively). Interestingly, Vientiane Capital and Champasak province had slightly higher female literacy rates than male literacy rates, at 38% and 37%, respectively, and 32% and 30%, respectively.

In 2018, in the LMB provinces of Thailand, the average national literacy rate was 92%, with slightly disparities between male and female literacy rates, at 94% and 91%, respectively. There were some disparities between the different LMB provinces: for example, Khon Kaen had the highest literacy rate, at around 99%, whereas Chiang Rai recorded the lowest, at around 83%.

In 2020, in the LMB provinces of Viet Nam, the average national literacy rate was around 93% with some disparities across LMB provinces: for example, Ca Mau had the highest literacy rate, at 96%, whereas Gia Lai recorded the lowest, at 85%.

Table 29. Average literacy rate in LMB

Country	Literacy Rate (%)
Cambodia (2019)	87.70
Lao PDR (2019)	53.70
Thailand (2018)	92.35
Viet Nam (2020)	92.70
Average LMB	81.61

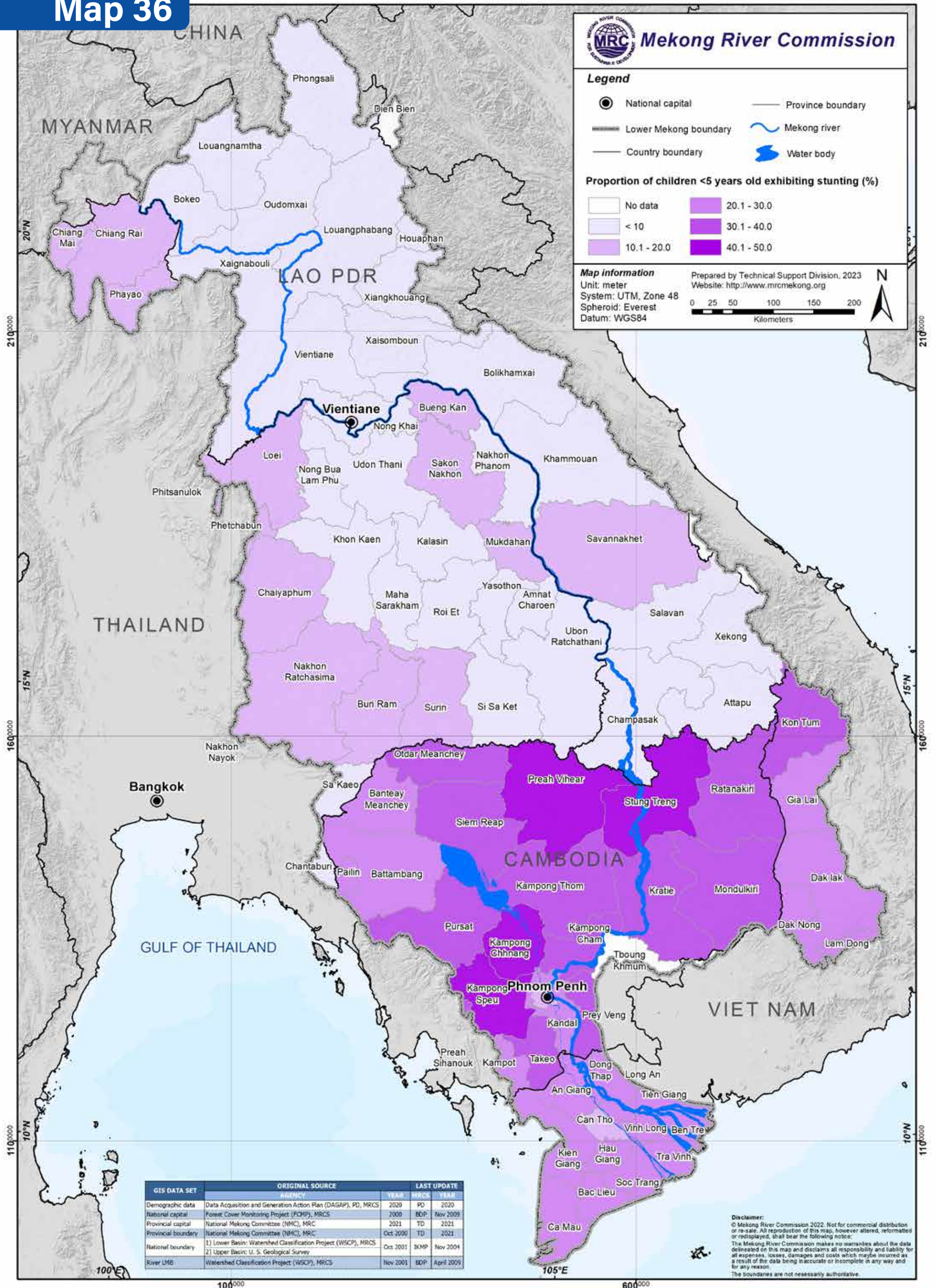
Data source

Country	Source	Year	Data level	Agency
Cambodia	- General Population Census of Cambodia, 1998, 2008 and 2019 - Cambodia Social-Economic Survey, 2004, 2007, 2009–2017, 2019/20	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Lao Expenditure Consumption Surveys, 2003, 2018, 2013 and 2019, Lao Statistics Bureau	2019	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	The Reading of Population Survey	2018	Province	National Statistical Office of Thailand, Ministry of Information and Communication Technology
Viet Nam	Statistical Year Book of Viet Nam	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment



Prevalence of stunting among children under five

Map 36



Prevalence of stunting among children under five

Map 36 shows the prevalence of stunting among children under five by province in different years in the LMB countries. In Cambodia, the proportion of children under five suffering from stunting refers to the percentage of children under five classified as malnourished according to three anthropometric indices of nutritional status: height-for-age, weight-for-height and weight-for-age, by background characteristics. Stunting reflects chronic malnutrition; wasting reflects acute malnutrition; and underweight reflects chronic or acute malnutrition, or a combination of both. Plotted values are smoothed by a 5-month moving average. In Lao PDR, the proportion of children under five suffering from stunting refers to the percentage of children with low height-for-age as a result of inadequate daily protein intake. In Thailand, stunting refers to length/height less than the standard with a value below -2 SD of the length or height curve according to age criteria. This indicates not having enough food for a long time and is known as chronic malnutrition. $\text{Proportion of children under five suffering from stunting} = (\text{Number of children suffering from stunting} / \text{Number of children whose height and weight were measured}) \times 100$. According to WHO, the percentage of stunting (height-for-age less than -2 SD of the WHO Child Growth Standards median) among children aged 0–5.

Table 29 shows the proportion of children under five suffering from stunting in the LMB countries, which, based on 2014, 2019 and 2020 data, was 18% on average. Across the LMB areas, there were very large differences between the LMB countries, particularly the average rate of children under five suffering from stunting in Lao PDR, at 4.4%, compared to in Cambodia, Thailand and Viet Nam, at 34.1%, 10.7% and 22.7%, respectively.

In 2014, in Cambodia, the average proportion of children under five suffering from stunting was 34.1% in its LMB provinces (no data available for Tboung Khmum). Many provinces have higher rates than the average rate of between 35.9% and 44.3%, such as Kampong Chhnang, Kampong Speu, Kampong Thom, Kratie, Mondulhiri, Preah Vihear, Pursat, Ratanakiri, Siem Reap, Stung Treng and Otdar Meanchey provinces. Preah Vihear and Stung Treng provinces recorded the highest proportion of children under five suffering from stunting, at 44.3%, while Phnom Penh recorded the lowest rate, at 17.9%.

In 2019, in Lao PDR, the average proportion of children under five suffering from stunting was 4.4%, and the average rate in urban areas and rural area was 3% and 1.4%, respectively. In all LMB areas, many provinces recorded higher rates than the average rate, at between 4.58% and 12.55%, such as Champasak, Luangprabang, Salavan, Savannakhet, Vientiane, Vientiane capital and Xaignabouli provinces. Savannakhet province recorded the highest proportion of children under five suffering from stunting, at 12.55%, while Xaisomboun had the lowest rate, at 1.25%.

In 2020, in Thailand, the average proportion of children under five suffering from stunting was 10.7%. Some provinces recorded high rates, such as Loei and Chiang Mai (both at around 18%), and Phetchabun and Chiang Rai (both at around 15%), while others recorded much lower rates, such as Khon Kaen (6.39%) and Roi Et (6.57%).

In 2020, in the LMB provinces of Viet Nam, the average proportion of children under five suffering from stunting was 22.7%. Some provinces recorded higher rates than the average, at between 27.6% and 30.8%, such as Kon Tum, Gia Lai, Dak Lak and Dak Nong provinces. Kon Tum recorded the highest rate, at 30.8%, while Long An province recorded the lowest rate, at 17.6%.

Table 30. Percentage of children under five exhibiting stunting

Country	Average percentage of children < 5 exhibiting stunting in the LMB (%)
Cambodia (2014)	34.1
Lao PDR (2019)	4.4
Thailand (2020)	10.7
Viet Nam (2020)	22.7
LMB Average	18.0

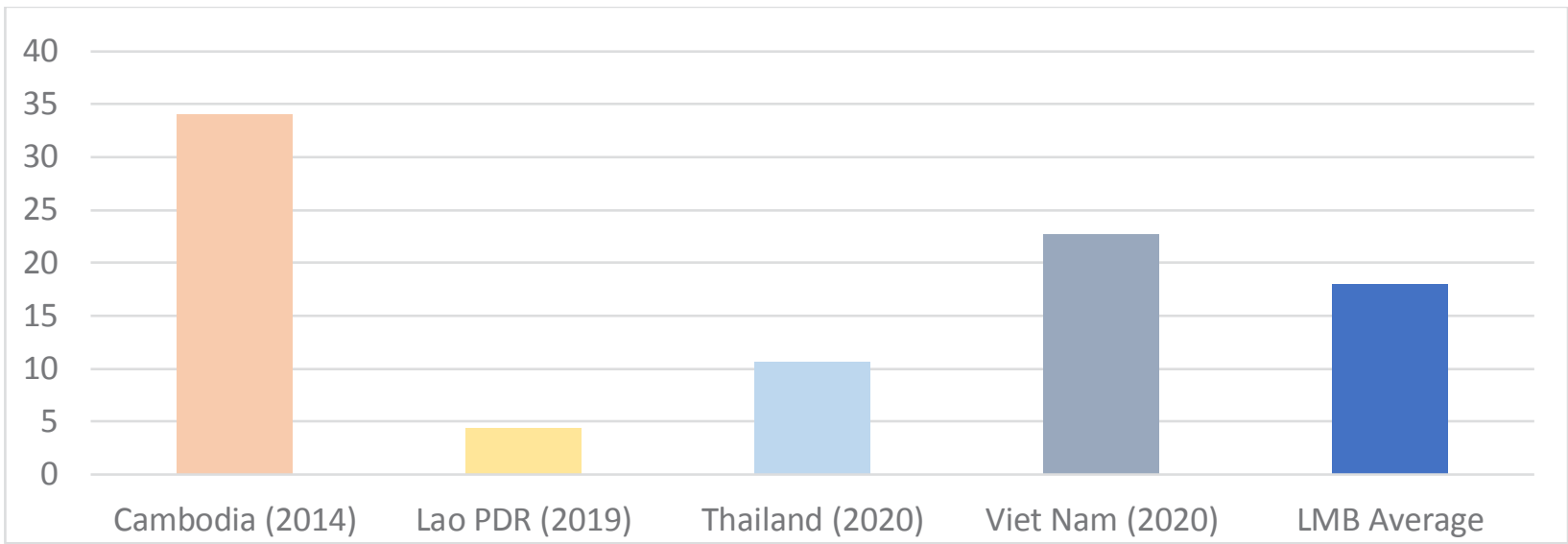


Figure 15. Percentage of children under five exhibiting stunting in the LMB

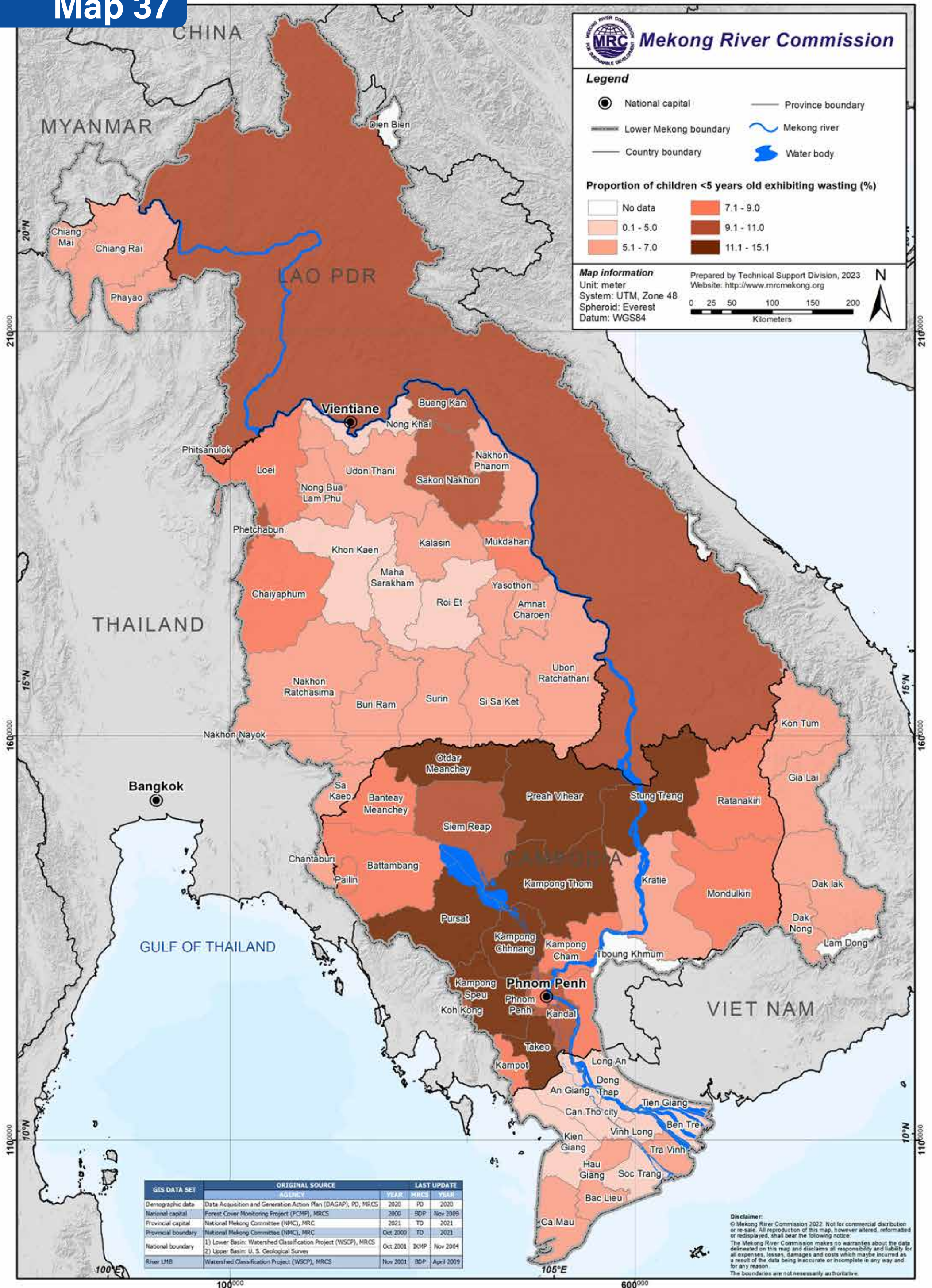
Data source

Country	Source	Year	Data level	Agency
Cambodia	● Cambodia Demographics and Health Survey, 2010 and 2014	2014	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● ata are based on the Lao Expenditure Consumption Survey in 2019, Lao Statistics Bureau, Ministry of Planning and Investment ● Ministry of Health	2019	Province	● Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	● Health Data Center, Department of Health, Ministry of Public Health	2020	Province	● The Multiple Indicator Cluster Survey (MICS) conducted by the National Statistics Office (NSO) and United Nations International Children's Emergency Fund (UNICEF Thailand)
Viet Nam	● National Institute of Nutrition	2020	Province	● National Institute of Nutrition



Prevalence of wasting among children under five

Map 37



Prevalence of wasting among children under five

Map 37 shows the prevalence of wasting among children under five by province in 2014/2020 in the LMB countries. In Cambodia, this refers from to the percentage of children under five classified as malnourished according to three anthropometric indices of nutritional status: height-for-age, weight-for-height, and weight-for age, by background characteristics. In Lao PDR, this refers to children who are too short for their age. In Thailand, this refers to children who weigh less than the standard with a value less than -2 SD of the weight curve based on length or height criteria. This indicates an insufficient uptake of nutrients (also called undernutrition or undernourishment). According to WHO/UNICEF/World Bank 2012, child wasting refers to a child who is too thin for his or her height and is the result of recent rapid weight loss or the failure to gain weight. The data collection and estimation method is based on the following: the percentage of children aged <5 years stunted for age = (Number of children aged 0-5 years that fall below minus two standard deviations from the median height-for-age of the WHO Child Growth Standards/Total number of children aged 0-5 years that were measured) * 100.

According to 2014 and 2020 data, the average percentage of children under five in the LMB areas suffering from wasting was 7.88%. Table 30 shows that in 2014 and 2020, respectively, Cambodia and Lao PDR recorded the highest average percentage in the LMB areas, at 10.22% and 10.90%, respectively. In 2020, in Thailand and Viet Nam, it was 6.26% and 4.73%, respectively.

In Cambodia, many LMB provinces had a high proportion of children under five suffering from wasting, which was higher than the average, such as Otdar Meanchey (15.1%), Takeo (14.6%), Stung Treng (13.8%), Preah Vihear (13.8%), Kampong Thom (13%) and Pursat (12.3%), while other provinces recorded lower rates such as Banteay Meanchey (7.8%), Battambang (7.9%), Pailin (7.9%) and Kampong Cham (8.1%). There were no data from Tboung Khmum province. In Lao PDR, the province data were not available. Based on the available national data, the proportion of children under five suffering from wasting significantly increased from 5.3% in 2015 to 10.4% in 2016, and then gradually increased to 10.9% in 2020.

In 2020, in Thailand, the average percentage of children under five suffering from wasting in the LMB provinces was around 6.26%. Some LMB provinces, especially Sakon Nakhon, Phetchabun and Bueng Kan, had a high proportion, of 9–10%, whereas other LMB provinces had 3–8%. In Viet Nam, around 3–6% of children under five suffered from wasting in most of the LMB provinces. Dak Lak recorded the highest rate, at 6.2%, whereas Can Tho city recorded the lowest, at 2.7%.

Table 31. Percentage of children under five exhibiting wasting

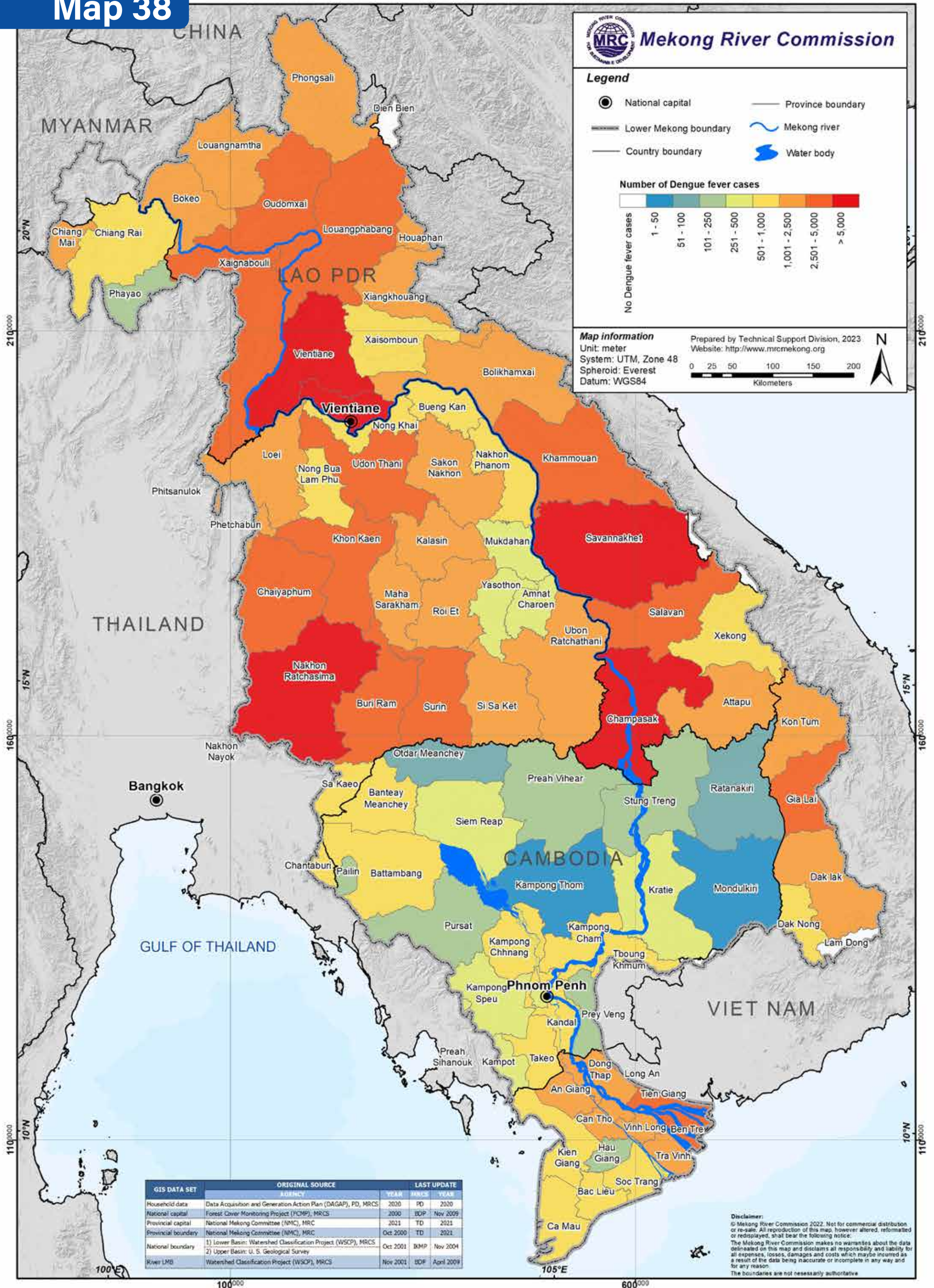
Country	Average percentage of children under 5 exhibiting wasting in the LMB (%)
Cambodia (2014)	10.22
Lao PDR (2019)	10.90
Thailand (2020)	5.66
Viet Nam (2020)	4.73
LMB Average	7.88

Data source

Country	Source	Year	Data level	Agency
Cambodia	● Cambodia Demographics and Health Survey, 2010 and 2014	2014	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● Data are based on the Lao Expenditure Consumption Survey in 2019, LSB, MPI ● Ministry of Health	2019	Province	● Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	● Health Data Centre, Department of Health, Ministry of Public Health	2020	Province	● The Multiple Indicator Cluster Survey conducted by the National Statistics Office (NSO) and United Nations International Children's Emergency Fund (UNICEF Thailand)
Viet Nam	● National Institute of Nutrition	2020	Province	● National Institute of Nutrition

Cases of dengue fever

Map 38



Cases of dengue fever

Map 38 shows the number and proportion of reported cases of dengue fever by province in the LMB countries based on 2019 and 2020 data. In Cambodia, the number of reported cases of malaria refers to the number of reported cases by village chiefs. In Lao PDR, the number of reported cases of dengue fever refers to the occurrence of malaria infection in a person in whom the presence of dengue parasites in the blood has been confirmed by a diagnostic test. In Thailand, it refers to the number of hospital patients (Other arthropod-borne viral fevers and viral haemorrhagic fevers). According to WHO, dengue (break-bone fever) is a viral infection caused by the dengue virus (DENV) that spreads from mosquitoes to humans through the bite of infected mosquitoes.

In 2020, the number of reported cases of dengue fever in the LMB areas differed between the LMB countries: Cambodia had a low number of reported cases, at 8,021, or around 6% of the total number of reported cases in the LMB (138,783 cases based on 2019 and 2020 data). In contrast, based on 2019 and 2020 data, Lao PDR, Thailand and Viet Nam recorded very high numbers of cases, at 54,409 (39%), 44,095 (32%) and 32,258 (23%), respectively. Further consideration should be made and assistance provided in order to address this water-related health issue in these LMB areas.

In 2020, in the LMB provinces of Cambodia, 8,021 cases of dengue fever were reported. Some provinces had high numbers of cases such as Kandal (919), Battambang (864), Kampong Cham (788) and Banteay Meanchey (686), whereas some provinces have very low cases such as Mondul Kiri (4), Kampong Thom (17), Ratanak Kiri (76 cases) and Otdar Meanchey (78). The number of cases among males was higher than those among females, at 4,395 (55%) and 3,572 (45%), respectively.

In 2019, in Lao PDR, the number of reported cases of dengue fever was significantly high, at 54,409, and most of the provinces had a high number, at around 1,000 and 8,000. For example, Savannakhet had the highest number of reported cases, at 8,212, followed by Vientiane Capital, with a very high number, at nearly 6,000 cases. Only two provinces (Xekong and Xaisomboun provinces) had a low number of cases, at 696 and 727, respectively.

In 2020, in the LMB provinces of Thailand, the total number of reported cases of dengue fever was very high, at 44,095 cases (male, 22,899 and female, 21,196). Most of the LMB provinces recorded a high number, at around 1,000–6,000 cases; for example, Nakhon Ratchasima had the highest number, at 6,049 reported cases, followed by Khon Kaen (3,862 cases) and Buri Ram (3,163 cases); and other LMB provinces recorded low numbers, such as Phayao (187 cases), Mukdahan (327 cases) and Amnat Charoen (369 cases).

In 2020, in the LMB provinces of Viet Nam, the number of reported cases of dengue fever was high, at 32,258. Many LMB provinces had a high number of reported cases, at around 1,000–4,000: for example, Ben Tre had the highest number, at 4,110, followed by Gia Lai, at 3,592, Tien Giang, at 4,110 and Long An at 2,973. Hau Giang recorded the lowest number, at 177.

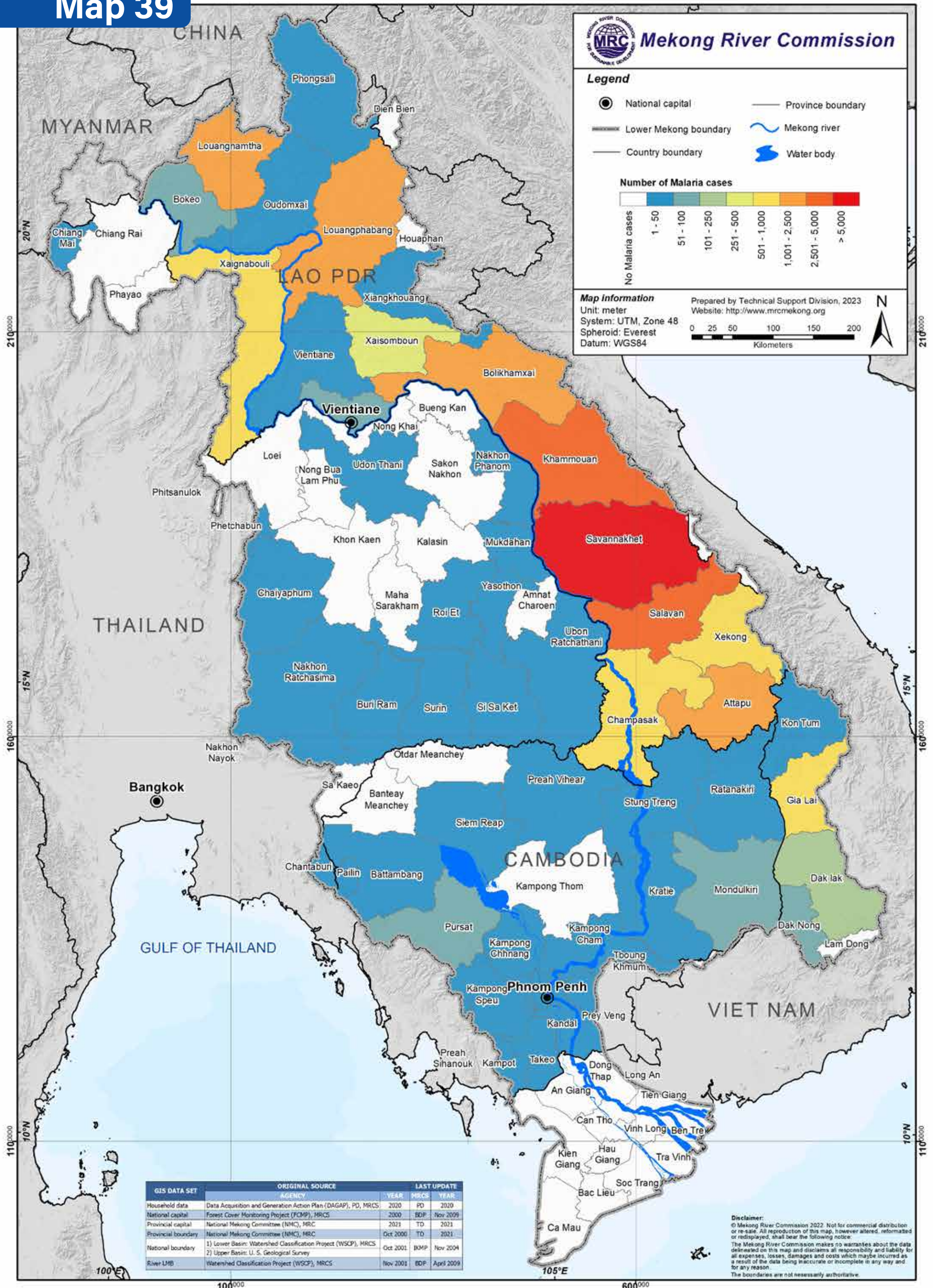
Table 32. Number and LMB share (%) of reported cases of dengue fever in the LMB, 2019/2020

Country	Number of reported cases	Percentage in the LMB (%)
Cambodia (2020)	8,021	5.78
Lao PDR (2019)	54,409	39.20
Thailand (2020)	44,095	31.77
Viet Nam (2020)	32,258	23.24
Total LMB	138,783	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Country indicators annual reports (National hospital and health facilities), Ministry of Health	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Lao Expenditure Consumption Survey, 2003, 2008, 2013 and 2019	2019	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Health service data of the Strategy and Planning Division	2020	Province	◆ Office of the Permanent Secretary, Ministry of Public Health
Viet Nam	Database of the Ministry of Health	2020	Province	◆ Department of Preventive Medicine of Ministry of Health





Cases of malaria

Map 39 shows the number and proportion of reported cases of malaria by province in 2019 and 2020 in the LMB countries. In Cambodia, the number of reported cases of malaria refer to the number report case by village chief. In Lao PDR, it refers to the occurrence of malaria infection in a person in whom the presence of malaria parasites in the blood has been confirmed by a diagnostic test. In Thailand, it refers to the number of hospital patients (malaria). According to WHO, a case of malaria is defined as the occurrence of malaria infection in a person in whom the presence of malaria parasites in the blood has been confirmed by a diagnostic test.

The number of reported cases of malaria differed greatly between LMB countries: in 2019, out of a total number of reported cases (22,659), Lao PDR recorded the highest number, i.e. 21,653 cases (around 96%); in 2020, Viet Nam recorded 827, Cambodia recorded 476 and Thailand recorded only 86.

In 2020, in Cambodia, some LMB provinces had high numbers of reported cases of malaria, such as Pursat and Monduliri, at 69 and 55, respectively. In contrast, other provinces had much fewer or no reported cases: Banteay Meanchey, Kampong Thom, and Otdar Meanchey had no reported cases, and Preah Vihear, Preah Sihanouk, Pailin, Kandal, Battambang, Koh Kong and Siem Reap had fewer than 10 reported cases in each province. There were 346 reported cases of malaria among males (73%), which was much higher than among females, at 130 (27%), out of the total number of 476 reported cases in its LMB provinces; similar gender discrepancies emerged in each of its LMB province. This illustrates that the male population in the LMB provinces were more vulnerable than the female population, with high percentages of people impacted by water-related health diseases such as malaria illness.

In 2019, in Lao PDR, the number of reported cases of malaria in some provinces, especially in the northern and southern provinces, was significantly high: for example, Luangnamtha (1,737 cases), Luangprabang (1,291 cases), Borikhamxay (1,298 cases), Khammuane (3,401 cases), Salavan (2,820 cases), Savannakhet (6,399 cases) and Attapu (1,761 cases). Further consideration should be made and assistance provided in order to address this health-related issue. The total number of cases of malaria among females is 11,063 (51%), which was slightly higher than the number of cases among males, at 10,590 (49%). This demonstrates that the female population is more vulnerable than the male population, although the number of cases among males was slightly higher than cases among females in some provinces, such as Luangprabang, Luangnamtha, Oudomxai and Savannakhet provinces.

In 2020, in the LMB provinces of Thailand, the number of reported cases of malaria was low, at less than 25 cases in each LMB province. While many of these provinces had very few or no cases, some still had this water-related health disease, such as Phetchabun, with 24 cases, Si Sa Ket with 19 cases, and Ubon Ratchathani, with 15 cases. Out of a total number of 86 cases, the number among males (64 cases, or 74%) was much higher than among females (22 cases, or 26%). In particular, there was a significant gender gap in the number of reported cases in some provinces, such as Phetchabun (16 male and 8 female), Si Sa Ket (18 male and 1 female) and Ubon Ratchathani (14 male and 1 female). This indicates that the male population was more vulnerable than the female population regarding malaria infection.

In 2020, in the LMB provinces of Viet Nam, a high number of reported cases of malaria was recorded, at 827 cases. Within the LMB provinces, only five provinces reported cases of malaria, including Gai Lai, which had the highest number of cases (586), followed by Dak Lak (126), Dak Nong (54), Binh Phuoc (34) and Kon Tum (27).

Table 33. Total number of reported cases of malaria in the LMB

Country	No. of reported cases of malaria	Proportion (%) of reported cased in the LMB
Cambodia (2020)	476	2.07
Lao PDR (2019)	21,653	93.97
Thailand (2020)	86	0.37
Viet Nam (2020)	827	3.59
Total LMB	22,573	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	Country indicators annual reports (National Hospital and Health Facilities)	2020	Province	Ministry of Health
Lao PDR	Lao Expenditure Consumption Survey in 2019, Lao Statistics Bureau, Ministry of Planning and Investment Ministry of Health	2019	Province	Lao Statistics Bureau, Ministry of Planning and Investment, Ministry of Health
Thailand	Health service data of the Strategy and Planning Division, Office of the Permanent Secretary, Ministry of Public Health	2020	Province	Office of the Permanent Secretary, Ministry of Public Health
Viet Nam	Database from Ministry of Health	2020	Province	Department of Preventive Medicine of Ministry of Health







ECONOMIC DIMENSION

Household asset value

Household expenditure

Hydropower

- » Status of hydropower projects
- » Installed capacity of hydropower projects
- » Live storage of hydropower projects
- » Mean annual energy of hydropower projects

Irrigation

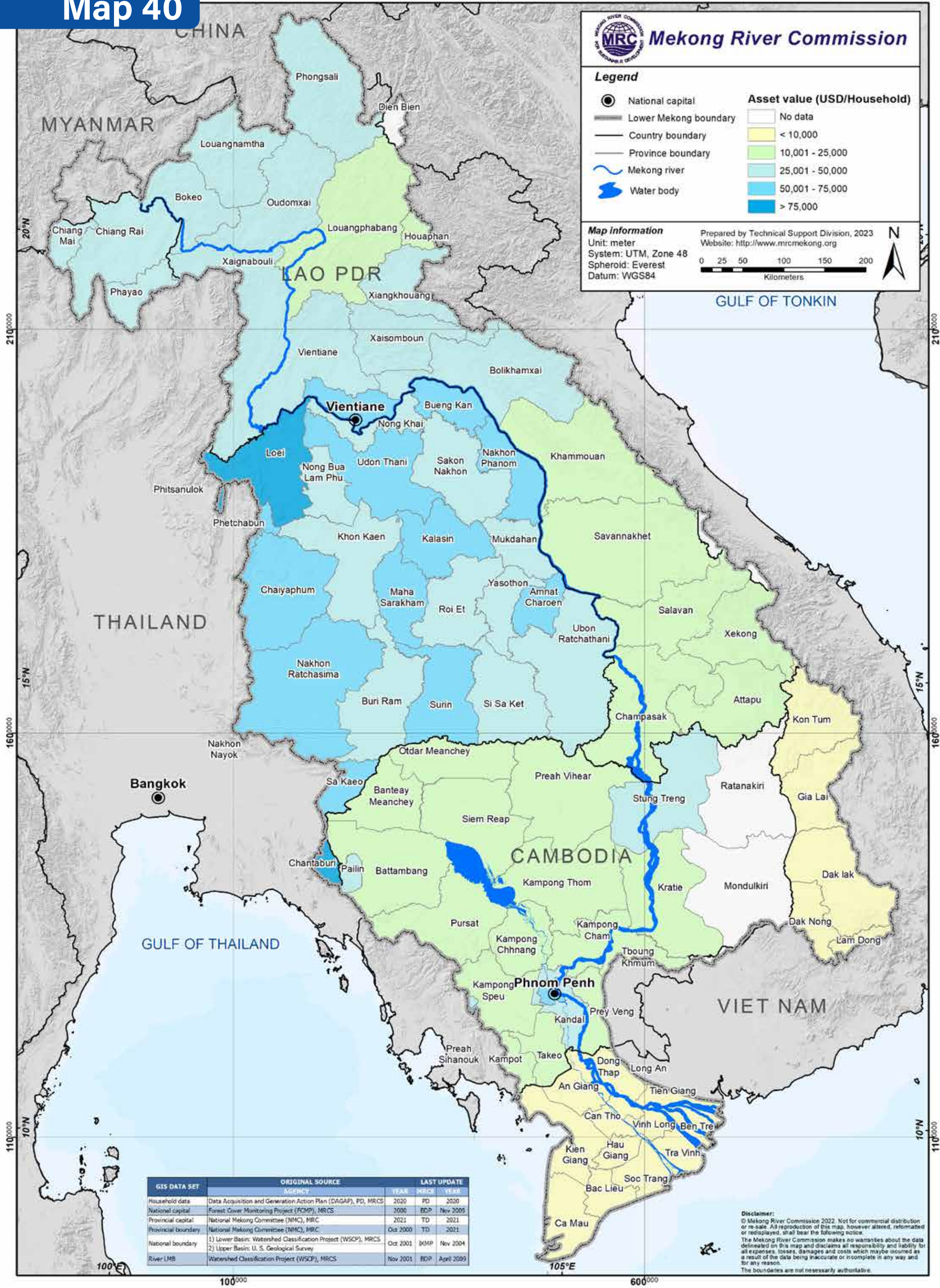
- » Irrigation projects and reservoirs
- » Irrigation headworks and reservoirs
- » Irrigation area
- » Irrigated rice crop area

Production

- » Rice production
- » Annual irrigated rice yield
- » Hydropower production for domestic consumption
- » Meat production from livestock
- » Aquaculture production
- » Forestry area
- » Gross domestic production
- » Annual GDP growth rates

Household asset value

Map 40



Household asset value

Map 40 shows the value and proportion of household assets by province of the LMB countries based on 2019 and 2020 data. In Cambodia, the total value of household assets is defined as the total value of 44 durable goods owned by households, together with the combined value of land ownership and ownership of buildings for agriculture, commercial purposes, factories and housing. In Lao PDR, this value refers to the total value of household assets, including that of land, buildings, and durables such as motor vehicles. In Thailand, this value refers to that of houses, land, buildings, household-owned vehicles, as well as financial assets such as household savings. In Viet Nam, this value refers to that of household durable goods of the household, such as cars, motorbikes, telephones, refrigerators, videos, colour TVs, stereo equipment, computers, air conditioners, washing and drying machines and water heaters. According to the Organisation for Economic Co-operation and Development (OECD, the household net worth represents the total value of assets (financial as well as non-financial) minus the total value of outstanding liabilities of households.

In 2019, among all LMB countries, Thailand recorded the highest value of household assets (around 74%), at USD 53,158 per household on average for a total value of household assets of USD 392,821 billion (out of around USD 533,381 billion). In contrast, in 2020, Viet Nam recorded the lowest value of household assets, at only USD 2,626 per household on average, or around USD 16,55 billion, i.e. only 3% of the total value of household assets in the LMB.

In 2019, in the LMB provinces of Cambodia, the average value of household assets (no data were available for Mondulkiri and Ratanakiri provinces) was USD 24,416 per household. There were some significant disparities between LMB provinces and between male- and female-headed households, which reflects that vulnerable households have assets with lower value. For example, the average of the total value of household assets in Stung Treng was USD 27,957 per household, i.e. USD 30,203 per male-headed households, and only USD 7,779 per female-headed households. This shows that female households asset value is less than male value of household assets.

In 2019, in Lao PDR, the average value of household assets was USD 31,279 per household in the LMB areas. There were some disparities between LMB provinces and between urban and rural households, which indicates that there are vulnerabilities regarding the value of household assets. For example, the value of household assets in Oudomxai was USD 38,753 per household, with USD 109,658 for urban households, and only USD 12,913 per household for the rural households.

In Thailand, there were some disparities in the value of household assets between urban and rural areas, which indicates that there are vulnerabilities regarding the value of household assets. For example, in Chantaburi province, the average value of household assets was USD 120,334 per household, i.e. only USD 77,360 for urban households and USD 166,379/household for rural households.

In Viet Nam, there were slight differences in the values of household assets between provinces; for example, in Lam Dong province, the average value of household assets was USD 3,550 per household, whereas in Ca Mau, it was USD 2,039 per household.

Table 34. Average and proportion of values of household assets in the LMB

Country	Total number of HHs	Average household asset values (USD/HH)	Total HH values (USD)	Percentage (%) of HH value in the LMB (USD)
Cambodia (2019)	3,481,013	24,416	84,992,452,060	16
Lao PDR (2019)	1,247,248	31,279	39,012,197,820	7
Thailand (2019)	7,389,691	53,158	392,821,366,154	74
Viet Nam (2020)	6,303,870	2,626	16,555,156,120	3
Total LMB	18,421,822		533,381,172,154	100

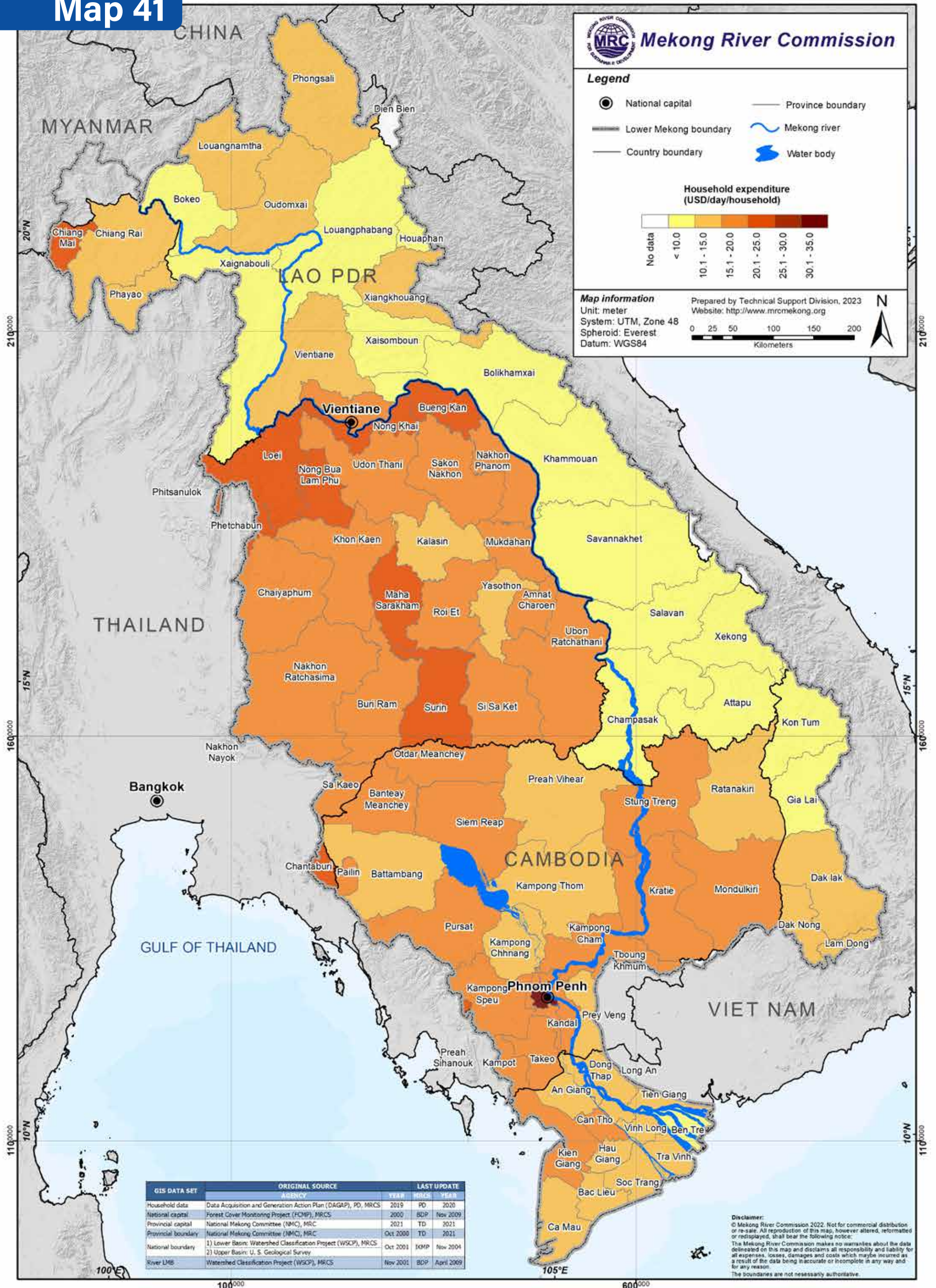
Data source

Country	Source	Year	Data level	Agency
Cambodia	● Cambodia Social-Economic Surveys, 2011–2017, 2019	2019	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● Database from Lao Statistics Bureau and the 3rd, 4th, 5th and 6th Lao Expenditure and Consumption Survey	2019	Province	● Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	● Socio-Economic Survey conducted by the National Statistics Office	2019	Province	● National Statistical Office, Ministry of Digital Economy and Society
Viet Nam	● Internal documents of General Statistics Office ● Interpolated from the Viet Nam household Living Standard Surveys	2020	Province	● General Statistics Office of Viet Nam, Ministry of Planning and Investment



Household expenditure

Map 41



Household expenditure

Map 41 shows the value of household expenditures by province in the LMB countries. In Cambodia, household expenditure refers to the 22 food items covering all food as well as alcohol, tobacco and food consumed outside the home, and prepared meals bought outside and eaten at home, and the 23 non-food items covering all non-food expenditures except housing. Data on household expenditure refer to the average household expenditure in USD per day, which is calculated by converting the average monthly household expenditure in riels to USD by applying the yearly exchange rate and then dividing it into 30 days. In Lao PDR, the household expenditure is estimated by the sum of purchased goods and services for household consumption, including own products for final consumption. In Thailand, the household expenditure (USD per day per household) = Household expenditure per month (USD per month per household)/30 days. In all LMB countries, the standard definition of household expenditure is the sum of all food and non-food expenditure (purchased goods and services) for household consumption.

Based on 2019 and 2020 data, the LMB average household expenditure was USD 22.87 per day per household, which was above the poverty line. Cambodia and Thailand recorded the highest average household expenditure at around USD 18 per day per household, whereas Lao PDR and Viet Nam recorded lower household expenditure, at USD 10 per day per household and USD 12 per day per household, respectively. In all of the LMB, the average total household expenditure was around USD 288.37 per day.

In 2019, in the LMB provinces of Cambodia, the average household expenditure was USD 18.14 per day per household. When disaggregated by male and female household expenditure, it emerges that there were higher expenditures among male-headed households than female-headed households across the LMB provinces. For example, there were significant gender gaps between male and female household expenditures in Stung Treng (USD 17.25 per day per household and USD 8.90 per day per household, respectively) and in Otdar Meanchey (USD 19.15 per day per household and USD 11.14 per day per household, respectively). The total household expenditures in the LMB provinces of Cambodia was USD 63,444,936 per day. Phnom Penh had the highest household expenditure, at around USD 10 million per day, whereas Pailin had the lowest, at only USD 293,811 per day.

In 2019, in the LMB provinces of Lao PDR, the average household expenditure was around USD 10 per day per household; Luangnamtha, Oudomxai and Vientiane capital provinces recorded the highest household expenditure, at USD 14.59 per day per household, USD 12.86 per day per household and USD 15.74 per day per household, respectively. Household expenditure in urban areas was higher than in rural areas across all provinces of the country. There were significant gaps in some provinces between urban and rural household expenditures, such as in Bokeo (USD 14.55 per day per household and USD 7.59 per day per household, respectively), Huaphanh (USD 14.54 per day per household and USD 8 per day per household, respectively) and Oudomxai (USD 22.47 per day per household and USD 9.36 per day per household, respectively). The total household expenditures in its LMB provinces was USD 12,567,738 per day. Vientiane Capital had the highest household expenditure, at around USD 2.7 million per day, whereas Xaisomboun had the lowest, at only USD 134,466 per day.

In 2020, in the LMB provinces of Thailand, the average household expenditure was USD 18.03 per day per household. Across LMB areas in Thailand, some provinces such as Chantaburi, Nong Bua Lam Phu and Bueng Kan had high household expenditures of around USD 22–24 per day per household. The average household expenditure in urban areas (USD 20.25 per day per household) was higher than in rural areas (USD 17.16 per day per household), which is the case for most of the LMB provinces. There were large gaps between urban and rural household expenditures in Khon Kaen (USD 22 per day per household and USD 15 per day per household, respectively), Maha Sarakham (USD 25 per day per household and USD 19 per day per household, respectively) and Chiang Mai (USD 22 per day per household and USD 17 per day per household, respectively). The total household expenditures in the LMB provinces of Thailand was USD 136,284,532 per day. Nakhon Ratchasima, Chiang Mai and Khon Kaen provinces had very high household expenditures, at around USD 15 million per day, USD 12 million per day and USD 11 million per day, respectively, whereas other LMB provinces had lower household expenditures, at around USD 1–8 million per day.

In 2020, in the LMB provinces of Viet Nam, the average household expenditure was USD 12.07 per day per household. Some LMB provinces of Viet Nam, such as Lam Dong, Long An, Tien Giang, Dong Thap, Kien Giang, Cantho city and Hau Giang, recorded higher household expenditures than the average household expenditure (USD 11.86 per day per household). Kien Giang and Can Tho city provinces recorded the highest household expenditure, at around USD 15–16 per day per household, while Kon Tum, Gai Lai and Ben Tre had the lowest household expenditure, at around USD 9–10 per day per household. The total household expenditures in the LMB provinces of Viet Nam was USD 76,073,093 per day. Some LMB provinces including Tien Giang, Kien Giang and Long An provinces recorded high household expenditures, at around USD 6–7 million per day, whereas other LMB provinces recorded lower household expenditures, at around USD 1–5 million per day.

Table 35. Proportion (%) of average household expenditure in the LMB

Country	Average HH expenditure (USD/day/HH)	Total HH expenditure in the LMB areas (USD/day)	Percentage in the LMB (%)
Cambodia (2019)	18.14	63,444,936	22.00
Lao PDR (2019)	10.08	12,567,738	4.36
Thailand (2020)	18.03	136,284,532	47.26
Viet Nam (2020)	12.07	76,073,093	26.38
Average/Total LMB	15.50	288,370,299	100

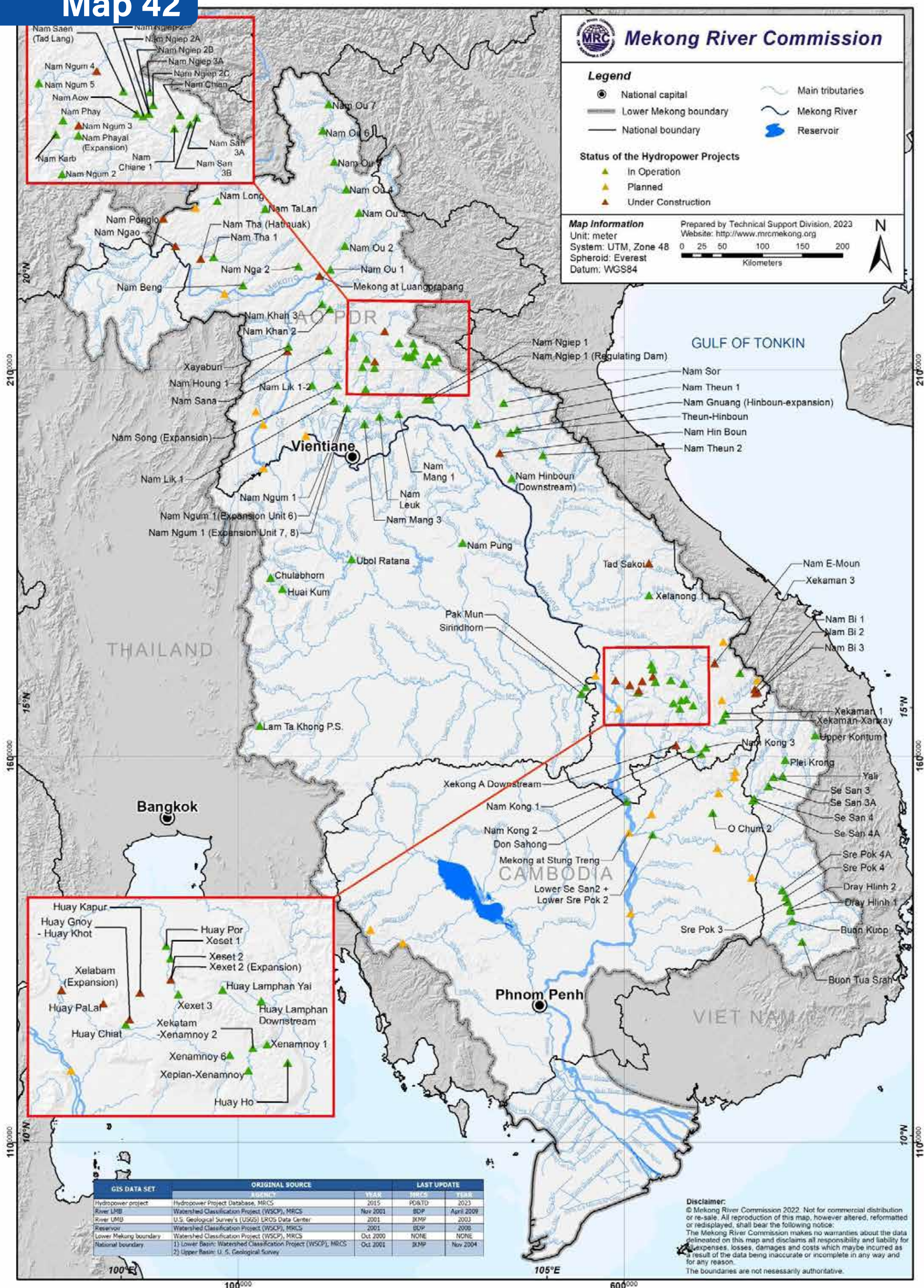
Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Cambodia Socio-Economic Surveys, 2011–2017 and 2019	2019	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Database from Lao Expenditure Consumption Survey 3rd, 4th, 5th and 6th Lao Statistics Bureau	2019	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Socio-Economic Survey data from the National Statistics Office (NSO)	2020	Province	◆ Ministry of Digital Economy and Society
Viet Nam	◆ Interpolated from the Viet Nam Living Standard Survey (VLSS); Statistical Yearbook of Viet Nam	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment



Status of hydropower projects

Map 42



Status of hydropower projects

Mekong has become one of the most active regions in the world for hydropower development with a number of large HPPs either planned, commissioned or constructed. Map 42 is the first of four maps in each chapter dedicated to HPPs, describing the location, storage capacity and energy production characteristics of existing and planned HPPs in the LMB.

This first map shows the location of all projects operating in 2022, projects under construction in 2022, including Louangphabang, which recently started construction, and planned projects. Table 35 shows the number of projects in each country. The information in this map and subsequent three maps is from the MRC's Hydropower and PNPCA Database (MRC, 2022) based on data provided by the four LMB countries. There are 90 dams on the mainstream and tributaries of the Mekong River and 21 under construction and 22 planned.

On the Mekong mainstream downstream of China, there are 11 planned mainstream dams, two of which, Xayaburi Dam and the Don Sahong Dam, are currently in operation. A third HPP at Louangphabang is under construction. All are in Lao PDR. The remaining mainstream HPPs are in different stages of planning and review by the LMB countries. This review and consultation process falls under the Procedures for Notification, Prior Consultation and Agreement (PNPCA) as a requirement of the 1995 Mekong Agreement. Under PNPCA MRC member countries jointly review any development project proposed for the mainstream with the aim of reaching consensus on whether or not the project should proceed, and if so, under what conditions.

Of the remaining eight planned mainstream dams, four are in Lao PDR, two in the lower reaches in Cambodia, and the remaining two are considered transboundary projects because they are located on the Thailand – Lao PDR border (Pak Chom and Ban Koum).

Of the four mainstream dam projects in Lao PDR, Pak Lay HPP and Pak Beng HPP have undergone the PNPCA process and are under construction, while Sanakham HPP is currently undergoing a review and consultation process, and Phou Ngoy HPP will soon follow; the other four, i.e. two in Cambodia and two Thailand-Lao PDR transboundary projects, are at the early stages of planning and study.

Similarly, the other 14 proposed tributary dams are at various stages of planning and their planned start dates vary widely. Some projects have yet to complete a feasibility study whereas others are at an advanced stage of planning and of undergoing an environmental assessment.

Several large tributary basins in Lao PDR have several operational dams that have the potential to operate as cascade dam operations for efficient water resources management and power production. This includes the Nam Ngum catchment near Vientiane, Nam Thuen – Nam Kading catchments in central Lao PDR, Nam Ou catchment in the north and the Se Done catchment in the south.

In Cambodia, most HPPs are still in the planning stage. The Lower Se San 2 HPP stands out as the largest operational project at present. Additionally, there are significant planned projects such as Sambor and Lower Se San 3, both of which involve large reservoir areas. These planned projects are undergoing reassessments to address various factors and ensure their feasibility and sustainability.

Thailand currently operates seven hydropower dams in the northeast region of the country. However, there are no immediate plans for the construction of additional conventional dams, with the exception of the two proposed transboundary projects with Lao PDR. Similarly, Viet Nam currently has 14 conventional hydropower dams in the Mekong Basin, as notified to the MRC.

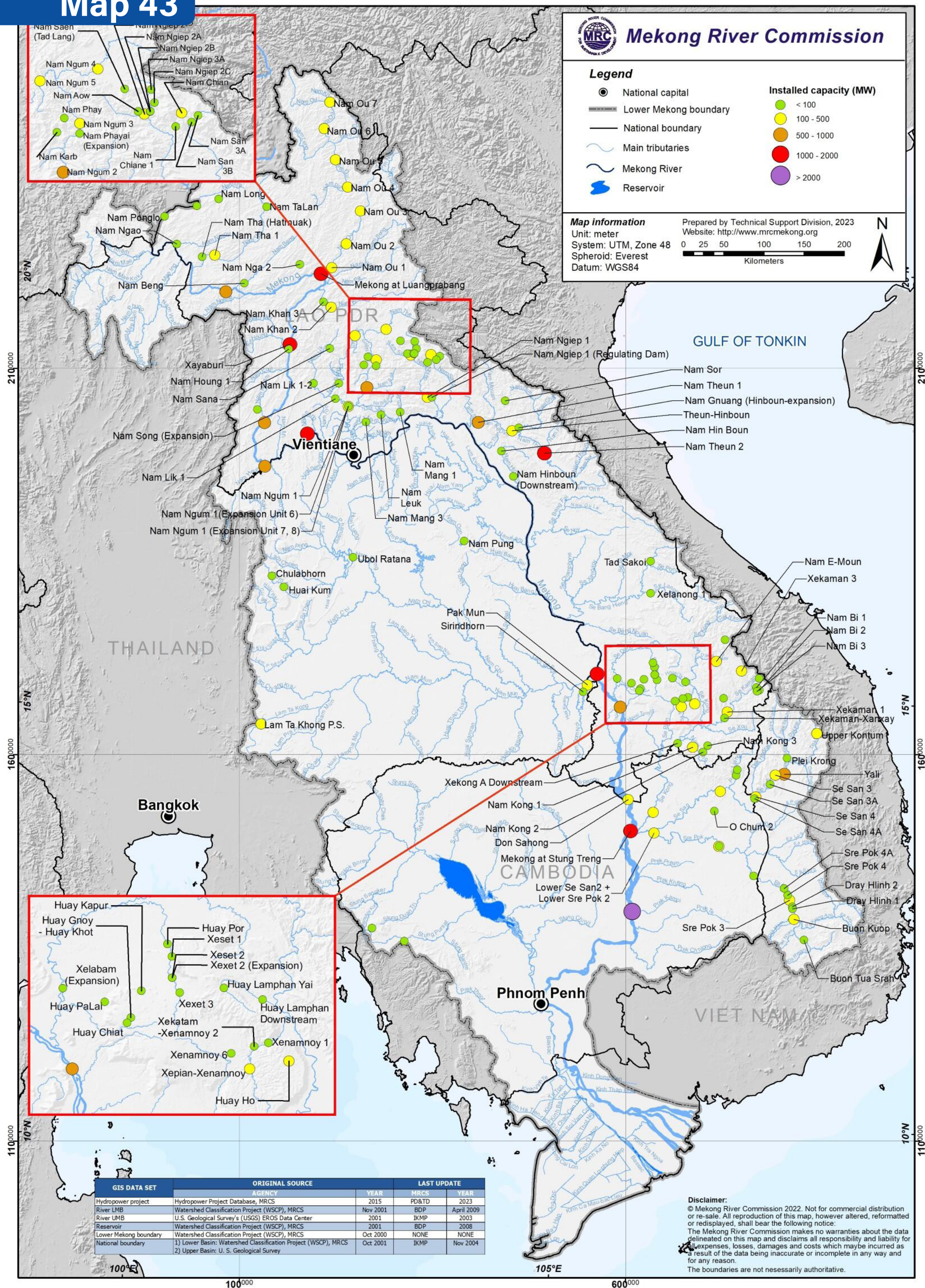
Table 36. Number of hydropower projects in operation, under construction and planned in the LMB, by country

Country	Mekong			Tributary			Total
	In operation	Under construction	Planned	In operation	Under construction	Planned	
Cambodia	-	-	2	2	-	9	13
Lao PDR	2	1	5 (1)*	65	20	5	98 (1)
Thailand	-	-	1 (1)*	7	-	-	8 (1)
Viet Nam	-	-	-	14	-	-	14
Total	2	1	8	88	20	14	133

* Two transboundary joint projects were proposed by Lao PDR and Thailand, i.e. the Ban Koum Dam project and the Pak Chom Dam project, shown in the PNPCA database.



Map 43



Installed capacity of hydropower projects

Installed capacity refers to the total power output of turbines at a dam and is measured in megawatts (MW). The installed capacity is determined by the design of turbines, the number of turbines, the ‘design flow’ (the rate of water flow through the turbines) and the ‘head’ (the pressure difference between the reservoir water level and the outfall level). The design flow is predominately a function of the mean flow of the river and hence also a catchment (watershed) area such that larger catchments and larger river flows allow for greater installed capacity. The design flow is also influenced by the operating procedures of the dam, for example, in response to fluctuations in energy demand.

The adjacent map shows the installed capacity of existing and planned hydropower project (HPPs) and those under construction. The installed capacity is represented by the size and colour of the circles on the map. The planned dams of the Mekong River mainstream will have the largest installed capacity (>1,000 MW) owing to the large mean annual flow of the Mekong River. The largest of these is the planned Sambor dam in Cambodia with an installed capacity of 2,600 MW.

The total installed capacity of all operational dams currently in the LMB is just over 13,257 MW. However, this figure could double to 27,302 MW if all planned dams are constructed and when all of those are completed, i.e. 14,403 MW from all tributary dams and 12,899 MW from all 11 dams on the Mekong mainstream (Table 37).

Table 37. Total installed capacity of hydropower projects that are in operation, under construction and planned for the four Lower Mekong Basin countries and in the entire Basin

Sum of capacity (MW)	Mekong				Tributary				Total
	In operation	Planned	Under construction	Total	In operation	Planned	Under construction	Total	
Cambodia	-	4,000.00	-	4,000.00	401.00	1,110.00	-	1,511.00	5,511.00
Lao PDR	1,545.00	4,865.00	1,410.00	7,820.00	7,959.39	265.00	1,315.70	9,540.09	17,360.09
Thailand	-	1,079.00	-	1,079.00	744.68	-	-	744.68	1,823.68
Viet Nam	-	-	-	-	2,607.00	-	-	2,607.00	2,607.00
Grand Total	1,545.00	9,944.00	1,410.00	12,899.00	11,712.07	1,375.00	1,315.70	14,402.77	27,301.77

Figure 16 illustrates that the majority (64%) of commissioned and future potential installed capacity is in Lao PDR, encompassing both the Mekong mainstream and tributaries. Currently, most HPPs are being carried out in Lao PDR. In addition, 20% of the commissioned and future potential installed capacity is attributed to Cambodia, primarily due to a small number of large, planned dams. While Thailand and Viet Nam already tapped into their hydropower potential within the Mekong Basin tributaries in previous years, Thailand has two potential mainstream joint projects (Pak Chom proposed by Thailand and Ban Koum proposed by Lao PDR) in the planning stage.

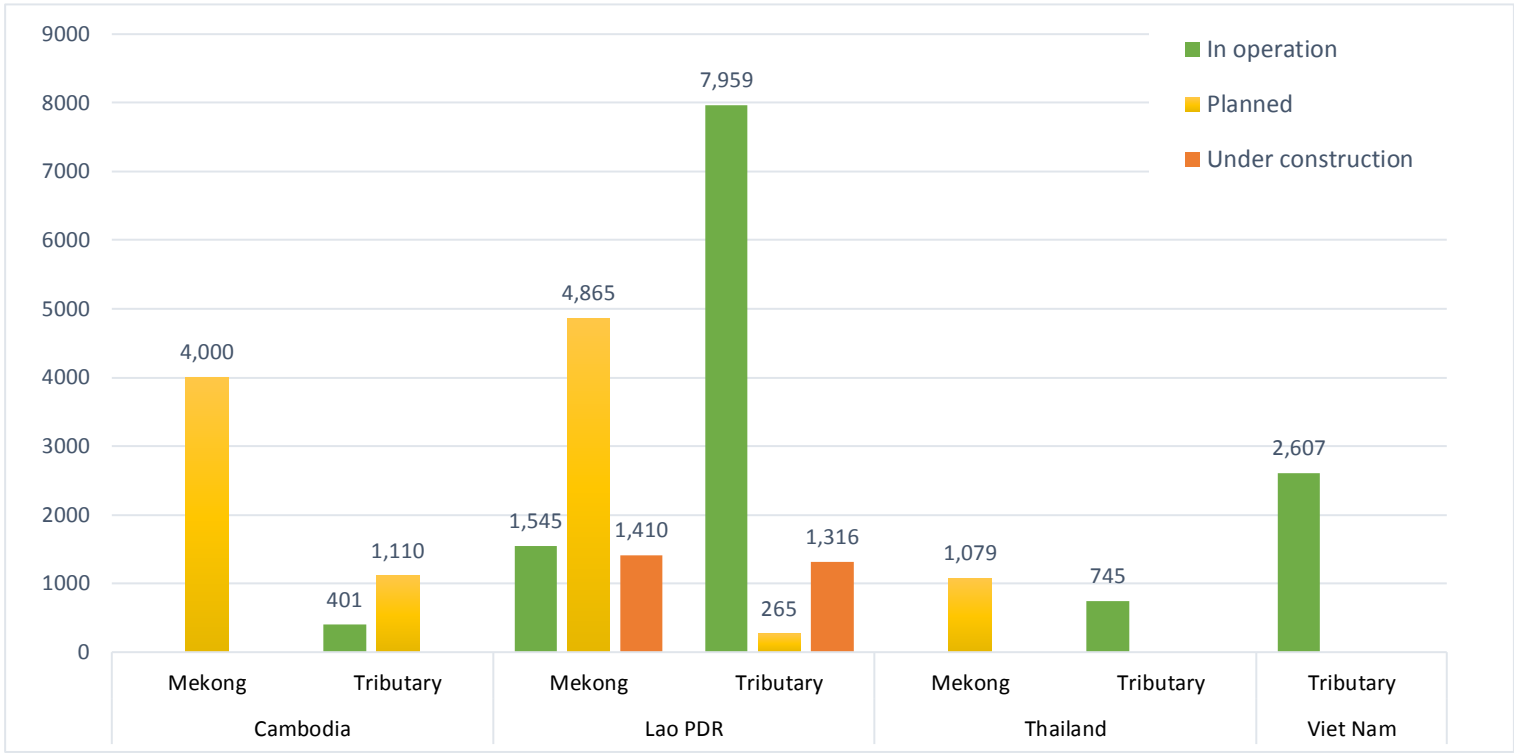
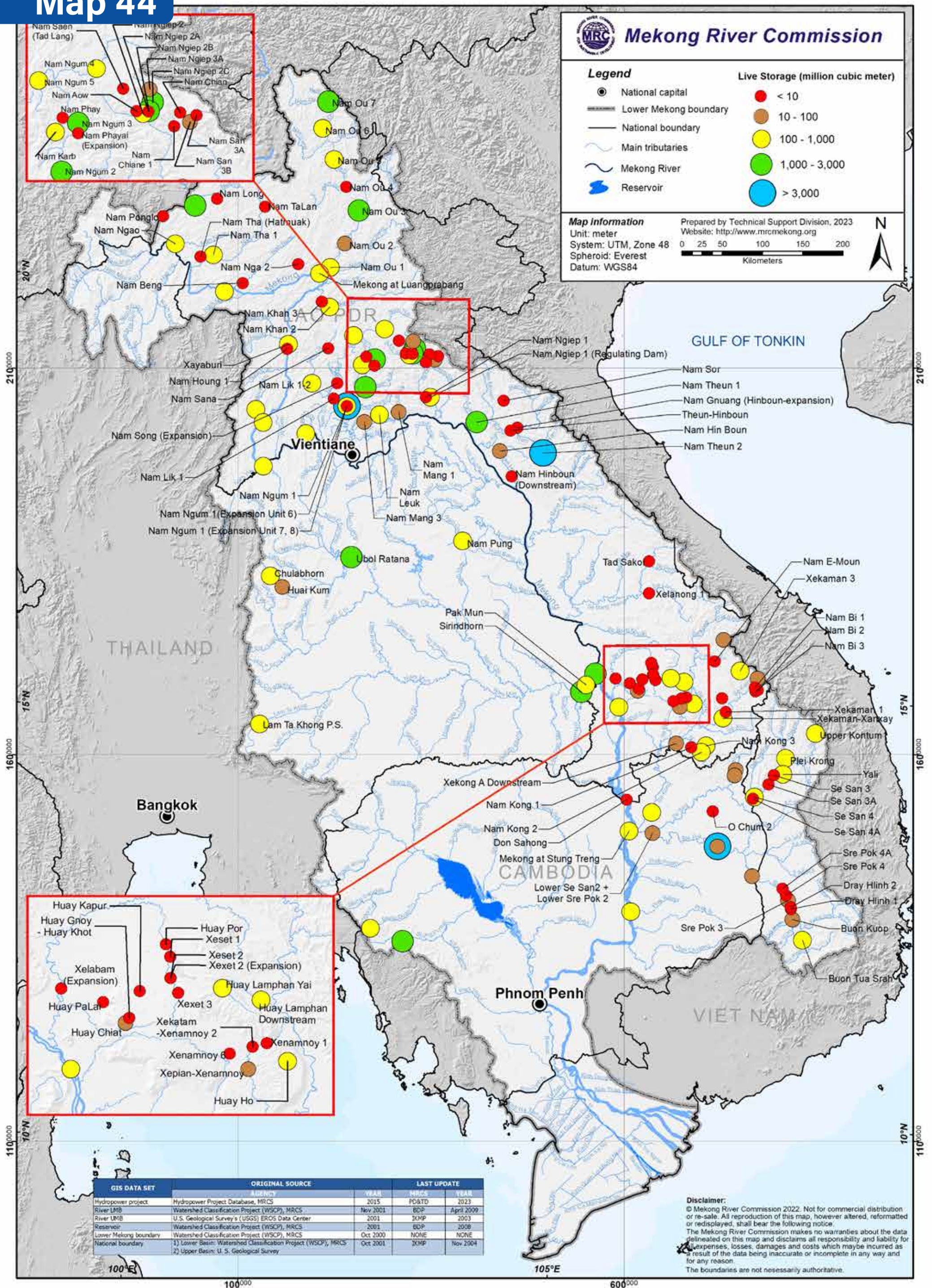


Figure 16. Total installed capacity of hydropower projects that are operating, under construction and being planned on the Mekong mainstream and tributaries for the four Lower Mekong countries.



Live storage of hydropower projects

Map 44



Live storage of hydropower projects

Live storage, also known as ‘active storage’, refers to the volume of water retained by a dam (i.e. in the reservoir) between the normal minimum operating water level and the full supply level. It should be noted that several planned large projects, as reported by Member Countries, require re-evaluation and updating. As a result, the Active Storage Atlas includes only projects that are currently operational and those that are in operation.

Operating levels and storage volumes will fluctuate seasonally in response to changes in river flow but also in response to energy demand. In the adjacent map, Map 44, live storage of all projects that are in operation and those that are under construction is illustrated by the colour and size of the circle. The largest dam in terms of live storage is Nam Ngum located north of Vientiane in Lao PDR, with a live storage of 4,700 million m³. The Nam Thuen 2 dam in central Lao PDR has a similarly large live storage of 3,378 million m³. It should be noted that the live storage of dams on the Mekong mainstream is relatively low due to their run-of-river characteristics with minimal storage relative to the mean annual inflow.

The scale of live storage plays a critical role in determining the extent of sediment trapping behind the dams. Reservoirs with larger capacities and longer lengths tend to trap a greater proportion of incoming sediment load due to slower water velocities within the reservoir. Sediment trapping may limit the dam lifespan and affect turbine operation. Excessive sedimentation can also compromise the structural stability of the dam wall over time. It also has several environmental consequences. Sediment trapping reduces the supply of sediment and nutrients downstream, which can disrupt the natural ecosystem dynamics. Live storage also determines a dam’s capacity to re-regulate river flows, and consequently the degree to which it can contribute to reducing flood peaks and consequential damage to the livelihoods and property of those living downstream. Dams commonly obstruct fish migration, diminishing the productivity of natural fisheries. However, in some cases, reservoirs created by dams may offer new opportunities for fish farming. Additionally, scientifically designed fish passages can be constructed to mitigate the barrier effect of low head dams and facilitate fish migration.

Live storage is closely related to the area of land inundated upstream of a dam (i.e. the reservoir area), as illustrated in Figure 17. However, reservoir area required for storage is also determined by the land topography upstream of the dam. The areas of reservoirs in deep and narrow valleys will be smaller than those located on low lying topography, which will be shallow and larger. Larger reservoir areas tend to displace more people and create greater losses of agricultural land and forests.

Among the operational hydropower dams, Nam Ngum 1 and Nam Thuen 2 in Lao PDR, together with Thailand’s Ubon Rattana and Cambodia’s Lower Sesan 2 dam, stand out for their large reservoir areas, each exceeding 300 km², while the mainstream dams have reservoir areas of less than 90 km².

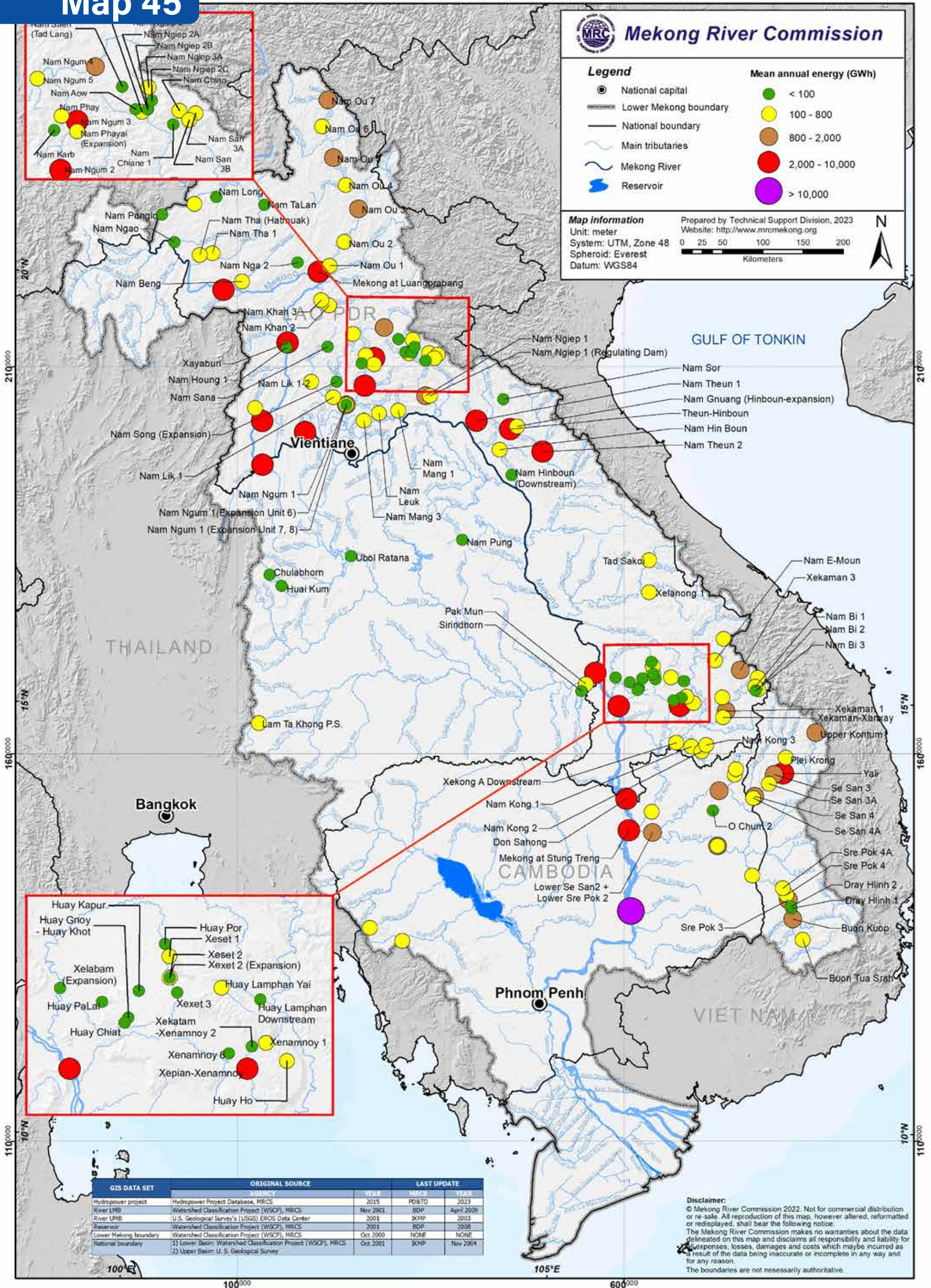


Figure 17. A plot of predicted mean reservoir area (averaged over the year) versus live storage for hydropower projects that are operational and under construction in the LMB



Mean annual energy of hydropower projects

Map 45



Mean annual energy of hydropower projects

The mean annual energy output of a hydropower dam is a function of the installed capacity of the turbines (see previous map, Map 43), the rated head and the volume of water passed through the turbines. 'Head' is defined as the difference between the water level elevation in the reservoir and the elevation of the turbines, which are usually located towards the base of the dam wall, or in certain cases, some distance downstream or in a neighbouring valley. Head represents the potential energy of the water stored in the reservoir. Rated head is the net head at which the full-gate output of the turbine produce the generator rated output in kilowatts. Over a year, the installed capacity, net head and water volume through the turbines will determine the energy production.

The adjacent map, Map 45, indicates the mean annual energy production of all existing and planned HPPs in the LMB and those under construction. Map 42 shows the status of the HPP.

Mean annual energy production is represented by the size and colour of circles. The planned Sambor Dam will have the largest mean annual energy output of 11,740 gigawatt hours (GWh). This large energy output is predominantly due to the dam's position in the lower reaches of the Mekong River allowing a very large design flow through the turbines of more than 19,000 m³/s. The rated head of the Sambor dam, like most of the planned mainstream dams, is only moderate, at 32.9 m.

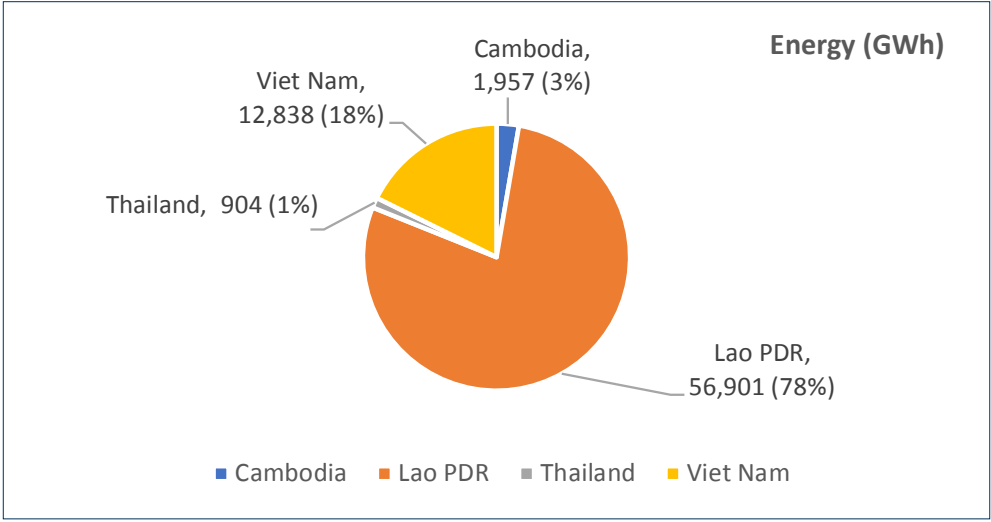
Figure 18 illustrates the distribution of mean annual energy production from hydropower between the four LMB countries for:

- A) projects in operation and under construction;
- B) planned projects; and
- C) the projects in operation, under construction and planned combined.

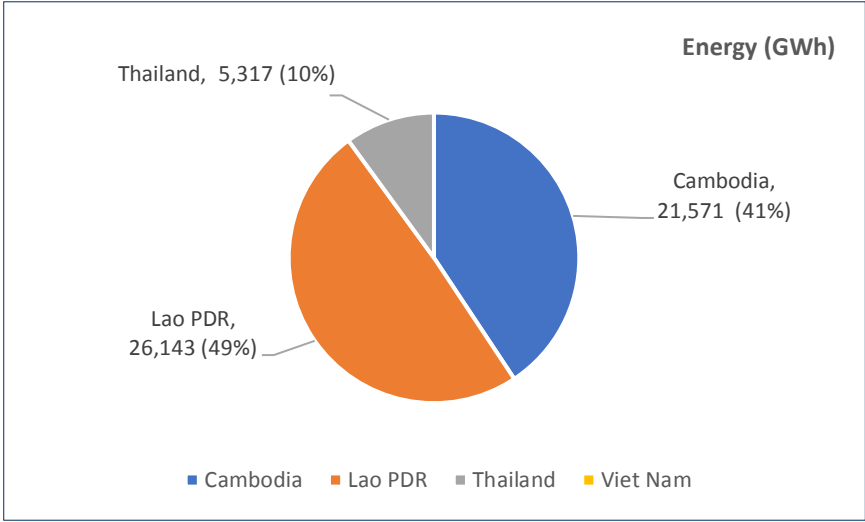
When the projects under construction become operational, Lao PDR will produce 78% of total hydropower energy production in the LMB (over 56,000 GWh), Viet Nam, 18% (12,838 GWh), Thailand, 1% (904 GWh) and Cambodia, 3% (1,957 GWh). Of the planned projects, 49% of the total planned additional energy production is in Lao PDR, which aims to increase production by 26,143 GWh, and 41% in Cambodia, which aims to produce 21,571 GWh from the proposed projects. If all planned projects would be completed, Lao PDR would produce 66% of the Basin's energy (83,044 GWh), followed by Cambodia (19%), much of which would come from the Sambor Dam on the Mekong mainstream, Viet Nam (10%) and Thailand (5%).

It should be noted that the electricity demand of the region is much higher than hydropower development in the LMB can provide (125,630.82 GWh). For example, the electricity demand alone of Viet Nam and Thailand (>200,000 GWh) is far greater than the annual energy potential of all the operational, under construction and planned HPPs combined in the LMB. Note that, in recent years, other sources of renewable energy have begun to made headway in the region.

A) Projects in operation and under construction



B) Planned projects



C) Projects in operation, under construction and planned combined

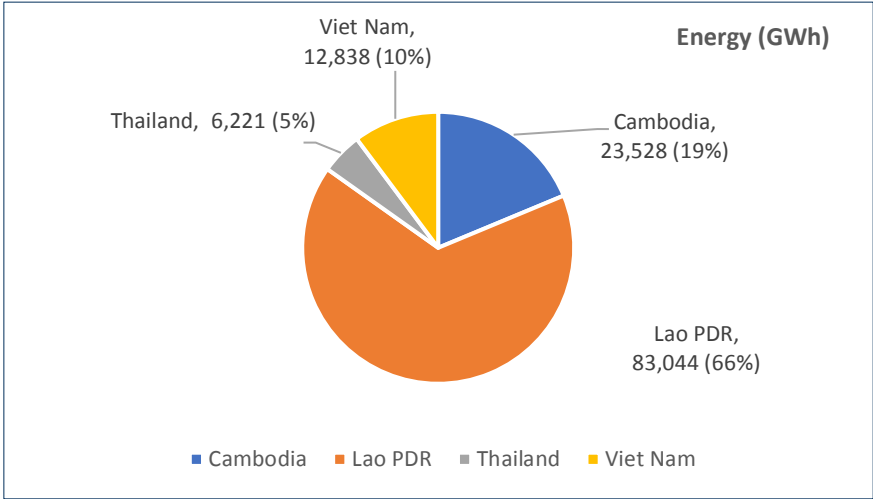
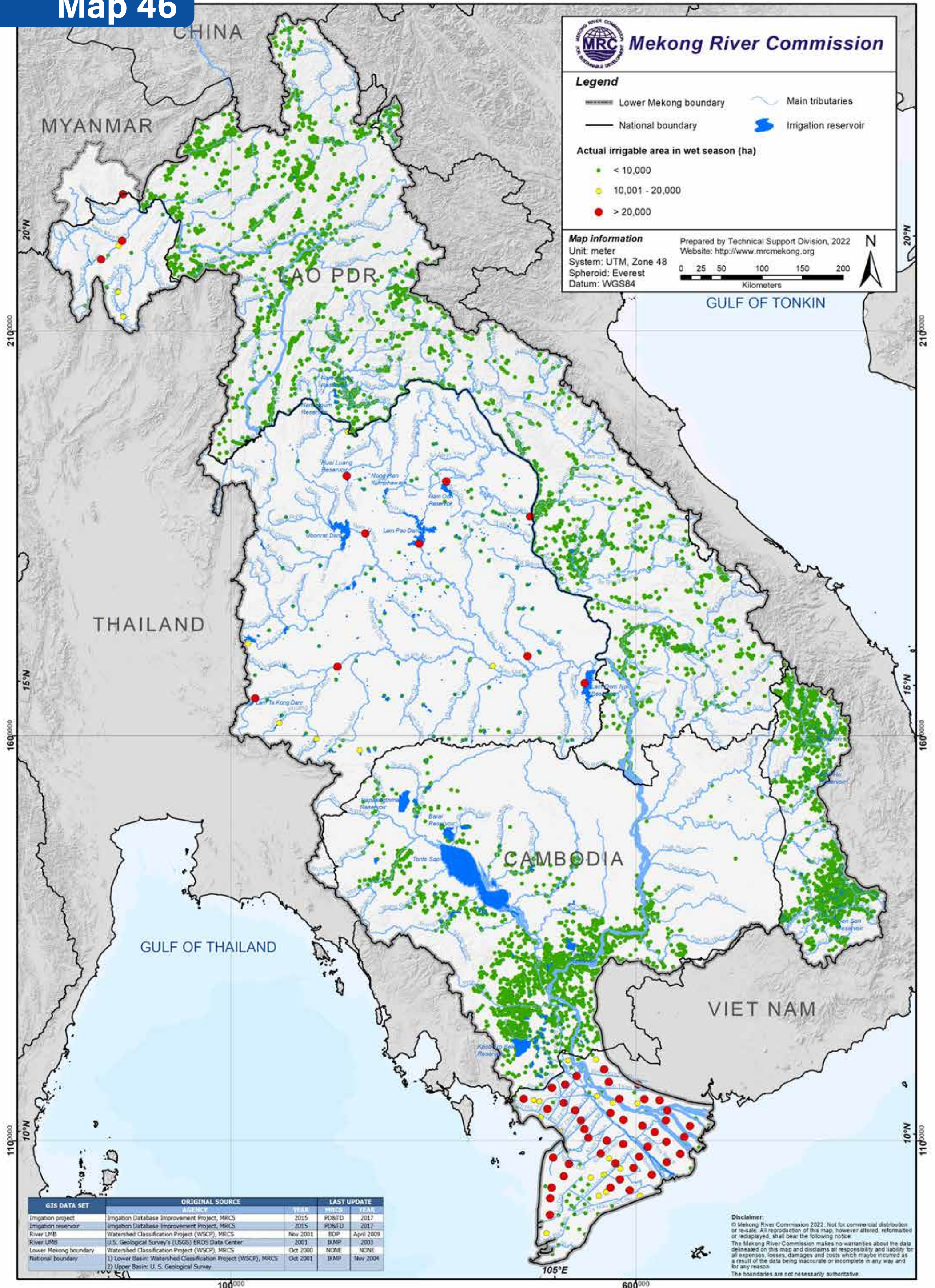


Figure 18. The distribution of mean annual energy production from hydropower between the four LMB countries



Irrigation projects and reservoirs

Map 46



Irrigation projects and reservoirs

Irrigated agriculture is the sector with the largest consumptive water use in the Basin. According to the irrigation database consolidated from national data, the LMB includes 6,755 irrigation projects, which can benefit 4,780,730 ha of actual irrigable area and 4,825,885 ha of estimated maximum irrigable area for rice crops planned during irrigation periods (MRC, 2018).

Map 46 shows the distribution of the irrigation project based on the size of its irrigation area covered by its project. Irrigation project size is divided into three categories – small, medium-sized and large. Small irrigation projects cover less than 10,000 ha of the project area; medium-sized irrigation projects cover between 10,000 ha and 20,000 ha; and large irrigation projects cover over 20,000 ha.

The key features of this map are the large density of irrigation projects located in the Delta area of Viet Nam. There are some large irrigation projects located northeastern part of Thailand, but fewer than in the Delta area. In contrast, there are a huge number of small irrigation projects throughout Lao PDR, Cambodia and Viet Nam Highlands.

In Cambodia, there are 2,044 irrigation projects that cover a small irrigation area (less than 10,000 ha), and there are no medium-sized or large irrigation projects. Similarly, in Lao PDR, there are only small irrigation projects, as many as 3,094. In Thailand and Viet Nam, there are medium-sized and large irrigation projects whose distribution is shown in Table 38.

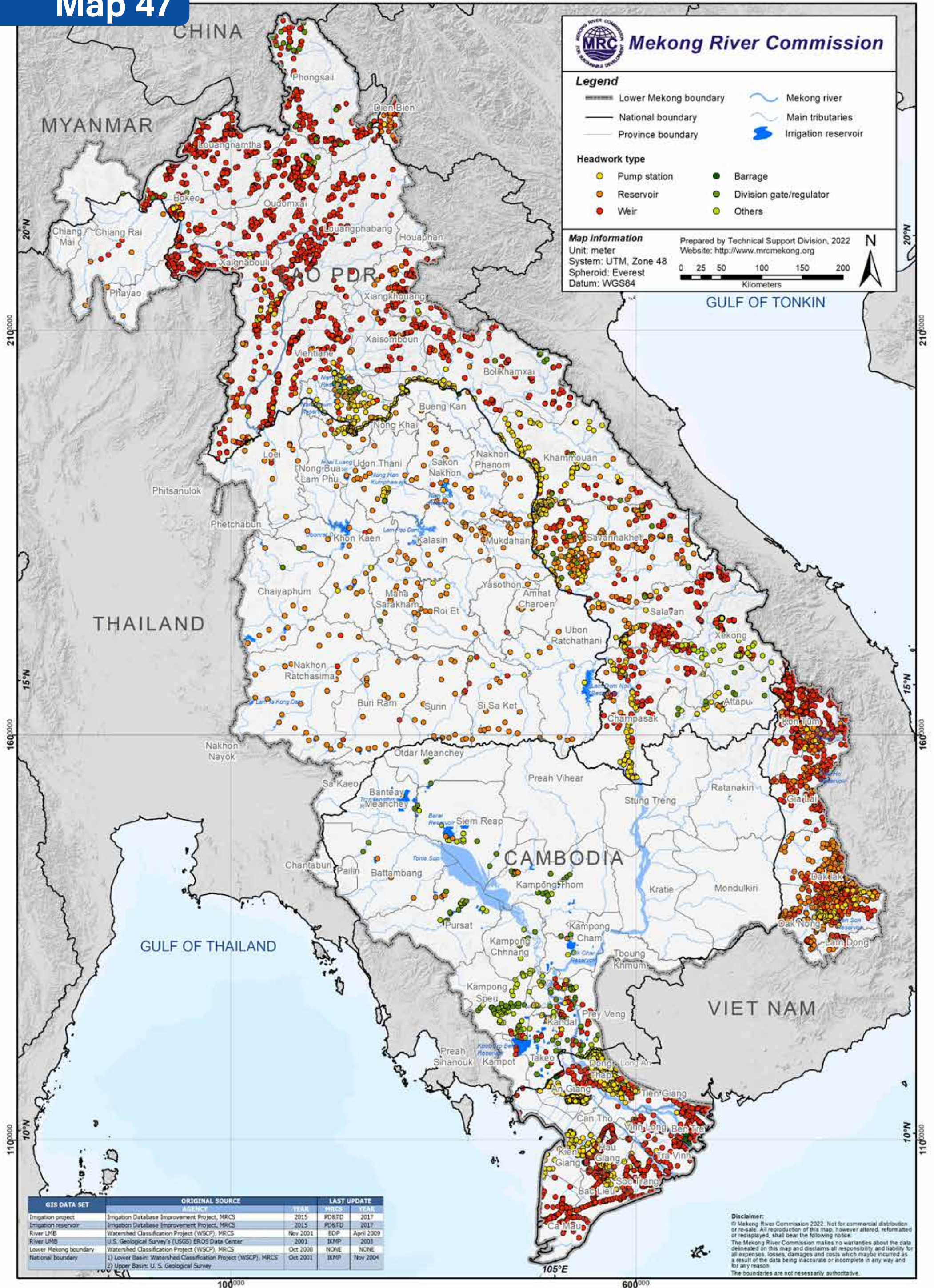
In addition to the irrigation projects, there are 1,307 irrigation reservoirs located throughout the LMB: 124 in Cambodia, 257 in Lao PDR, 256 in Thailand, and 670 in Viet Nam. Table 38 shows the number of irrigations together with active irrigation capacity.

Table 38. Summary of irrigation projects, reservoirs and active irrigation capacity

Country	No. of irrigation projects			No. of irrigation reservoirs	Active capacity for irrigation (1,000 m ³)
	< 10,000 ha	10,000–20,000 ha	> 20,000 ha		
Cambodia	2,044	-		124	N/A
Lao PDR	3,094	-		257	863.9
Thailand	113	9	12	256	6,381.5
Viet Nam	1,406	17	44	670	4,132.6

Irrigation headworks and reservoirs

Map 47



Irrigation headworks and reservoirs

The Governments of the MRC Member Countries realized the importance of the agriculture and water sectors in achieving poverty reduction and food security goals. During the implementation of the MRC's Strategic Plan (SP) 2011–2015, the Agriculture and Irrigation Programme (AIP) was designed to address land and water use issues in the agriculture sector to promote basin development. The AIP played an important role in providing technical support to irrigation development. In the AIP document 2011–2015, improving the MRC irrigation database was a priority, which illustrated that MRC Member Countries needed to fill the gaps in their national irrigation databases and create a manageable regional dataset for irrigation data management and sharing.

The map describes the location and type of irrigation headworks. There are various types of irrigation headworks such as pumping stations, reservoirs, weirs and barrages, and various types of reservoir structures, such as earth dams, rockfill concrete dams and operational dams. The irrigation reservoir headworks are usually located on the routes around the irrigation project the latest data, i.e. 2017 data, were used.

Cambodia: There were various types of irrigation headworks (310), such as regulators, pumping stations, reservoir and flood prevention devices. The irrigation areas for both wet and dry seasons cover 479,762 ha. There are 124 reservoirs listed in the database.

Lao PDR: There are a total of 3,094 irrigation headworks, which are usually located on the routes around the irrigation projects; these are mainly irrigation weirs (2,091) and pumping stations (566). The irrigation reservoirs are also counted according to size and storage capacity. There are 257 earth dams or reservoirs constructed mainly for domestic water supply into irrigated areas through a gravity-fed irrigation system connected to canal lines.

Thailand: There are 322 irrigation headworks located on the routes around the irrigation projects, which are mainly irrigation reservoir headworks. The irrigation reservoirs include 177 earth dams and 79 rockfill dams (256 in total), which are not only constructed for water storage, but also primarily used for flood control and domestic water supply.

Viet Nam: The irrigation areas cover 3,452,451 ha. Some small lakes and reservoirs in the area are mainly for domestic water supply, tourism and agriculture, especially irrigation. In the

highland area of the country, irrigation projects have constructed irrigation works at different levels, which are used for water storage. There are 1,386 irrigation headworks: 714 pumping stations, 658 weirs and 14 barrages. There are also a total of 670 small- and large-scale dams or reservoirs, including mainly earth dams (643) and other types (e.g. rockfill and concrete dams), for hydropower, irrigation and domestic use.

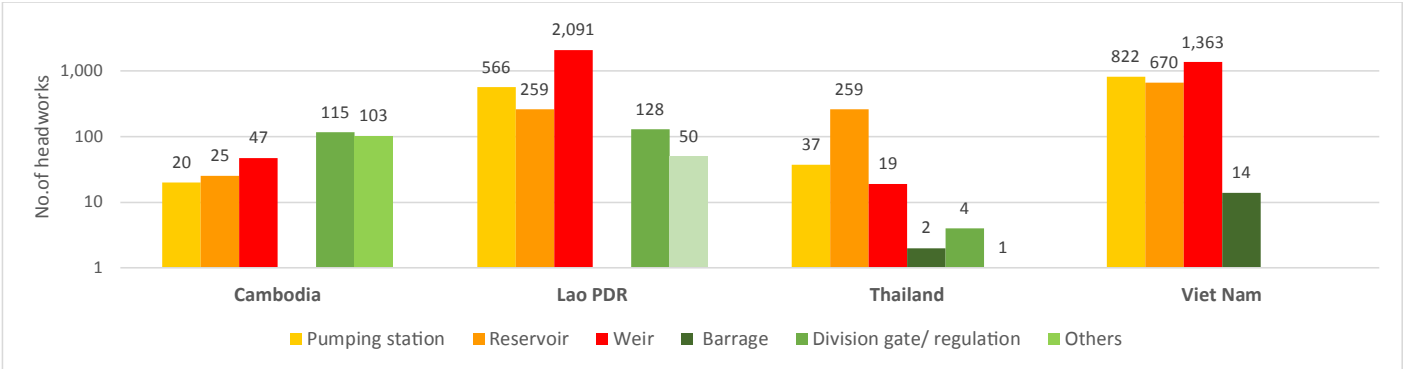


Figure 19. Number and type of irrigation headworks

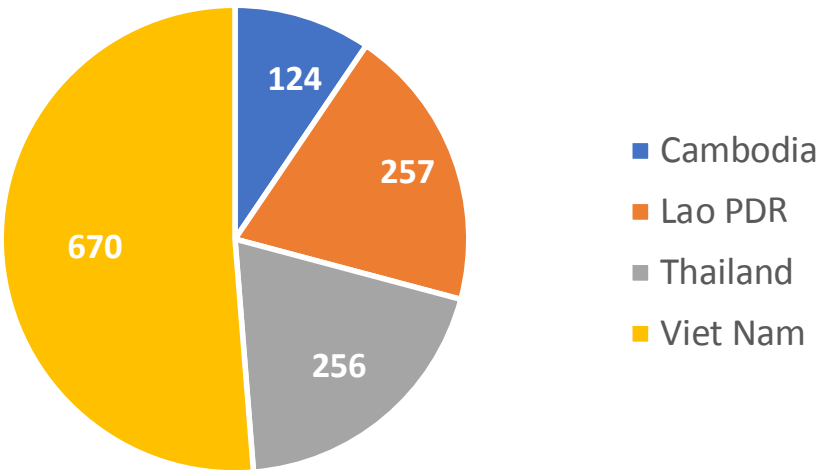
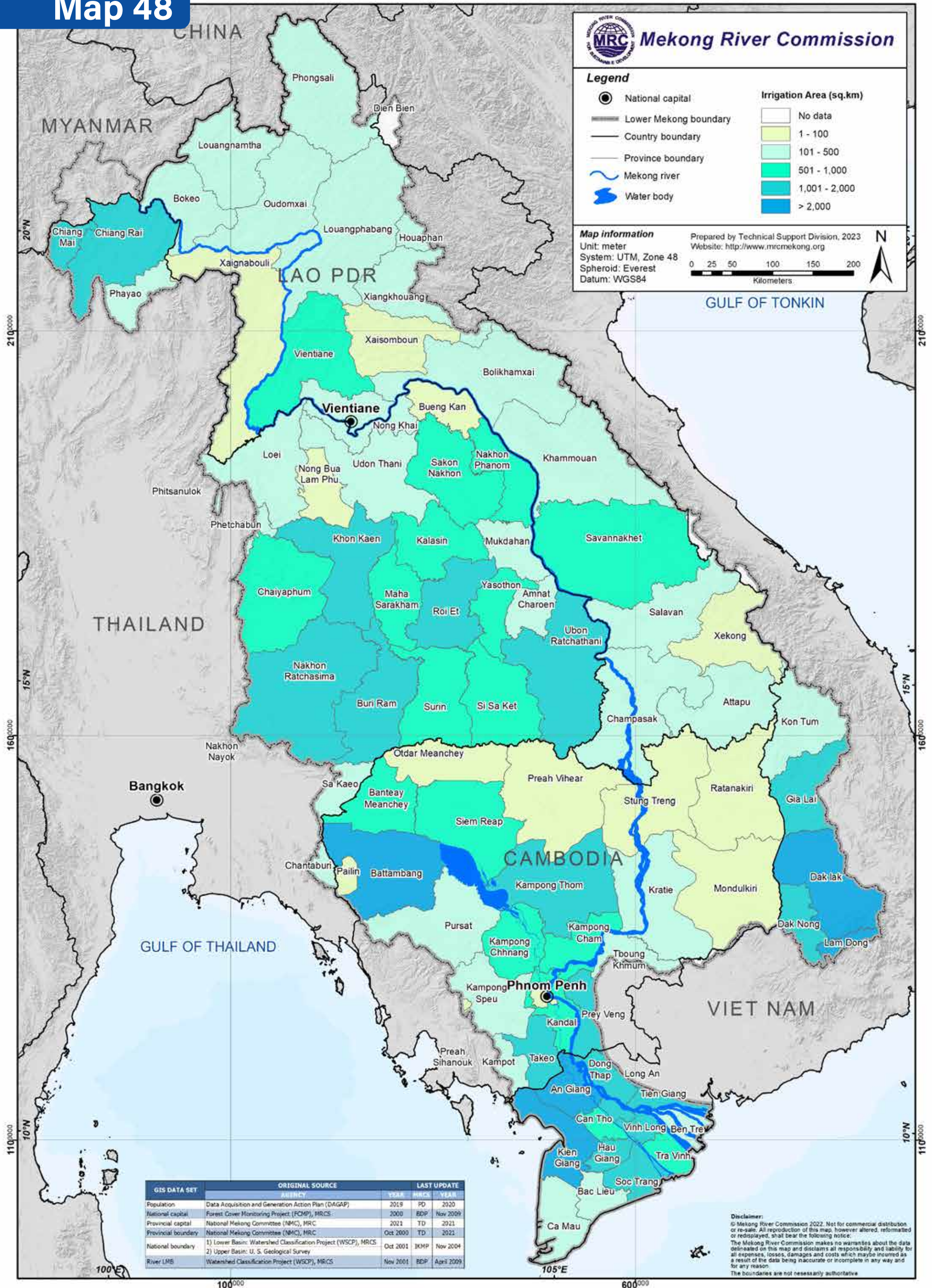


Figure 20. Number of irrigation reservoirs in the LMB

References and further reading

MRC. (2019). Technical report: Irrigation Database Improvement for the Lower Mekong River Basin.





Irrigation area

According to FAO, irrigated areas consist of areas equipped with hydraulic structures to provide water to crops. It includes areas equipped for full and partial control irrigation, spate irrigation areas, and equipped wetland or inland valley bottoms. It does not include non-equipped cultivated wetland and inland valley bottoms and recession cropping areas.

Sufficient data were available to allow an estimation of the LMB irrigation area of the LMB countries; Map 48 shows the irrigation area (km²) in each LMB country in 2020. In Cambodia, the total irrigated area was estimated through the following calculation: total irrigation area in ha*10,000 m²/1,000,000 m². In Lao PDR, irrigation area refers to areas of land covered by irrigation. In Thailand, irrigation area includes area under small, medium-sized and large electric water pumping projects, and under Monkey Cheek projects (under the Royal Development Project); in Viet Nam, irrigation area refers to cultivated area.

In 2020, Viet Nam had the largest irrigation area, at 27,167 km² (46% of the total LMB irrigation areas), while Thailand, Cambodia and Lao PDR had smaller irrigation areas, with 7,316 km² (29%), 10,630 km² (18%) and 4,263 km² (7%), respectively.

In Cambodia, some provinces had large irrigation areas, such as Battambang (2,090 km²), Takeo (1,646 km²), Kampong Thom (1,173 km²) and Prey Beng (1,046 km²), where other have very small irrigation areas, such as Koh Kong (8 km²), Ratanakiri (9 km²), Stung Treng (15 km²), Phnom Penh (16 km²) and Monduliri (18 km²).

In Lao PDR, some provinces had large irrigation areas, such as Savannakhet (793 km²) and Vientiane Province (569 km²), whereas others had smaller irrigation areas, especially Xaignabouli (17 km²), Xekong (72 km²) and Xaisomboun (76 km²).

In Thailand, some provinces had large irrigation areas such as Nakhon Ratchasima (1,988 km²), Chiang Mai (1,623 km²), Khon Kaen (1,250 km²) and Ubon Ratchathani (1,118 km²), whereas others had much smaller irrigation areas, such as Bueng Kan (20 km²) and Nong Bua Lam Phu (35 km²).

In Viet Nam, some provinces had large irrigation areas such as Dak Lak (3,451 km²), Kien Giang (2,540 km²) and Lam Dong (2,460 km²), whereas others have much smaller irrigation areas such as Ben Tre (324 km²) and Ca Mau (426 km²).

Table 39. Irrigation area within the LMB, 2020, by country

Country	Irrigation area (Sq.km)
Cambodia	10,630
Lao PDR	4,263
Thailand	17,316
Viet Nam	27,167
Total	59,376

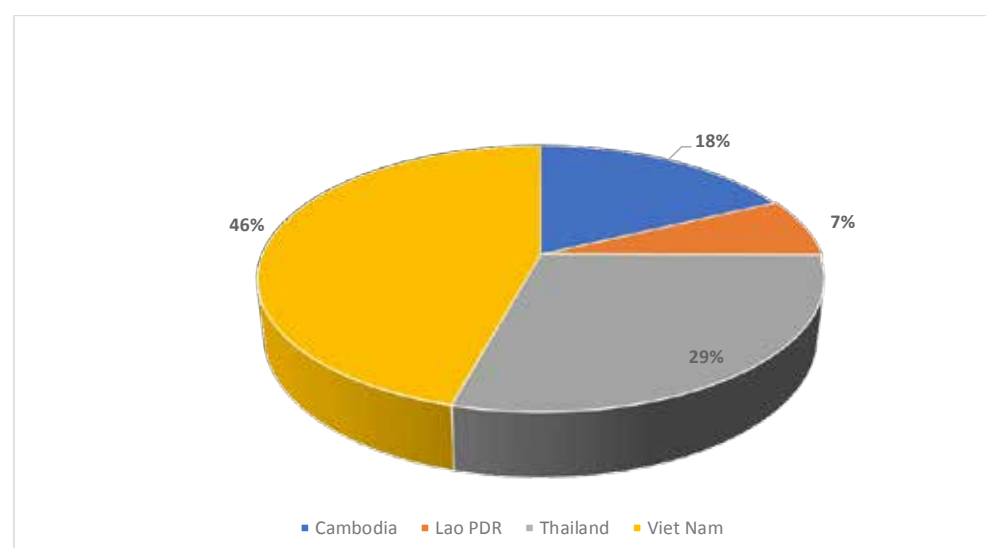
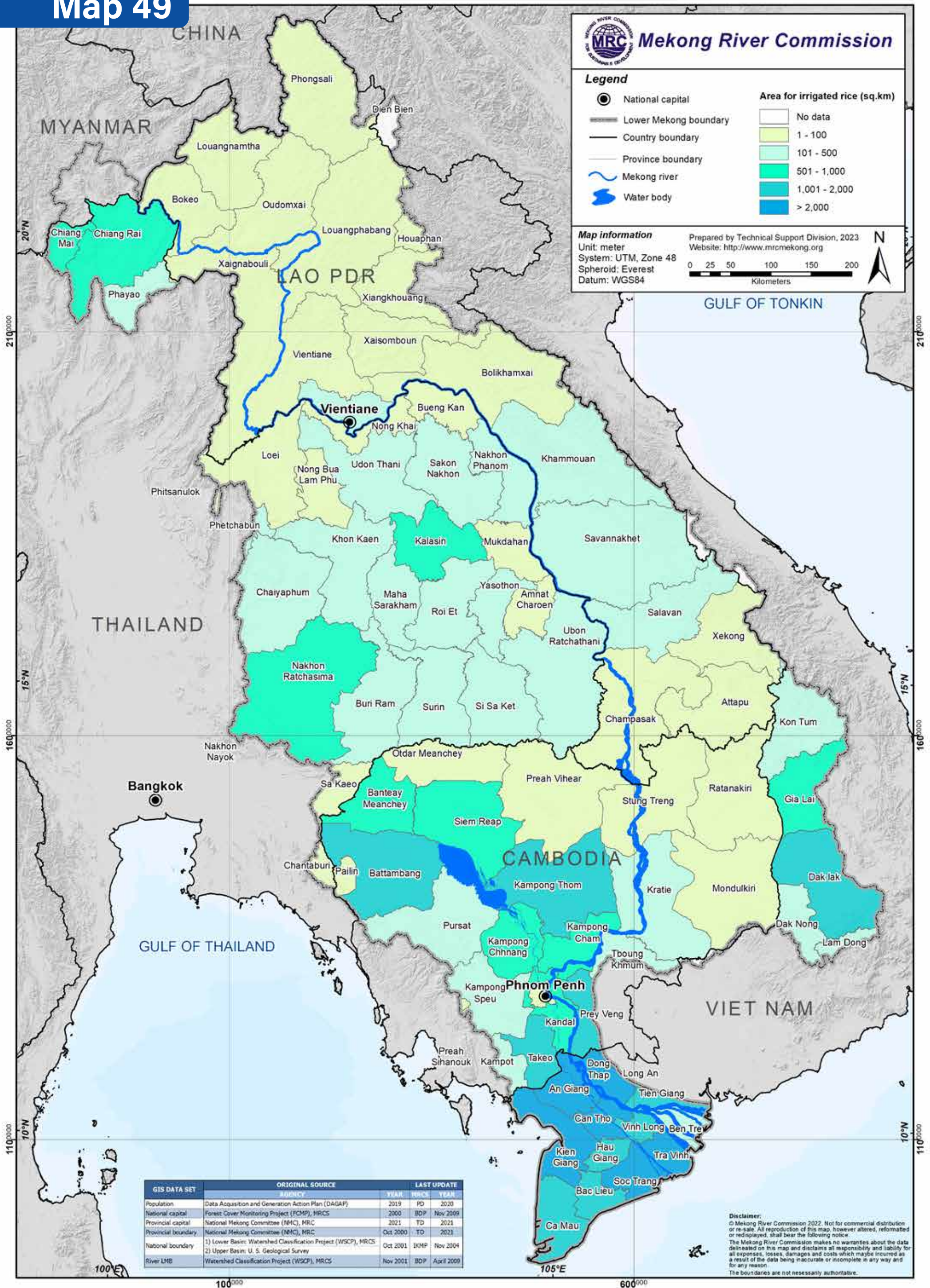


Figure 21. LMB share of irrigation area, 2020

Data source

Country	Source	Year	Data level	Agency
Cambodia	- Commune Database, 2006–2016 - Province profiles, 2017–2020	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Agricultural Statistics Yearbooks, 2010–2021	2020	Province	Ministry of Agriculture and Forestry
Thailand	Royal Irrigation Department	2020	Province	Royal Irrigation Department, Ministry of Agriculture and Cooperatives
Viet Nam	- Interpolated from internal documents of the General Statistics Office - Statistical Yearbook of the Provinces	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment





Irrigated rice crop area

Sufficient data were available to estimate the share of total irrigated rice crop area in the LMB provinces (the data disaggregated by maize and other crops were not available from the Member Countries). Map 49 shows the share of irrigated rice crop area in each LMB country and their respective LMB provinces according to 2020 data. In Cambodia, the total irrigated rice crop area is estimated using the equation: Total irrigated rice crop area in ha *10,000 m² /1,000,000 m². In Lao PDR and Thailand, total irrigated rice crop area refers to the total crop area for irrigated rice; in Viet Nam, this refers to planting areas.

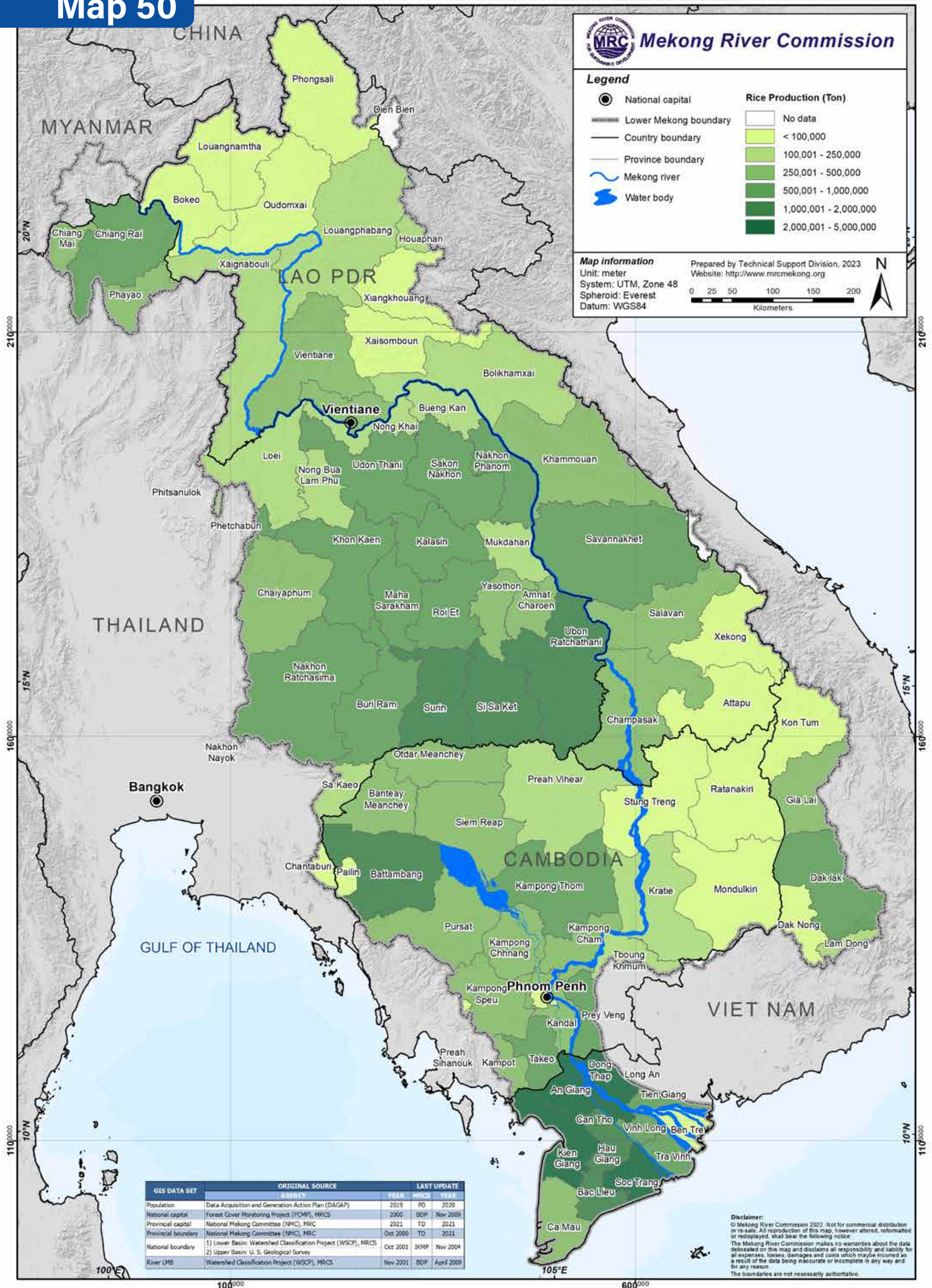
Based on Map 49, in 2020, the irrigated rice crop area in Viet Nam was significant share of LMB’s total rice production area, i.e. around 42,106 km² (70%) of the total irrigated rice crop area in the basin (around 60,662 km²). Kien Giang and Takeo provinces had the largest irrigated rice crop area, at 7,258 km² and 1,646 km², respectively, i.e. both around 17% of total irrigated rice crop area in the LMB provinces of Viet Nam. Cambodia and Thailand also had large irrigated rice crop areas, at 9,630 km² (16%) and 7,882 km² (13%), respectively, whereas Lao PDR had the smallest irrigated rice crop area, at only 1,044 km² (2%).

Table 40. LMB share of irrigated rice crop area (km²), 2020

Country	Area (sq.km)	Percentage
Cambodia	9,630	16%
Lao PDR	1,044	2%
Thailand	7,882	13%
Veit Nam	42,106	69%
Total	60,662	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Yearbooks, 2001, 2005, 2006 and 2011 ◆ Ministry of Agriculture, Forestry and Fisheries (MAFF) reports, 1985–2005 ◆ Commune Database, 2006–2016 ◆ Province profile reports, 2017–2020	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Statistics Yearbooks, 1975–2015 and 2016–2020 ◆ Agricultural Statistics Yearbooks, 2010–2020	2020	Province	◆ Ministry of Agriculture and Forestry
Thailand	◆ Office of Agricultural Economics, Ministry of Agriculture and Cooperatives	2020	Province	◆ Office of Agricultural Economics. Ministry of Agriculture and Cooperatives
Viet Nam	◆ Statistical Yearbook of Viet Nam	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment



Rice production

In Cambodia, quantity of rice produced refers to the volume of rice production in tonnes. In Lao PDR, this total rice production includes total paddy rice harvested from rice production in the dry season and the rainy season, and upland rice, as well as rice that is threshed but not processed. In Thailand, this refers to the sum of the amount of rice produced (both in- and off-season rice). In Viet Nam, this refers to unhusked rice. In the entire LMB, the standard definition for the quantity of rice produced is the amount of rice that can be harvested only for dry grain per tonne, which includes in- and off-season rice. The data year is the production year, which refers to the harvest period of crop production from January 1 to December 31 of the same year.

Map 50 shows the volume and proportion of the rice production by LMB province in each of the LMB countries in 2020. It also shows that the productivity of rice production in the LMB continues to provide a significant contribution to the basin economy. Rice production is one of significant contributions to the LMB countries’ water-related sectors and their economy. At the basin level, Viet Nam and Thailand have a significant share of LMB rice production, with around 25 million tonnes (50%) and 14 million tonnes (28%), respectively, of the total rice production in the basin (around 51 million tonnes).

As shown on the map, in 2020, Kien Giang province and Ubon Ratchathani province recorded the highest rice production, at 4.5 million tonnes and 1.4 million tonnes, respectively, i.e. around 18% and 10% of total rice production in the LMB provinces of Viet Nam and Thailand, respectively. The map also shows that Battambang province had the highest rice production in Cambodia, at 1.4 million tonnes, i.e. 18% of total rice production of 7.9 million tonnes in Cambodia. Lao PDR had the lowest rice production in the basin, with a total of 3.5 million tonnes, including Savannakhet province, which had the highest share (23%) of total rice production in the country.

Table 41. LMB share of rice production (tonnes), 2020

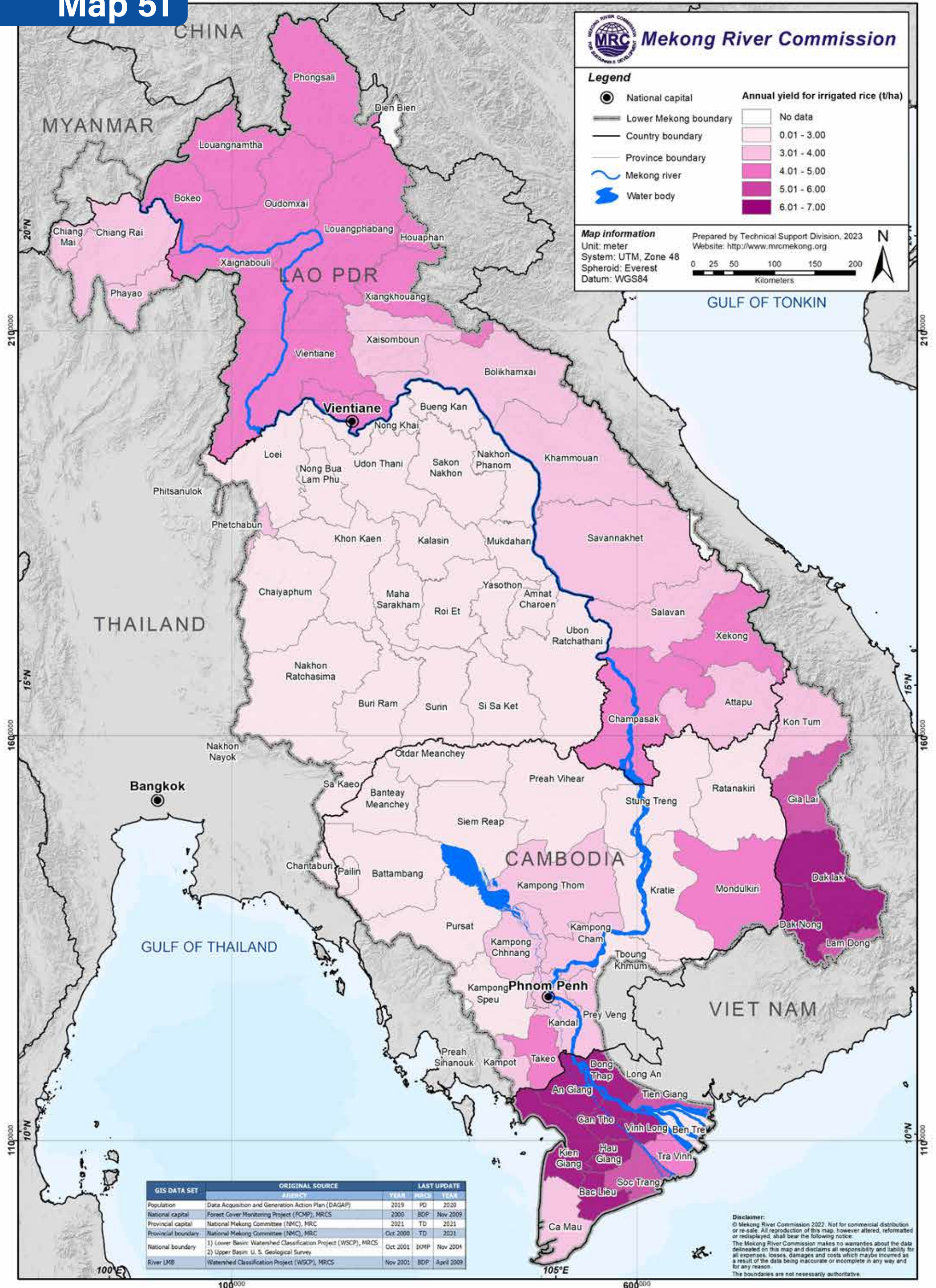
Country	Rice production (tons)	Percentage
Cambodia	7,902,829	16%
Lao PDR	3,487,312	7%
Thailand	14,351,020	28%
Veit Nam	25,241,300	50%
Total	50,982,461	100%

Data source

Country	Source	Year	Data level	Agency
Cambodia	● Statistical Yearbooks, 1998–2005 ● Commune Database, 2006–2016 ● Province profiles, 2017–2020	2020	Province	● National Institute of Statistics, Ministry of Planning
Lao PDR	● Statistics Yearbooks, 1975–2015 and Statistics Yearbooks, 2016–2020 ● Agricultural Statistics Yearbook, 2010–2021	2020	Province	● Lao Statistics Bureau, Ministry of Planning and Investment ● Ministry of Agriculture and Forestry
Thailand	● Office of Agricultural Economics, Ministry of Agriculture and Cooperatives	2020	Province	● Office of Agricultural Economics. Ministry of Agriculture and Cooperatives
Viet Nam	● Statistical Yearbook of Viet Nam	2020	Province	● General Statistics Office of Viet Nam, Ministry of Planning and Investment

Annual irrigated rice yield

Map 51



Annual irrigated rice yield

Sufficient data were available to estimate the share of the LMB provinces’ annual irrigated rice yield (tonne/ha). In Cambodia, annual irrigated rice yield is estimated by the formula: Total annual yield in tonnes (t) of irrigated rice)/total area in ha of irrigated rice. In Lao PDR, the annual yield of each irrigated crop refers to the yield of crop in the dry season per ha (the data cover rice only). In Thailand, it is defined as total irrigated rice crop area (km²).

Map 51 shows that Viet Nam had the largest annual irrigated rice yield of the total LMB production of 306 t/h, at 99.88 t/h (33%), followed by Lao PDR, Thailand and Cambodia, with a production of 75.29 t/h (25%), 68.82 t/h (22%) and 62 t/h (20%), respectively. In Cambodia, Mondulkiri and Takeo provinces recorded the highest yield, at around 4–5 t/h. In Lao PDR, the yields were not significantly different across the provinces, at 3–5 t/h. In Thailand, Sa Kaeo province recorded the lowest production, at 1.94 t/h, while other provinces, especially Chiang Mai, Phayao, Chiang Rai and Phetchabun, recorded higher yields, at 3–4 t/h. In Viet Nam, Ben Tre province had the lowest yield, at 2.69 t/h, while many other provinces had higher yields, at 6–7 t/h, such as Dak Lak, Dak Nong, Vinh Long, Dong Thap, An Giang, Kien Giang, Can Tho city, Hau Giang and Bac Lieu.

Table 42. Proportion of annual yield of irrigated rice in the LMB, 2020

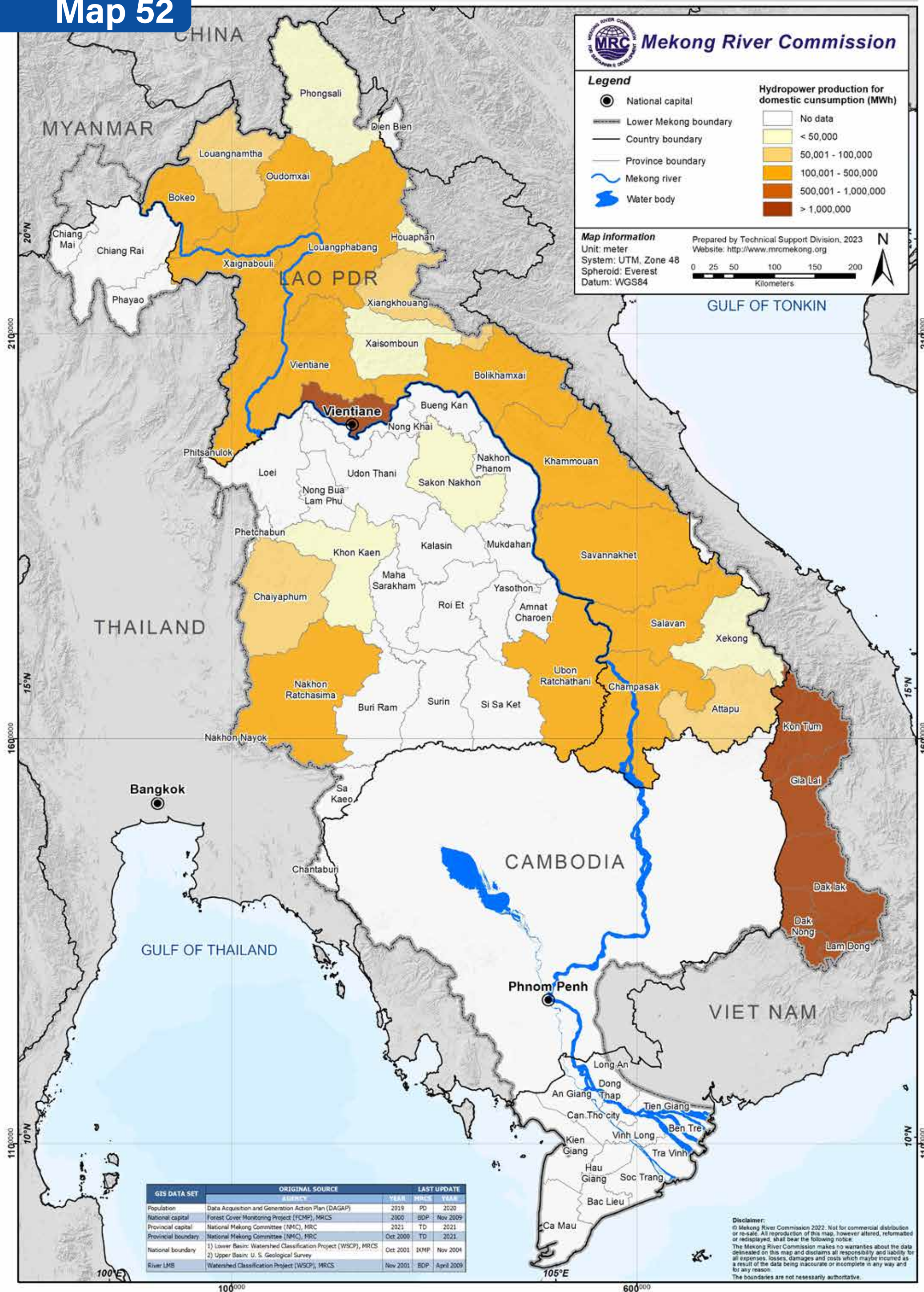
Country	Total annual yield for irrigated rice	Percentage in the LMB (%)
Cambodia	62.01	20
Lao PDR	75.29	25
Thailand	68.82	22
Viet Nam	99.88	33
Total LMB	306	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Commune Database, 2006–2020 ◆ Province Profiles, 2017–2020	2020	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Statistics Yearbooks ◆ Agricultural Statistics Yearbook, 2020	2020	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Office of Agricultural Economics, Ministry of Agriculture and Cooperatives	2020	Province	◆ Office of Agricultural Economics. Ministry of Agriculture and Cooperatives
Viet Nam	◆ Statistical Yearbook of Viet Nam ◆ National Statistics Yearbook, 2020	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment

Hydropower production for domestic consumption

Map 52



Hydropower production for domestic consumption

Map 52 shows total hydropower production by province in the LMB countries in 2020. In Lao PDR, total hydropower production refers to quantity of electricity distribution. In Thailand, this refers to original unit from the Electricity Generation Authority of Thailand. (EGAT) in KWh (MWh = KWh/1,000). Sufficient data were available to estimate the share of LMB province hydropower production for domestic consumption (MWh).

In 2020, in the LMB countries, with the exception of Cambodia, the HPPs produced a total of around 20.4 million MWh of hydropower, of which Viet Nam had the highest share, at around 15.4 million MWh (76%), followed by Lao PDR, at around 4.2 million MWh (21%) and Thailand, at 666,134 MWh (3%).

In 2020, all 18 provinces of Lao PDR produced hydropower for domestic consumption, for a total of around 4.2 million MWh. Vientiane Capital had the highest production, at around 1.7 million MWh (40% of total production), whereas Xaysomboon province had the lowest, at only 24,876 MWh in 2020. Note that data on the hydropower production for export were not available; therefore, data on hydropower production in this map refer to hydropower production for domestic consumption.

In 2020, the HPPs in five LMB provinces of Thailand produced a total of at around 666,134 MWh for domestic consumption. Nakhon Ratchasima province had the highest production, at 457,128 MWh, while Khon Kaen had the lowest, at only 2,562 MWh. It should be noted that in Thailand, there is no hydropower production for export in the LMB provinces; therefore, the data on hydropower production in this map refer to the total hydropower production in the LMB provinces.

In 2020, the HPPs in five LMB provinces of Viet Nam produced a total of 15,480,384 MWh for domestic consumption. Gia Lai province had the highest production, at around 5 million MWh, while Dak Lak had the lowest, at around 1.9 million MWh. Note that in Viet Nam, there was no hydropower production for export in the LMB provinces; therefore, the data on the hydropower production in this map refer to the total hydropower production in the LMB provinces.

Table 43. LMB share of total hydropower production (MWh), 2020

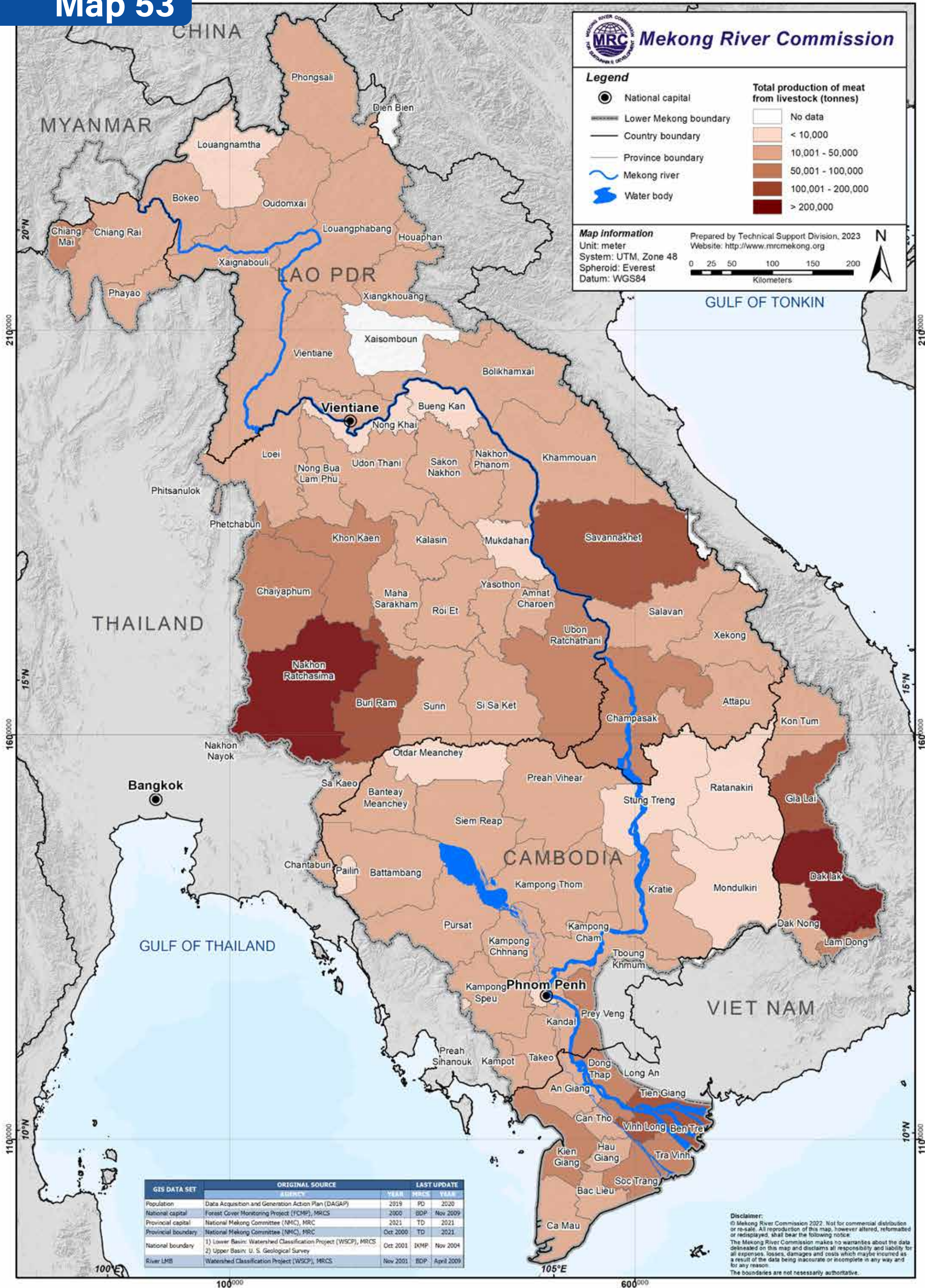
Total hydropower production in the LMB	MWh	Percentage (%)
Cambodia	0	0
Lao PDR	4,299,445	21
Thailand	666,134	3
Viet Nam	15,480,384	76
Total	20,445,963	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	Not available			
Lao PDR	Ministry of Energy and Mine	2020	Province	Ministry of Energy and Mine
Thailand	Electricity Generating Authority of Thailand	2020	Province	Province Electricity Generating Authority of Thailand
Viet Nam	General Statistics Office Institute of Energy	2020	Province	General Statistics Office Institute of Energy

Meat production from livestock

Map 53



Meat production from livestock

Sufficient data were available to estimate the share of LMB provinces' meat production from livestock, which is one of the most important contributions to the LMB countries' economies. Map 53 shows the quantity (tonnes) and proportion (%) of meat production by LMB province in each LMB country and in the basin as a whole based on 2020 data. In Cambodia, the data are expressed in tonnes. Meat production from livestock is estimated by converting head count to meat production by using the MRC Council Study (cow is calculated at 121.062 kg/head, buffalo at 121.062 kg/head, pig at 50 kg/head, chicken at 1.1 kg/head, duck at 1.1 kg/head and goats or sheep at 11 kg/head). In Lao PDR, total production of meat is estimated from the meat from cows, buffaloes, pigs and poultry. In Viet Nam, total production of meat refers to the living weight of buffaloes + the living weight of cattle + the living weight of pigs + the slaughtered poultry.

In 2020, Thailand and Viet Nam had the most significant share of LMB meat production, at around 1.2–1.3 million tonnes (35–38%) of the total meat production in the basin (around 3.5 million tonnes). In Cambodia and Lao PDR, meat production from livestock was 413,603 tonnes (12%) and 524,987 tonnes (15%) of the total meat production in the basin, respectively.

In 2020, in Cambodia, Prey Veng province had the highest meat production from livestock (50,771 tonnes, or 12% of the total production in its LMB provinces, at 413,603 tonnes). Many provinces had a high meat production from livestock such as Kampong Speu (38,828 tonnes), Siem Reap (31,885 tonnes) and Tboung Khmum (31,314 tonnes). Some provinces had a low meat production from livestock such as Pailin (1,503 tonnes) and Phnom Penh (1,988 tonnes).

In 2020, in Lao PDR, Savannakhet had the highest meat production from livestock, at 105,894 tonnes, i.e. around 20% of total production (524,987 tonnes). Champasak province also had a high production, at 61,660 tonnes (12% of total production), whereas other provinces such as Luangnamtha (9,550 tonnes), Xekong (11,256 tonnes) and Bokeo (14,127 tonnes) had a low production.

In 2020, out of the LMB provinces in Thailand, Nakhon Ratchasima province had the highest meat production from livestock, at 303,150 tonnes, or around 25% of total production (1.2 million tonnes). Buri Ram province also had a high meat production from livestock, at 122,499 tonnes (10% of total production), followed by Phetchabun (97,130 tonnes), Chaiyaphum (93,495 tonnes), Chiang Mai (67,183 tonnes), Khon Kaen (60,556) and Ubon Ratchathani (60,026 tonnes). Some provinces had low production such as Mukdahah (7,574 tonnes), Bueng Kan (8,014 tonnes) and Nong Khai (9,559 tonnes).

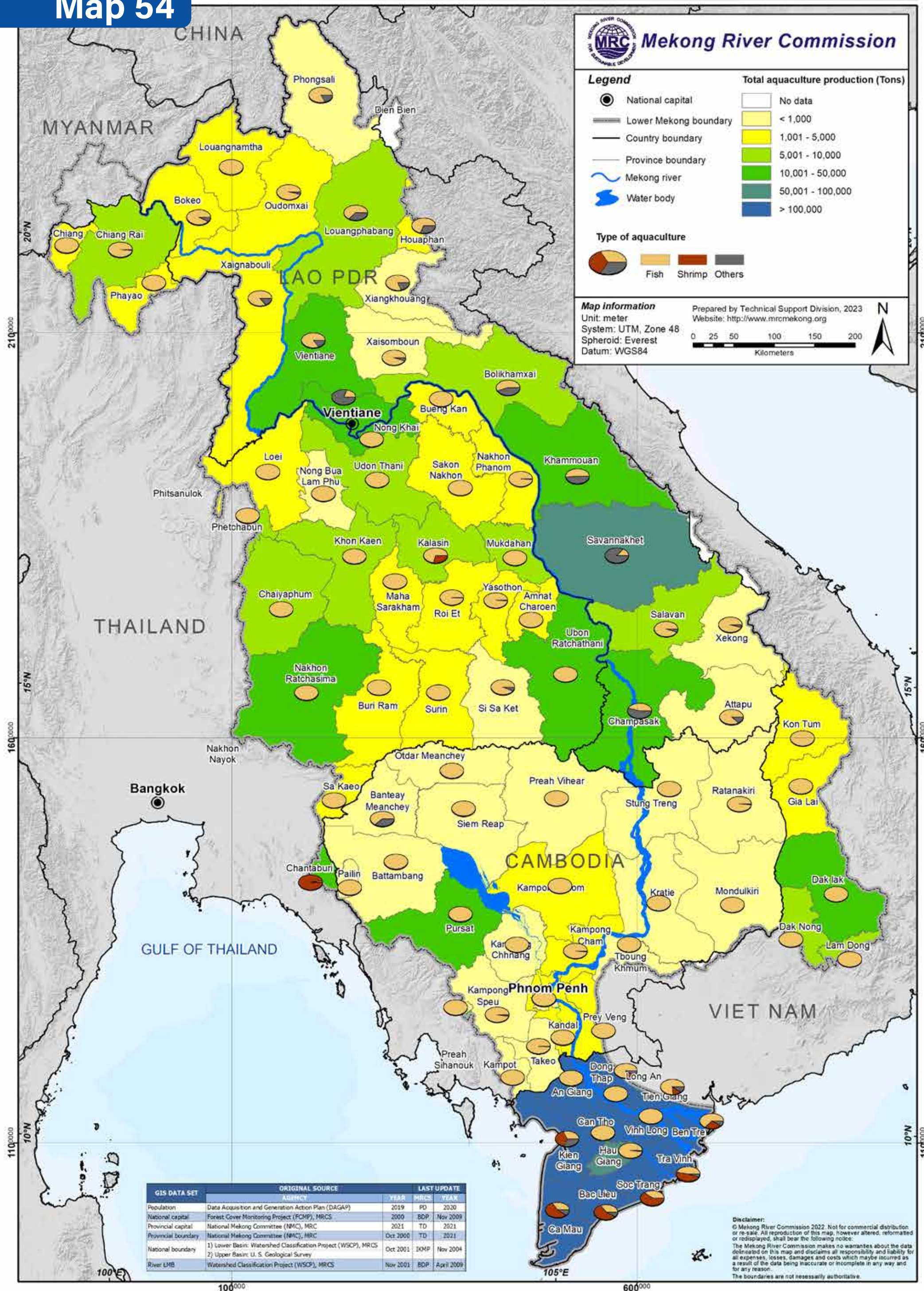
In 2020, in Viet Nam, Dak Lak province had the highest meat production from livestock of 224,516 tonnes, at around 17% of total meat production from livestock in the LMB provinces of Viet Nam (1.35 million tonnes). Some provinces recorded a high production such as Tieng Giang (164,046 tonnes), Ben Tre (148,600 tonnes), Vinh Long (121,483 tonnes) and Gia Lai (103,350 tonnes), whereas others recorded low production such as An Giang (24,627 tonnes), Can Tho city (25,145 tonnes), Ca Mau (28,038 tonnes) and Bac Lieu (29,706 tonnes).

Table 44. LMB share of meat production from livestock (tonnes), 2020

Country	Total meat production from livestock (tonnes)	Percentage in the LMB
Cambodia	413,603	12%
Lao PDR	524,987	15%
Thailand	1,231,818	35%
Viet Nam	1,352,939	38%
Total LMB	3,523,346	100%

Data source

Country	Source	Year	Data level	Agency
Cambodia	- Commune Database, 2000–2020 - Province profiles, 2017–2020	2020	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Ministry of Foreign Affairs of Lao PDR	2020	Province	Ministry of Foreign Affairs of Lao PDR
Thailand	Department of Livestock Development	2020	Province	Department of Livestock Development, Ministry of Agriculture and Cooperatives
Viet Nam	Statistical Yearbook of the Provinces	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment



Aquaculture production

Sufficient data were available to estimate the share of LMB aquaculture production which is one of significant contributions to the LMB countries' water-related sectors and their economy. The quantity of aquaculture produced means the total amount of fish, shrimps and OAA that can be harvested. The map shows the proportion of the aquaculture production by LMB province in each LMB country and in the entire Basin in 2020. The productivity of aquaculture production, particularly fish production in the LMB, continues to contribute significantly to the basin economy. In Lao PDR, total production from aquaculture covers fish and OAA production (without shrimp production). In Cambodia, Thailand and Viet Nam, the total production from aquaculture includes fish, shrimp and OAA production.

In 2020, Viet Nam significantly contributed to the aquaculture production of the entire LMB (around 3.7 million tonnes), i.e. around 3.3 million tonnes (90%). This included the most significant share of fish production, at around 2.3 million tonnes (91%) of the total fish production in the Basin (around 2.5 million tonnes). In contrast, Cambodia, Lao PDR and Thailand contributed less to aquaculture production, i.e. only 1%, 5% and 4%, respectively.

In 2020, in Cambodia, the total aquaculture production including fish production was very small compared with the other LMB countries, at 41,397 tonnes. The fish production was the major contributor to aquaculture production, at nearly 100% of total aquaculture production (41,241 tonnes fish production). Pursat and Preah Sihanouk provinces had the highest aquaculture production, at 14,915 tonnes and 13,725 tonnes, respectively (33–36% of total production), whereas other provinces had very low production, such as Pailin (10 tonnes), Monduliri (11 tonnes) and Ratanakiri and Stung Treng (19 tonnes).

In 2020, in Lao PDR, the total aquaculture production including fish production was small compared with the other LMB countries, at 200,024 tonnes. Yet, fish production (70,002 tonnes, or 35%) continues to contribute significantly to the total aquaculture production (200,024 tonnes), OAA production (130,022 tonnes, or 65%). Savannakhet province had the highest aquaculture production, at 95,133 tonnes, including fish production of 13,082 tonnes and OAA production of 82,051 tonnes. Vientiane Capital also recorded a high aquaculture production of 29,536 tonnes, including 23,698 tonnes from OAA production and only 5,838 tonnes of fish production. Some provinces recorded a low aquaculture production, such as Phongsali (274 tonnes), Attapu (371 tonnes) and Xekong (464 tonnes).

In 2020, in Thailand, fish and shrimp production contributed significantly to the total aquaculture production of the entire LMB (151,048 tonnes), at 121,744 tonnes (81%) and 29,027 tonnes (19%), respectively. Chantaburi province had the highest aquaculture production, at 26,986 tonnes and the highest shrimp production, at 26,447 tonnes (this number is very high because it includes brackish fish and marine shrimp production of the entire Chantaburi province, but some are produced outside the LMB area of Chantaburi province). Ubon Ratchathani province had the highest fish production, at 14,867 tonnes.

In 2020, in the LMB provinces of Viet Nam, fish and shrimp production contributed significantly to the total aquaculture production of the entire LMB (3.3 million tonnes), at 2.3 million tonnes (70%) and 789,748 tonnes (24%), respectively. Dong Thap and An Giang provinces recorded the highest fish production (547,116 tonnes and 496,006 tonnes), i.e. around 15–16%. Ca Mau, Soc Trang and Bac Lieu provinces significantly contributed to shrimp production (147,000–195,000 tonnes), i.e. around 19–25% of total shrimp production (789,748 tonnes).

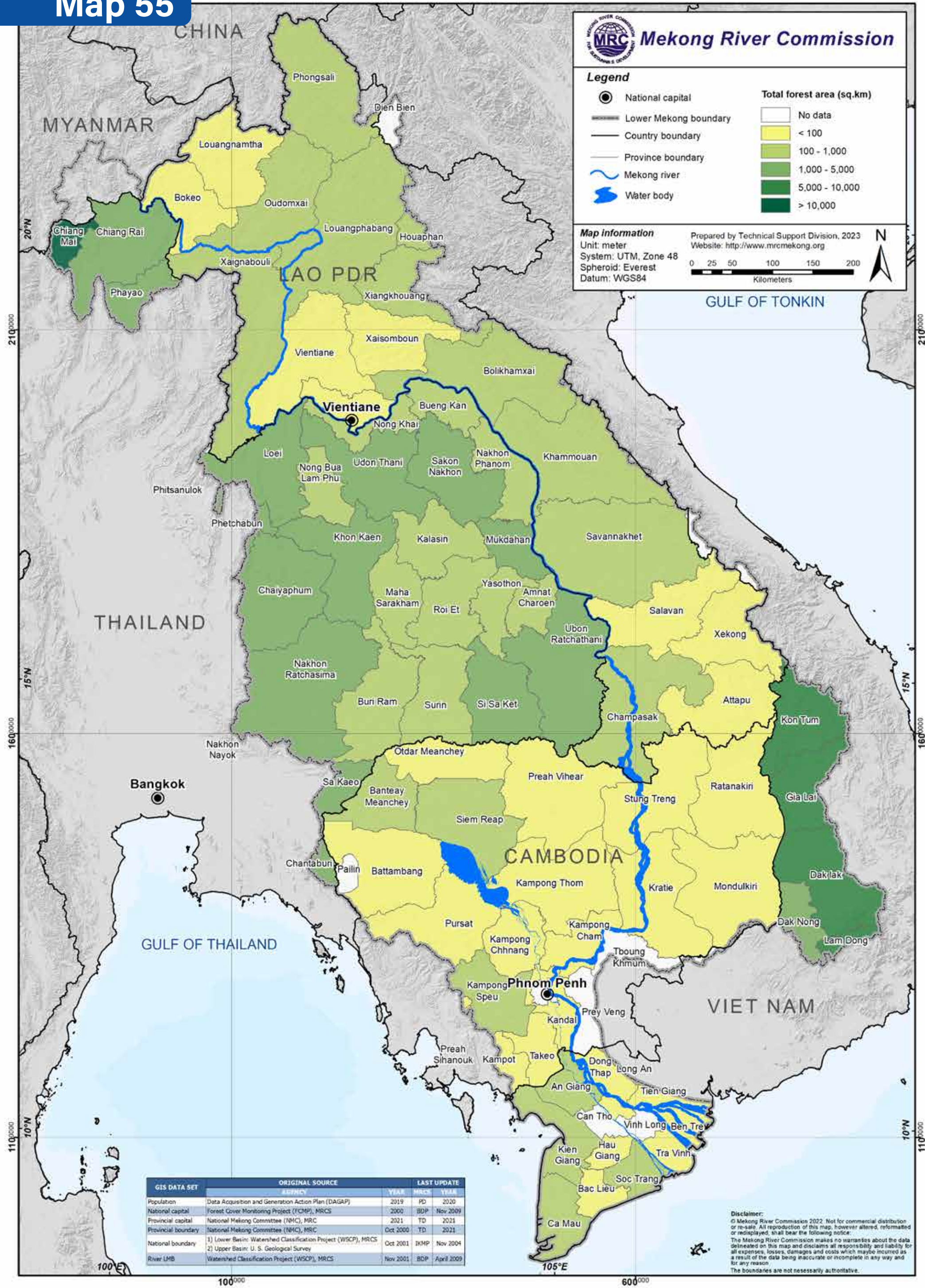
Table 45. LMB share of fish and of aquaculture production (tonnes), 2020

Country	Total fish production (tonnes)	Percentage of fish production in the LMB (%)	Total aquaculture production (tons)	Percentage of aquaculture production in the LMB (%)
Cambodia	41,241	2	41,397	1
Lao PDR	70,002	3	200,024	5
Thailand	121,744	5	151,048	4
Viet Nam	2,355,945	91	3,358,855	90
Total	2,588,932	100	3,751,324	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	- Yearbooks, 2001, 2005 and 2006 - Ministry of Agriculture, Forestry and Fisheries reports, 1990–2000 - Commune Database, 2006–2016 - Province profile reports, 2017–2020	2020	Province	- National Institute of Statistics, Ministry of Planning - Ministry of Agriculture, Forestry and Fisheries
Lao PDR	Statistics Yearbooks, 1975–2015, and Statistics Yearbooks, 2016–2020	2020	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Department of Fisheries, Ministry of Agriculture and Cooperatives	2020	Province	Department of Fisheries, Ministry of Agriculture and Cooperatives
Viet Nam	Statistical Yearbook of Viet Nam	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment





Forestry area

Sufficient data is available to allow estimation of the share of forestry areas in LMB boundary in different years 2005, 2018, 2019 and 2020. The map shows the area in Sq.km and proportion (%) of the forestry area in LMB boundary in each LMB countries (Cambodia, Lao PDR, Thailand and Viet Nam) at provincial level. In Cambodia, the forest area is defined as forestry land remaining from forestry land grasp after withdrawal forestry land and handover. In Lao PDR, total area of forestry is estimated land with various tree species growing naturally or planted in an area of at least zero point five (0.5) hectares and a crown cover of at least 20 percent. In Thailand, original data unit of forest land is in Rai and convert to Sq Km.

At the basin level, Thailand has the significant share of LMB forestry area with 56,032 sq.km (64%) in 2018, followed by Viet Nam with 28,624 Sq.km (33%) in 2020 of the total forestry area in the basin (87,679 Sq.km). Cambodia and Lao PDR have forestry area of 1,082 Sq.km (2%) in 2005 and 1,942 Sq.km (1%) in 2019 respectively.

In Cambodia, the total forestry area in LMB provinces is 1,082 Sq.km in 2005 where Banteay Meanchey province has the largest forestry area of 251 Sq.km (23 %) of the total forestry area in LMB provinces in Cambodia. Some provinces have larger forestry areas such as Kampong Speu and Siem Reap with forestry areas of 130 and 199 sq.km, whereas some provinces such as Kandal, Prey Veng and Pursat have very small forestry areas of less than 3 sq.km. There is no data on forestry areas in 2020 for some provinces including Phnom Penh, Pailin and Tboung Khmum.

In Lao PDR, the total forestry area is 1,942 Sq.km where Luangprabang province has the largest forestry area of 182 Sq.km (9%) of the total forestry area in 2019. Some provinces have larger forestry areas such as Borikhamxay, Champasak, Huaphanh, Khammuane, Oudomxai, Phongsali, Savannakhet, Xaignabouli and Xiengkhuang provinces of forestry areas larger than 100 sq.km. Vientiane capital has the smallest forestry area of 17 Sq.km and other provinces have less than 100 sq.km forestry area in 2019.

In Thailand, the total forestry area is 56,032 Sq.km where Chiang Mai province has the largest forestry area of 15,458 Sq.km (28%) of the total forestry area in LMB provinces in 2018. Some provinces have larger forestry areas such as Chantaburi, Nakhon Ratchasima, Ubon Ratchathani, Chaiyaphum, Loei, Phayao, Chiang Rai and Phetchabun provinces of forestry areas larger than 2,000 sq.km. Nong Khai, Maha Sarakham and Bueng Kan provinces have the smallest forestry area less than 300 Sq.km in 2018.

In Viet Nam, Gia Lai and Kon Tum provinces have the largest forestry area of 6,333 Sq.km and 6,210 sq.km respectively which is approx. 22% of the total forestry area of 28,624 Sq.km in LMB provinces in Viet Nam in 2020. Some provinces have quite large forestry areas such as Dak Lak (5,179 sq.km), Dak Nong (2,511 sq.km) and Lam Dong (5,887 sq.km). Some provinces have quite small forestry area of less than 100 sq.km such as Tien Giang (26 sq.km), Hau Giang (36 sq.km), Ben Tre (44 sq.km), Bac Lieu (48 sq.km), Dong Thap (62 sq.km) and Tra Vinh (92 sq.km). It is interesting to note that Vinh Long and Can Tho city do not have forestry areas.

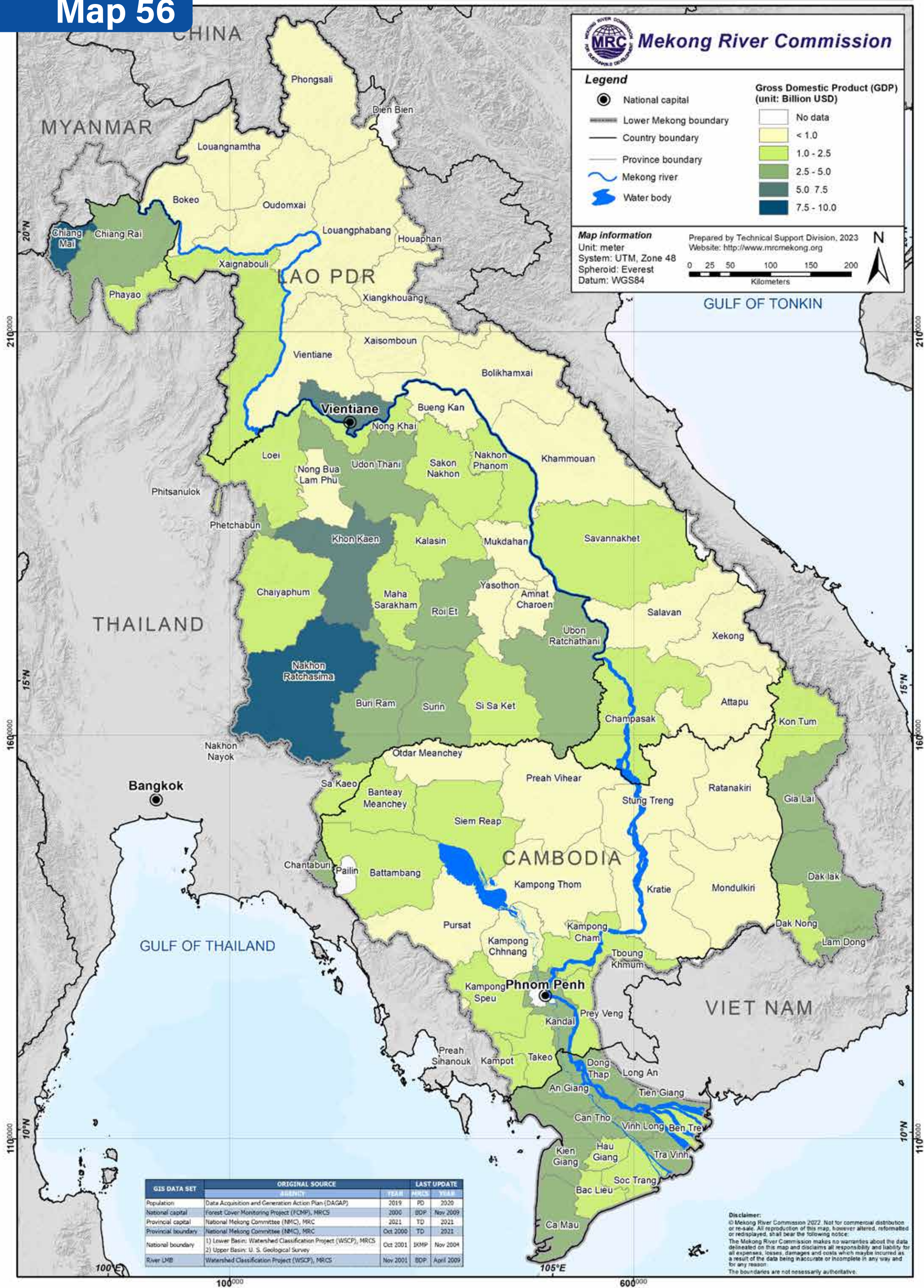
Table 46. LMB share of total forestry area, based on 2005, 2018, 2019 and 2020 data

Country	Total forestry area	Percentage in the LMB %
Cambodia (2005)	1,082	1
Lao PDR (2019)	1,942	2
Thailand (2018)	56,032	64
Viet Nam (2020)	28,624	33
Total LMB	87,679	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ Yearbook 2005 ◆ Ministry of Agriculture, Forestry and Fisheries report, 2005	2005	Province	◆ National Institute of Statistics, Ministry of Planning ◆ Ministry of Agriculture, Forestry and Fisheries
Lao PDR	◆ Ministry of Agriculture and Forest	2019	Province	◆ Ministry of Agriculture and Forest
Thailand	◆ Office of the Forest Land Management, Royal Forest Department	2018	Province	◆ Office of the Forest Land Management, Royal Forest Department
Viet Nam	◆ Statistical Yearbook of the Provinces ◆ Statistical Yearbook of Viet Nam	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment





Gross domestic product

Sufficient data were available to estimate the share of the LMB provinces' gross domestic product (GDP). Map 56 shows the value and proportion of GDP by LMB province in 2019/2020. In Cambodia, GDP is the sum of the total value added of GDP. In Lao PDR, GDP refers to the total value of final goods and services produced within the country in a year. In Thailand, GDP refers to GDP at current market prices: Calculation: GDP = Consumption + Investment + Government + (Export - Import). According to ILO, GDP is the main measure of a country's national economic output. It is the total value of all final goods and services produced in a particular economy. According to OECD, GDP at market prices can be measured in three different ways: (i) as output less intermediate consumption (i.e. value added) plus taxes on products (e.g. VAT) less subsidies on products; (ii) as the income earned from production, equal to the sum of employee compensation, the gross operating surplus of enterprises and government, the gross mixed income of unincorporated enterprises, and net taxes on production and imports (VAT, payroll tax, import duties, etc., less subsidies); and (iii) as the expenditure on final good and services minus imports – final consumption expenditures, gross capital formation and exports less imports.

Based on 2019 and 2020 data, the total GDP in the entire LMB was around USD 164.7 billion, of which USD 71.3 billion (43%) from Thailand, 55.1 billion (34%) from Viet Nam, 22.2 billion (14%) from Cambodia and 15.9 billion (10%) from Lao PDR.

In 2019, in Cambodia, the total GDP in the LMB provinces amounted to USD 22.2 billion, of which 2.5 billion (12%) from Kandal and 2.1 billion (10%) from Battambang. Some LMB provinces contributed little to the total LMB GDP, such as Koh Kong, Kratie, Monduliri, Preach Vihear, Ratanakiri, Stung Treng and Otdar Meanchey, which had around USD 0.2–0.5 billion (1–2%).

In 2020, in Lao PDR, the total national GDP was USD 15.9 billion. At the provincial level, Vientiane Capital had the highest GDP, at USD 5.8 billion, followed by Champasak and Savannakhet, both at around USD 2.2 billion, and Xaignabouli, at USD 1.1 billion. Other provinces contributed little to the total GDP in Lao PDR, such as Xaisomboun (USD 0.12 billion), Phongsali (USD 0.18 billion), Xekong (0.19 billion) and Xiengkhuang (USD 0.27 billion).

In 2020, in Thailand, the total GDP amounted to USD 71.3 billion, of which USD 9.4 billion (13%) from Nakhon Ratchasima, USD 7.6 billion (11%) from Chiang Mai and USD 6.7 billion (9%) from Khon Kean province. Other LMB provinces contributed little to the total LMB GDP, such as Yasothon, Amnat Charoen, Nong Bua Lam Phu, Mukdahan and Bueng Kan, at around USD 0.6–0.9 billion (1%).

In Viet Nam, the total GDP of its LMB provinces amounted to around USD 55.1 billion, of which USD 5.6 billion (10%) from Long An and USD 4.2 billion from Kien Giang (8%) provinces. Other provinces contributed very little, such as Kon Tum, Dak Nong and Hau Giang at USD 1–1.6 billion (2–3%).

Table 47. LMB share of GDP, 2019/2020

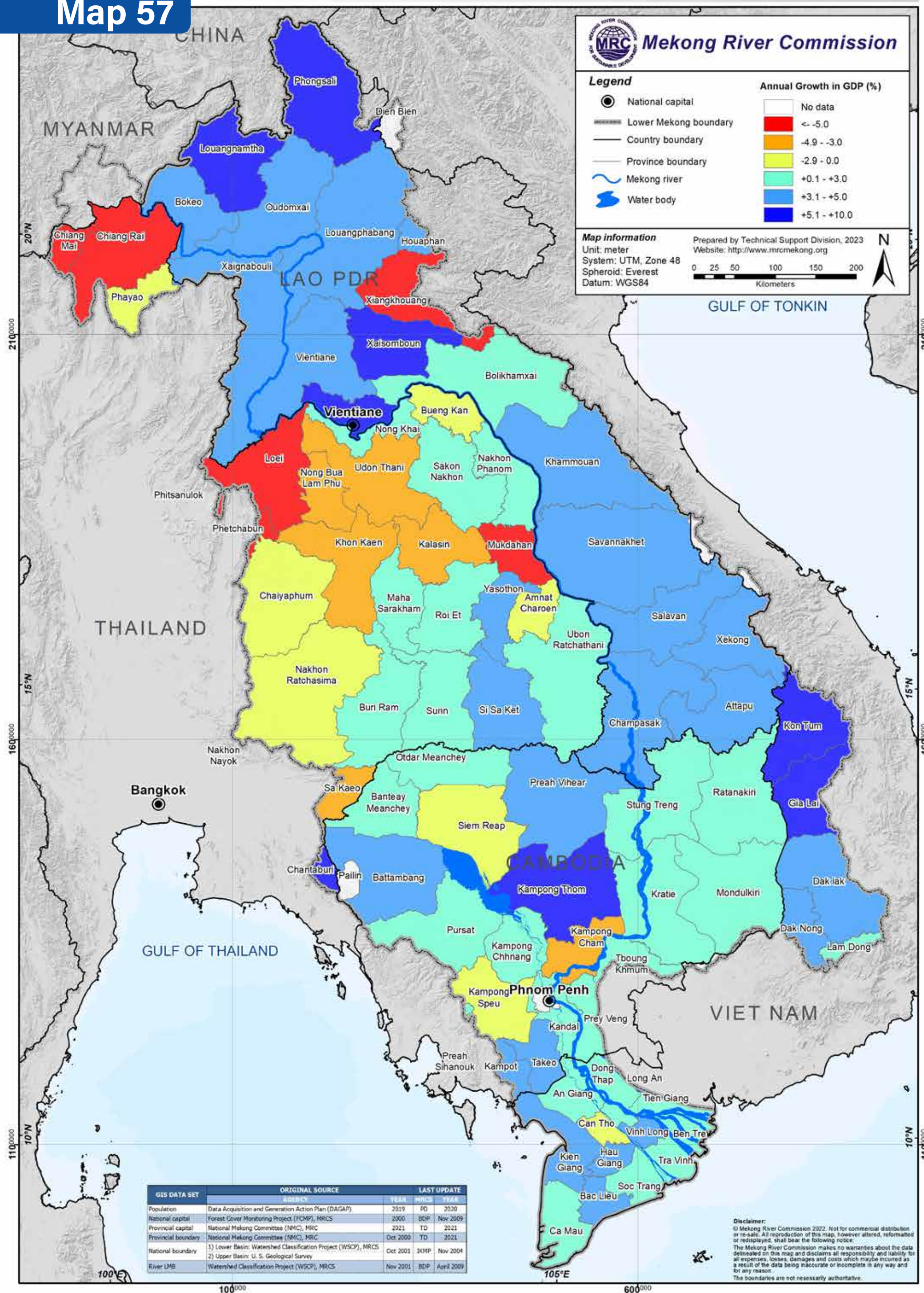
Country	Total GDP (USD)	Percentage of GDP in the LMB (%)
Cambodia (2019)	22,255,205,271	14
Lao PDR	15,914,437,819	10
Thailand	71,357,639,707	43
Viet Nam	55,190,343,840	33
Total LMB	164,717,626,637	100

Data source

Country	Source	Year	Data level	Agency
Cambodia	◆ National Accounts, 1993–2020	2019	Province	◆ National Institute of Statistics, Ministry of Planning
Lao PDR	◆ Statistics Sector Provincial Department of Planning and Investment	2020	Province	◆ Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	◆ Office of the National Economic and Social Development Council, Office of the Prime Minister	2020	Province	◆ Office of the National Economic and Social Development Council, Office of the Prime Minister
Viet Nam	◆ Calculation from internal documents of the General Statistics Office ◆ Provincial Statistics Yearbooks ◆ National Statistics Yearbooks	2020	Province	◆ General Statistics Office of Viet Nam, Ministry of Planning and Investment

Annual GDP growth rates

Map 57



Annual GDP growth rates

According to OECD (n.d.), GDP growth refers to the changes in the volume of GDP (often referred to as 'real' GDP,) i.e. real reflects the fact that changes in GDP due to inflation are removed. Converting nominal values of GDP to real values requires a set of detailed price indices, implicit or directly collected. Comparability of nominal values of GDP across countries is good. There is generally some variability in how countries calculate their volume estimates of GDP, particularly regarding government consumption, but this does not necessarily mean that growth rates are less comparable.

Sufficient data were available to estimate the share of the LMB provinces' annual GDP growth. Map 57 shows the annual GDP growth by LMB province. In Cambodia, it is defined as the annual average rate of change of the GDP at market prices based on constant local currency for a given national economy during a specified period of time. Annual GDP growth by nation covered the period from 1993 to 2020. In Lao PDR, the annual GDP growth refers to the changing rates of GDP at constant prices from one period compared to the previous period. In Thailand, GDP at current market prices is calculated as follows: $\text{GDP of previous year} - \text{GDP current year} / (\text{GDP of previous year}) * 100$.

In 2020, in the LMB, the average annual GDP growth rate was around 1.77%. The highest average annual GDP growth rate was in Lao PDR (3.30%), followed by Viet Nam (3.16%) in 2020, and Cambodia (1.95%) in 2019, and the lowest annual GDP growth rate was in Thailand (-1.34) in 2020.

In 2019, in the LMB provinces of Cambodia, the average annual GDP growth rate was 1.95%, with some disparities between provinces, some with positive growth rates and others with negative growth rates. For example, the annual growth rates in GDP in Battambang, Kampong Thom and Takeo provinces were between 4.2% and 5.1%, while the rates in Kampong Cham, Kampong Speu and Siem Reap provinces were between -1.8% and -4.3%.

In 2020, in the LMB provinces of Lao PDR, the average annual GDP growth rate was 3.3%, with some disparities between them, some with positive and others with negative growth rates. The annual average GDP growth rates in most of the provinces were positive, between 2.9% and 7%, except for Xiengkhuang province, which had the lowest annual GDP growth rate, at -5.3%.

In 2020, in the LMB provinces of Thailand, the average annual GDP growth rate was -1.3%, with some disparities between them. The annual GDP growth rates in some provinces were between 0.4% and 8.5%, while other provinces had negative growth rates of between -1.1% and -9.7%. The highest GDP growth rate was 8.5% in Chantaburi province, while the lowest was -9.7% in Chiang Mai.

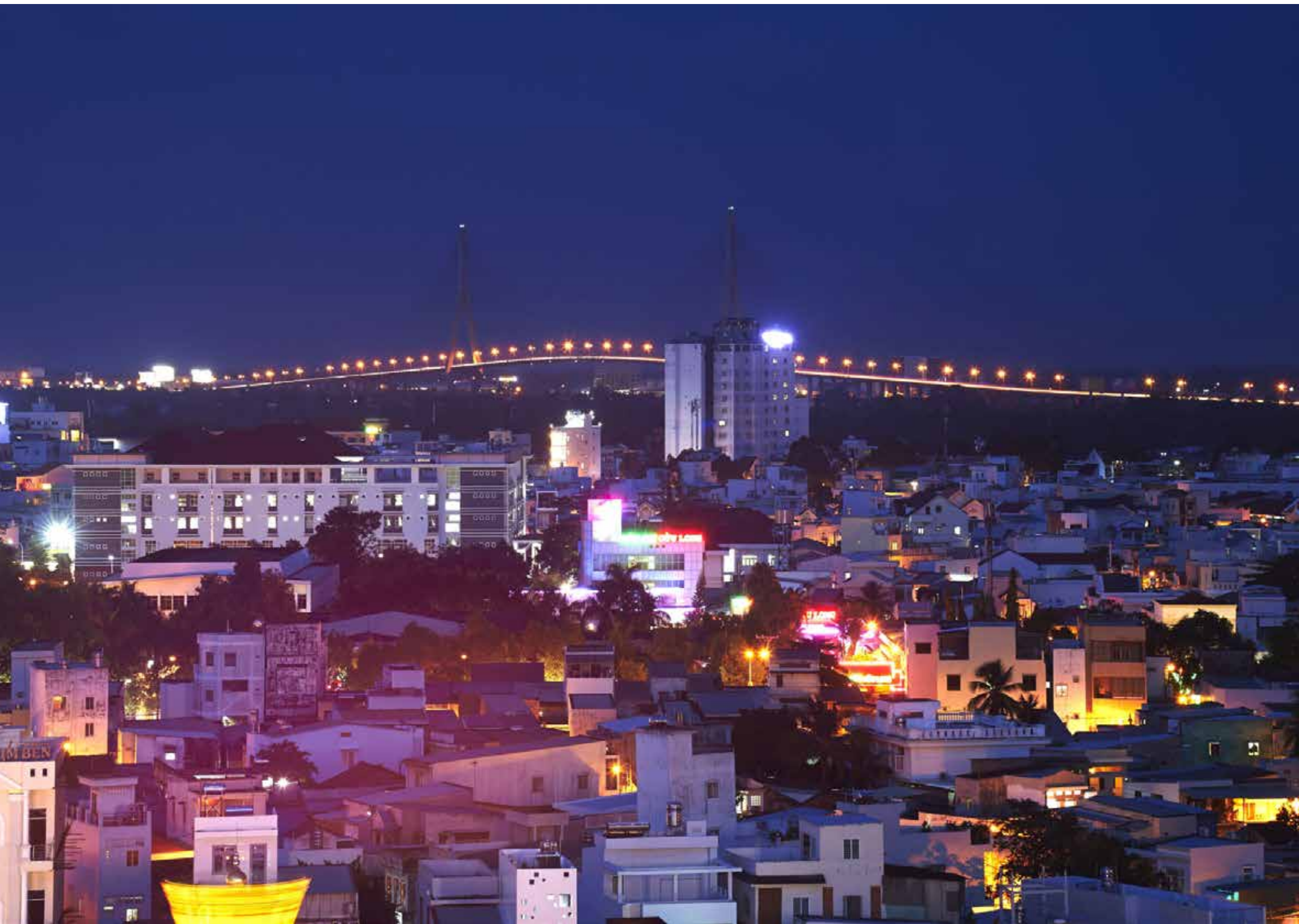
In 2020, in the LMB provinces of Viet Nam, the average annual GDP growth rate was 3.16% in 2020, with some disparities between them. Most of the LMB provinces had positive annual GDP growth rates of between 0.2% and 7.09%, except for Can Tho city, which had an annual growth rate of -2.73; Kon Tum province had the highest annual GDP growth rate, at 7.09%.

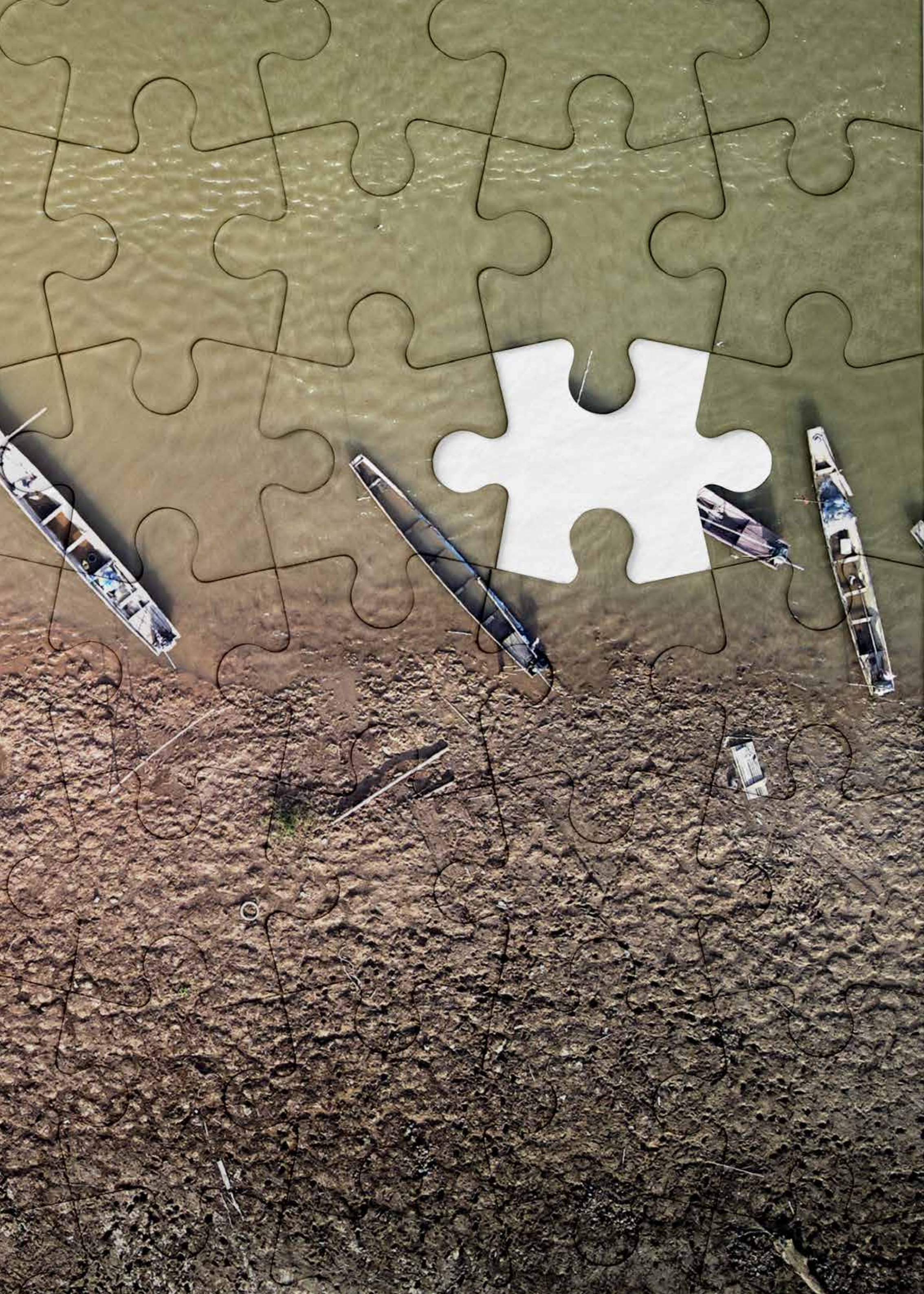
Table 48. Average Annual Growth in GDP in LMB in 2019/2020

Country	Annual growth
Cambodia (2019)	1.95
Lao PDR	3.30
Thailand	-1.34
Viet Nam	3.16
Total LMB	1.77

Data source

Country	Source	Year	Data level	Agency
Cambodia	National Accounts, 2010–2019	2019	Province	National Institute of Statistics, Ministry of Planning
Lao PDR	Statistics Sector, Provincial Department of Planning and Investment	2020	Province	Lao Statistics Bureau, Ministry of Planning and Investment
Thailand	Office of the National Economic and Social Development Council's website	2020	Province	Office of the National Economic and Social Development Council, Office of the Prime Minister
Viet Nam	- Calculated from internal documents of the General Statistics Office - Provincial Statistics Yearbooks	2020	Province	General Statistics Office of Viet Nam, Ministry of Planning and Investment







CLIMATE CHANGE DIMENSION

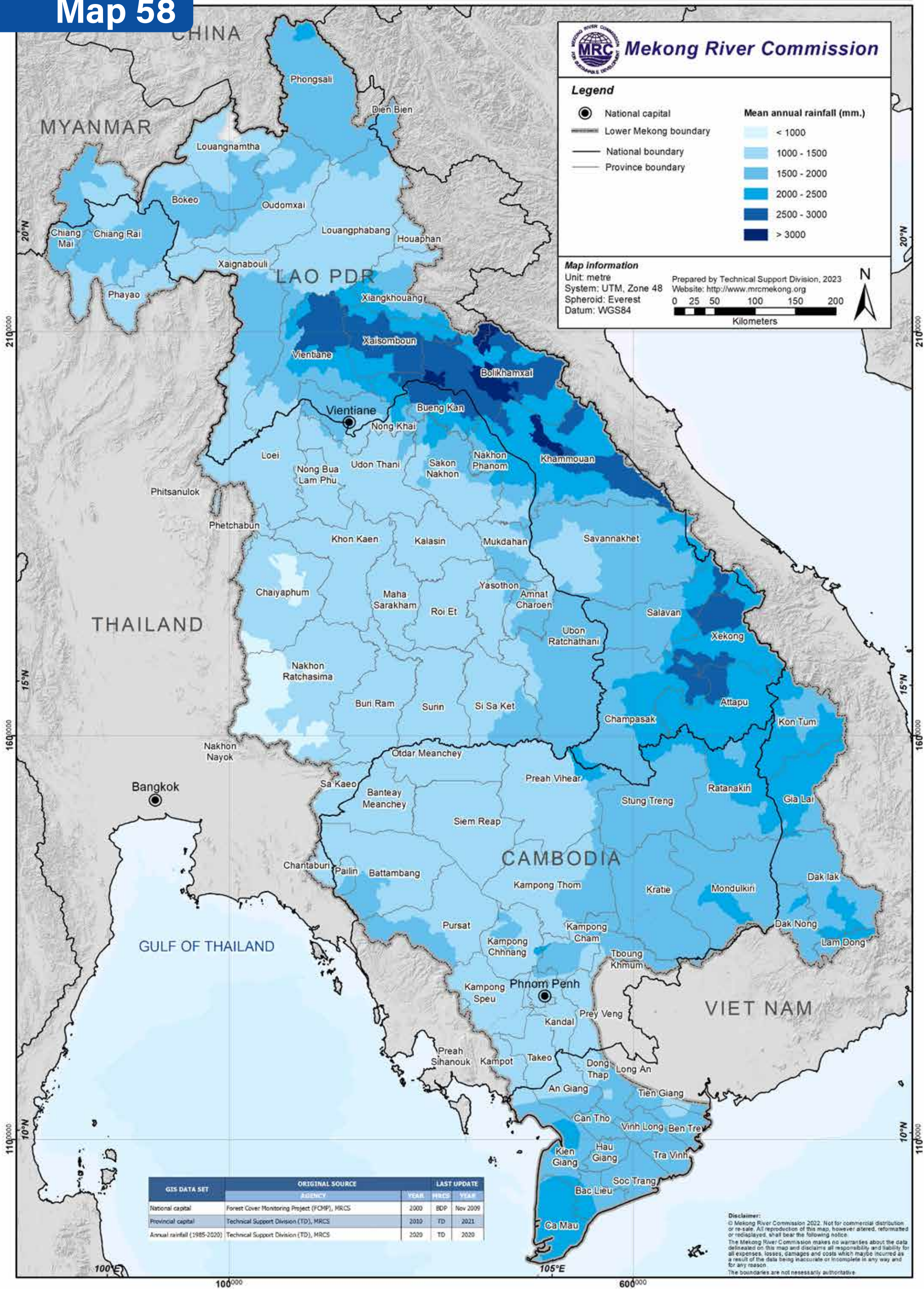
Mean annual rainfall

Mean annual runoff

Flood hazards

Drought risk

Drought severity



Mean annual rainfall

The distribution of mean annual rainfall over the LMB is highly variable, ranging from more than 3,000 mm in north-central Lao PDR to less than 1,000 mm in much drier areas of northeast Thailand. Map 58 was produced from extracted outputs of the MRC-DSF for 680 sub-basins using 228 observed rainfall stations for the 1985–2020 period across the LMB. For the rainfall data not covered by the MRC-DSF model at Mekong Delta, available in situ rainfall data were used applying the inverse distance weighted (IDW) interpolation method, which is considered the most accurate and reliable method for precipitation interpolation (Knight, Yu and Morris, 2005).

The distribution of rainfall is primarily driven by topography and the general direction of the southwest monsoon and isolated tropical cyclones from the northeast across the East Sea. Areas of very high rainfall in excess of 2,500 mm (found in north-central Lao PDR and the headwaters of the Se Kong and Se San Rivers in southern Lao PDR, Cambodia and Viet Nam) generally correspond to the areas of the highest elevation along the Annamite Range. As the southwest monsoon and tropical storms approach the eastern part of the Basin from the northeast, rainfall is generated due to the forced upward movement of air over the mountains.

The mean annual rainfall decreased to the west away from the mountains, and that there was a clear east-west rainfall gradient evident in the Chi-Min Basin in Thailand and the Tonle Sap Basin in eastern Cambodia. Also, from 1985 to 2020, average rainfall was generally low (<1,750 mm) around Phnom Penh and the upper Delta in Viet Nam but increases to 2,250–2,500 mm in the lower delta and up to 2,750 mm on the Ca Mau peninsula, where the influence of typhoons is greater.

In the more temperate northern regions of Lao PDR and Thailand, rainfall is generally lower than the central highlands, but is also highly variable, ranging from 1,000 mm just south of Louangphabang to 2,250–2,750 mm in Phongsali Province (headwaters of the Nam Ou River).

Figure 22 shows the distribution of seasonal rainfall from Chiang Saen in Thailand to Kratie in Cambodia, indicating that rainfall occurs predominantly from May to October, peaking in August. However, at Tan Chau in Viet Nam, the rainfall peaks in September and October before declining in November.

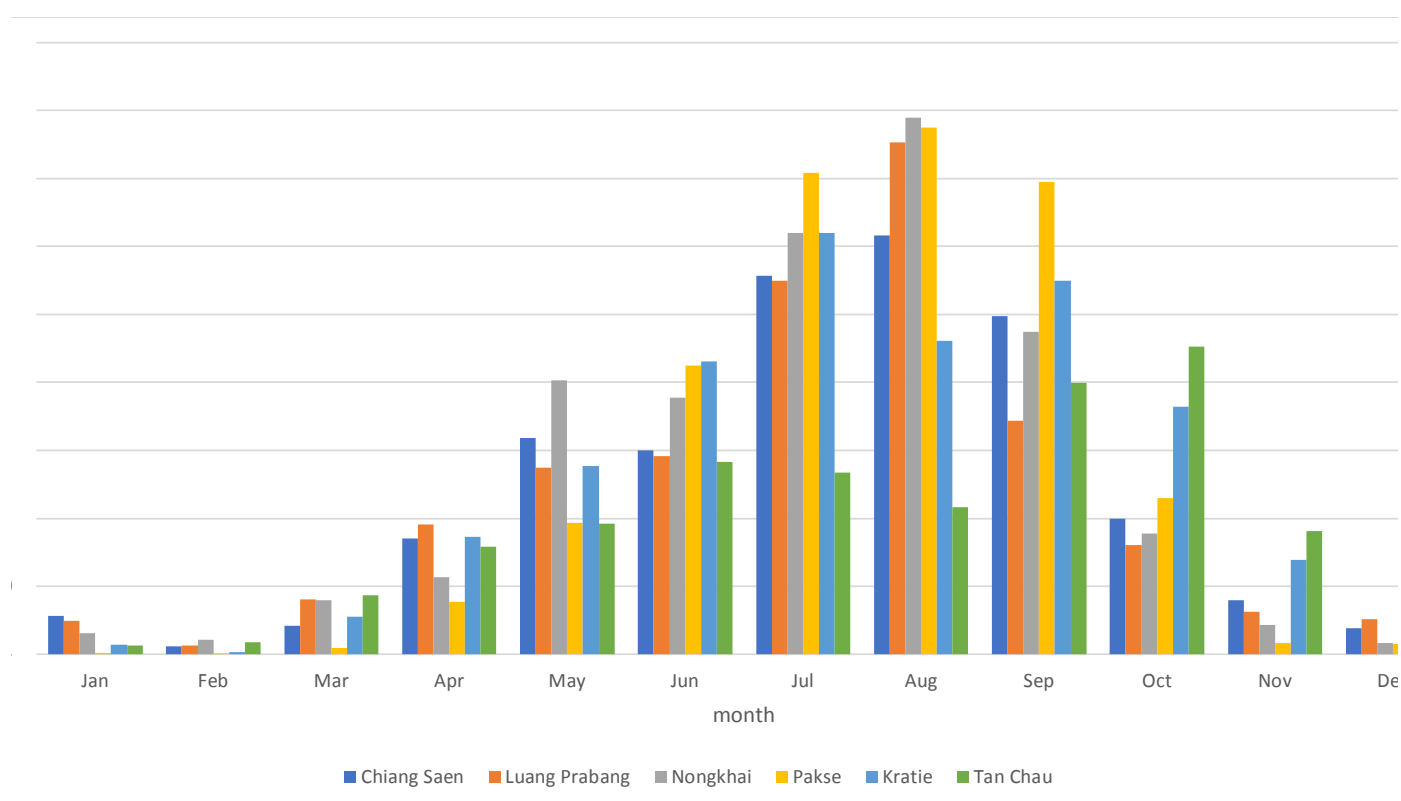
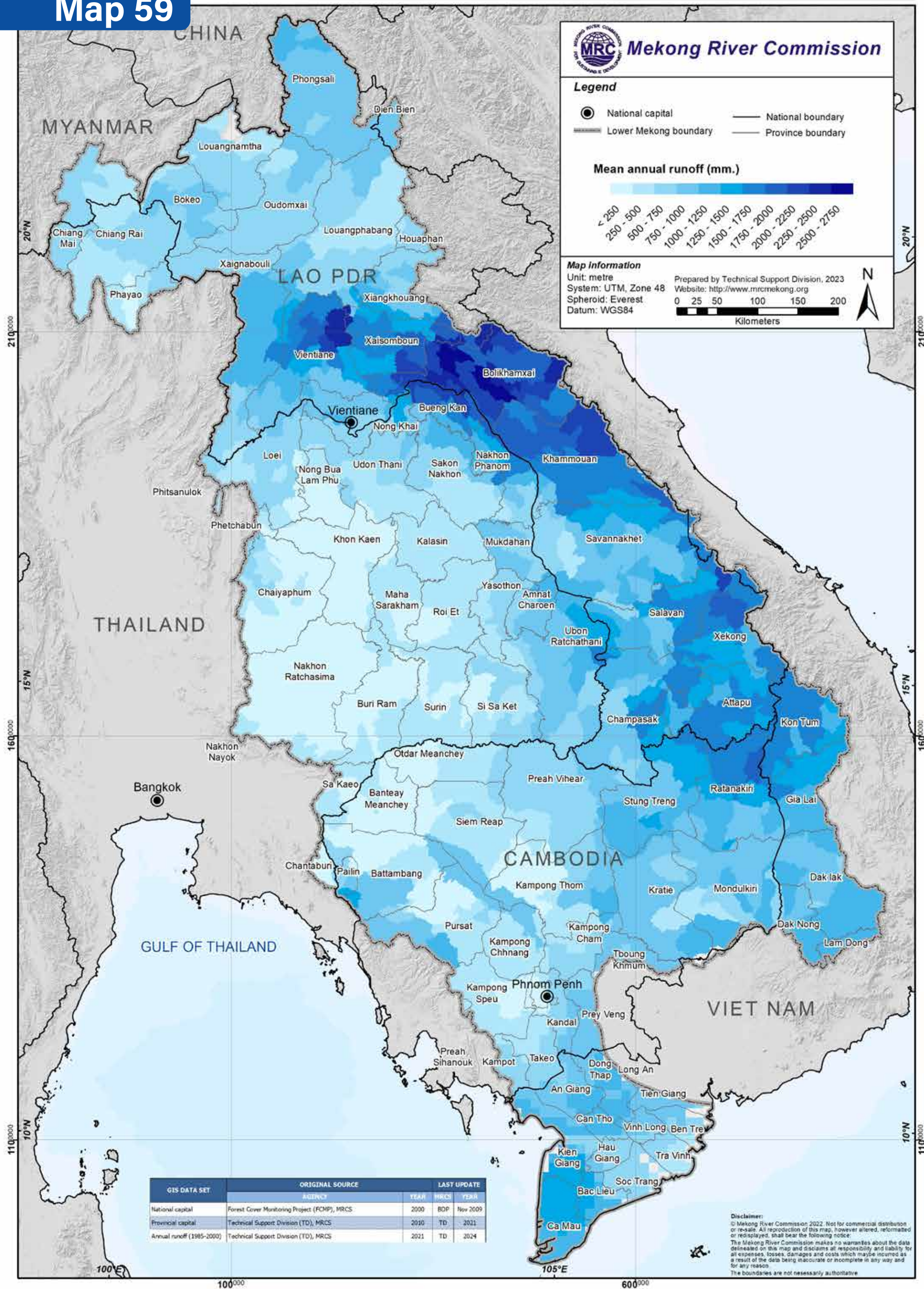


Figure 22. Average monthly rainfall at selected stations from Chiang Saen to Mekong Delta at Tan Chau station, 2010–2020.

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Mean annual runoff

Runoff refers to water flow in streams and rivers expressed on a per unit area basis. It represents the proportion of rainfall that leaves the catchment as stream flow, with the remaining portions being stored in soils and groundwater aquifers or exported from the catchment through evapotranspiration. Mean annual runoff is reported as a depth and is calculated by dividing the mean annual stream flow (discharge) of a particular river by its catchment area. This annual runoff (mm) is extracted from MRC-DSF platform using 228 rainfall stations and 39 climatic stations across Lower Mekong Basin (LMB) in associated with other data for a period 1985-2020.

The distribution of mean annual runoff in the Lower Mekong Basin closely reflects the spatial patterns in rainfall described for the map of mean annual rainfall. However, it is also affected by topography, soil texture and vegetation type and density. In the case of topography, flatter catchments such as the Chi-Mun basin in northeast Thailand, will tend to have higher evaporation rates in part, due to the longer time taken for rainfall to reach streams, meaning that only between 25% and 50% of rainfall leaves the catchment as streamflow. Much higher proportions of rainfall (up to 75%) are translated into streamflow in steeper catchments, including the left bank tributaries of the Mekong in southern and central Lao PDR.

Among the left bank tributaries, the Nam Ngum and Nam Kading-Namthuen catchments stand out for their steep terrain and high moisture levels. These catchments produce significant runoff, up to 2500 mm annually, contributing about 6% each to the total flow of the Mekong River. The Mun-Chi and Tonle Sab basins, despite their larger catchment areas, each contribute a proportion similar to 5% and 6% respectively. This reflects the combined impact of low rainfall and higher evapotranspiration rates, resulting in generally lower runoff per unit catchment area.

The six major left bank tributaries entering the Mekong River between Vientiane and Nakhon Phanom together contribute 19% of the total mean annual flow (MRC 2005). The other major contributor is the 3S basin (Se Kong - Se San – Sre Pok) which contributes 17% to the total annual flow of the mainstream. The large area of this catchment means that runoff is slightly lower than the Nam Ngum and Nam Kading-Nam Thuen catchments. Overall, the left bank tributaries of the Mekong River contribute 60% to the total flow of the Mekong compared to 24% for the right bank tributaries. This can be attributed to the general trend for higher rainfall and steeper topography in the east of the Basin.

The results from the Joint Study (LMC Water Center and MRC 2023) in corresponding with the MRC river monitoring data indicate the significant change of the streamflow at all mainstream stations that decrease in wet season and increase in dry season between two periods (2000–2009) and (2010–2020). As illustrated in Figure 25, the flow volume was evidently reduced for all stations along the Mekong mainstream.

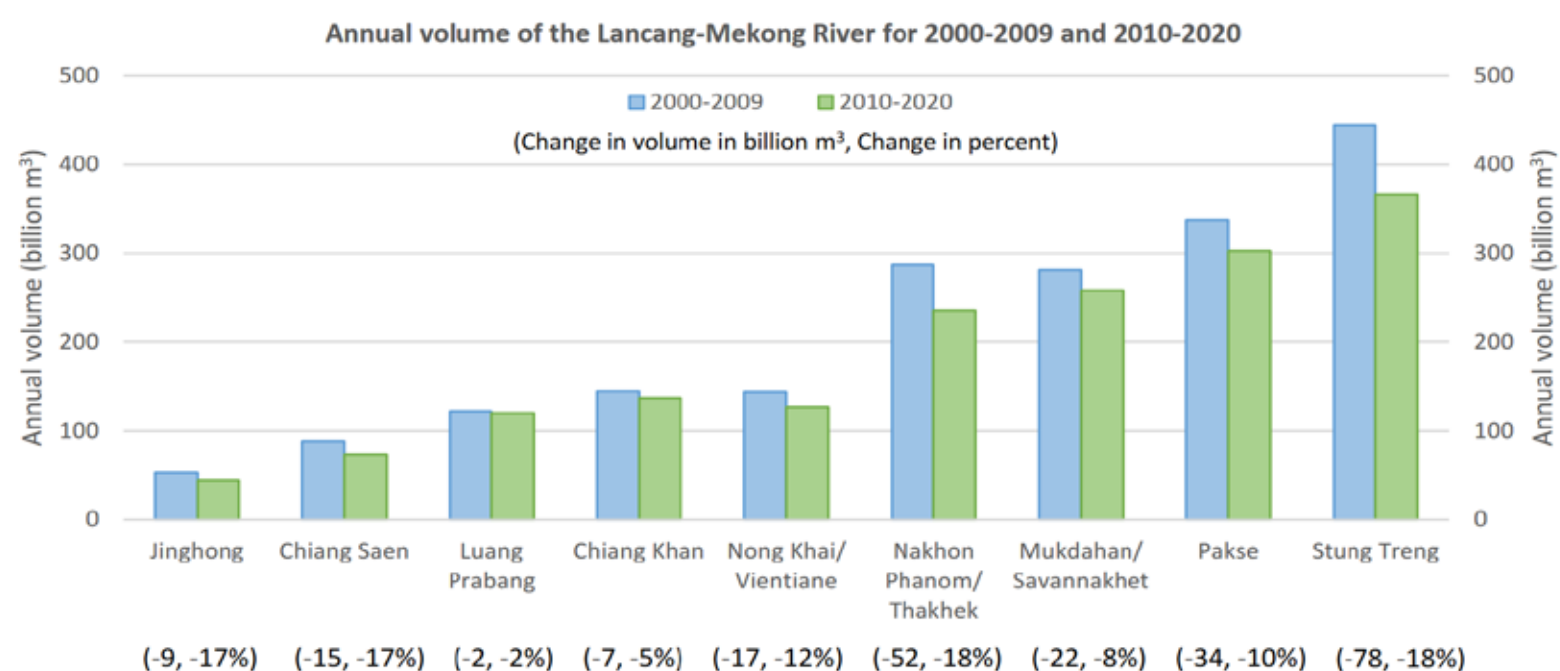


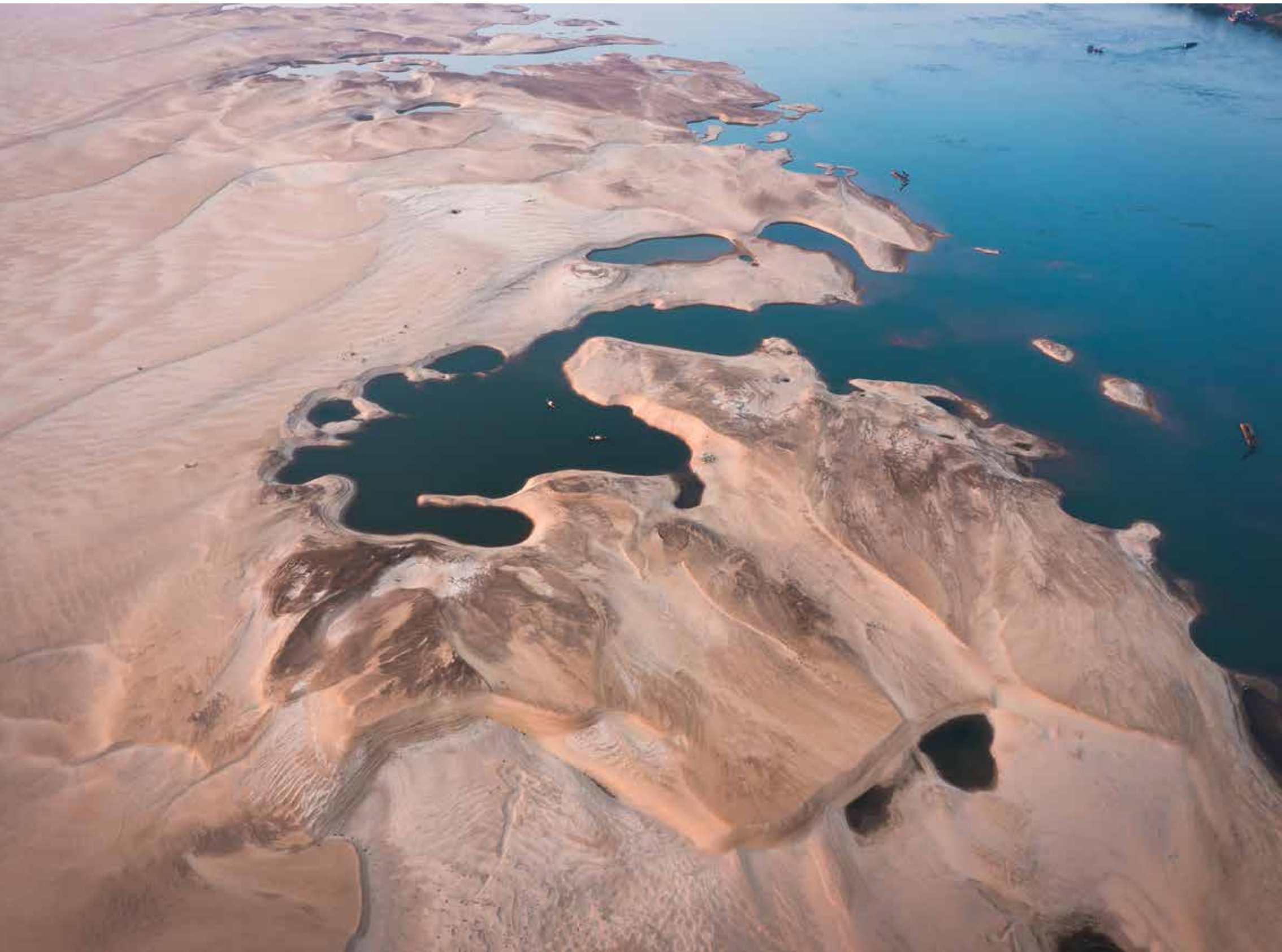
Figure 23. Changes in annual volume along the key stations of the Lancang-Mekong River, 2000–2009 and 2010–2020

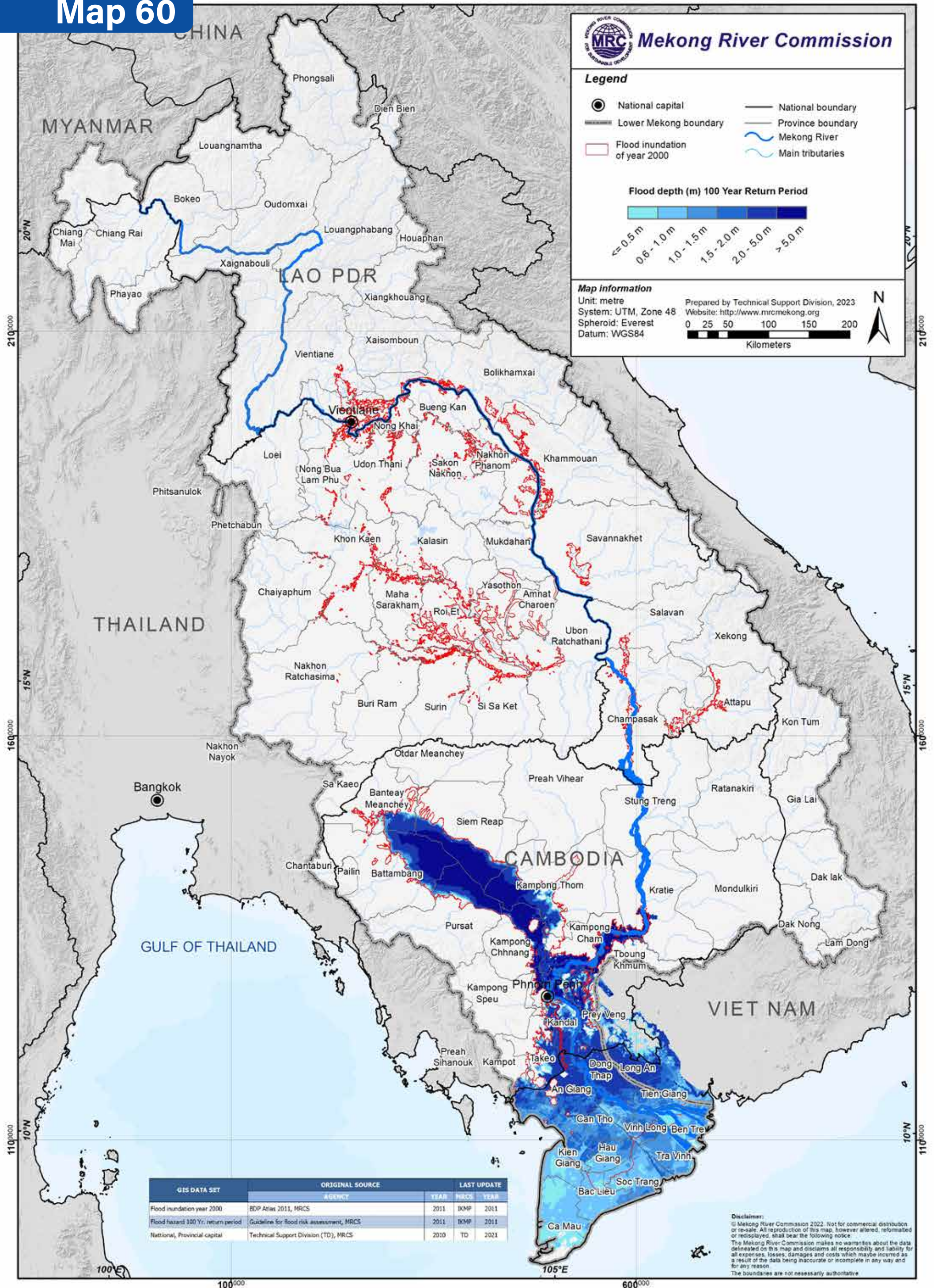
Source: Lancang-Mekong Water Resources Cooperation Centre and the Mekong River Commission, 2023

Reference document

MRC (2005), Overview of the Hydrology of the Mekong River Basin, 73 pp., Mekong River Commission, Vientiane.

Lancang-Mekong Water Resources Cooperation Center and Mekong River Commission. (2023). Technical Report – Phase 1 of the Joint Study on the Changing Patterns of Hydrological Conditions of the Lancang-Mekong River Basin and Adaptation Strategies. Beijing: LMC Water Center or Vientiane: MRC Secretariat.





Flood hazards

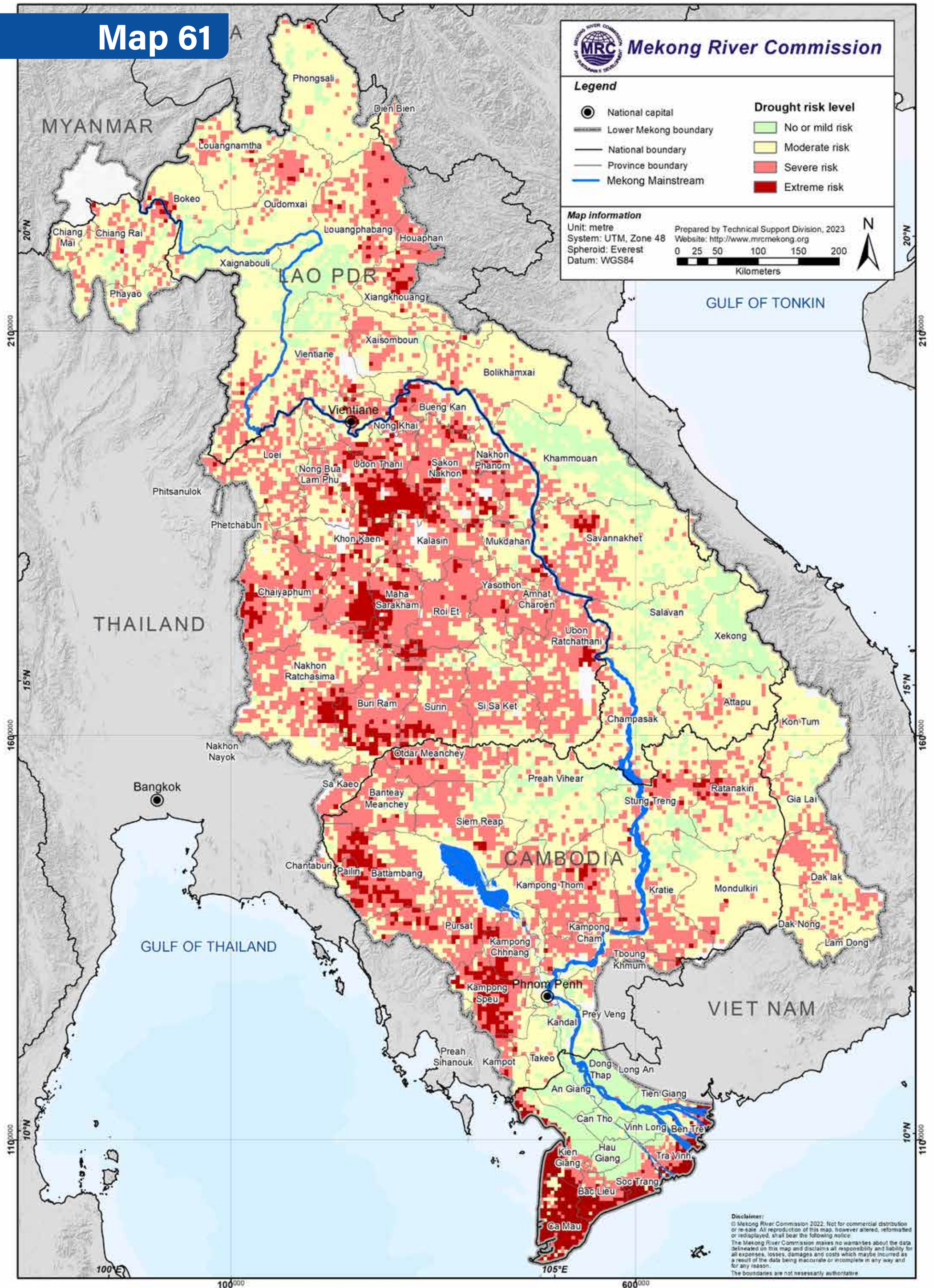
The Mekong Delta, nestled at the confluence of the Mekong and Bassac Rivers, stands as a testament to the intricate relationship between water and land in this expansive region. Its unique geography, characterized by a vast network of channels, tributaries and floodplains, plays a pivotal role in shaping the hydrological dynamics of the area. The periodic floods in the Delta are caused by a complex interplay of various factors, both natural and anthropogenic, making them a distinctive phenomenon within the broader context of the LMB.

Unlike the floods observed upstream near Kratie, where the Mekong River dominates, the hydrological regime in the Mekong Delta is influenced by a multitude of factors. Upstream and lateral inflows, driven by seasonal variations in precipitation and snowmelt from the Tibetan Plateau, contribute to the influx of water into the Delta. Local rainfall, often intensified by monsoonal patterns, further amplifies the volume of water flowing through the intricate network of waterways. Additionally, the unique hydraulic infrastructure of the Delta, which includes canals, embankments and reservoirs, plays a crucial role in modulating flood levels and managing water distribution. The temporal variability of water levels in the Mekong Delta is further compounded by the seasonal dynamics of Tonle Sap Lake, Southeast Asia’s largest freshwater lake, which acts as a natural flood buffer. During the wet season, the lake’s capacity expands, temporarily storing excess water from the Mekong River and attenuating flood peaks downstream. Conversely, during the dry season, water is released from the lake, replenishing downstream flow, and supporting agricultural activities in the Delta.

To fully assess flood hazards in the Mekong Delta, a multidisciplinary approach is used, integrating hydrological modelling, historical data analysis and field surveys. The ISIS software system (MRC-DSF), tailored to riverine and estuarine environments, is a powerful tool for simulating flood scenarios and estimating associated risks. By incorporating data on river discharge, sea-level rise and land-use changes, the system provides valuable insights into the frequency, duration and extent of potential flood events. Moreover, this flood hazard assessment was possible because key data were available from a relatively long historical discharge series for Stung Treng, just upstream of Kratie station. Furthermore, for the tributary inflow further downstream and to the Tonle Sap Lake, representative long historical discharge series were created, preserving the serial and cross-correlation with the Mekong flow. The series, which covers the 1910–2006 period, is used as boundary conditions for a hydrodynamic model to derive a 97-year series of water levels in the flood-prone areas. The hydraulic model is based on conditions in the Mekong Delta in 2000. Further input into the model consists of local rainfall, evaporation, water use, and tidal conditions of 2000 at the Gulf of Thailand and the East Sea. The relevant statistics including the probabilities of flooding for a 100-year return period can be derived directly from the series of water levels and depths computed with the model.

Reference

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Drought risk

Drought risk is the likelihood of incurring damages and economic losses during and after drought events, which depends on the interaction between three dimensions: (i) the severity and probability of occurrence of a certain drought; and (ii) the exposed assets and/or people and (iii) the intrinsic vulnerability or capacity of the exposed people to cope with the hazard (Jurgen et al., 2018). Drought risk in the LMB is caused by multidimensional factors, such as drought hazard, exposure and vulnerability. All of the three main indicators – meteorological, hydrological and agricultural indicators – are used to compute drought hazard over a 43-year period of historical records. Human population, land cover and baseline water stress data for 2020 are used to quantify exposure levels within the LMB area, while groundwater potential and areas with irrigation are used to evaluate drought vulnerabilities in the region.

$$Drought\ Risk = f(Hazard, Exposure, Vulnerability)$$
$$Risk = hazard * \frac{(pop + landcover + waterstress)}{3} * \frac{(groundwpot + irrigateda)}{2}$$

The drought risk assessment presented above is solely based on available data from the MRC. However, parameters might be adjusted based on the actual conditions of drought risk at the country level when performing drought risk assessment for the national and sub-national levels. Normally, there are more data available with higher accuracy at the country level.

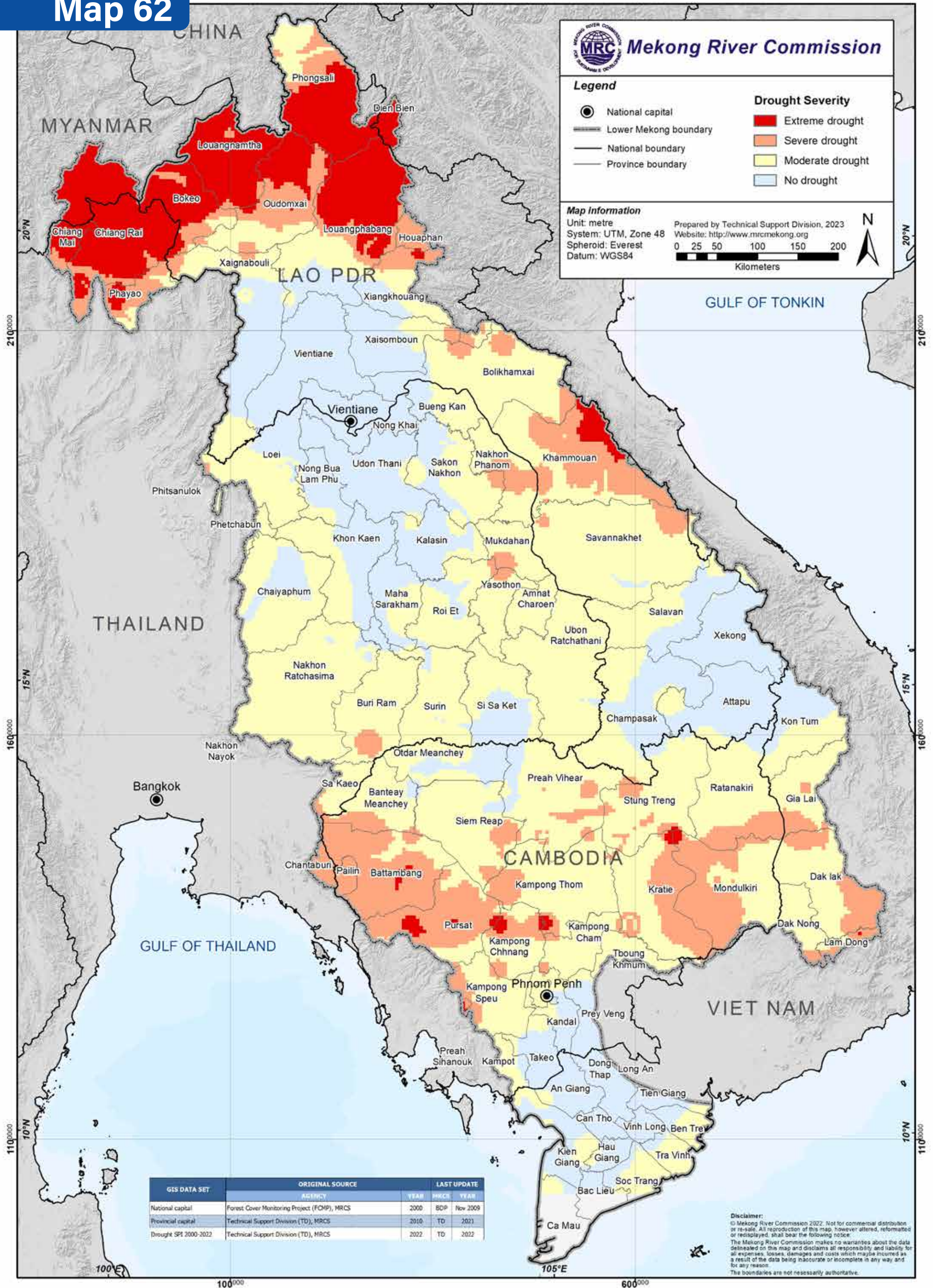
It is clear from Map 61, as expected, most of the high-risk drought areas are in the north-eastern region of Thailand, most of Cambodia, and the Mekong Delta of Viet Nam. It illustrates the severity of risk from salinity intrusion in the Mekong Delta of Viet Nam, which results from severe low flows of the Mekong River during the reverse flow period. In the Lower Mekong Delta of Viet Nam, salinity intrusion is the major risk factor, which usually takes place during the severe hydrological droughts when the water level of the Mekong River mainstream is significantly lower than the sea water level.

Note: In Viet Nam’s Mekong Delta, since the area is at high risk of salinity intrusion from the sea level, average salinity intrusion during 2013–2020 was used as an indicator of drought hazard. The data on salinity intrusion were obtained from the Viet Nam Institute of Water Resources Sciences.

Four categories of drought risk are used to measure the risk levels: (i) no or mild; (ii) mild-moderate; (iii) moderate-severe; and (iv) severe-extreme. Using the above selected parameters, Thailand is the LMB country that is most at risk from drought, followed by Cambodia; Viet Nam is at high risk from drought due to salinity intrusion in the Mekong Delta area; and Lao PDR is the country that is least at risk from drought in the region.

Table 49. Number of provinces at risk

Country	Drought risk level			
	Severe-extreme	Moderate-severe	Mild-moderate	No or mild
Cambodia	4	9	6	1
Lao PDR	3	7	4	1
Thailand	6	17	2	0
Viet Nam	4	9	4	0



Drought severity

There are three indicators of drought severity: the meteorological indicator, or the standardized precipitation index (SPI), which is the most important indicator, and the hydrological and agricultural indicators. SPI was first developed by T.B. McKee, N.J. Doesken, and J. Kleist in 1993 (McKee et al., 1993) and is calculated by:

$$g_x = \frac{1}{\beta^\alpha \Gamma(\alpha)} x^{\alpha-1} e^{-x/\beta} \quad (1)$$

$$\alpha = \frac{1}{4A} \left(1 + \sqrt{1 + \frac{4A}{3}} \right) \quad (2)$$

$$\beta = \frac{\bar{x}}{\alpha} \quad (3)$$

$$A = \ln(\bar{x}) - \frac{\sum \ln(x)}{n} \quad (4)$$

$$G_x = \int_0^x g_x dx = \frac{1}{\beta^\alpha \Gamma(\alpha)} \int_0^x x^{\alpha-1} e^{-x/\beta} dx \quad (5)$$

Where α is the parameter of the gamma probability density function, β is the parameter of the gamma probability density function, n is number of precipitation observations, and x is mean precipitation.

SPI is a statistical index, which is calculated by comparing the total precipitation at a particular location during a period of weeks or months with the long-term rainfall distribution for the same period of time. Ideally, SPI is used for 1-, 3-, 6, 9-, 12-, 24- or 48-month periods, but it can also be used for weekly time periods. The SPI method consists of transforming the accumulated precipitation into a standard normal variable, with a mean of zero and variance of 1. SPI values are given in units of standard deviation from the long-term mean of the standardized distribution.

Climate Hazards group InfraRed Precipitation with Stations (CHIRPS) rainfall data from 2000 to 2022 were used to quantify the drought occurrences during this period. The more severe the drought, the more severe the evaluation of the area was, i.e. an area evaluated as the most severe drought area is the area in which drought took place more often than in other areas, or vice versa. SPI is calculated by comparing the value of rainfall at one particular location with its historical records of the same location. The longer historical data are used, the better results of the SPI are produced. The minimum recommended record of rainfall data for SPI is 30 years to reflect the climate change cycle. In this exercise, rainfall data from 1981 to 2022 (42 years) were used to calculate SPI from 2000 to 2022.

The results reveal that northern LMB covering mainly northern Thailand and Lao PDR had the most severe meteorological drought during the past 23 years; southern LMB was the second most drought-hit area, while the central part of the region was the least drought severe area in the past two decades.

Further reading

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Mekong River Commission Secretariat

P. O. Box 6101, 184 Fa Ngoum Road, Unit 18 Ban Sithane Neua,
Sikhottabong District, Vientiane 01000, Lao PDR
Tel: +856 21 263 263. Fax: +856 21 263 264
www.mrcmekong.org

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